2019-2020 ANNUAL REPORT

PRAIRIE PROVINCES WATER BOARD

photo credit: Curtis Matwishyn

PRAIRIE PROVINCES WATER BOARD

FOR THE FISCAL YEAR

April 1, 2019 to March 31, 2020

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LETTER OF TRANSMITTAL

January 31, 2022

Honourable Ministers:

On behalf of the members of the Prairie Provinces Water Board (PPWB), it is my pleasure to submit the Annual Report of the Prairie Provinces Water Board for the fiscal year covering the period April 1, 2019 to March 31, 2020.

Sincerely,

Nadine Stiller
Chair, Prairie Provinces Water Board

Honourable Steven Guilbeault
Minister of Environment
and Climate Change
Government of Canada

Honourable Marie-Claude Bibeau
Minister of Agriculture and Agri-Food
Government of Canada

Honourable Warren Kaeding
Minister of Environment
Government of Saskatchewan

Honourable Fred Bradshaw
Minister Responsible for the
Saskatchewan Water Security Agency
Government of Saskatchewan

Honourable Jason Nixon
Minister of Environment and Parks
Government of Alberta

Honourable Jeff Wharton
Minister of Environment,
Climate and Parks
Government of Manitoba

MESSAGE FROM THE CHAIR

This year was a significant milestone as we marked the 50th Anniversary of the Master Agreement on Apportionment (MAA). For five decades, the MAA has served as an effective governance model for the Prairie region and successfully enabled the three Prairie Provinces and the Federal government to collaboratively set goals for the management of transboundary waters, and to equitably share water resources. The PPWB, which administers the MAA, provides a cooperative forum for discussion and action on transboundary water issues.

In 2019-20, the PPWB achieved its core commitments under the Master Agreement on Apportionment (MAA) related to water apportionment and water quality. Further to its core mandate, the PPWB continued to monitor, assess and report important water management issues. Key highlights this year included:

- All apportionment requirements were met;
- Continued to improve apportionment methods through ongoing Basin Reviews for the Qu'Appelle and South Saskatchewan Rivers;
- Completed the latest recurring 'five-year' review of interprovincial water quality objectives, including an updated Addendum to Schedule E;
- Continued discussions on a new Schedule on transboundary aquifers proposed for addition to the Master Agreement on Apportionment; and
- Held a joint workshop on hydrology and flow forecasting on the topic of resiliency of the MAA.

There were several changes in Board and Secretariat positions. Board Member Brian Yee with Alberta Environment and Parks retired and we thank him for his dedicated service with the PPWB since joining as a Board Member in July 2014. In 2019-20, two members of the PPWB Secretariat, Mike Renouf and Lynne Quinnett-Abbott, also retired. Mike Renouf served as Executive Director to the PPWB from April 2008 to March 2020 and was a trusted voice and a knowledgeable leader in transboundary water issues. Lynne Quinnett-Abbott was the Secretary to the Board from March 2013 to September 2019 and provided excellent support to the Board during her tenure. In 2019-20, Megan Garner left the PPWB Secretariat. Megan provided engineering support and expertise to the PPWB since February 2012. In the back half of the year, we welcomed the incoming Executive Director, Patrick Cherneski.

The Prairie Provinces Water Board (PPWB) continues to be a vital institution of governance that facilitates the sound and collaborative management of shared water resources in the Canadian Prairie region. The success of the PPWB depends on the work of the Secretariat and the four standing committees: the Committee on Hydrology (COH), the Committee on Water Quality (COWQ), the Committee on Groundwater (COG) and the Committee on Flow Forecasting (COFF). The dedication and engagement by Board members, jurisdictional representatives on committees, and the Secretariat are essential, and are much appreciated. The MAA was a forward-looking document when it was created in 1969. We are confident the Board and the Agreement will continue to serve the Prairie region well in the decades ahead.

Nadine Stiller
Chair

MESSAGE FROM THE EXECUTIVE DIRECTOR

I was pleased to join the PPWB in the milestone 50th anniversary year. The PPWB has a lengthy and proud history in the Prairie region and the work of the PPWB builds on the knowledge and expertise of those who came before. I am grateful to outgoing Executive Director Mike Renouf for sharing his knowledge and expertise as I transitioned into this new role.

During fiscal year 2019-20, the work of the PPWB Secretariat and the four standing Committees focused on achieving the goals outlined in the PPWB Strategic Plan and activities in the five-year Work Plan. Overall in 2019, the agreed transboundary apportionment of flows on all eastward flowing streams was achieved for all river reaches. Adherence to the *MAA*'s water quality objectives was good. As a reminder, the period of reporting for the PPWB annual report is the fiscal year (April 2019 to March 2020), and the transboundary apportionment and water quality excursion report is the calendar year (January 2019 to December 2019).

The Committee on Hydrology (COH) continued to review and improve apportionment methods through the Qu'Appelle River Basin Review and the South Saskatchewan River Basin Review. The Committee also continued its work to investigate evaporation estimation methods.

The transboundary water quality objectives (WQO) are descriptions of water quality conditions that are known to protect specific water uses and are acceptable to upstream and downstream provinces. The Committee on Water Quality (COWQ) completed the comprehensive scientific review of the PPWB WQOs, and provided recommendations to the PPWB in November 2019. The Committee also completed a nutrient study to better understand causes of excursions and trends, notably in the Red Deer River. A report on fish tissue and biological monitoring for PPWB rivers was also completed.

The Committee on Groundwater (COG) recommended a document on the roles and responsibilities for a proposed Schedule F on aquifers. They also continued development of a methodology to classify transboundary aquifers on the basis of risk per the previously-developed Risk Informed Management (RIM) document.

The Committee on Flow Forecasting (COFF) continued to work on information sharing, and to discuss development of a harmonized spring runoff model. This work is ongoing. The COH and COFF jointly held a workshop in Calgary in November. More than 85 persons participated in the workshop and represented a cross-section of government and other stakeholders. The theme of the event was resiliency and this served to highlight the strengths of the Master Agreement on Apportionment and the PPWB, and consider some of the drivers and future challenges facing the Board. Climate change was a significant topic as it is already a known driver, and will be even more so for the future.

In 2019-20, there were a number of membership changes to the Committees. Garth van der Kamp (ECCC) retired from the Committee on Groundwater after sixteen years of excellent service. Bernard Trevor and Patrick Cherneski left the Committee on Flow Forecasting during the year, Bernard due to retirement, and Patrick to take on the role as Executive Director. Thank you to all outgoing Committee Members for your contributions to the PPWB.

In early 2020, a global pandemic impacted Canada and in mid-March the federal government enacted policies that required many people, including the PPWB Secretariat staff, to work remotely from home. The fiscal year ended with uncertainty about the nature, degree and duration of the pandemic and the impacts to our work. Year 2019 was a memorable year due to a milestone anniversary. Year 2020 may be memorable due to a pandemic.

Patrick Cherneski
Incoming Executive Director

SUMMARY OF PERFORMANCE RESULTS

Apportionment and water quality monitoring in 2019-2020 indicated that interprovincial apportionment and water quality obligations were met in accordance with schedules to the *Master Agreement on Apportionment* (MAA):

- All rivers met apportionment obligations at the Alberta-Saskatchewan boundary (Schedule A) and the Saskatchewan-Manitoba boundary (Schedule B).
- The overall adherence rate for transboundary water quality objectives was 97.6%, for all parameters (Schedule E).
- There were no acute water quality concerns apparent from review of the adherence rate values for 2019.

During 2019-2020, responsibilities of PPWB were met through the following activities:

- Reviewing and approving the hydrometric, meteorological and water quality monitoring networks.
- Monitoring apportionment requirements and water quality adherence for the six transboundary sites along or near the Alberta-Saskatchewan boundary and the six sites along the Saskatchewan-Manitoba boundary.
- Providing oversight and direction to the activities of PPWB including approving the 2020-2021 budget and work plan of the Board and four standing Committees.
- Reporting on adherence to the MAA obligations and communicating the results with Ministers, government agencies and external collaborators.
- Convening a COFF-COH Workshop on hydrology, flow forecasting, and the resiliency of the MAA.

The Committee on Hydrology (COH) activities included:

- Continuing to review and recommend the apportionment monitoring network of hydrometric and meteorological stations;
- Recommending apportionment computations on 12 transboundary rivers; and
- Continuing to improve apportionment methods through the Qu'Appelle River Basin Review, the South Saskatchewan River Basin Review, and investigating evaporation estimation methods.

The Committee on Water Quality (COWQ) activities included:

- Recommending the water quality monitoring network;
- Reviewing water quality data to identify concerns and make recommendations as needed;
- Completing the latest recurring 'five-year' review of interprovincial water quality objectives, including an updated Addendum to Schedule E;
- Completing a report and nutrient study to better understand causes of excursions and trends;
- Completing the Red Deer River report to address water quality concerns and identify data gaps;
- Completing a report on fish tissue monitoring and biological monitoring for PPWB rivers; and,
- Touring the National Laboratory for Environmental Testing in Saskatoon in February 2020.

The Committee on Groundwater (COG) activities included:

- Recommending a document describing anticipated roles and responsibilities for a proposed Schedule F; and
- Continuing the development of a methodology to classify transboundary aquifers according to the Risk Informed Management document within the proposed Schedule F.

The Committee on Flow Forecasting (COFF) discussions included:

- Ideas for the development of a harmonized spring runoff model and improving flow forecasting through a soil moisture module, model testing, collaborative modelling, and other potential tools;
- Drought management through drought monitor maps and provincial drought planning; and
- Potential collaboration between COFF work and FloodNet and/or the Global Water Futures research program.

INTRODUCTION

This report summarizes the activities of the PPWB, its Secretariat, and four standing Committees that supported PPWB activities for the period April 1, 2019 to March 31, 2020.

The PPWB administers the *Master Agreement on Apportionment (MAA),* signed on October 30, 1969 by Canada and the Provinces of Alberta, Saskatchewan and Manitoba.

The *MAA* provides for an equitable sharing of available waters for all eastward flowing streams that cross interprovincial boundaries, including transboundary lakes.

It also serves to protect transboundary aquifers and surface water quality. Schedules to the *MAA* describe the role of the Board, stipulate how the water shall be apportioned, and set water quality objectives for the water passing from Alberta to Saskatchewan and from Saskatchewan to Manitoba.

The Board consists of three provincial members, representing the Provinces of Alberta, Saskatchewan and Manitoba and two federal members, representing Environment and Climate Change Canada and Agriculture and Agri-Food Canada.

PPWB activities are jointly funded by the provinces and the federal government, with the provinces each contributing one-sixth and the federal government contributing one-half to the annual budget. The *MAA* assigns responsibility to monitor water quantity and quality in support of the Agreement to the federal government. Environment and Climate Change Canada conducts this monitoring on behalf of the Government of Canada. The Board approves the annual budget and costed Work Plan.

Section 2 of this Annual Report presents the performance results for each of the Goals in the Strategic Plan and 2019-2020 activities in the Work Plan. Included in this section is Goal 8, which provides a summary of the administration activities and financial expenditures for the year 2019-2020.

Appendices provide detailed information on the PPWB. Appendix I illustrates where monitoring is conducted to assess whether jurisdictions have met their requirements in the *MAA*. Appendix II presents 2019 apportionable flow data. Appendices III and IV present the water quality parameters that were monitored by Environment and Climate Change Canada and the 2019 Report on Excursions to Interprovincial Water Quality Objectives. Appendix V provides the organization chart, and Appendix VI lists agency representatives on the Board and Committees. Appendix VII provides the Financial Expenditure Statement. Finally, Appendix VIII describes the history of the PPWB.

PERFORMANCE RESULTS

GOAL 1: Agreed Transboundary Apportionment of Water is Achieved

The PPWB's Strategic Goal 1 is to achieve transboundary apportionment of water as agreed to in the 1969 *Master Agreement on Apportionment (MAA)* Schedule A and Schedule B.

Apportionment Monitoring of Rivers

The PPWB is required to assess and report on whether surface water quantity apportionment requirements have been met. Environment and Climate Change Canada conducts the water quantity monitoring in accordance with the terms of the *MAA*.

Currently, the Board conducts apportionment monitoring for 12 rivers including Cold Lake, North Saskatchewan River, South Saskatchewan River, Battle Creek, Lodge Creek, and Middle Creek on the Alberta-Saskatchewan boundary; and Churchill River, Saskatchewan River, Red Deer River, Qu'Appelle River, Assiniboine River, and Pipestone Creek on the Saskatchewan-Manitoba boundary.

In 2019, the PPWB Secretariat calculated apportionable flows with monitoring data from 90 hydrometric stations, 24 meteorological stations, as well as various third party water use measurements. The PPWB requires data from four additional hydrometric stations to support bilateral water management (Appendix I).

To prepare for next year, the 2020-2021 hydrometric and meteorological monitoring station lists were reviewed and approved by the Board at Meeting No.132 (November 4-5, 2019). There were no changes to the PPWB Hydrometric Monitoring Stations list from the previous year.

2019 Water Apportionment

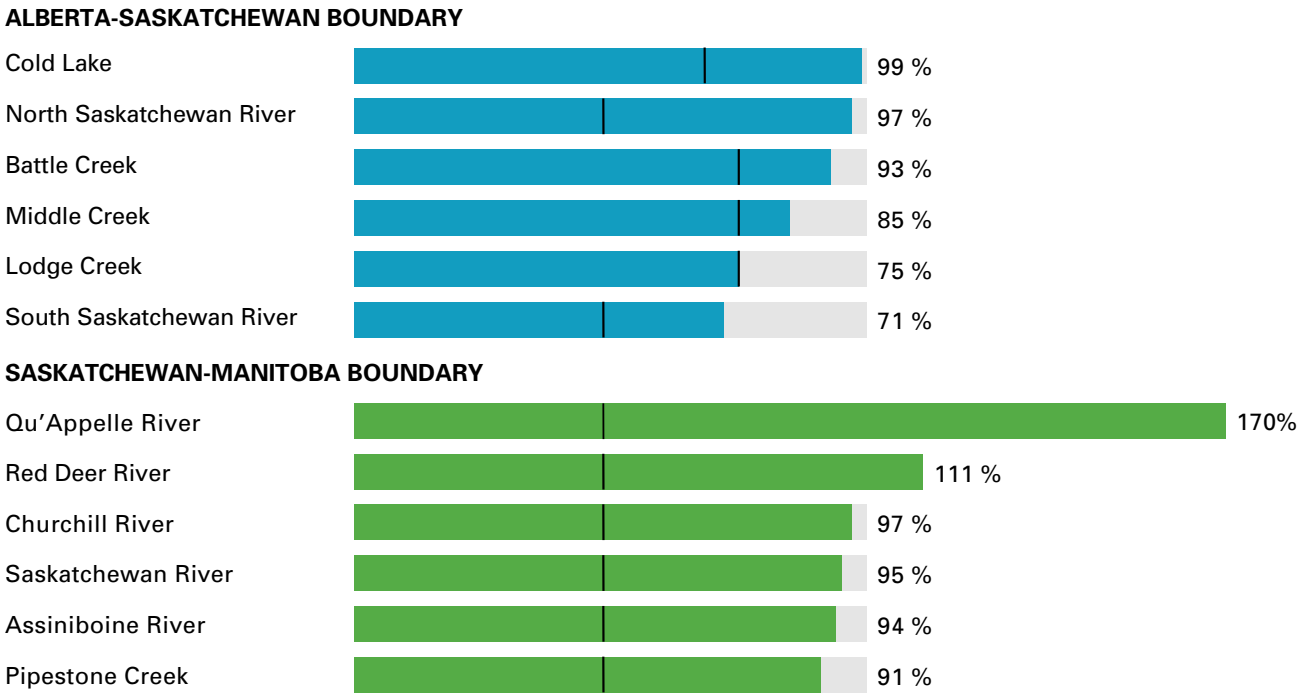
Interim apportionable flow reporting was completed for four basins in 2019 including for the South Saskatchewan River, Middle Creek and Lodge Creek, as well as one mid-year report for Cold Lake.

Appendix II presents the final monthly and total apportionment results in 2019 for all twelve rivers. Figure 1 below illustrates the percentage of annual apportionable flow, delivered from Alberta to Saskatchewan and from Saskatchewan to Manitoba in 2019. For all apportioned rivers and creeks, the recorded flow at the interprovincial boundary was higher than the amount the upstream province was required to deliver. In summary, all apportionment requirements were met in the 2019 calendar year.

Historic river flows and apportionment balances for each basin are provided in Appendix II for the historic period of PPWB monitoring. Large surpluses are fairly common for many of the rivers. Only Middle Creek (in 1989, 1998 and 2008) and Lodge Creek (in 1988 and 1989) at the Alberta-Saskatchewan boundary have experienced deficits in delivery through the apportionment record. Flow deficits have not occurred on the Saskatchewan-Manitoba boundary.

As there have been past years with deficits on Lodge and Middle Creeks, Alberta and Saskatchewan continue to work cooperatively and investigate solutions, including improvements to timing and accuracy of interim water use reporting, to ensure future deficits do not occur.

Figure 1. Percent of Apportionable Flow Passed from Alberta to Saskatchewan (blue bars; upper panel) and from Saskatchewan to Manitoba (green bars; lower panel) in 2019.



*Black lines in each bar above represent the 2019 apportionment requirements according to the Master Agreement on Apportionment. See Appendix II for detail.

PERFORMANCE RESULTS *continued*

Improving Apportionment Methods

Apportionment Procedure Review

The Committee on Hydrology (COH) continued with the ongoing review of apportionment methods to ensure apportionment monitoring and calculations have a level of accuracy acceptable to the Committee for the purposes of monitoring compliance with the *MAA*.

The COH continued work on finalizing the review of the apportionable flow calculation procedures for the Qu'Appelle River Basin at the Saskatchewan-Manitoba boundary through 2019. The Qu'Appelle River calculation is slightly more complex than some of the other apportioned basins due to the complexity of the connection between the river and Last Mountain Lake.

The COH is conducting the review of the South Saskatchewan River apportionable flow calculation procedure in several phases. The timing of each phase was shifted, with Phase 2 work set to begin in the 2020-21 fiscal year. The COH reviewed a draft report on Phase 1 work regarding apportionment monitoring needs and confirmed no changes will be pursued for the calculation time step reporting. The Phase 1 report will be refined and finalized in 2020-21.

Evaporation Investigation

The PPWB contracted researchers at the University of Saskatchewan to conduct a two-year evaporation field study at Newton Lake (Saskatchewan) and Shellmouth Reservoir (Manitoba) using eddy covariance techniques. The study will provide direct measurement of lake evaporation and associated hydrometeorological variables, which can be used to assess evaporation estimates from various models and potentially used to calibrate model parameters for optimized results. Results from this study are expected to improve understanding of lake evaporation in the Canadian Prairie environment and improve PPWB apportionment calculations.

The final deliverable from the study will be measurements of evaporation and associated hydrometeorological variables from both locations at various time increments (hourly, daily, etc.). A graduate thesis was published in February 2020 on this work and the final report is expected at the end of 2020. The next step will be to compare the field-measured evaporation with modelled evaporation and make recommendations on which model provides the best approximation, as well as possible refinements to those models.

Carrot River Sediment Investigations

An analysis was completed by Manitoba and Saskatchewan members of the COH to address the question of whether sediment transport by the Carrot River was impeding channel capacity at or near its mouth. The analysis indicated that there was no evidence of recent changes to channel capacity. The Board directed the COH to implement the following recommendations for future action:

- Review historic and future bathymetric survey data in the lower Carrot River as it becomes available and determine if sedimentation is changing the channel capacity.
- Continue to monitor rating curves at hydrometric stations to determine if there are trends in how the rating curves are shifting.
- Assess the Carrot River for trends in water quality that would suggest higher sediment loading to the river. If trends suggest increasing sediment loads, investigation into potential causes should be undertaken including forestry, agricultural drainage, and natural responses to hydrologic changes. This could be a joint undertaking with representatives from the Committee on Water Quality and the Committee on Hydrology.

PERFORMANCE RESULTS *continued*

GOAL 2: Transboundary Groundwater Aquifers Are Protected and Used in a Sustainable Manner

The PPWB Strategic Goal 2 is to protect groundwater quantity and quality and promote sustainable use of transboundary aquifers.

The *Master Agreement on Apportionment (MAA)* currently has a general statement to refer any transboundary groundwater issues to the Board for their review and recommendation. No issues or concerns were identified in 2019.

Groundwater Schedule F

Development and Consultation

In October 2007, the Board directed the Committee on Groundwater (COG) to develop a specific groundwater agreement to be added as Schedule F to the *MAA*. The objectives of the proposed Schedule are to promote:

- Effective and efficient management of transboundary aquifers;
- Sustainable use and equitable sharing of transboundary aquifers; and,
- Protection and preservation of transboundary aquifers and associated aquatic environments.

An internal review by each of the signatories to the *MAA* of the draft Schedule F began in 2014 and is progressing. The Government of Canada continued its review of Schedule F and consulted with other federal departments that have an interest in groundwater.

Roles and Responsibilities

As part of the internal review and consultation process, a document containing several mock scenarios was developed to illustrate the response to various groundwater situations under the proposed Schedule F. The Board determined that the next step would be to develop a roles and responsibilities document as part of the implementation plan for the proposed Schedule F. Under the direction of the Board, the COG developed a "Schedule F Anticipated Roles and Responsibilities" document that outlines some of the expected duties of the Jurisdictions, the Board, the COG, and the PPWB Secretariat for future implementation of proposed Schedule F.

In 2019-20, the Roles and Responsibilities document was reviewed and approved by the Board at PPWB Meeting No. 132 (November 4-5, 2019), pending finalization of Schedule F.

Aquifer Inventory

In early 2019, the COG created a sub-committee for developing a methodology to classify transboundary aquifers according to the Risk Informed Management (RIM) document within the proposed Schedule F.

The aquifers identified along the Alberta-Saskatchewan and Saskatchewan-Manitoba boundaries would be subject to the assessment once Schedule F is ratified. The list includes aquifers that have been agreed upon by the Committee along the Alberta-Saskatchewan and Saskatchewan-Manitoba boundaries as test cases for the implementation of the RIM methodology.

In 2019, the COG continued its work to develop the aquifer assessment method. The COG tested a matrix of aquifer demand versus vulnerability for one aquifer near the Alberta-Saskatchewan boundary and one aquifer near the Saskatchewan-Manitoba boundary and identified a number of challenges and opportunities with aquifer assessment under the proposed Schedule F. Next steps include development of a proof of concept document on the proposed method to classify transboundary aquifers.

Notification System

COG members are notifying their neighbouring jurisdiction of groundwater development proposals that may have transboundary impacts. In 2019, Saskatchewan provided notification to Alberta on two new developments near the Alberta-Saskatchewan boundary. Manitoba did not have any new notifications to report.

PERFORMANCE RESULTS *continued*

GOAL 3: Agreed Transboundary MAA Water Quality Objectives Are Achieved

The PPWB Strategic Goal 3 is to achieve agreed transboundary water quality objectives. Schedule E of the MAA includes a list of water quality objectives that were established for a number of key water courses at the Alberta-Saskatchewan and Saskatchewan-Manitoba boundaries.

Each fall a water quality monitoring program is approved by the PPWB and subsequently implemented by ECCC. The PPWB compares monitoring results annually to the objectives to determine if any excursions to the objectives occurred. If there are excursions, the Committee on Water Quality (COWQ) reviews the excursions, and when necessary prepares a work plan to assess the cause and the potential to mitigate. The work plan is then carried out by the member agencies.

Water Quality Monitoring

The 2019 monitoring program was approved by the Board at Meeting 127 (November 2, 2018). Environment and Climate Change Canada conducted water quality monitoring at 12 major interprovincial rivers in 2019 (Appendix I). A list of the water quality monitoring locations is provided in Appendix IV (Table 1). The *MAA's* water quality monitoring parameters are in Appendix III.

The water quality monitoring program for 2019 included:

- Monthly sampling for nutrients, physical, major ions, metals and biota (bacteria and chlorophyll a) parameters for all of the PPWB rivers, with the exception of the Churchill River which has a sampling frequency of four times a year (February, May, July and October);
- Sampling for pesticide parameters such as neutral herbicides, organo-chlorines and glyphosate:
- Monthly on the Carrot and Assiniboine Rivers, with the exception of the organochlorines which were sampled eight times (in February, April, May, June, July, August, October and December);
- Eight times (in same months as noted above) on the Battle River and Red Deer River (Alberta-Saskatchewan boundary) as part of the annual rotation for pesticide sampling;
- Sampling for acid herbicides eight times a year on the North Saskatchewan River, South Saskatchewan River, Battle River, Red Deer River (Alberta-Saskatchewan boundary), Saskatchewan River, and the Qu'Appelle River, and monthly on the Carrot River and Assiniboine River as part of the normal pesticide monitoring.

The 2019 water quality monitoring program was completed, with the following exceptions. In 2019, some pesticide samples were not reported for several rivers on both boundaries either because of a sampling error or because some samples were broken in transit. On the Saskatchewan-Manitoba boundary, the Saskatchewan River was not sampled in November 2019 for any of the parameters due to unsafe ice conditions.

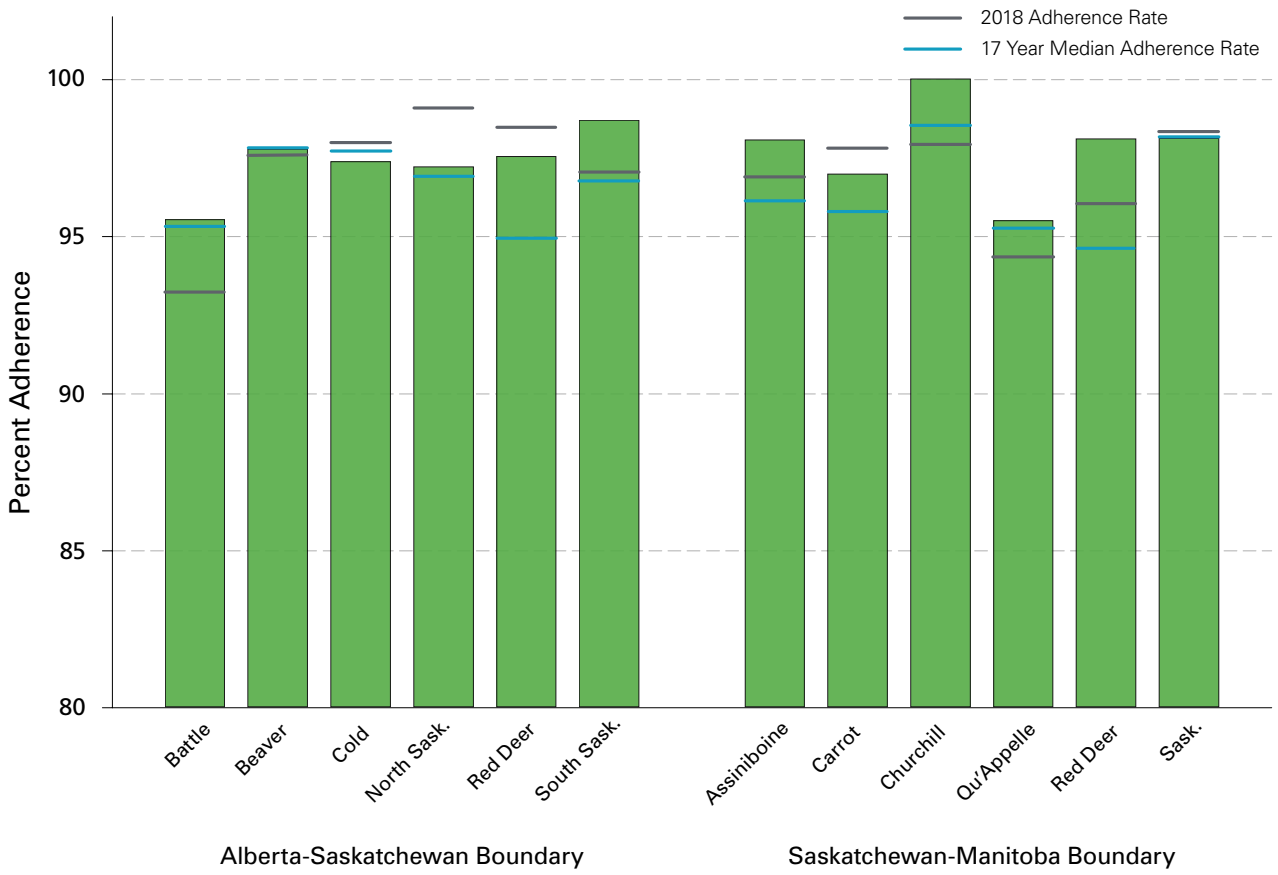
Further details on the 2019 water quality monitoring program and the 2019 PPWB Report on Excursions of Interprovincial Water Quality Objectives, January-December 2019 are presented in Appendix IV.

Adherence or Excursions to Transboundary Water Quality Objectives

A total of 5,361 water quality parameter values were compared to transboundary water quality objectives that protect aquatic life, source water for drinking, recreation, agriculture uses and fish consumption to determine whether any excursions to the objectives occurred in 2019.

Overall, there were no acute water quality concerns apparent from review of the adherence rate values for 2019. The transboundary water quality objectives were met on average in 97.6 % of samples for all parameters. Adherence rate is the degree to which a river meets the interprovincial water quality objectives. Adherence rates from 2019 are similar to those of previous years. Most rivers showed approximately 4 to 6 % variation in adherence rates over the last 17 years (Figure 2).

Figure 2. Percent Adherences to Interprovincial Water Quality Objectives in 2019.



On the Alberta-Saskatchewan boundary, adherence rates were similar to the historical median. Three Alberta-Saskatchewan boundary rivers showed an increase in the overall adherence rate between 2018 and 2019 including the Beaver River, Battle River and the South Saskatchewan River. The Cold, North Saskatchewan and the Red Deer rivers showed a decrease in adherence rate.

On the Saskatchewan-Manitoba boundary, adherence rates fall well within the historical variation. Four transboundary rivers on the Saskatchewan-Manitoba boundary (Churchill, Assiniboine, Red Deer and Qu'Appelle rivers) showed an increase in adherence rate and two rivers (Carrot and Saskatchewan rivers) showed a reduction in adherence between 2018 and 2019.

Excursions of total metals, nutrients, and bacteria objectives at several sites appear to be related to physical parameters (e.g., flow, suspended sediment). Trends in metal concentrations continue to be examined for select rivers. Common use pesticides are frequently detected in transboundary rivers. The COWQ is working with the jurisdictions to understand better the potential effects of all these factors to the aquatic environment.

PERFORMANCE RESULTS *continued*

Red Deer River: Jurisdictional Report on Excursions

A report was prepared by Alberta Environment and Parks (AEP) in response to the high number of excursions in the Red Deer River near Bindloss in 2015. The Red Deer River at the Alberta-Saskatchewan boundary has historically had a number of excursions to the interprovincial water quality objectives including metals, total dissolved solids, nutrients, major ions and bacteria.

Generally, the analysis indicated that the majority of metals excursions in the Red Deer River are due to highly variable sediment fluxes and erosion during high runoff events, especially in areas of the river that flow through the Badlands region. Total dissolved solids (TDS) excursions were inversely related to flow with excursions generally found during low flow periods. TDS may also be impacted by other factors such as runoff, point sources (e.g., wastewater) and non-point sources (e.g., road salts).

The PPWB accepted the report as a jurisdictional report and supports Alberta's recommendations for further study. This report was approved as a PPWB jurisdictional technical report no. 183 at Meeting 133 (March 11-12, 2020) and is available on the PPWB website.

Nutrient Sources Study: Red Deer and Carrot Rivers

In 2019, the COWQ completed a pilot study to quantify sources of nutrients in the Red Deer River (Alberta-Saskatchewan boundary) and the Carrot River. The main objectives of the study were to:

- Develop a comprehensive review of state of knowledge on point and non-point sources of nutrients in the Carrot and Red Deer Rivers
- Determine what was driving nutrient concentrations and trends in the Red Deer River and Carrot River watersheds.

The Board approved PPWB technical report no. 180 entitled Quantifying Non-Point and Point Nutrient Sources in Interprovincial Watersheds at PPWB Meeting 132 (November 4, 2019). The report is available on the PPWB website. The COWQ identified some limitations to the study and will be continuing its work to better understand nutrient sources and trends in 2020.

Water Quality Objectives Review

The COWQ aims to review the PPWB water quality objectives every five years. The Ministers responsible for the PPWB approved the most recent interprovincial water quality objectives in 2015. The 2015 objectives recognized the need to protect all water uses for all rivers and included a number of site-specific water quality objectives for selected parameters.

In 2019, COWQ completed their review of the 2015 objectives and produced an Addendum to the Review of the 1992 Interprovincial Water Quality Objectives and Recommendations for Change. The scope of the review was smaller as compared to the comprehensive 2015 review and primarily focused on parameters for which there was no objective identified in the 2015 review. The Addendum recommended water quality objectives for total copper, total iron and dissolved manganese. The COWQ also recommended updates to total cadmium, total silver, and dissolved zinc to align with recent updates to CCME guidelines. The Addendum was approved by the Board at Meeting 132 (November 4-5, 2019) and is available on the PPWB website. Formal adoption of the Addendum as part of Schedule E requires approval by the responsible Ministers and will begin in 2020.

The next comprehensive review of the water quality objectives will begin in 2020 and is expected to conclude in 2025.

PERFORMANCE RESULTS *continued*

Fish Tissue Report and Biomonitoring

In response to the establishment of Schedule E in 1992 and in recognition that the MAA specifies a broader ecosystem approach to interprovincial water quality management, the PPWB initiated a program from 1993 to 2004 monitoring metals and organochlorine pesticides in fish tissue. The principal focus of the program was an assessment of mercury concentration in fish tissue as compared to established fish tissue consumption objectives designed for the protection of human health.

In 2019, a report was completed on the 1993 to 2004 PPWB fish monitoring program, including an assessment of the methods, mercury concentrations in fish and excursion rates for mercury and organochlorine pesticides in fish compared with established interprovincial objectives. The report also provides recommendations and options for future fish and benthic invertebrate monitoring. PPWB technical report no. 181 was approved by the Board and is available on the PPWB website.

The report recommendations are being reviewed by COWQ to determine how biomonitoring might be useful to the PPWB and what methods would be most appropriate to address the PPWB's objectives and mandate. The intent of this exploration is to determine the most appropriate biological approach for assessing ecosystem health.

Trend Assessments

Trend assessments are considered to be an important tool for understanding the water quality of PPWB rivers. Trend assessments provide a means of identifying whether there have been long-term statistically significant changes in concentrations. However, identifying the causes of changes can be difficult due to the natural variations in water quality and anthropogenic influences. The most recent report on trend analyses was released in 2017 and included data up until 2013. The next trend assessment is planned for 2022.

Trend Investigation Studies

The COWQ is currently reviewing the most recent trend results (to 2013) and has prioritized which trends to examine more closely. Some considerations included the statistical significance, direction of change and magnitude of the trend and whether the trends were waterbody specific or common at a border ('global' trends').

COWQ is considering using GIS to examine linkages between water quality trends and land use changes. COWQ is also working with the COH to understand better the relationship between changes in hydrology and trends in water quality.

PERFORMANCE RESULTS *continued*

GOAL 4: Governments Are Informed About Emergency and Unusual Water Conditions

The Prairie Provinces Water Board's Strategic Goal 4 is to inform jurisdictions of emergency and unusual water conditions, facilitating effective and cooperative transboundary water management.

PPWB Contingency Plan

The PPWB Interprovincial Event Contingency Plan is an effective method of informing government agencies of events that may adversely affect water quality in transboundary water bodies or aquifers, or cause public concern in transboundary basins. The PPWB Event Contingency Plan is not meant to replace any jurisdictional emergency spill response mechanism. The Contingency Plan includes information on: area coverage, responsibilities, pattern of response and organizational structure. The Contingency Plan also ensures that proper communication approaches within each jurisdiction are addressed and that the Board will discuss the effectiveness of this communication on a regular basis.

No notifications were received in 2019-2020.

*The MAA provides for an **equitable sharing of available waters** for all eastward flowing streams that cross interprovincial boundaries, including lakes and **serves to protect** transboundary aquifers and surface water quality.*

PERFORMANCE RESULTS *continued*

GOAL 5: Transboundary Water Issues Are Addressed Cooperatively to Avoid Disputes

The PPWB Strategic Goal 5 is to avoid conflicts and disagreement over transboundary water issues. During the year, the PPWB discussed issues related to several existing projects of interest to different jurisdictions.

Committee on Flow Forecasting

The Committee on Flow Forecasting (COFF) was formed in 2015 to improve collaboration, coordination and communication between jurisdictions as well as federal agencies concerning flow forecasting.

During 2019-2020, COFF initiatives included a project on harmonizing provincial spring runoff potential reports and review of the five year workplan. In 2019, the COFF also planned and co-hosted the joint COH/COFF workshop on flow forecasting, hydrology and the resilience of the *MAA* (more under Goal 7).

In March 2019, the COFF completed a summary report on *Spring Runoff Potential Forecasting for the Canadian Prairies*. The report documents the practices of each jurisdiction for spring runoff forecasting and reporting and will inform the development of the harmonization of spring runoff potential for the Prairies. The jurisdictions are working towards a common approach, accommodating differences in practices and the unique timing of runoff in each province. In 2019, a subcommittee was formed to lead the harmonization project and develop a plan with recommendations to the Board on next steps. The COFF discussed multiple options for completing the harmonization project including the potential to leverage external collaborations.

The COFF also continues to share flow forecasting knowledge and experience between jurisdictions related to flow forecasting platforms, collaborative modelling, forecasting data and tools, research initiatives (e.g., FloodNet, Global Water Futures) and relevant workshops/events. The COFF also discussed bringing on a student to assist with the development of a real-time forecasting model for the Saskatchewan River Basin.

Lake Winnipeg Nutrient Issues

Lake Winnipeg is Canada's sixth-largest freshwater lake and is fed by a vast international basin covering 960,000 square km, extending over four provinces and four states. Nutrient loading to Lake Winnipeg from agriculture, municipal wastewater, and urban surface runoff from multiple transboundary sources continues to exceed the lake's natural capacity to process them, causing increased magnitude, duration and frequency of algal blooms. The Province of Manitoba, Environment and Climate Change Canada and many other partners are engaged in numerous initiatives to address water quality issues.

Environment and Climate Change Canada's commitment to Lake Winnipeg includes $25.7 million over 5 years (2017-2022) for the Lake Winnipeg Basin Program in support of the following priority issues:

- on the ground nutrient reducing actions throughout the Lake Winnipeg Basin using a strategically targeted and outcome focused approach;
- enhancing collaborative efforts and increased capacity building to protect freshwater quality throughout the Lake Winnipeg Basin; and
- enhancing engagement of Indigenous peoples in addressing freshwater issues.

For 2019-2020 under the Lake Winnipeg Basin Program there were 11 nutrient reduction projects with Prairie associations and academia, five collaborative governance projects with Prairie consortiums and foundations, and five Indigenous Engagement projects.

PERFORMANCE RESULTS *continued*

Canada/Manitoba MOU Respecting Lake Winnipeg and Lake Winnipeg Basin

Canada and Manitoba signed a Memorandum of Understanding (MOU) in September 2010 to continue their joint partnership by establishing a long-term collaborative and coordinated approach to support the sustainability of Lake Winnipeg. In 2015, the MOU was extended to September 13, 2020. Plans for a renewal are underway.

The MOU provides a forum for information sharing and the involved agencies provide regular reports on activities.

Alberta and Saskatchewan do not participate in this forum. However any issue that arises can be facilitated for broader discussion through the PPWB Chair, who is also the co-chair of the MOU forum.

In 2019-20, the second edition of the State of Lake Winnipeg report was released and initial scoping work began on an adaptive management framework for Lake Winnipeg.

Saskatchewan-Manitoba MOU Respecting Water Management

Saskatchewan and Manitoba signed a MOU in October 2015 to facilitate a cooperative and coordinated approach to mitigate flooding and drought and to protect and improve water quality and aquatic ecosystem health.

Current dialogue between Saskatchewan and Manitoba includes renewal of the existing MOU (which expires in 2020), discussion of upcoming drainage and other water infrastructure projects, watershed planning, and various aspects of drainage including regulatory and enforcement approaches, mitigation measures and assessment of impacts.

GOAL 6: Ministers, Senior Managers and Appropriate Staff of Governments Are Informed About PPWB Activities

This Strategic Goal is about keeping jurisdictions informed about PPWB activities. This transparency ensures that cost-shared activities are delivered efficiently and effectively and are consistent with the mandate of the PPWB.

The PPWB member governments were informed about PPWB activities through various means, including the ongoing distribution of Board and Committee Minutes and Quarterly and Annual Reports, as well as through technical reports, the PPWB website, fact sheets and brochures. In 2019, the PPWB produced a 50th Anniversary brochure to celebrate 50 years of the MAA (more under Goal 7).

The PPWB website (www.ppwb.ca) exists to inform the public and interested parties of PPWB activities, and provide a means for member governments to exchange information and facilitate the business of the PPWB. The PPWB website provides access to a complete suite of PPWB publications and fact sheets. A member portal also facilitates the exchange of information.

To maintain good communications between the Board and the Committees, the Board regularly invites Committee members to participate in Board meetings when the meetings are held in the Committee members' jurisdiction. Senior executives are also invited to Board meetings to share information, remain informed on Board activities and discuss important water issues across the Prairies.

PERFORMANCE RESULTS *continued*

GOAL 7: Information, Knowledge and Research Are Shared Among Governments

The PPWB provides a forum to foster effective and cooperative water management on the Prairies. Goal 7 facilitates cooperation by exchanging information and knowledge amongst jurisdictions and participating in research projects of mutual interest and relevance to the PPWB mandate.

The PPWB has been involved in a number of outreach activities to share information and become engaged and increase public awareness of work conducted by the Board.

50th Anniversary of the MAA

2019 marked the 50 year anniversary of the MAA. The MAA was signed in 1969 by Canada, Alberta, Saskatchewan and Manitoba and has allowed the three Prairie Provinces to collaboratively set goals for the management of important transboundary waters, and to equitably share water resources. Much of the MAA's enduring success is attributable to a structure that encourages collaboration amongst governments on common goals, and respects each Province's autonomy to independently manage water resources. In 2019, the PPWB produced a 50th Anniversary brochure to communicate the importance of the MAA to share and protect interprovincial waters across the Prairies. The brochure is available on the PPWB website. The PPWB gave a presentation on the 50th Anniversary at the joint COFF-COH Workshop and also tweeted about the release of the 50th anniversary brochure.

Board and Committee Outreach

In 2019-2020, the Board and its Committees interfaced with guest presenters from the Canadian Centre for Meteorological and Environmental Prediction, the Prairie Climate Centre, Canada Centre for Mapping and Earth Observation and Mapping, the Global Institute for Water Security and the ECCC Coordinated Aquatic Biomonitoring Program and facilitated further discussion on topics of mutual interest. Opportunities also included continued collaboration with Global Water Futures and the Partners FOR the Saskatchewan River Basin on modeling programs and conference participation.

In 2019, the PPWB was invited to give a presentation at the Lake Winnipeg Basin Symposium on transboundary collaboration in the Lake Winnipeg Basin. The presentation provided an overview of the history and work of Prairie Provinces Water Board and the International Joint Commission's International Red River Board. Over 100 stakeholders attended each day of the Symposium representing government and non-governmental organizations (NGOs), scientists, Indigenous governments, organizations and communities and regional conservation districts.

The Board also facilitates regular updates on the Canada-Manitoba MOU respecting Lake Winnipeg and Lake Winnipeg Basin Program. The PPWB also continued to interface with Alberta, Saskatchewan and Manitoba on Lake Winnipeg activities. This includes keeping Alberta and Saskatchewan apprised of MOU developments and activities being carried out related to Lake Winnipeg.

In 2019, the Government of Canada invested $1 million to work with partners and stakeholders to develop a new strategy to sustainably manage water and land on the Prairies. Several Board and Committee members attended the Prairie Water Summit and regional Prairie Water Workshops to engage with other water experts, stakeholders and organizations and provide technical advice on the development of a land-water management strategy for the Prairie region.

PERFORMANCE RESULTS *continued*

Joint COFF-COH Workshop

On November 27-28, 2019 the COH and COFF convened a two day workshop on flow forecasting and hydrology in Edmonton, Alberta. The workshop theme was 'resilience' of the MAA including climate change impacts. Approximately 70 people attended the workshop in person and 16 people attended virtually. Attendees included PPWB Committee Members (COFF and COH) and provincial and federal government staff (Environment and Climate Change Canada, Agriculture and Agri-Food Canada, Alberta Environment and Parks, Saskatchewan Water Security Agency, Manitoba Agriculture and Resources Development), academia (University of Lethbridge, University of Saskatchewan , University of Winnipeg, University of Waterloo), industry (EPCOR), and consulting firms (Halliday & Associates).

Day one of the workshop focused on future challenges to the PPWB and featured a breakout session on 'Resilience of the MAA' and included presentations on the 50th Anniversary of the PPWB, the Climate Atlas of Canada, Impacts of Climate Change on Mountain River Watersheds, Changes in Freshwater Availability, Strengthening Water Management in Manitoba, and Natural Hazards Risk Assessment for Saskatchewan.

Day two of the workshop featured presentations on EPCOR's Water Supply Climate Change Adaptation Plan, ECCC's Collaborative Monitoring Initiative & Risk Based Approach to Hydrometric Network Design, Flood Forecasting and FloodNet and Global Water Futures. There were two concurrent breakout sessions: '*Incorporating Climate Change Model Output into Prairie Water Management' and 'Soil Moisture Forecasting Needs*'.

The complete workshop agenda and presentations are available on the PPWB website.

Agency Reports

The PPWB member agencies continue to share information and knowledge on their aquatic invasive species programs and legislation.

Alberta's Agency Report provided information on the Alberta River Forecast Centre, Source Water Protection in Alberta, Climate Change Effects on Regional Hydrology, Chloride Impacts on Regional Water Quality from Road Salts, Treatment of Tile Drainage Water, and Nutrient Objectives. Alberta also provided information on The Water Innovation Program, Water Regulations for Alberta's Energy Industry, Tailings Management Framework, Industry Incident Response, Land-use Framework for Regional plans, and Watershed Planning and Advisory Councils.

Saskatchewan's Agency Report provided information on the Implementation of the Agricultural Water Management Strategy, Quill Lakes Flood Mitigation, Current Moisture Conditions, Transfer of Federal Dams, the Qu'Appelle Water Quality Study, the Completion of Regina's Wastewater Treatment Plant, and the Husky Oil Spill.

Manitoba provided information on Shellmouth Reservoir and Downstream Flooding, Lake Winnipeg, the Manitoba Drought Management Strategy, and new legislation for drainage and water control works.

Environment and Climate Change Canada provided information on the Lake Winnipeg Basin Program, Cold-Region Nutrient Best Management Practices, Quantification of Nutrient Sources, In-stream Biological Indicators, Water Quality Monitoring and Surveillance Report, Open Data and Whirling Disease.

PERFORMANCE RESULTS *continued*

GOAL 8: PPWB Business is Conducted Effectively

The PPWB Strategic Goal 8 focuses primarily on administration, work planning, and financial management. Goal 8 ensures that work planning and budgeting are consistent amongst jurisdictions, day to day activities are administered effectively, communications are effective, and succession planning is done to ensure continuity of Board, Committee and Secretariat functions.

Administrative and Financial Management

As illustrated by the organization chart in Appendix V, the Board operates through its Executive Director and four technical Standing Committees (Committee on Hydrology, Committee on Groundwater, Committee on Water Quality and Committee on Flow Forecasting). The Board consists of senior officials engaged in the administration of water resources in the Provinces of Alberta, Saskatchewan, and Manitoba and senior officials from Environment and Climate Change Canada and Agriculture and Agri-Food Canada (Appendix VI). Committee members are managers and technical experts within each member agency. The Board is chaired by the Environment and Climate Change Canada member. The Committees are chaired by the Executive Director.

Secretariat support is provided to the PPWB through the Transboundary Waters Unit, Environment and Climate Change Canada. The portion of time each Secretariat staff person spends on PPWB activities is charged to the PPWB and cost-shared by the members. In addition, technical support is provided, as required, by other staff of the Government of Canada and the three Prairie provinces.

Three Board meetings and nine Committee meetings were held during 2019-2020.

PPWB
- Meeting No. 131. October 10, 2019 – Teleconference
- Meeting No. 132. November 4-5, 2019 – Regina
- Meeting No. 133. March 11-12, 2020 – Teleconference

COH
- Meeting No. 139A. October 28, 2019 – Teleconference
- Meeting No. 139B. November 28-29, 2019 – Edmonton
- Meeting No. 140. February 26-27, 2020 – Winnipeg

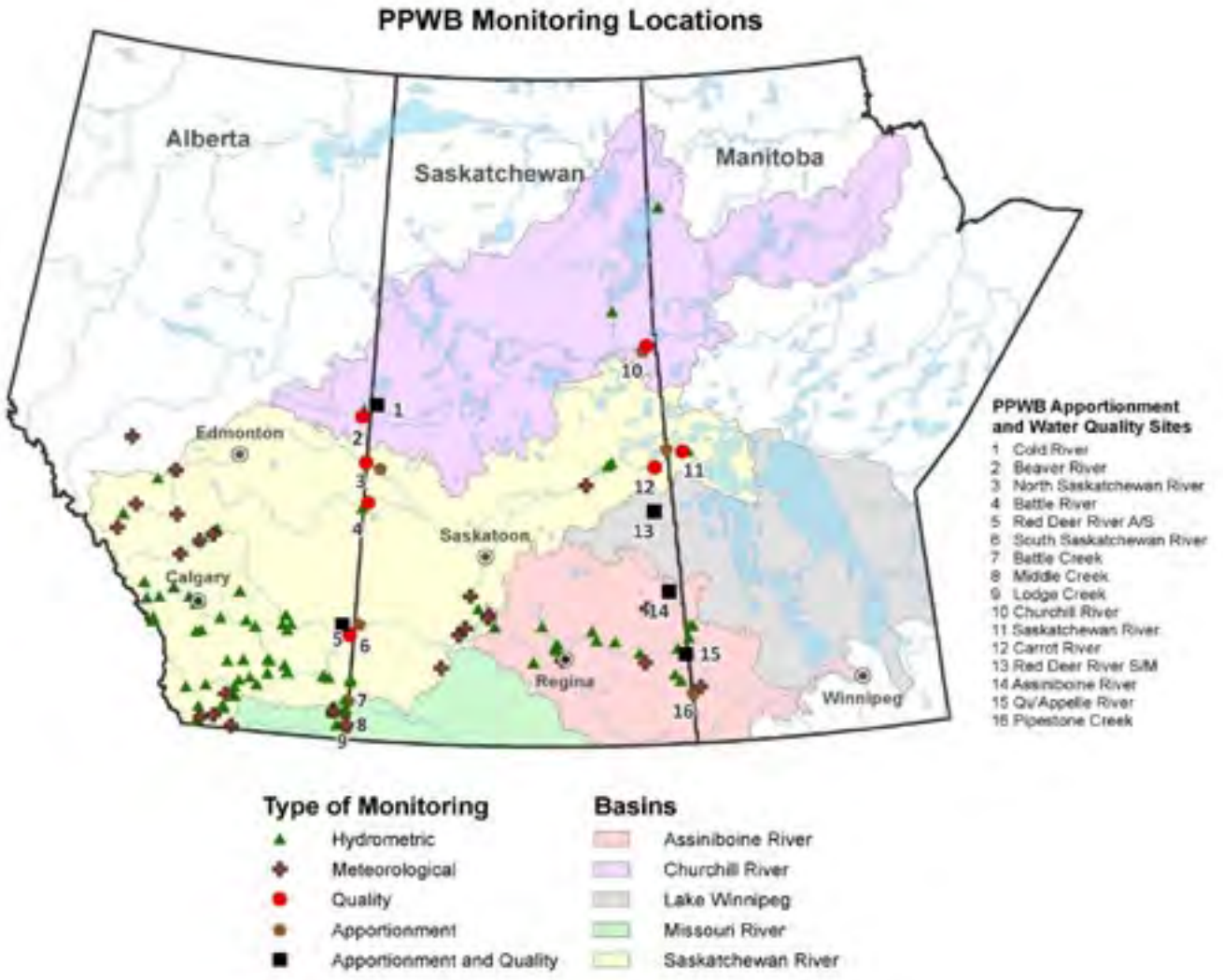
COWQ
- Meeting No. 136. October 16-17, 2019 – Edmonton
- Meeting No. 137. February 4-5, 2020 – Saskatoon

COG
- Meeting No. 76. October 8, 2019 – Edmonton
- Meeting No. 77. January 21, 2020 – Videoconference

COFF
- Meeting No. 9. November 26, 2019 – Edmonton
- Meeting No. 10. February 6, 2020 – Videoconference

The Board approved the annual budget for the PPWB. The budget for 2019-2020 was $790,974 and final expenditures were $571,597 as shown in Appendix VII. Final expenditures were below the approved budget due to a number of delays with deliverables for existing contracts.

APPENDIX I: PPWB Monitoring Stations for 2019-2020



APPENDIX II: 2019 Recorded and Apportionable Flows
APPENDIX IIA: Flows at the Alberta-Saskatchewan Boundary (in Cubic Decametres)

SOUTH SASKATCHEWAN RIVER – ALBERTA-SASKATCHEWAN BOUNDARY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
RECORDED FLOW	132000	115000	243000	282000	185000	601000	547000	281000	346000	431000	297000	209000	3669000
CONSUMPTIVE USE	0	0	0	55300	285000	587000	551000	375000	152000	17400	0	198	2023000
CHANGE IN RESERVOIR STORAGE	-53100	-73500	-71800	-26900	263000	381000	34900	-110000	-108000	-1550	-4610	-16600	213000
INTERBASIN TRANSFER*	0	0	0	22000	10900	17500	17600	16600	15300	11600	0	0	91700
APPORTIONABLE FLOW	78900	41500	171000	313000	744000	1587000	1151000	563000	405000	458000	292000	193000	5997000

* Irrigation diversions to the Eastern and Western Irrigation Districts which are subsequently returned to the Red Deer River.

RED DEER RIVER – ALBERTA-SASKATCHEWAN BOUNDARY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
RECORDED FLOW	39400	51500	152000	295000	139000	235000	402000	148000	119000	113000	80100	47000	1821000
CONSUMPTIVE USE	0	0	0	0	1080	4810	6850	5640	3250	1150	41	0	22800
CHANGE IN RESERVOIR STORAGE	-29600	-30900	-19300	-1250	31600	44400	17100	20000	2050	180	621	-11600	23300
INTERBASIN TRANSFER**	0	0	0	-2200	-10900	-17500	-17600	-16600	-15300	-11600	0	0	-91700
APPORTIONABLE FLOW	9800	20600	133000	292000	161000	267000	408000	157000	109000	103000	80800	35400	1777000

** Irrigation return flow from the Eastern and Western Irrigation Districts.

SOUTH SASKATCHEWAN RIVER – BELOW CONFLUENCE WITH RED DEER RIVER

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
RECORDED FLOW	171000	167000	395000	577000	324000	836000	949000	429000	465000	544000	377000	256000	5490000
APPORTIONABLE FLOW	88700	62100	304000	605000	905000	1854000	1559000	720000	514000	561000	373000	228000	7774000
NET DEPLETION BY ALBERTA	-82300	-104900	-91000	28000	581000	1018000	610000	291000	49000	17000	-4000	-28000	2284000
CUMULATIVE PERCENT DELIVERY	193%	224%	161%	124%	83%	65%	64%	63%	65%	68%	69%	71%	71%

Recorded flow was 71% of the apportionable flow. Alberta is required to deliver 50% of the apportionable flow to Saskatchewan unless the total annual apportionable flow below the confluence is less than 5,180,000 dam^3, in which case Alberta is allowed a total net depletion of 2,590,000 dam^3 regardless of the percent delivery. However, Alberta cannot consume, divert or store more than 50% of the apportionable flow if the effect reduces the flow below the confluence to less than 42.5 m^3/s at any time. As the apportionable flow for 2019 was 7,774,000 dam^3, and Alberta delivered greater than 50% of the apportionable flow, Alberta has met its obligations.

NORTH SASKATCHEWAN RIVER – ALBERTA-SASKATCHEWAN BOUNDARY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
ESTIMATED FLOW	354000	329000	522000	1086000	676000	1153000	1816000	905000	653000	524000	542000	396000	8956000
APPORTIONABLE FLOW	112000	73200	344000	955000	768000	7697000	2324000	1243000	772000	463000	376000	147000	9274000

Estimated flow at the Alberta-Saskatchewan boundary is calculated by taking the recorded flow at the hydrometric station near Deer Creek, SK and subtracting the estimated net inflow to the river between the boundary and the station. Estimated flow was 97% of the apportionable flow. Alberta is required to deliver 50% of the apportionable flow to Saskatchewan.

COLD LAKE – ALBERTA-SASKATCHEWAN BOUNDARY (AT THE OUTLET OF COLD LAKE)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
RECORDED FLOW	48700	42500	43900	44900	48900	57800	88700	12000	105000	83800	63900	53100	801000
APPORTIONABLE FLOW	49100	42800	44300	45300	49300	58200	89200	12000	105000	84100	64300	53400	805000

Recorded flow was 99% of the apportionable flow. Alberta is required to deliver 68.4% of the apportionable flow to Saskatchewan.

LODGE CREEK – ALBERTA-SASKATCHEWAN BOUNDARY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
RECORDED FLOW	N/A	0	1520	382	202	17	1	0	0	0	N/A	N/A	2120
APPORTIONABLE FLOW	N/A	0	2180	382	241	17	1	0	0	0	N/A	N/A	2820

Recorded flow was 75% of the apportionable flow. Alberta is required to deliver 75% of the apportionable flow to Saskatchewan. Hydrometric data is only collected for the open water season.

MIDDLE CREEK – ALBERTA-SASKATCHEWAN BOUNDARY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
RECORDED FLOW	N/A	4	182	52	55	45	25	10	14	31	N/A	N/A	418
APPORTIONABLE FLOW	N/A	4	231	57	76	45	25	10	14	31	N/A	N/A	493

Recorded flow was 85% of the apportionable flow. Alberta is required to deliver 75% of the apportionable flow to Saskatchewan. Hydrometric data is collected only for the open water season.

BATTLE CREEK – ALBERTA-SASKATCHEWAN BOUNDARY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
RECORDED FLOW	N/A	12	1060	655	694	454	272	216	269	278	N/A	N/A	3910
APPORTIONABLE FLOW	N/A	12	1060	729	857	507	285	216	271	278	N/A	N/A	4220

Recorded flow was 93% of the apportionable flow. Alberta is required to deliver 75% of the apportionable flow to Saskatchewan. Hydrometric data is collected only for the open water season.

APPENDIX IIB: Flows at the Saskatchewan-Manitoba Boundary (in Cubic Decametres)

CHURCHILL RIVER – SASKATCHEWAN-MANITOBA BOUNDARY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
ESTIMATED FLOW	2485000	2144000	2213000	2066000	2560000	2261000	2474000	2234000	2158000	3030000	2696000	2618000	28939000
APPORTIONABLE FLOW	2366000	1968000	1979000	1822000	2391000	2419000	2876000	2984000	2716000	3069000	2689000	2560000	29839000

Estimated flow includes recorded flow at Sandy Bay, SK and estimated inflow from Sandy Bay to the Saskatchewan-Manitoba Boundary. Estimated flow was near 97% of the apportionable flow. Saskatchewan is required to deliver 50% of the apportionable flow to Manitoba.

SASKATCHEWAN RIVER – SASKATCHEWAN-MANITOBA BOUNDARY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
ESTIMATED FLOW	1216000	1292000	1368000	2447000	1844000	1560000	2412000	2065000	1477000	1361000	910000	921000	18873000
APPORTIONABLE FLOW	758000	791000	1174000	2890000	1994000	2009000	3128000	2445000	1704000	1550000	824000	616000	19883000

Estimated flow at the Saskatchewan-Manitoba boundary is calculated using the recorded flow of the Saskatchewan River at The Pas minus 1.34 times (Fall and Winter) and 1.64 times (Spring and Summer) the recorded flow of the Carrot River near Turnberry. Estimated flow was 95% of the apportionable flow. Saskatchewan is required to deliver 50% of the apportionable flow to Manitoba.

RED DEER RIVER – SASKATCHEWAN-MANITOBA BOUNDARY (NEAR ERWOOD)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
RECORDED FLOW	6800	5690	42600	114000	67500	18900	29500	27900	48200	19800	11100	8410	400000
APPORTIONABLE FLOW	6070	5080	37900	105000	60800	15700	25700	24600	43000	17600	9910	7500	359000

Recorded flow was 111% of the apportionable flow due to the contribution of agricultural drainage to the flow of the Red Deer River. Saskatchewan is required to deliver 50% of the apportionable flow to Manitoba.

ASSINIBOINE RIVER – SASKATCHEWAN-MANITOBA BOUNDARY (AT KAMSACK)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
RECORDED FLOW	1410	1170	1040	74400	94800	42500	11100	1610	785	1680	1850	1920	234000
APPORTIONABLE FLOW	1390	1170	939	77700	95600	43000	11800	2370	933	1780	1820	1920	240000

Recorded flow was 94% of the apportionable flow. Saskatchewan is required to deliver 50% of the apportionable flow to Manitoba.

QU'APPELLE RIVER – SASKATCHEWAN-MANITOBA BOUNDARY (NEAR WELBY)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
RECORDED FLOW	2220	995	3900	28000	10900	26800	13500	4570	3700	16500	10500	6090	128000
APPORTIONABLE FLOW													85700

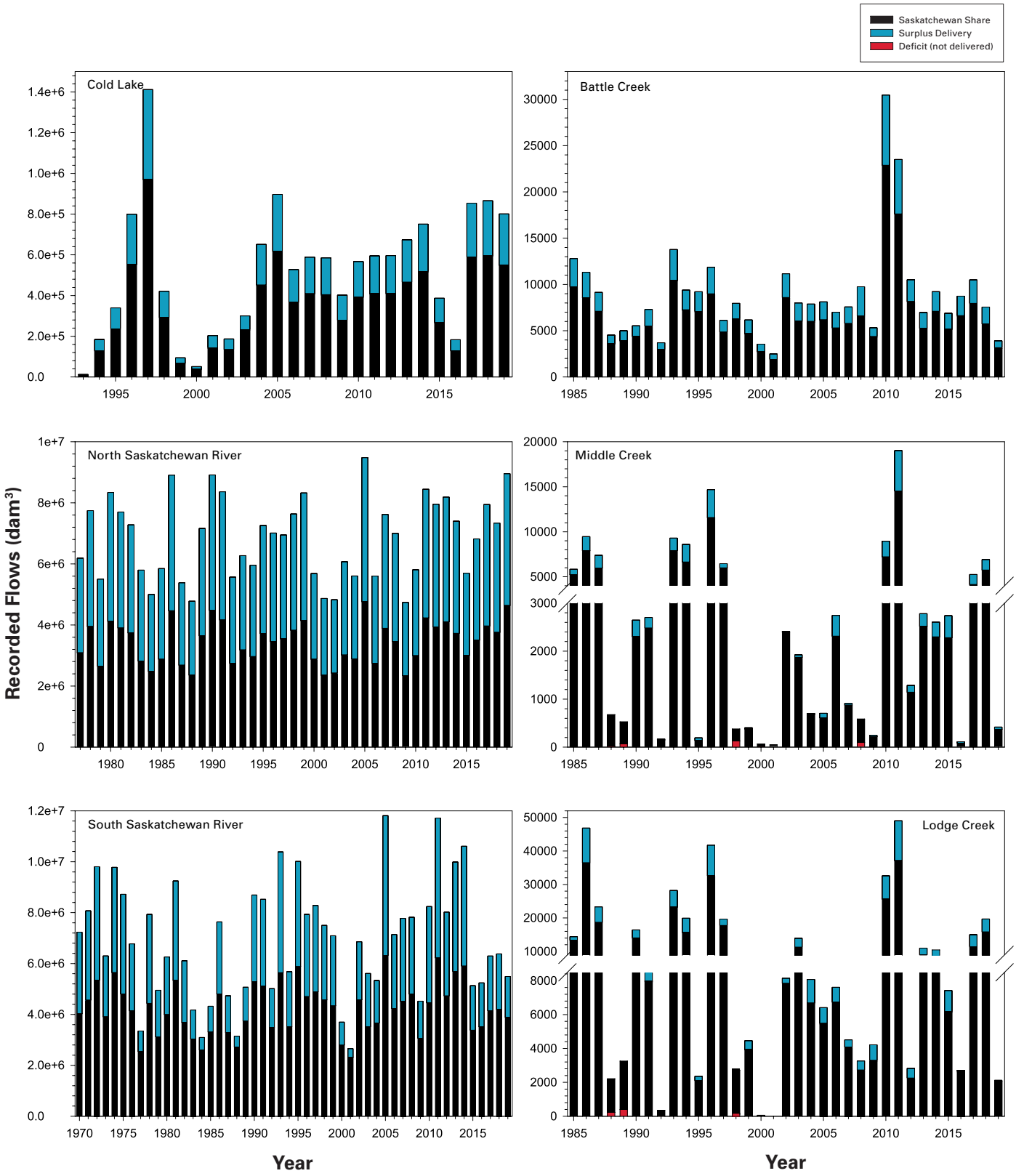
Recorded flow was 170% of the apportionable flow. The current calculation method overestimates the percent delivery. The PPWB is currently undertaking a study to revise the calculation procedures to address these problems. Saskatchewan is required to deliver 50% of the apportionable flow to Manitoba.

PIPESTONE CREEK – SASKATCHEWAN-MANITOBA BOUNDARY

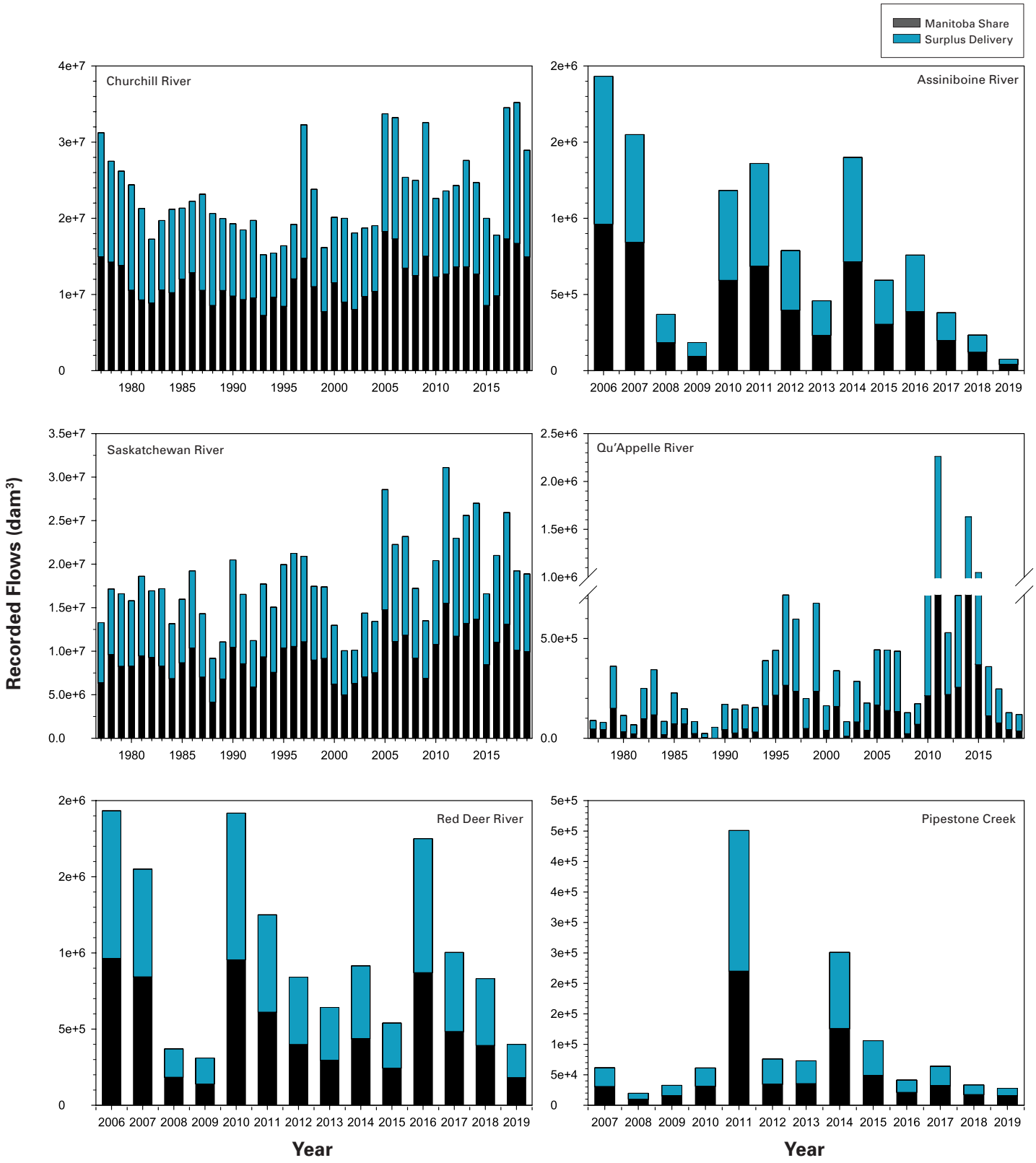
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
RECORDED FLOW	136	123	345	8570	3740	16700	2270	17	402	372	233	382	33300
APPORTIONABLE FLOW													34800

Recorded flow was 91% of apportionable flow. Saskatchewan is required to deliver 50% of the apportionable flow to Manitoba. Due to unresolved issues with the Fortran program used to calculate monthly apportionable flows, a simplified procedure was developed in 2018 was used again for the 2019 annual apportionable flow for Pipestone Creek. The Kipling Marsh drainage project was not operational in 2019 due to a fire in 2018. Some water was pumped using temporary works and a rough estimate was made of the 2019 volume based on number of days pumped and the nominal pump capacity.

APPENDIX IIC: Historic River Flows on the Alberta-Saskatchewan Boundary



APPENDIX IID: Historic River Flows on the Saskatchewan-Manitoba Boundary



APPENDIX III: PPWB Water Quality Monitoring 2019 Parameter List

Water is collected monthly at all sites with the exception of the Churchill River (4x/yr)

ALKALINITY, phenol & total
ALUMINUM, diss. & total
AMMONIA, total. θ
ANTIMONY, diss. & total
ARSENIC, diss. θ & total θ
BARIUM, diss. & total θ
BERYLLIUM, diss. & total θ
BICARBONATE, calcd.
BISMUTH, diss. & total
BIOLOGICAL OXYGEN DEMAND (BOD)•
BORON, diss. & total θ
CADMIUM, diss. & total θ
CALCIUM, diss.
CARBON, diss. organic
CARBON, part. organic
CARBON, total organic, calcd.
CARBONATE, calcd.
CHLORIDE, diss. θ
CHLOROPHYLL A
CHROMIUM, diss. & total θ
COBALT, diss. & total θ
COLIFORMS FECAL θ
COLOUR TRUE
COPPER, diss. & total θ
E. COLI θ
FLUORIDE, diss. θ
FREE CO2, calcd.
GALLIUM, diss. & total
GLYPHOSATE ◆
HARDNESS NON-CARB. (calcd.)
HARDNESS TOTAL (calcd.) CACO3
IRON, diss. θ & total
LANTHANUM, diss. & total
LEAD, diss. & total θ
LITHIUM, diss. & total θ
MAGNESIUM, diss.
MANGANESE, diss. θ & total
MOLYBDENUM, diss. & total θ
NICKEL diss. θ & total
NITROGEN NO_3 & NO_2, diss. θ
NITROGEN. part.
NITROGEN, total calcd.
NITROGEN, diss.
OXYGEN, diss. θ
pH θ
PHOSPHOROUS ortho, diss.
PHOSPHOROUS, part. calcd.
PHOSPHOROUS, total θ
PHOSPHOROUS, diss.
POTASSIUM, diss.
RESIDUE FIXED NONFILTRABLE
RESIDUE NONFILTRABLE θ
RUBIDIUM, diss. & total
SELENIUM, diss. & total θ
SILVER, diss. & total θ
SILICA,
SODIUM ADSORPTION RATIO, calcd. θ
SODIUM, diss. θ
SODIUM PERCENTAGE, calcd.
SPECIFIC CONDUCTANCE
STRONTIUM, diss. & total
SULPHATE, diss. θ
TEMPERATURE WATER
THALLIUM, diss. & total θ
TOTAL DISSOLVED SOLIDS, calcd. θ
TURBIDITY
URANIUM, diss. & total θ
VANADIUM, diss. & total θ
ZINC diss. & total θ

ACID HERBICIDES*θ
NEUTRAL HERBICIDES◆
ORGANOCHLORINE INSECTICIDES◆

θ Parameters with PPWB site-specific objectives

* Collected from all PPWB Transboundary Rivers except Beaver, Churchill, and Red Deer (S/M) Rivers in 2019

◆ Collected from the Assiniboine, Carrot, Battle and Red Deer (A/S) in 2019

• Collected from Battle, Beaver, and Carrot Rivers in 2019

APPENDIX IV: PPWB Report on Excursions of Interprovincial Water Quality Objectives

JANUARY – DECEMBER 2019

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SUMMARY

This 2019 report fulfils requirements of the *Master Agreement on Apportionment (MAA)* to report on the protection of water quality for major interprovincial prairie rivers. During 2019, water quality samples were collected from 12 major interprovincial rivers. The water quality results were compared to water quality objectives for each site. In general, water quality was suitable for the intended water uses for the rivers. Based on the evaluation of excursions in 2019 and with consideration of results from previous excursion reports, trends, and on-going work by the Committee on Water Quality (COWQ), the following are recommended:

- There were no unexpected water quality issues or concerns specifically highlighted as a result of the 2019 sampling program. As such the Committee will continue to focus its efforts to better understand broader scale questions related to factors affecting water quality on the prairies.
- Nutrients continue to be a priority area of investigation for the transboundary rivers because increasing levels of nutrients can lead to more eutrophic waters, which can affect ecosystem function. Understanding the processes affecting nutrient concentrations in rivers will improve understanding regarding the causes of excursions and trends. The Committee's on-going work to understand nutrient sources and trends continued in 2019.
- Common use pesticides, such as dicamba, 2-methyl-4-chlorophenoxyacetic acid (MCPA) and glyphosate, are frequently detected in transboundary rivers on the prairies. There are frequent pesticide excursions at several transboundary rivers, notably of MCPA and dicamba. The objectives for these two pesticides are based on irrigation guidelines for sensitive crops and are low compared to other pesticides. Glyphosate and its primary breakdown product are also detectable at mostly low concentrations in the transboundary rivers. The COWQ is working with the jurisdictions to better understand the potential effects of trace-level pesticides to the aquatic environment and users of these waters. Once this work is complete, the Committee will provide a recommendation to the Board. Given low level but frequent occurrence of certain pesticides, understanding the aquatic life and use implications continues to be a priority.
- Excursions of total metals, nutrients and bacteria objectives at several sites appear to be related to peaks in suspended solids, and sometimes flow, although these relationships do not explain all of the excursions observed. Trends in metal concentrations and relationships to physical parameters, including flow and suspended solids, and chemical conditions at time of sampling continue to be examined for select rivers to gain further understanding on how these factors influence metal concentrations and other parameters in transboundary rivers.

INTRODUCTION

In 1969 the governments of Alberta, Saskatchewan, Manitoba and Canada entered into the Master Agreement on Apportionment (MAA). This agreement provided for equitable sharing of water in eastward flowing streams across interprovincial boundaries. Schedule E, the agreement on water quality, was added to the Agreement in 1992. The Agreement is administered by the Prairie Provinces Water Board (PPWB) who has a mandate to foster and facilitate interprovincial water quality management among the parties to encourage the protection and restoration of the aquatic environment. One of the processes the PPWB uses to meet this mandate is this annual report on adherences to the interprovincial water quality objectives. If, as a result of human activity, chemical, biological or physical variables do not meet acceptable limits then the appropriate jurisdiction has agreed to undertake reasonable and practical measures to ensure the quality of the water in that river reach is within acceptable limits (MAA Schedule E, 1992).

Schedule E requires the PPWB to monitor the quality of the aquatic environment and make annual comparisons with established interprovincial water quality objectives. Water quality objectives have been established at 12 major interprovincial eastward flowing river reaches (Appendix 1). The water quality objectives were reviewed and updated in 2015, and are designed to protect water uses including the protection of aquatic life, source water for drinking, recreation, agricultural uses (livestock watering and irrigation) and fish consumption. The Alberta-Saskatchewan and Saskatchewan-Manitoba boundaries each have six river sites (Figure 1; Table 1).

Water quality monitoring includes a range of physical, chemical and biological parameters at one site in each of the river reaches. Parameters include nutrients, major ions, metals, fecal coliforms, physical characteristics and pesticides. This report presents adherence of the 2019 water quality data to the interprovincial water quality objectives.

Field Program – Summary of (2019) Sampling

Environment and Climate Change Canada (ECCC) undertook a total of 135 water sampling outings at the 12 PPWB transboundary river sites in 2019. The monitoring program for 2019 was completed, as approved by the PPWB (Appendix 2), with the following exceptions:

On the Alberta-Saskatchewan boundary a number of pesticide samples were not reported in 2019 including the organochlorine pesticides on the Battle River in October, glyphosate and AMPA on the Battle, North Saskatchewan, Red Deer and the South Saskatchewan rivers in December. In addition glyphosate and AMPA were not collected on the South Saskatchewan River in February.

On the Saskatchewan-Manitoba boundary, the Saskatchewan River was not sampled in November 2019 for any of the parameters due to unsafe ice conditions. In addition, pesticide sample results were not reported on several rivers including acid herbicides on the Saskatchewan River in April; the neutral acids on the Carrot River in February; acid herbicides on the Assiniboine River in January and the neutral herbicides on the Assiniboine River in January and February. On the Qu'Appelle River, extra samples were collected for analyses of acid herbicides, glyphosate and AMPA in September. However, samples for glyphosate and AMPA were not collected in December. Glyphosate and AMPA were also not collected on the Carrot River in December. Pesticide samples that were not reported were broken in transit, lost in storage, or there was a sampling error.

Figure 1: Map showing location of PPWB water quality monitoring stations.

Table 1: PPWB water quality station information

RIVER	STATION NUMBER	LATITUDE	LONGITUDE	LATITUDE	LONGITUDE	HYDROMETRIC SITE(S)
Alberta-Saskatchewan		Open Season		Closed Season		
Battle	SA05FE0001	52° ’56’23.09”	109° 52’34.60"	52°56'23.20"	109°52'33.55"	05FE004
Beaver	AL06AD0001	54° 21’19.06"	110° 12’57.13"	54°21'19.71"	110°13'00.19"	06AD006
Cold	SA06AF0001	54°33'56.51"	109°50'29.23"	54°33'56.65"	109°50'29.81"	06AF001
N. Saskatchewan	AL05EF0003	53°36'13.35"	110°00'38.87"	53°35'50.28"	109°59'31.05"	05EF001
Red Deer	AL05CK0001	50°54'11.91"	110°17'57.69"	50°54'10.00"	110°17'48.98"	05CK004
S. Saskatchewan	AL05AK0001	50°43'51.88"	110°04'10.73"	50°44'01.31"	110°05'00.87"	05AJ001*
Saskatchewan-Manitoba		Open Season		Closed Season		
Assiniboine	SA05MD0002	51°31'57.86"	101°52'38.33"	51°31'57.85"	101°52'37.72"	05MD004
Carrot	SA05KH0002	53°36'52.54"	102°06'14.75"	53°36'52.79"	102°06'15.84"	05KH007
Churchill	SA06EA0003	55°33'40.16"	102°15'41.83"	55°33'47.10"	102°15'48.90"	06EA002**
Qu’Appelle	SA05JM0014	50°29'28.38"	101°33'31.37"	50°29'28.17"	101°33'30.93"	05JM001
Red Deer	SA05LC0001	52°51'34.87"	102°11'44.70"	52°51'33.73"	102°11'44.88"	05LC001
Saskatchewan	MA05KH0001	53°50'36.19"	101°19'59.70"	53°51'08.80"	101°20'33.90"	05KJ001***

*Estimated flow for the PPWB South Saskatchewan site is based on recorded flow at Medicine Hat plus the flow from Seven Persons Creek and Ross Creek with a two-day lag.
**Estimated flow for PPWB Churchill site includes recorded flow at Sandy Bay and estimated inflow from Sandy Bay to the boundary.
***Estimated flow for PPWB Saskatchewan site includes recorded flow at 05KJ001 minus flow at the Carrot River 05KH007.

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Overall Adherence to Interprovincial Water Quality Objectives

The overall adherence rate to the interprovincial water quality objectives was, on average, 97.6% in 2019 (Figure 2). This adherence rate is based on the comparison of 5,361 water quality results to water quality objectives (Table 8 and 9). There are no acute water quality concerns apparent from review of these data or as indicated by the adherence rates in 2019.

Site adherence rates from 2019 are similar to those from previous years (Figure 3). While water quality objectives were updated in 2015 and have been applied to the PPWB river reaches since then, adherence rates were calculated retroactively for 2003 through 2014 with the revised water quality objectives to understand how rates have changed over a longer period of time. This analysis allows for comparison of adherence rates for 2019 with previous years using the same 2015 water quality objectives.

Most rivers show little variation in adherence rates among years (approximately 4 to 6%). The Red Deer River on the Alberta-Saskatchewan boundary has had the greatest variability in adherence rate among years, with an 8% variation in adherence rate over the past 17 years. For this river, high and low adherence rates were observed in 2018 and 2005, respectively. The lower adherence rate in 2005 was not specifically attributable to a single variable or one group of variables, although annual discharge was on the higher end for this river in 2005. However, the higher adherence rate in 2018 was attributed to no excursions for metals and fewer nutrient excursions. Quite often the variability of adherence rates demonstrates the susceptibility of a watershed to various weather/hydrological events (e.g. storm, drought) and environmental and land use factors (e.g. agriculture and urban activities, erosion) that also vary annually.

Between 2018 and 2019, three of the Alberta-Saskatchewan boundary rivers showed an increase in the overall adherence rate, and three rivers showed a decrease in the overall adherence rate. The three rivers showing a decrease in adherence rate were the Cold, North Saskatchewan and the Red Deer rivers. This is not totally unexpected given that in 2018 the Red Deer and North Saskatchewan rivers had their highest adherence rates to the interprovincial water quality objectives in the previous 16 years. The drop in the adherence rate for the Cold River was a result of increased number of phosphorus excursions and excursions to the low-level TSS objective.

On the Saskatchewan-Manitoba boundary, the Red Deer River near Erwood has historically shown the greatest fluctuations in overall adherence rate to water quality objectives, with a variation of 6.7% over the last 17 years. In 2019, the overall adherence rate for the Red Deer River was higher than the 2018 adherence rate, with an increase of 2%. In 2018, the Red Deer River near Erwood had 16.5 excursions to the interprovincial water quality objectives and this was reduced to 8 in 2019. Exceedances to objectives on this river included nutrients, TSS, and several metals.

In 2019, four of the transboundary rivers on the Saskatchewan-Manitoba boundary (Churchill, Assiniboine, Red Deer and Qu'Appelle rivers) showed an increase in adherence rate and two rivers (Carrot and Saskatchewan rivers) showed a reduction in adherence rate as compared to 2018. The Churchill River showed the largest increase in adherence rate at 2.1%, with no excursions to the interprovincial water quality objectives in 2019. Of note was that the Churchill, Red Deer and Assiniboine rivers had the highest adherence to the interprovincial water quality objectives in 17 years. The Carrot River had the largest decrease in adherence rate at 0.2% between 2018 and 2019. The excursions were for nutrients, several metals and TSS.

For seven of the PPWB river reaches, the adherence rate was similar to that river's 17-year median adherence rate (with six sites within less than 1%, and one site within 1.5%). However, for the five remaining rivers, adherence rates varied between 1.5 to 3.5% from the 17-year median (Red Deer and South Saskatchewan rivers on the Alberta/Saskatchewan boundary and the Churchill, Red Deer and Assiniboine on the Saskatchewan/Manitoba boundary). The larger variation in the adherence rate for these five rivers was due to the higher adherence rates to the water quality objectives in 2019, which were the highest reported in the last 17 years.

Figure 2: Percent adherences to interprovincial water quality objectives in 2019.

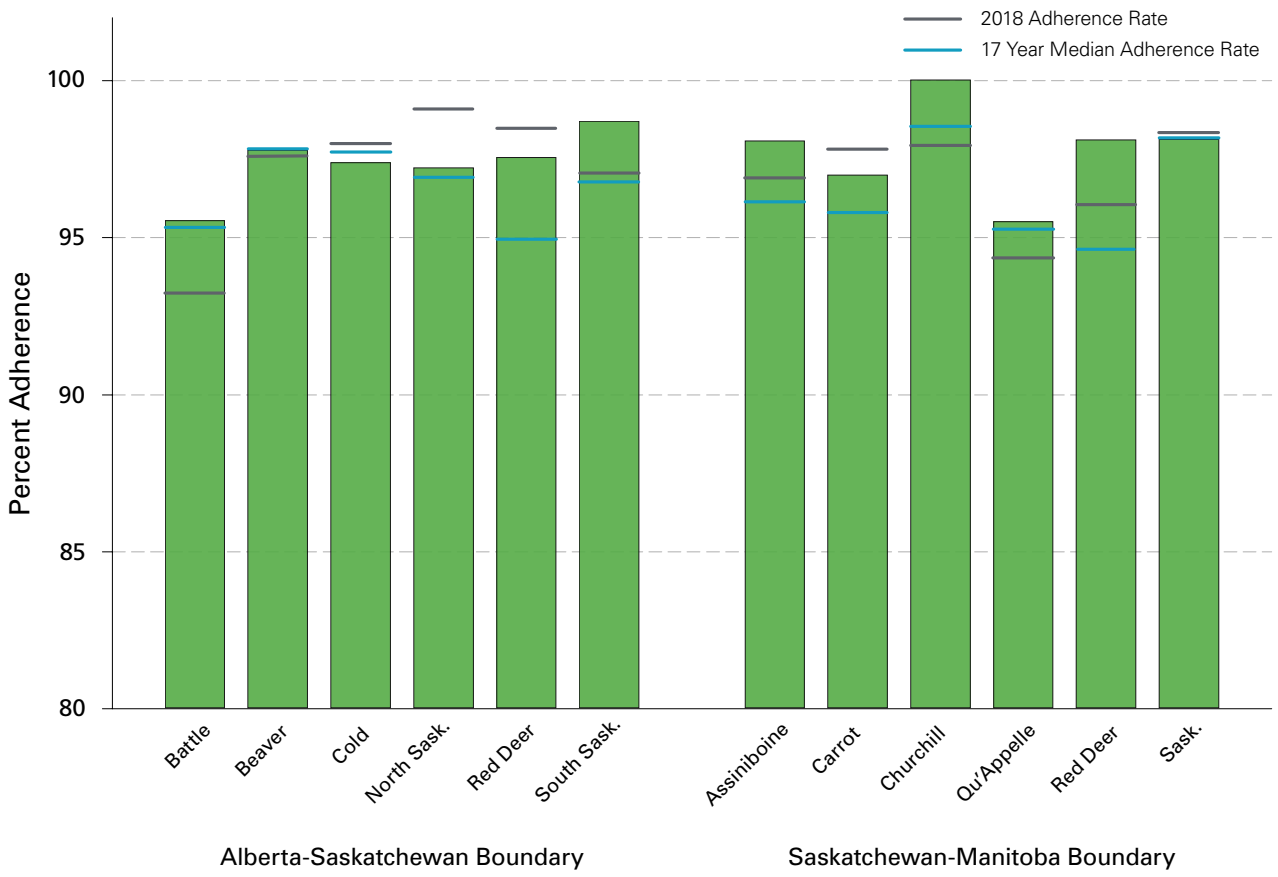
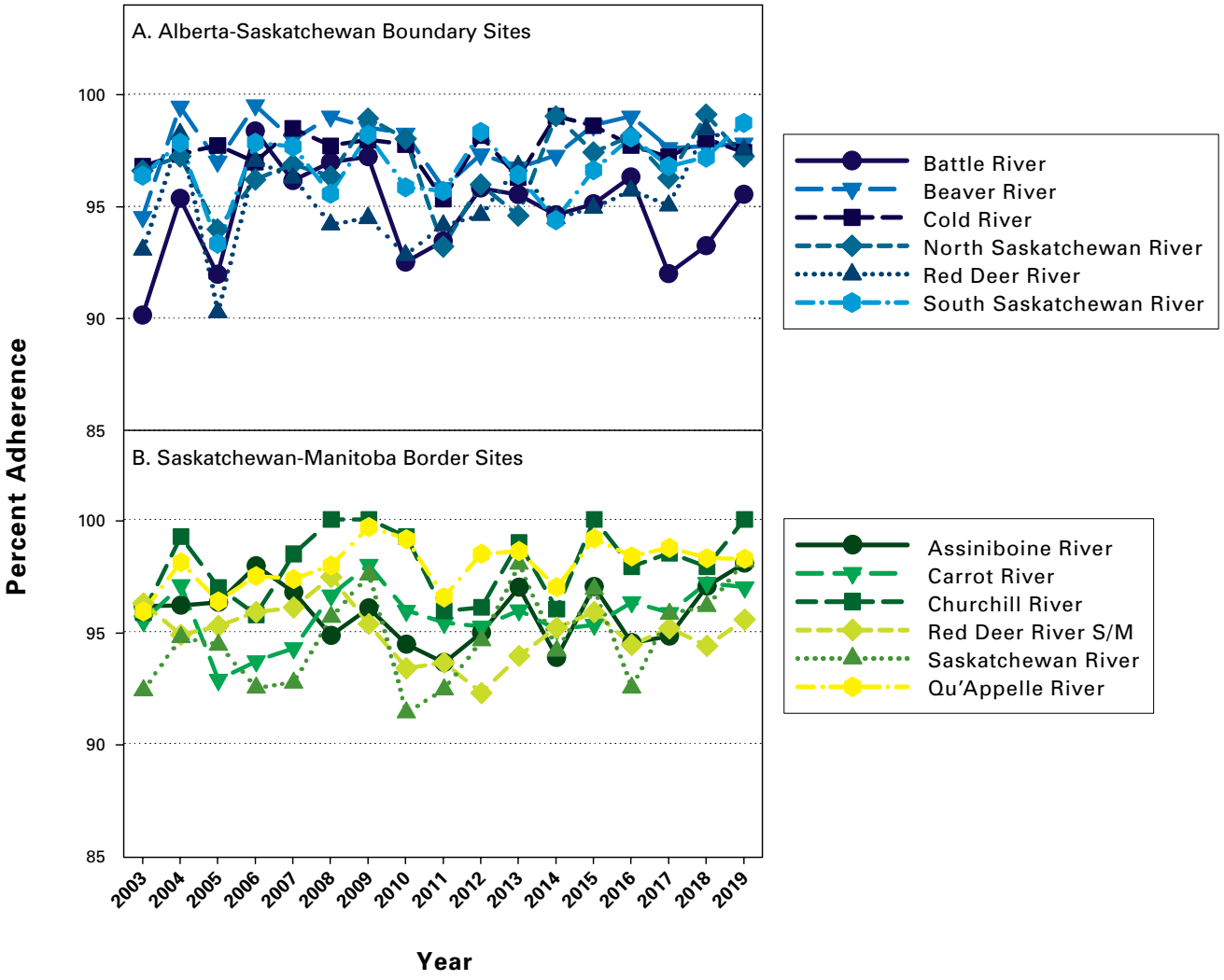


Figure 3: Percent adherences to interprovincial water quality objectives for (A) the Alberta-Saskatchewan and (B) the Saskatchewan-Manitoba boundaries from 2003 to 2019.



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Examination of Specific Parameter Excursions for 2019

Alberta-Saskatchewan Boundary

For the Alberta-Saskatchewan transboundary rivers, there were excursions of objectives for nutrients (total phosphorus (TP), total nitrogen (TN), and total dissolved phosphorus (TDP)), total suspended solids (TSS), metals (arsenic, cadmium, copper, iron, lead, and zinc), and total dissolved solids (TDS)), bacteria (fecal coliforms and E. *coli*), and pesticides (dicamba and MCPA) (Tables 2, 4, 6 and 8).

Total suspended solids is a measure of sediment and particulate matter in the water column. In the water column, sediment may arise from a variety of different processes including erosion of soils in the watershed and along riverbanks and re-suspension of river sediments. When TSS concentrations are elevated, elevated levels of nutrients, total metals and coliform bacteria can occur. Elevated TSS concentrations are typical during spring runoff and other episodic flow events such as following summer storms. For the transboundary rivers, a lower water quality objective for TSS was also set in recognition of the turbid nature of prairie rivers. This lower objective was designated in recognition that some fish species require turbidity, particularly during spring spawning (*e.g.* Goldeye and mooneye). The minimum TSS objective was not met (water was low in TSS) at some sites on some dates in 2019 (*e.g.* Cold River). Generally, flow has an influential effect on water quality and is therefore important to consider when understanding inter- and intra-annual changes in water quality.

Site-specific nutrient objectives were established for TP, TDP and TN for each of the transboundary rivers in 2015. The objectives were established using a statistical approach that evaluated long-term data from each site. In all cases, a site-specific nutrient objective was set at the 90th percentile of all data for each season. Where statistical trends existed, an additional objective was established based on the lowest running 10-year 90th percentile. Given this percentile approach, it is known that there will be a certain proportion of excursions over the long term. The reason for establishing these objectives was to provide a benchmark for evaluating nutrient levels in each river. For objectives set using the complete period of record it is expected that the excursion rate will, on average, be 10%. Typically, these excursions are expected to be more frequent in some years and less frequent in other years based on annual variability affected by hydrology, precipitation and temperature.

Nutrient excursions occurred in five of the six rivers at the Alberta-Saskatchewan boundary in 2019 (Tables 2 and 6). No excursions to the nutrient objectives were observed on the South Saskatchewan River. Nutrient excursions occurred in both seasons for the North Saskatchewan, Red Deer and Cold rivers, while the Battle and Beaver rivers only had nutrient excursions in the open water season.

The Battle River and the Cold River had the highest number of nutrient excursions on the Alberta-Saskatchewan boundary in 2019. The Battle River had excursions to all three site-specific nutrient objectives, which is similar to previous years; however, the total number of excursions was lower in 2019, with six excursions, compared to 8.5 in 2018 and 14 in 2017. The Cold River also had six excursions in 2019, but most (5) were related to TDP with one related to TP. The Red Deer River (near Bindloss) had the third highest number of nutrient excursions in 2019.

The Battle River had total nitrogen (TN) and phosphorus (TP and TDP) excursions to the interprovincial objectives in April. These nutrient excursions coincided with high TSS values in April during spring freshet. Additional phosphorus excursions also occurred in the open water season with excursions of TP occurring in May when TSS was still elevated and excursions of TDP occurring in July and August.

The Cold River had six excursions to the nutrient objectives, exceeding TP once and TDP five times but with no excursions of the TN objective in 2019. For TDP, excursions occurred in April, June, October, November and December. For these excursions, with the exception of June, TDP comprised 73 to 89% of the TP although it was also a high proportion (70 to 80%) of the TP when it met the objectives from January to March. There was an excursion of the total phosphorus value in November to its site-specific objective. Similar to previous years and as expected for the Cold Lake site the nutrient excursions did not coincide with higher TSS. In fact, excursions to the minimum TSS value were reported for April through October with the exception of June and September. The Cold River sampling location is located at the outlet for Cold Lake, and therefore the relationships between TSS and flow observed at other prairie rivers are

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not observed at this site. Particulate material typically settles in the lake making the water at the outlet low in TSS.

With four excursions out of 36 comparisons, the Red Deer River had the third highest number of excursions to the nutrient objectives in 2019 on the Alberta-Saskatchewan boundary. Total nitrogen exceeded the nutrient objective once in February. The majority of TN was comprised of total dissolved nitrogen, notably nitrate/nitrite, and did not coincided with elevated TSS. The high proportion of dissolved nitrogen contributing to the TN concentration was consistent with other winter samples. Total phosphorus did not exceed the period-of-record objective in 2019 but exceeded the lowest-running 10-year objective twice (July and November). The TDP period-of-record objective was exceeded once in July, while the lowest-running 10-year objective was also exceed in April and November. The nutrient excursions in April and November do not appear to be related to spikes in TSS, but the nutrient excursions in April followed a peak in flow during spring freshet. However, excursions of the TP and TDP site-specific objectives that occurred in July correspond with a peak in TSS and flow. Therefore, elevated TSS levels and flow account for some but not all the nutrient excursions observed on this river in 2019.

The Beaver River had excursions of the TP and TDP nutrient objectives in 2019, but not the TN objective. These two excursions occurred in April during spring freshet and an accompanying increase in TSS. Similarly, on the North Saskatchewan River the TN and TP objectives were exceeded during spring freshet in April when flows and TSS were elevated. The objective based on the lowest-running 10-year 90th percentile of TDP was also exceeded on the North Saskatchewan River in April, although the period of record objective was not. For both these rivers, there was an increase in TSS in April, but slightly larger peaks in TSS occurred in July. Total phosphorus increased from pre- and post-July value but did not exceed the objectives in either river.

The Committee continues to work towards a better understanding of nutrient dynamics and sources and while peaks in flow and TSS can explain some of the observed excursions to objectives, these factors do not explain all nutrient excursions. The statistical method used to derive the objectives also accounts for some of the observed excursions, because a certain percentage of excursions will occur. The nutrient objectives were established so the Committee has a means of more readily assessing the frequency of high concentrations. In 2019, the frequency and magnitude of nutrient excursions observed did not raise specific, short-term concerns about high concentration levels of nutrients of these rivers.

Objectives for TSS were set using historical data and included an upper and lower limit to protect aquatic life, in particular to protect turbid water fish that are present in prairie river systems. Total suspended solids site-specific objectives were based on the open water season only as this is the most critical time for the protection of fish and early life stages. Given the statistical approach used to set the TSS objectives, there is an expectation that a certain number of excursions will occur over the long term (10% lower objective plus 10% upper objective).

Three of the six rivers on the Alberta-Saskatchewan boundary exceeded the open water site-specific objective for TSS in 2019. The upper water quality objective was exceeded once on Battle River in April during spring freshet and once on the Beaver River in July in conjunction with a mid-summer flow event. The lower TSS objective was not met on the Cold River throughout the open water season (April, May, July, August and October). The North and South Saskatchewan rivers, and the Red Deer River did not exceed the site-specific open water season TSS objectives in 2019. While the open water site-specific objectives were not exceeded in these three rivers, there were seasonal peaks in TSS on the North Saskatchewan and Red Deer rivers in the spring and mid-summer (July). These two rivers had early summer peak flow events larger than their spring freshet events. The South Saskatchewan River did not experience large spring or summer flows compared to historic patterns and the smaller flow increase at the end of March/early April did not correspond with when water quality samples were collected. There was a slight increase in TSS observed during July in conjunction with a short-term increase in flow, but it was well below the objective value.

Of note, for the Cold River all observed TSS excursions (5 of 7 samples) were a result of not meeting the minimum TSS concentrations for this river. This was also the case in 2015, 2016, and 2018. Low concentrations of TSS, as noted above, are expected given that water quality is monitored at the

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outflow from Cold Lake. Cold Lake is a substantial deep-water lake and it has a moderating effect on the water quality of the outlet.

Six metals (arsenic, cadmium, copper, iron, lead, and zinc) exceeded water quality objectives in one or more rivers on the Alberta-Saskatchewan transboundary rivers in 2019. Five of the six rivers monitored on this boundary had at least one exceedance to a metal objective. Cold River did not exceed a metal objective in 2019. The objectives are for total metals with the exception of iron, manganese and nickel, which are in the dissolved form.

The Battle River exceeded water quality objectives for six metals (arsenic, cadmium, copper, iron, lead and zinc) in 2019. Excursions for arsenic, cadmium, copper, and lead occurred in April and May during the spring and when TSS was elevated. There was also one excursion to the zinc objective in April. A peak in TSS of 517 mg/L was reported in April for this river, while the TSS had declined by May and did not exceed the open water site-specific objective, it was still elevated and the second highest TSS reported for this river in 2019. An excursion of the dissolved iron objective occurred in March under ice conditions with low dissolved oxygen levels. Such conditions are known to have an effect on sediment iron release.

The North Saskatchewan River had excursions of cadmium and copper in 2019. Cadmium (total) concentrations exceeded objectives in January, April, June and July. Of these excursions, two were associated with increased TSS and the proportion of the particulate fraction of cadmium increased, providing a probable explanation for those two exceedances. The January exceedance was atypical for this site. Since 2003 when there was a method change for analyzing metals, the concentration of total cadmium has only been measured at concentrations greater than 0.50 µg/L on three occasions, including the January 2019 sample. The other two samples (June 2006 and June 2013) were largely comprised of particulate cadmium (75% or greater). In contrast the January 2019 concentration of 0.827 µg/L, which was the second highest concentration measured since 2003, had a much smaller particulate proportion (45%) meaning the majority of the measured cadmium was in dissolved form. While a high proportion of dissolved form is not atypical, it is atypical to see it at the concentration measured. The preceding under-ice months (November and December 2018) had excursions of the cadmium objective as reported in the 2018 PPWB Annual Report. However, concentrations were lower (0.155 and 0.057 µg/L, respectively) and do not appear to be linked to the further increase in January 2019. The cause of the January 2019 exceedence is unknown at this time, so the Committee will pay particular attention to winter cadmium levels on the North Saskatchewan River in upcoming years.

Copper (total) exceeded the objectives in January, April and July on the North Saskatchewan River. The particulate proportion of copper was high on all three occasions there were excursions; and while the site-specific TSS objective was not exceeded on the North Saskatchewan River in 2019, peaks of TSS occurred in April and July. The field observations in January 2019 also reported higher than usual turbidity (70 NTU) and slightly elevated TSS for that time of year. For the South Saskatchewan River, cadmium and copper exceeded the water quality objectives in 2019. Excursions occurred in September, and similar to 2018, did not coincide with high flows or TSS although field observations of turbidity at the time were high (160 NTU) and TSS was the second highest concentration of the year (after July).

The Beaver River exceeded the cadmium objective twice in 2019, similar to 2018. Excursions occurred in July and September; while TSS levels were not high in September, a TSS peak did occur in July. The Beaver River also had three excursions of dissolved iron throughout the closed water season (January, November, and December), and one in April during freshet.

For the Red Deer River, two metals (iron and lead) exceeded the water quality objectives in 2019. Iron (dissolved) exceeded the interprovincial water quality objectives in May and July; while the lead (total) objective was exceeded once in July. While the TSS levels were below the upper site-specific water quality objectives in 2019, peaks in TSS did occur in May and July, which coincided with the excursions to the water quality objectives for iron and lead.

In a recent publication, elevated metal concentrations on the Red Deer were explained by natural erosion of soils and high instream sediment mass (Kerr and Cooke, 2017). Alberta

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recently reported to the Committee (PPWB Report #183) on various metal and nutrient excursions for the Red Deer River and similarly concluded that metal exceedances on this river are related to high TSS and erosion of soils, particularly through the badlands region downstream of Drumheller, Alberta.

The Battle River was the only river on the Alberta-Saskatchewan boundary to exceed the total dissolved solids (TDS) objective in 2019. This same pattern occurred in 2018 and 2017. While none of the major ions exceeded the interprovincial water quality objectives, TDS exceeded the water quality objective in the Battle River during the ice-cover season (January and February). These exceedances are considered to be a result of low flows in the Battle River in late winter and under-ice conditions. In recognition of higher salinity in the Battle River, a site-specific objective was established using a similar approach to nutrients (90th percentile). Therefore there is an expectation that this objective will be exceeded 10% of the time over the long-term.

All rivers on the Alberta-Saskatchewan boundary, except the Beaver and Cold rivers, exceeded the fecal coliform bacteria water quality objective of 100 No./100 mL occasionally in 2019. Fecal coliform densities ranged from less than 2 to 470 No./100 mL. Peak densities for the North Saskatchewan, South Saskatchewan, Battle, and Red Deer rivers were 330, 470, 130, and 390 No./100 mL respectively. Sources of fecal coliform are numerous and include wildlife waste, discharge of wastewater, and runoff from agricultural activities including livestock operations and agricultural fields that receive animal-waste products. Occasional exceedances of fecal coliform objectives are expected in surface waters, particularly in response to rainfall events that can transport fecal bacteria through runoff.

In the case of the Red Deer River, the detection of fecal coliform bacteria occurred in July and September, and while the TSS levels were below water quality objectives, the exceedances did occur during the highest TSS levels on this river in 2019. For the other three rivers (Battle, North Saskatchewan and South Saskatchewan rivers) the detection of fecal coliform bacteria did not appear to be related to any significant increase in TSS. All fecal coliform bacteria excursions occurred during the open water season.

Escherichia coli (E. *coli*), is also a measure of fecal contamination in water sources and is generally considered the preferred indicator because it is more specific than fecal coliform bacteria counts. In 2019, E. *coli* exceeded the water quality objectives once in each the Battle, Red Deer, South Saskatchewan, and North Saskatchewan rivers. All these excursions matched dates where there were excursions of the fecal coliform objective. As E. *coli* is a sub group of bacteria within the fecal coliform group it is not unexpected that excursions may occur at the same time for the two measures of fecal contamination. The Battle and Red Deer rivers each had one additional excursion of the fecal coliform objective where the E.*coli* objective was met. *Escherichia coli* concentrations ranged from less than 2 to 340 No./100 mL for the four transboundary rivers. The E. *coli* excursions occurred during July for the Battle and Red Deer River, August for the North Saskatchewan River, and September for the South Saskatchewan River.

The E. *coli* excursion on the Red Deer River corresponded with the July peak flow event, but there was no such clear correspondence for the other three transboundary rivers. Fecal coliform bacteria exceeded the water quality objective more frequently than the E.*coli*, but the interprovincial water quality objective is lower for fecal coliforms as compared to E.*coli*.

Pesticide monitoring on the transboundary rivers is conducted on a rotational basis with each river being monitored once every four years. As a result of this rotational sampling, the full suite of pesticide monitoring was conducted on the Red Deer and Battle rivers on the Alberta-Saskatchewan boundary in 2019. In addition, the acid herbicide group of pesticides were also measured on the North and South Saskatchewan rivers on this boundary.

In 2019, excursions were observed for the acid herbicide dicamba on three rivers and for MCPA on one river (Table 4). Dicamba exceeded the water quality objective twice in the South Saskatchewan River (July and October) and once each in the Red Deer River (June) and North Saskatchewan River (August). MCPA exceeded the water quality objective once in the Battle River in July. The Beaver and Cold rivers were not sampled in 2019 as part of the rotational pesticide monitoring program. The Committee is continuing to follow up with each of the jurisdictions on the presence of these pesticides in the transboundary river systems.

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Glyphosate is a nonselective systemic herbicide that is used extensively throughout the prairie region. The PPWB does not currently have a numerical objective for glyphosate, but given its extensive use throughout the prairies, the PPWB has chosen to report detections of this herbicide. In 2019, glyphosate was monitored on the South Saskatchewan, North Saskatchewan, Red Deer River, and Battle River. Glyphosate was not detected on the Red Deer River, but it was detected in the North and South Saskatchewan rivers and the Battle River. Glyphosate was detected at low levels in two water samples collected from the North Saskatchewan River and ranged in concentration from 84.4 ng/L in April to 27.6 ng/L in May. For the South Saskatchewan River, glyphosate was detected in one sample in July with a concentration of 36.3 ng/L. The Battle River had three samples with detections throughout the summer months with concentrations for each month of 51.8 ng/L (June), 55.4 ng/L (July), and 38.9 ng/L (August).

Aminomethylphosphonic acid (AMPA), a breakdown product of glyphosate, was also reported at low levels for three of the four rivers monitored on the Alberta-Saskatchewan boundary in 2019. Aminomethylphosphonic acid was detected in six of the seven samples collected from the Battle River with concentrations ranging from 78.6 to 287 ng/L. The North Saskatchewan River had low levels of AMPA in five of the seven samples collected in 2019 (26.4 to 130 ng/L), while the South Saskatchewan River had no detections for AMPA. The Red Deer River, which did not have detectable levels of glyphosate in 2019, did have low detectable levels of AMPA in February and July with concentrations of 42 and 28 ng/L, respectively.

Saskatchewan-Manitoba Boundary

In 2019, water quality excursions for the Saskatchewan-Manitoba boundary included objectives for nutrients (TP, TDP, TN), total suspended solids (TSS), metals (arsenic, cadmium, and copper), major ions (sulphate and TDS), and bacteria (E.*coli* and fecal coliforms) (Tables 3, 5, 7 and 9).

Nutrient objectives for the Saskatchewan-Manitoba boundary, similar to the Alberta-Saskatchewan boundary, were established with a statistical approach that evaluated long-term data from each site. There were nutrient excursions at four sites on the Saskatchewan-Manitoba boundary in 2019 (Tables 3 and 7). The number of excursions, out of 36 comparisons, to the site-specific objectives were 9.5 excursions on the Carrot River, 3 on the Red Deer River, 2.5 on the Saskatchewan River and 2 on the Assiniboine River. The Qu'Appelle and the Churchill rivers did not exceed any site-specific nutrient objectives in 2019.

In 2019, the Carrot River had the highest number of nutrient excursions to the site-specific objectives of any of the transboundary rivers. As the Carrot River has shown statistically significant increasing trends in concentrations of phosphorus (TP and TDP), and nitrogen (TN), site-specific objectives were established for both the 90th percentile of the entire period of record and the 90th percentile of the lowest running 10 years for each of the two seasons.

For TP, excursions of the 90th percentile objective on the Carrot River occurred during spring freshet in April and May. When this objective is exceeded, the lowest running 10-year 90th percentile objective (lower objective) is also exceeded (Table 7). During the spring freshet (April and May) phosphorus was comprised of over 83% particulate phosphorus. In February, July, August, September and October, while the 90th percentile site-specific objective was not exceeded, the lowest running 10-year 90th percentile objective did exceed its seasonal objective. For TDP the 90th percentile site-specific objective was exceeded in July, while the lowest running 10-year 90th percentile objective was exceeded throughout the open water season from April to September 2019.

Total nitrogen for the Carrot River did not exceed the higher 90th percentile objective but there were excursions to the lowest running 10-year 90th percentile in May, August and October. For the Carrot River, 44% of the nutrient samples collected in 2019 exceeded the lowest running 10-year 90th percentile site-specific nutrient objectives. However, this excursion rate cannot be directly compared to the expected 10% of exceedances over the long-term based on the method to derive these objectives. For a direct comparison only the excursion of the period-of-record objective can be made, which had an excursion rate of 8.3% in 2019. The excursion rate of the combined objectives was 26% (Table 7). The combined excursion rate for the Carrot River in 2019 is higher than that reported in 2018; however, 2019 had the same number of excursions to the period-of-record objective as 2018. Elevated TSS was reported in April and May during spring freshet, with a TSS of 112 and 530 mg/L respectively.

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These TSS peaks in April and May coincided with exceedances of the two TP period-of-record based seasonal site-specific objectives. Exceedances of the lowest-running 10 year-based nutrient objectives were not always related to increases in TSS.

The Red Deer River (Erwood) had the second highest number of excursions to the site-specific nutrient objectives on the Saskatchewan-Manitoba boundary. Three period of record-based objectives were exceeded, one each for TP, TDP, and TN. This means less than 10% of samples analyzed had excursions, which is less than the expected long-term average excursion rate based on the methods used to derive the objective values. The number of nutrient excursions on the Saskatchewan-Manitoba boundary was also lower in 2019 than it was in 2018. The excursions to the 90th percentile (and hence lowest running 10-year 90th percentile) site-specific nutrient objectives all occurred at the same time as spring freshet and a peak in TSS. The measured TSS in April was 131 mg/L compared to values of 6 mg/L or lower in all the other samples from 2019. During April, 50% of the total phosphorus was in the particulate form, and this remained relatively consistent throughout the summer months, until October and November when the dissolved fraction increased as a percentage of the total phosphorus. Particulate nitrogen generally comprised a small fraction of total nitrogen in 2019 (between 1 and 11%) except for April when it comprised 26%. Thus, during April there was an increased contribution from particulates making up the TN concentration, which is attributed to the increase in suspended sediment and particulates measured that month.

The Saskatchewan River had excursions of the 90th percentile site-specific objectives for TP and TN in August. These occurred in conjunction with a corresponding peak in TSS. There was also an excursion of the TDP lowest running 10-year 90th percentile objective in December under-ice conditions.

The Assiniboine River had one excursion to the 90th percentile site-specific objectives of TN and TDP in 2019. The excursion to TN occurred in April during peak flow and coincided with a peak in the TSS, while the TDP excursion to the objective occurred in October. The TDP exceedance did not coincide with increases in TSS for the Assiniboine River.

Understanding specific factors affecting nutrient concentrations continues to be a priority for all jurisdictions. The Committee has, for the last several years, focussed work on the Red Deer River (AB) and the Carrot River watersheds to assess point and non-point sources of nutrients to these transboundary rivers. While, this work was completed in 2019 (PPWB Report #180), the Committee will continue to look at nutrients in all transboundary rivers. Trend analysis (PPWB report #179) and a prioritization process highlighted TN as the nutrient with the highest priority for understanding factors affecting its temporal changes in prairie rivers.

The total suspended solids objectives, which have only been established for the open water season, were exceeded on at least one occasion for five of the six Saskatchewan-Manitoba boundary river sites in 2019. As in 2018, the TSS objectives were not exceeded in 2019 on the Churchill River. For the Assiniboine and Carrot rivers, only the upper objective was exceeded in 2019. These exceedances corresponded with peak freshet flows in April and/or May. For the Red Deer River, there were two excursions to the lower objective (June and October) and there were no exceedance of the upper objective in 2019. The excursions fit the expected pattern of suspended solids in these rivers and based on flows and methods to derive objectives using a percentile approach, are not a concern.

For the Saskatchewan River in 2019, there were three excursions to the TSS objectives during the open water season including one exceedance of the upper objective and two exceedances of the lower objective. Of note were the two exceedances of the lower objective that occurred in April and May when higher TSS levels are typically expected when flows are high during spring freshet. For the Qu'Appelle River there was one excursion of the lower objective in September.

Three metals (arsenic, cadmium and copper) exceeded water quality objectives at one or more river sites on the Saskatchewan-Manitoba boundary in 2019. Five of the six transboundary rivers had at least one excursion, with the Churchill River being the only river where exceedences to metal objectives were not observed. On the Saskatchewan-Manitoba boundary, the Assiniboine and Carrot rivers had the most number of metal excursions (five each) in 2019.

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Cadmium and copper each exceeded water quality objectives at four of the transboundary rivers on this boundary in 2019. Three rivers, the Carrot, Red Deer and Saskatchewan exceeded both the cadmium and copper objectives. The Qu'Appelle River exceeded the cadmium, but not the copper objective, while the Assiniboine River exceeded the copper objective, but did not exceed the cadmium objective. For the three rivers with excursions of both cadmium and copper, exceedences appear to coincide with peaks in TSS. The Carrot River had three excursions of the total cadmium objective, two of which coincided with peak TSS during spring freshet and of which the majority of the metal (90% or greater) was in the particulate form. The third excursion occurred in March and was largely a result of the increased proportion of dissolved cadmium (74% was in dissolved form). This may be in response to lower pH and oxygen in combination with factors causing sediment disturbance during spring melt. However, these factors have not been specifically investigated.

Cadmium was the only metal to exceed interprovincial water quality objectives on the Qu'Appelle River in 2019. The exceedance occurred in March, but similar to the excursion on the Carrot River in March, it was largely comprised of dissolved cadmium (91%) and did not coincide with elevated levels of TSS.

Copper exceeded water quality objectives on the Assiniboine River in April and June. The April excursion coincided with high flows and increased TSS, while the June excursion coincided with elevated TSS.

Arsenic (total) exceeded the water quality objective on the Assiniboine River in July, August and October. Similar to 2018, these excursions did not appear to coincide with increased flows or elevated TSS levels. Dissolved arsenic comprised a high percentage of the total arsenic concentrations (95-96%) on these dates. Saskatchewan prairie soils are known to contain natural arsenic at levels above protection of aquatic life (5 µg/L) and drinking water (10 µg/L) guidelines. Exceedances of this objective on the Assiniboine River are not entirely unexpected.

Three rivers, the Assiniboine, Qu'Appelle and Red Deer rivers, on the Saskatchewan-Manitoba boundary had excursions to TDS in 2019. The Qu'Appelle River also had multiple excursions to sulphate throughout the year in 2019. However, the Churchill, Carrot, and Saskatchewan rivers did not have any reported excursions to major ions and/or TDS objectives in 2019.

For the Assiniboine and Qu'Appelle rivers, TDS and sulphate objectives were set with a similar approach to nutrients, whereby statistical analysis using historical data was used to define an expected range of concentrations. As with nutrients, there is an expectation that there will be a certain proportion of excursions over the long term.

In 2019, the Assiniboine River had three excursions to TDS during the closed water season (January, February, and December) representing 25% of the samples with a maximum exceedance of 16% over the objective. The proportion of exceedances in 2019 was higher than that in 2018 (17% exceedances) and lower than the 42% of exceedances found in 2017. In 2019 the Assiniboine River did not have any exceedances to the sulphate objective, which have been reported in previous years including in 2018 and 2017. Trend analysis work completed by the Committee to the end of 2013 has shown increasing trends for sulphate in a number of the transboundary rivers including the Assiniboine River. Initial review of these data suggests that during periods of higher flow in the Assiniboine River, the Whitesand River, which is a tributary to the Assiniboine River and has higher concentrations of sulphate and TDS, contributes a greater proportion of flow.

For the Qu'Appelle River TDS exceeded its objective in January to March and October to December. The objective was exceeded to a maximum amount of 12%. Sulphate excursions occurred on all the same dates as those for TDS but also included excursions in July and August. Excursions for sulphate occurred in eight of the 12 samples (67%) collected in 2019. Sulphate levels from July to September ranged from 473 to 518 mg/L (Qu'Appelle sulphate objective = 486 mg/L) The expected seasonal pattern for TDS in the Qu'Appelle River is increased concentrations throughout the ice-covered season, with a decrease in concentration associated with spring runoff and gradual increase over the summer and autumn depending on flow conditions.

The Red Deer (Erwood) River has a water use TDS objective of 500 mg/L and had one exceedance in March of 518 mg/L under ice-cover in 2019. Historically, this river has had excursions to the TDS objective during the late winter

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months (January to March). Long-term assessment has shown that more than half of the winter samples typically are greater than the objective. In 2019, TDS concentrations decreased following freshet and while subsequent samples did not exceed the water use objective in 2019, the concentrations gradually increased throughout the late fall and early winter.

There were no TDS excursions on the Carrot River in 2019. Similar to the Assiniboine and Qu'Appelle rivers, site-specific objectives for TDS were established based on historical background data. The Saskatchewan and Churchill rivers have a water use objective of 500 mg/L for TDS and did not have any excursions to this objective in 2019.

On the Saskatchewan-Manitoba boundary, the Qu'Appelle River was the one river to have excursions to the fecal coliform bacteria objective and the E.*coli* objective in 2019. The Qu'Appelle River had excursions to fecal coliforms in June, July and August and to E. *coli* in July. As noted above, E. *coli* is a subgroup of bacteria within the fecal coliform group, so it is not unexpected that excursions may occur at the same time for the two measures. Fecal coliform bacteria did exceed water quality objectives more frequently than the E. *coli*, but the interprovincial water quality objective for fecal coliform is lower than the water quality objective for densities of E.*coli*. Given the often high variability of bacterial indicators in water, the observed exceedences did not raise specific concerns.

In 2019, the Assiniboine and Carrot rivers were monitored for acid herbicides, neutral herbicides and organochlorine pesticides as part of their annual water quality-monitoring program. In addition, the Qu'Appelle and Saskatchewan rivers were monitored for the acid herbicides, a group of pesticides that have periodically exceeded the water quality objectives on the Carrot and Assiniboine rivers (PPWB Report #175). The Committee is continuing to follow up on pesticides and is working with the jurisdictions on the recommendations and follow-up actions from this report.

In 2019, none of the pesticides within the three pesticide groups monitored on the Assiniboine or Carrot rivers or the acid herbicides on the Qu'Appelle and Saskatchewan rivers exceeded the interprovincial water quality objectives.

The PPWB, as noted earlier, has also implemented the monitoring of glyphosate and its metabolites because glyphosate is the single highest use pesticide on the prairies. In 2019, glyphosate was monitored on the Carrot, Assiniboine, Qu'Appelle and Saskatchewan rivers on the Saskatchewan-Manitoba boundary. For the four rivers on the Saskatchewan/Manitoba border where samples were collected for glyphosate analysis, glyphosate was detected in at least one sample during the open water season.

For the Assiniboine River, glyphosate was detected in seven of the eleven samples collected in 2019 with detections occurring throughout the open water season (April through October). The maximum concentration for the Assiniboine River occurred in April during spring freshet at a concentration of 1390 ng/L. For the Carrot River, glyphosate was detected in four of the 11 samples collected with a maximum concentration of 187 ng/L. Similar to the Assiniboine River this peak in glyphosate concentration on the Carrot River also occurred in April during spring freshet.

Glyphosate was monitored eight times on the Qu'Appelle River and was detected in five samples in the open water season (April through August). Similar to the Assiniboine and Carrot rivers, the maximum concentration of glyphosate detected in the Qu'Appelle River occurred in April during spring freshet (493 ng/L). For the Saskatchewan River, glyphosate was detected once in July at a concentration of 16.9 ng/L, which is close to the method detection limit of 16.6 ng/L.

Aminomethylphosphonic acid (AMPA) was also detected at low levels in all four transboundary rivers monitored on the Saskatchewan-Manitoba boundary in 2019.

Aminomethylphosphonic acid was detected in eight of the samples collected from the Assiniboine River with a peak concentration of 25,400 ng/L in October. This is the highest concentration of AMPA detected in the transboundary river since monitoring for AMPA began in 2013. For the Carrot River, AMPA was detected in five of the 11 samples and occurred at low levels. For the Qu'Appelle River AMPA was detected throughout the open water season (April, May, June, July, September and October), with the peak concentration in April during spring freshet. The Saskatchewan River had two low level detections of AMPA in 2019 in May and August. Given its extensive use throughout the prairies, the Committee will continue to monitor and report detections of glyphosate in the transboundary rivers.

Table 2: Excursion frequency summary table for Alberta-Saskatchewan water quality stations. (The number of excursions is provided on the left and the total number of objective comparisons for each parameter is provided in brackets to the right).

	ALBERTA-SASKATCHEWAN BOUNDARY					
	BATTLE RIVER	BEAVER RIVER	COLD RIVER	NORTH SASK. RIVER	RED DEER RIVER A/S	SOUTH SASK. RIVER
METALS						
ARSENIC DISSOLVED	—	—	—	—	—	—
ARSENIC TOTAL	2(12)	0(12)	0(12)	0(12)	0(12)	0(12)
BARIUM TOTAL	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
BERYLLIUM TOTAL	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
BORON TOTAL	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
CADMIUM TOTAL	2(12)	2(12)	0(12)	4(12)	—	1(12)
CHROMIUM TOTAL	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
COBALT TOTAL	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
COPPER TOTAL	2(12)	0(12)	0(12)	3(12)	—	1(12)
IRON DISSOLVED	1(12)	4(12)	0(12)	0(12)	2(12)	0(12)
LEAD TOTAL	2(12)	0(12)	0(12)	0 (12)	1(12)	0(12)
LITHIUM TOTAL	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
MANGANESE DISSOLVED	—	—	0(12)	0(12)	0(12)	0(12)
MOLYBDENUM TOTAL	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
NICKEL DISSOLVED	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
SELENIUM TOTAL	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
SILVER TOTAL	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
THALLIUM TOTAL	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
URANIUM TOTAL	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
VANADIUM TOTAL	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
ZINC TOTAL	1(12)	0(12)	0(12)	0(12)	2(12)	0(12)
NUTRIENTS						
AMMONIA UN-IONIZED	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
PHOSPHORUS TOTAL *	2(12)	1(12)	1(12)	1.5(12)	1(12)	0(12)
PHOSPHORUS TOTAL DISSOLVED *	3(12)	1(12)	5(12)	0.5(12)	2(12)	0(12)
NITROGEN TOTAL *	1(12)	0(12)	0(12)	1(12)	1(12)	0(12)
NITROGEN DISSOLVED NO3 and NO2	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
MAJOR IONS						
CHLORIDE DISSOLVED	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
FLUORIDE DISSOLVED	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
SODIUM DISSOLVED/FILTERED	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
SULPHATE DISSOLVED	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
TOTAL DISSOLVED SOLIDS	2(12)	0(12)	0(12)	0(12)	0(12)	0(12)
BIOTA						
COLIFORMS FECAL	2(12)	0(12)	0(12)	1(12)	2(12)	1(12)
ESCHERICHIA COLI	1(12)	0(12)	0(12)	1(12)	1(12)	1(12)
PHYSICALS and OTHERS						
OXYGEN DISSOLVED	0(7)	0(6)	0(12)	0(12)	0(12)	0(12)
PH	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
SODIUM ADSORPTION RATIO	—	0(12)	0(12)	0(12)	0(12)	0(12)
TOTAL SUSPENDED SOLIDS	1(7)	1(7)	5(7)	0(7)	0(7)	0(7)
Number of Excursion Comparisons	398	409	427	427	403	427
Total Number of Excursions Observed	22	9	11	12	12	4
Sampling Frequency (no./year)	12	12	12	12	12	12

* Summary information – details in Table 6

Table 3: Excursion frequency summary table for Saskatchewan-Manitoba water quality stations. (The number of excursions is provided on the left and the total number of objective comparisons for each parameter is provided in brackets to the right).

	SASKATCHEWAN-MANITOBA BOUNDARY					
	ASSINIBOINE RIVER	CARROT RIVER	CHURCHILL RIVER	QU'APPELLE RIVER	RED DEER RIVER S/M	SASK. RIVER
METALS						
ARSENIC DISSOLVED	—	0(12)	—	0(12)	—	—
ARSENIC TOTAL	3(12)	—	0(4)	—	0(12)	0(11)
BARIUM TOTAL	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
BERYLLIUM TOTAL	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
BORON TOTAL	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
CADMIUM TOTAL	0(12)	3(12)	0(4)	1(12)	1(12)	1(11)
CHROMIUM TOTAL	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
COBALT TOTAL	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
COPPER TOTAL	2(12)	2(12)	0(4)	0(12)	1(12)	1(11)
IRON DISSOLVED	0(12)	—	0(4)	0(12)	0(12)	0(11)
LEAD TOTAL	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
LITHIUM TOTAL	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
MANGANESE DISSOLVED	—	—	0(4)	—	0(12)	0(11)
MOLYBDENUM TOTAL	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
NICKEL DISSOLVED	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
SELENIUM TOTAL	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
SILVER TOTAL	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
THALLIUM TOTAL	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
URANIUM TOTAL	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
VANADIUM TOTAL	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
ZINC TOTAL	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
NUTRIENTS						
AMMONIA UN-IONIZED	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
PHOSPHORUS TOTAL *	0(12)	4.5(12)	0(4)	0(12)	1(12)	1(11)
PHOSPHORUS TOTAL DISSOLVED *	1(12)	3.5(12)	0(4)	0(12)	1(12)	0.5(11)
NITROGEN TOTAL *	1(12)	1.5(12)	0(4)	0(12)	1(12)	1(11)
NITROGEN DISSOLVED NO3 and NO2	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
MAJOR IONS						
CHLORIDE DISSOLVED	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
FLUORIDE DISSOLVED	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
SODIUM DISSOLVED/FILTERED	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
SULPHATE DISSOLVED	0(12)	0(12)	0(4)	8(12)	0(12)	0(11)
TOTAL DISSOLVED SOLIDS	3(12)	0(12)	0(4)	6(12)	1(12)	0(11)
BIOTA						
COLIFORMS FECAL	0(12)	0(12)	0(4)	3(12)	0(12)	0(11)
ESCHERICHIA COLI	0(12)	0(12)	0(4)	1(12)	0(12)	0(11)
PHYSICALS and OTHERS						
OXYGEN DISSOLVED	0(12)	0(5)	0(4)	0(12)	0(12)	0(11)
PH	0(12)	0(12)	0(4)	0(12)	0(12)	0(11)
SODIUM ADSORPTION RATIO	0(12)	—	0(4)	—	0(12)	0(11)
TOTAL SUSPENDED SOLIDS	1(7)	2(7)	0(3)	1(7)	2(6)	3(7)
Number of Excursion Comparisons	415	384	143	403	426	392
Total Number of Excursions Observed	11	16.5	0	20	8	7.5
Sampling Frequency (no./year)	12	12	4	12	12	11

* Summary information – details in Table 7

Table 4: Excursion frequency summary table of pesticides for Alberta-Saskatchewan water quality stations. (The number of excursions is provided on the left and the total number of objective comparisons for each parameter is provided in brackets to the right).

	ALBERTA-SASKATCHEWAN BOUNDARY					
	BATTLE RIVER	BEAVER RIVER	COLD RIVER	NORTH SASK. RIVER	RED DEER RIVER A/S	SOUTH SASK. RIVER
PESTICIDES						
2,4-D	0(8)	Not Sampled	Not Sampled	0(8)	0(8)	0(8)
ATRAZINE	0(8)			NA	0(8)	NA
BROMOXYNIL	0(8)			0(8)	0(8)	0(8)
DICAMBA	0(8)			1(8)	1(8)	2(8)
DICLOFOP-METHYL	0(8)			NA	0(8)	NA
ENDOSULFAN	0(7)			NA	0(8)	NA
GAMMA-BENZENEHEXACHLORIDE	0(7)			NA	0(8)	NA
HEXACHLOROBENZENE	0(7)			NA	0(8)	NA
MCPA	1(8)			0(8)	0(8)	0(8)
METOLACHLOR	0(8)			NA	0(8)	NA
METRIBUZIN	0(8)			NA	0(8)	NA
PENTACHLOROPHENOL (PCP)	—			—	—	—
PICLORAM	0(8)			0(8)	0(8)	0(8)
SIMAZINE	0(8)			NA	0(8)	NA
TRIALLATE	0(8)			NA	0(8)	NA
TRIFLURALIN	0(8)			NA	0(8)	NA
GLYPHOSATE	3(7)a	Not Sampled	Not Sampled	2(7)[a]	0(7)[a]	1(6)[a]
Number of Excursion Comparisons	117			40	120	40
Total Number of Excursions Observed	1			1	1	2
Sampling Frequency (no./year)	8			8	8	8

a= Detected but no numerical objective has been established, not included in the excursion counts

Table 5: Excursion frequency summary table of pesticides for Saskatchewan-Manitoba water quality stations. (The number of excursions is provided on the left and the total number of objective comparisons for each parameter is provided in brackets to the right).

	SASKATCHEWAN-MANITOBA BOUNDARY					
	ASSINIBOINE RIVER	CARROT RIVER	CHURCHILL RIVER	QU'APPELLE RIVER	RED DEER RIVER S/M	SASK. RIVER
PESTICIDES						
2,4-D	0(11)	0(12)	Not Sampled	0(9)	Not Sampled	0(7)
ATRAZINE	0(10)	0(11)		NA		NA
BROMOXYNIL	0(11)	0(12)		0(9)		0(7)
DICAMBA	0(11)	0(12)		0(9)		0(7)
DICLOFOP-METHYL	0(10)	0(11)		NA		NA
ENDOSULFAN	0(8)	0(8)		NA		NA
GAMMA-BENZENEHEXACHLORIDE	0(8)	0(8)		NA		NA
HEXACHLOROBENZENE	0(8)	0(8)		NA		NA
MCPA	0(11)	0(12)		0(9)		0(7)
METOLACHLOR	0(10)	0(11)		NA		NA
METRIBUZIN	0(10)	0(11)		NA		NA
PENTACHLOROPHENOL (PCP)	—	—		—		—
PICLORAM	0(11)	0(12)		0(9)		0(7)
SIMAZINE	0(10)	0(11)		NA		NA
TRIALLATE	0(10)	0(11)		NA		NA
TRIFLURALIN	0(10)	0(11)		NA		NA
GLYPHOSATE	7(11)[a]	4(11)	Not Sampled	5(8)	Not Sampled	1(7)
Number of Excursion Comparisons	149	161		45		35
Total Number of Excursions Observed	0	0		0		0
Sampling Frequency (no./year)	11	12		9		7

a= Detected but no numerical objective has been established, not included in the excursion counts

Table 6: Nutrient Excursions for Alberta-Saskatchewan water quality stations

LOCATION		TOTAL PHOSPHORUS		TOTAL DISSOLVED PHOSPHORUS		TOTAL NITROGEN		NUMBER OF EXCURSION COMPARISONS	TOTAL NUMBER OF EXCURSIONS OBSERVED
BATTLE RIVER	Open Water Ice-Covered	2(7) 0(5)	2(7) 0(5)	3(7) 0(5)		1(7) 0(5)		36	6
BEAVER RIVER	Open Water Ice-Covered	1(7) 0(5)		1(7) 0(5)	1(7) 0(5)	0(7) 0(5)		36	2
COLD RIVER	Open Water Ice-Covered	0(7) 1(5)		3(7) 2(5)		0(7) 0(5)	0(7) 0(5)	36	6
NORTH SASK. RIVER	Open Water Ice-Covered	1(7) 1(5)	1(7) 0(5)	1(7) 0(5)	0(7) 0(5)	1(7) 0(5)	1(7) 0(5)	36	3
RED DEER RIVER A/S	Open Water Ice-Covered	1(7) 1(5)	0(7) 0(5)	2(7) 1(5)	0(7) 0(5)	0(7) 1(5)		36	4
SOUTH SASK. RIVER	Open Water Ice-Covered	0(7) 0(5)	0(7) 0(5)	0(7) 0(5)	1(7) 0(5)	0(7) 0(5)	0(7) 0(5)	36	0

Open water season = April or May to October

Downward Trend | Upward Trend | No Trend

Nutrient objectives were established based on analyses of historical data, which indicated that concentrations vary with season (open water versus ice-covered) and in some cases showed trends. In all cases, a site-specific base nutrient objective was set at the 90th percentile of the data for each season, which would be exceeded on average 10% of the time (values in yellow and white boxes). Where statistical trends existed, an additional objective was established based on the 90th percentile of the lowest value 10 year period (values in blue boxes = decreasing trend; green boxes = increasing trend). Exceedance of this second objective indicates a nutrient concentration greater than the 90th percentile of the lowest 10-year period for that site.

The total number of excursions is calculated as the sum of the base objective exceedances (yellow boxes) or the arithmetic average of the trend (blue or green boxes) and corresponding base (white boxes) objective exceedances.

Table 7: Nutrient Excursions for Saskatchewan-Manitoba water quality stations

LOCATION		TOTAL PHOSPHORUS		TOTAL DISSOLVED PHOSPHORUS		TOTAL NITROGEN		NUMBER OF EXCURSION COMPARISONS	TOTAL NUMBER OF EXCURSIONS OBSERVED
ASSINIBOINE RIVER	Open Water Ice-Covered	0(7) 0(5)		1(7) 0(5)		1(7) 0(5)		36	2
CARROT RIVER	Open Water Ice-Covered	5(6) 2(6)	1(6) 1(6)	5(6) 1(6)	1(6) 0(6)	3(6) 0(6)	0(6) 0(6)	36	9.5
CHURCHILL RIVER	Open Water Ice-Covered	0(3) 0(1)		0(3) 1(1)		0(3) 1(1)		12	0
QU'APPELLE RIVER	Open Water Ice-Covered	0(6) 0(6)	0(6) 0(6)	0(6) 0(6)	0(6) 0(6)	0(6) 0(6)		36	0
RED DEER RIVER S/M	Open Water Ice-Covered	0(6) 1(6)	0(6) 1(6)	0(6) 1(6)	0(6) 1(6)	0(6) 1(6)		36	3
SASK. RIVER	Open Water Ice-Covered	1(7) 0(4)	1(7) 0(4)	0(7) 1(4)	0(7) 0(4)	1(7) 0(4)		33	2.5

Open water season = April or May to October

Downward Trend | Upward Trend | No Trend

Table 8: Overall excursion summary, by category, for Alberta-Saskatchewan water quality stations. (The number of excursions is provided on the left and the total number of objective comparisons for each parameter is provided in brackets to the right).

	ALBERTA-SASKATCHEWAN BOUNDARY					
	BATTLE RIVER	BEAVER RIVER	COLD RIVER	NORTH SASK. RIVER	RED DEER RIVER A/S	SOUTH SASK. RIVER
CATEGORY						
METALS	10(228)	6(228)	0(240)	7(240)	5(216)	2(240)
NUTRIENTS (TN, TP, TDP)	6(36)	2(36)	6(36)	3(36)	4(36)	0(36)
NUTRIENTS (TOXICITY)	0(24)	0(24)	0(24)	0(24)	0(24)	0(24)
MAJOR IONS	2(60)	0(60)	0(60)	0(60)	0(60)	0(60)
BIOTA	3(24)	0(24)	0(24)	2(24)	3(24)	2(24)
PHYSICALS and OTHERS	1(26)	1(37)	5(43)	0(43)	0(43)	0(43)
PESTICIDES	1(117)	0(0)	0(0)	1(40)	1(120)	2(40)
Number of Excursion Comparisons	515	409	427	467	523	467
Total Number of Excursions Observed	23	9	11	13	13	6
Sampling Frequency (no./year)	12	12	12	12	12	12
Overall Adherence Rate	95.6	97.8	97.4	97.2	97.5	98.7

Table 9: Overall excursion summary, by category, for Saskatchewan-Manitoba water quality stations. (The number of excursions is provided on the left and the total number of objective comparisons for each parameter is provided to the right).

	SASKATCHEWAN-MANITOBA BOUNDARY					
	ASSINIBOINE RIVER	CARROT RIVER	CHURCHILL RIVER	QU'APPELLE RIVER	RED DEER RIVER S/M	SASK. RIVER
CATEGORY						
METALS	5(228)	5(216)	0(80)	1(228)	2(240)	2(220)
NUTRIENTS (TN, TP, TDP)	2(36)	9.5(36)	0(12)	0(36)	3(36)	2.5(33)
NUTRIENTS (TOXICITY)	0(24)	0(24)	0(8)	0(24)	0(24)	0(22)
MAJOR IONS	3(60)	0(60)	0(20)	14(60)	1(60)	0(55)
BIOTA	0(24)	0(24)	0(8)	4(24)	0(24)	0(22)
PHYSICALS and OTHERS	1(43)	2(24)	0(15)	1(31)	2(42)	3(40)
PESTICIDES	0(149)	0(161)	0(0)	0(45)	0(0)	0(35)
Number of Excursion Comparisons	564	545	143	448	426	427
Total Number of Excursions Observed	11	16.5	0	20	8	7.5
Sampling Frequency (no./year)	12	12	4	12	12	11
Overall Adherence Rate	98.1	97.0	100.0	95.5	98.1	98.2

CONCLUSION

Interprovincial water quality objectives established at the 12 transboundary river reaches are designed to protect water uses for aquatic life, agriculture, recreation, treatability of source water for drinking water, and fish consumption. Interprovincial water quality objectives were met on average 97.6% of the time in 2019. There is an expectation that objectives will be exceeded occasionally (particularly for those sites with a statistically derived site-specific objective) and that some exceedances will occur naturally (for example, during high flow events). The adherence rate to interprovincial water quality objectives ranged from 100% (Churchill River) to 95.5% (Battle and Qu'Appelle rivers) in 2019. Water Quality in these transboundary rivers continues to be generally suitable for their intended uses.

Overall, each of the 12 transboundary river reaches has shown little variation in adherence rate during the past 17 years. However, of the 12 rivers, the Red Deer River on the Alberta-Saskatchewan boundary has shown the greatest variation in compliance to the water quality objectives, with an adherence rate variation of 8%. On the Saskatchewan-Manitoba boundary, the river with the greatest variation in compliance to the water quality objectives was the Red Deer River near Erwood with a variation of 6.7%. In 2019, the South Saskatchewan River, Assiniboine River and Red Deer River at Erwood had their highest adherence rate to their interprovincial water quality objectives in 17 years. The Churchill River also had a 100% adherence to water quality objectives in 2019 and this is the fourth time in the past 17 years that no exceedances have been reported on this river.

Excursions from the water quality objectives for nutrients, biota (bacteria), TSS and major ions were the most common among sites. Excursions of TDS, sulphate, metal and pesticide objectives occurred for specific rivers on both boundaries. In 2019, the highest number of excursions to the interprovincial water quality objectives was observed for the Battle River on the Alberta-Saskatchewan boundary and the Qu'Appelle River on the Saskatchewan-Manitoba Boundary (each with a 95.5% overall adherence rate).

The results of this excursion report, in addition to those from previous years, indicates a number of areas that warrant further consideration by the Committee, Board, and/or provinces:

- There were no unexpected water quality issues or concerns specifically highlighted as a result of the 2019 sampling program. As such the Committee will continue to focus its efforts to better understand broader scale questions related to factors affecting water quality on the prairies.
- Nutrients continue to remain a priority for the PPWB. The Committee's work to understand sources and trends in nutrients is on-going. The pilot project on the Red Deer River (AB/SK) and Carrot River was completed in 2019 (PPWB Report #180). Following the completion of the pilot program, the Committee is continuing to assess several integrated studies including assessing land-use changes to understand how this might be influencing nutrients in prairie watersheds. As the Carrot River is

CONCLUSION *continued*

a small watershed and consistently has excursions and increasing trends to nutrients, the Committee is continuing to focus its follow-up work on this transboundary river and has engaged members of the Committee on Hydrology of the PPWB for a joint study to better understand how hydrology affects water quality. In 2020, the Committee will continue to discuss and follow up on nutrient issues in the transboundary rivers.

- Suspended solids and flow can play an important role with respect to their influence on certain water quality parameters, in particular certain metals (total) and nutrients. While TSS and flow appear to be related to spikes in metals and nutrients observed in the transboundary rivers, this does not explain all the exceedances or variations observed with these parameters. Further investigation of the relationship between flow and TSS to these parameters is warranted to better understand these relationships. The Committee is assessing several potential integrated studies to assess changes in hydrology and TSS within several watersheds to further investigate this issue.
- For pesticides, the frequent exceedance of the acid herbicides, MCPA and dicamba objectives in prairie rivers is suggestive of a generally low-concentration but wide spread presence of these pesticides in the environment. While excursion frequencies varies from year-to-year, with 2019 being a year with a lower number of excursions, the COWQ is currently working with the jurisdictions to complete a review of the prevalence of these pesticides and potential effects to the aquatic environment and users of these waters. The monitoring of glyphosate and its principal breakdown product also demonstrate that this widely used pesticide is frequently present at low concentrations. Given its detection in the larger transboundary river systems, it is considered to be present at a broad scale across the prairie provinces. The COWQ is continuing to work with the jurisdictions to better understand the presence and the effects of these pesticides to the aquatic environment and users of these waters.
- Overall, in comparison to other sites, the Battle River on the Alberta Saskatchewan boundary, had the lowest adherence rates to the water quality objectives (due to excursions in nutrients, metals, major ions, bacteria, and TSS) in 2019. On the Saskatchewan-Manitoba boundary, the Qu'Appelle River had the lowest compliance to the water quality objectives in 2019, due to excursions in major ions, biota, TSS and metals. A number of the transboundary prairie rivers have higher saline waters and constituent ions that vary based on precipitation, flow and groundwater inputs. Total dissolved solids and sulphate are the two parameters that exceeded water quality objectives most frequently in certain transboundary rivers, particularly on the Saskatchewan-Manitoba transboundary rivers. In addition, increasing trends of these parameters have been noted in a number of rivers. The COWQ will continue to track these parameters and evaluate as more data become available.

ON-GOING

Interprovincial water quality objectives for the 12 transboundary rivers were revised and approved by Ministers responsible for the PPWB on July 8th, 2015. These revised objectives recognized the need to protect all water uses for all rivers and included a number of site-specific water quality objectives for selected parameters. This report represents the fifth year that the PPWB is reporting against these water quality objectives. The Committee is continuing to review and work to update water quality objectives as needed, particularly in those areas where objectives were not established for select parameters and rivers. On-going objective review is part of the mandate within the PPWB, with the PPWB making recommendations to adopt new and/or revised objectives as appropriate, approximately every five years. It is anticipated that the objectives for parameters considered since 2015 will be updated with a recommendation for adoption within the next year.

The COWQ review of prioritized parameters with more frequent excursions and significant trends continues. Several water quality parameter groups have been flagged by the COWQ including nutrients, and in particular total nitrogen.

Future work assessing pesticides on the prairies is a priority topic for Committee work. The COWQ continues to follow up on reporting of pesticides found with the jurisdictions, with particular emphasis on the acid herbicides and glyphosate because they are the most frequently detected pesticides found in the transboundary rivers.

In the 2015 Excursion report, the Committee recommended a more detailed review examining causes for the higher and more variable number of annual excursions on the Red Deer River (AB/SK). This included excursions due to some unusual water quality conditions. Alberta Environment and Parks has completed a review of provincial data and has provided a report to the PPWB (PPWB Report #183). The report concluded that the majority of the excursions on the Red Deer River in 2015 were most probably attributable to two runoff events in the Red Deer-Drumheller and upstream Red Deer areas. The report also concluded that there was a strong relationship between TSS and total metals, especially in the badlands reach of the Red Deer River. During this investigation into the causes of excursions on the Red Deer River Alberta Environment and Parks' released a five-year provincial water quality monitoring, evaluation and reporting plan for lotic systems (2016–2021). This plan highlights the need for five long-term monitoring stations on the mainstem and 18 stations on tributaries of the Red Deer River. These data will provide valuable information to assist interpretation of water quality results at the boundary and better define point versus non-point source contributions of various water quality parameters to this river.

The assessment of excursions to water quality objectives will continue to assist the Committee to assess areas of potential concern and to set future priorities. In conjunction with the excursion assessment, the Committee will continue to look at long-term trends in water quality for each of the transboundary rivers. Trend analysis work incorporating additional data was completed in 2017 and the report is available on the PPWB website (PPWB 2018). The COWQ has initiated the trending of the PPWB data to the end of 2018, adding five additional years of long-term data.

REFERENCES

Kerr, J.G. and Cooke, C.A. 2017. Erosion of the Alberta badlands produces highly variable and elevated heavy metal concentrations in the Red Deer River, Alberta. Science of the Total Environment 596–597: 427–436.

MAA Schedule E 1992. Agreement on water quality. https://www.ppwb.ca/about-us/what-we-do/1969-master-agreement-on-apportionment/schedule-e

PPWB Report #175. 2016. Response to the 2011 pesticide excursions in transboundary rivers in the prairie provinces of Canada. pp. 103.

PPWB Report #179. 2018. Long-Term Trends in Water Quality Parameters at Twelve Transboundary River Reaches (from the beginning of the data record until the end of 2013). pp 1072.

PPWB Report #180. Quantifying Non-point and Point Nutrient Sources in Interprovincial Watersheds. pp 167. Prepared by Golder Associates Ltd. for the Committee on Water Quality, Prairie Provinces Water Board.

PPWB Report #183. An Analysis on non-compliance patterns to Prairie Provinces Water Board objectives in the Red Deer River at the Alberta/Saskatchewan Boundary. pp 62. Prepared by Alberta Environment and Parks for the Committee on Water Quality, Prairie Provinces Water Board.

APPENDIX 1: Water Quality Objectives

Table A1: AB-SK

PARAMETER	2015 Interprovincial Water Quality Objectives – AB-SK Boundary					
	BATTLE RIVER	BEAVER RIVER	COLD RIVER	NORTH SASK. RIVER	RED DEER RIVER (BINDLOSS)	SOUTH SASK. RIVER
NUTRIENTS						
Nitrate as N (mg/L)	3	3	3	3	3	3
Ammonia Un-ionized (mg/L)	0.019[a]	0.019[a]	0.019[a]	0.019[a]	0.019[a]	0.019[a]
MAJOR IONS						
Total Dissolved Solids (mg/L)	872	500	500	500	500	500
Sulphate Dissolved (mg/L)	250	250	250	250	250	250
Sodium Dissolved (mg/L)	200	200	200	200	200	200
Fluoride Dissolved (mg/L)	0.31	0.19	0.12	0.18	0.2	0.19
Chloride Dissolved (mg/L)	100	100	100	100	100	100
PHYSICALS AND OTHER						
pH Lab	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0
pH Field	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0
Oxygen Dissolved (mg/L)						
Open Water Season (>5°C)	5	5	5	5	5	5
Ice-Covered Season (<5°C)	Under Review	Under Review	3	3	3	3
Sodium Adsorption Ratio	Under Review	3	3	3	3	3
Total Suspended Solids (mg/L)	5.0-320.0	3.0-48.8	1.2-4.8	5.0-295.8	30.0-832.6	5.6-339.8
BIOTA						
E. Coli (No./100 mL)	200	200	200	200	200	200
Coliforms Fecal (No./100 mL)	100	100	100	100	100	100
METALS						
Arsenic Total (µg/L)	5	5	5	5	5	5
Arsenic Dissolved (µg/L)	No Objective	No Objective	No Objective	No Objective	No Objective	No Objective
Barium Total (µg/L)	1000	1000	1000	1000	1000	1000
Beryllium Total (µg/L)	100	100	100	100	100	100
Boron Total (µg/L)	500[b]	500[b]	500[b]	500[b]	500[b]	500[b]
Cadmium Total (µg/L)	Calculated[c]	Calculated[c]	Calculated[c]	Calculated[c]	Under Review	Calculated[c]
Chromium Total (µg/L)	50	50	50	50	50	50
Cobalt Total (µg/L)	50	50	50	50	50	50
Copper Total (µg/L)	Calculated[c]	Calculated[c]	Calculated[c]	Calculated[c]	Under Review	Calculated[c]
Iron Dissolved (µg/L)	300	300	300	300	300	300
Lead Total (µg/L)	Calculated[c]	Calculated[c]	Calculated[c]	Calculated[c]	Calculated[c]	Calculated[c]
Lithium Total (µg/L)	2500	2500	2500	2500	2500	2500
Manganese Dissolved (µg/L)	Under Review	Under Review	50	50	50	50
Molybdenum Total (µg/L)	10[d]	10[d]	10[d]	10[d]	10[d]	10[d]
Nickel Dissolved (µg/L)	Calculated[c]	Calculated[c]	Calculated[c]	Calculated[c]	Calculated[c]	Calculated[c]
Selenium Total (µg/L)	1	1	1	1	1	1
Silver Total (µg/L)	0.1	0.1	0.1	0.1	0.1	0.1
Thallium Total (µg/L)	0.8	0.8	0.8	0.8	0.8	0.8
Uranium Total (µg/L)	10	10	10	10	10	10
Vanadium Total (µg/L)	100	100	100	100	100	100
Zinc Total (µg/L)	30	30	30	30	30	30

Table A2: AB-SK

PARAMETER / PESTICIDES	2015 Interprovincial Water Quality Objectives – AB-SK Boundary					
	BATTLE RIVER	BEAVER RIVER	COLD RIVER	NORTH SASK. RIVER	RED DEER RIVER (BINDLOSS)	SOUTH SASK. RIVER
ACID HERBICIDES						
2,4-D (µg/L)	4	4	4	4	4	4
Bromoxynil (µg/L)	0.33	0.33	0.33	0.33	0.33	0.33
Dicamba (µg/L)	0.006	0.006	0.006	0.006	0.006	0.006
MCPA (µg/L)	0.025	0.025	0.025	0.025	0.025	0.025
Picloram (µg/L)	29	29	29	29	29	29
ORGANOCHLORINE PESTICIDES IN WATER						
Endosulfan (µg/L)	0.003	0.003	0.003	0.003	0.003	0.003
Hexachlorocyclohexane (gamma-HCH) (Lindane) (µg/L)	0.01	0.01	0.01	0.01	0.01	0.01
Hexachlorobenzene (µg/L)	0.52	0.52	0.52	0.52	0.52	0.52
Pentachlorophenol (PCP) (µg/L)	0.5	0.5	0.5	0.5	0.5	0.5
NEUTRAL HERBICIDES IN WATER						
Atrazine (µg/L)	1.8	1.8	1.8	1.8	1.8	1.8
Diclofopmethyl (Hoegrass)* (µg/L)	0.18	0.18	0.18	0.18	0.18	0.18
Metolachlor (µg/L)	7.8	7.8	7.8	7.8	7.8	7.8
Metribuzin (µg/L)	0.5	0.5	0.5	0.5	0.5	0.5
Simazine (µg/L)	0.5	0.5	0.5	0.5	0.5	0.5
Triallate (µg/L)	0.24	0.24	0.24	0.24	0.24	0.24
Trifluralin (µg/L)	0.2	0.2	0.2	0.2	0.2	0.2
OTHER						
Glyphosate (ng/L)	Report Detections	Report Detections	Report Detections	Report Detections	Report Detections	Report Detections

Legend

Protection of Aquatic Life	Ag-Livestock	Ag-Irrigation	Recreation	Treatability	Ag-Irrigation + Treatability	Ag-Irrigation and Livestock	Fish Consumption

Superscripts

a. Ammonia guideline: Expressed as mg un-ionized ammonia per L. This would be equivalent to 15.6 mg/L ammonia-nitrogen. Guideline for total ammonia is temperature and pH dependent.

b. Guideline is crop-specific 500 to 6000µg/L.

c. Value is a function of hardness (mg/L) in the water column. The objective is a calculated value.
Cadmium Concentration = $10^{0.86[\log10(\text{hardness})]-3.2}$ µg/L
Copper Concentration = $e^{0.8545[\ln(\text{hardness})-1.465}*0.2$ µg/L
The copper objective is a minimum of 2 µg/L regardless of water hardness. If the water hardness is not known, the objective is 2 µg/L. The Objective maximum is 4 µg/L.
Lead Concentration = $e^{1.273[\ln \text{hardness})]-4.705}$ µg/L The objective is a minimum of 1 µg/L regardless of water hardness. If the water hardness is not known, the objective is 1 µg/L.
Nickel Concentration = $\exp^{\{0.8460[\ln(\text{hardness})]+0.0584\}*0.997}$ µg/L.

d. Molybdenum guideline = up to 50 µg/L for short-term use on acidic soils.

APPENDIX 1: Water Quality Objectives continued

Table A3: SK-MB

PARAMETER	2015 Interprovincial Water Quality Objectives – SK-MB Boundary						
	ASSINIBOINE RIVER	CARROT RIVER		CHURCHILL RIVER	QU'APPELLE RIVER	RED DEER RIVER (ERWOOD)	SASKATCHEWAN RIVER
		OPEN	CLOSED				
NUTRIENTS							
Nitrate as N (mg/L)	3	3		3	3	3	3
Ammonia Un-ionized (mg/L)	0.019[a]	0.019[a]		0.019[a]	0.019[a]	0.019[a]	0.019[a]
MAJOR IONS							
Total Dissolved Solids (mg/L)	834	742	1672	500	1144	500	500
Sulphate Dissolved (mg/L)	299	250		250	486	250	250
Sodium Dissolved (mg/L)	200	164	442	200	200	200	200
Fluoride Dissolved (mg/L)	0.26	0.20	0.29	0.12	0.25	0.18	0.18
Chloride Dissolved (mg/L)	100	267	728	100	100	100	100
PHYSICALS AND OTHER							
pH Lab	6.5-9.0	6.5-9.0		6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0
pH Field	6.5-9.0	6.5-9.0		6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0
Oxygen Dissolved (mg/L)							
Open Water Season (>5°C)	5	5		5	5	5	5
Ice-Covered Season (<5°C)	3	Under Review		3	3	3	3
Sodium Adsorption Ratio	3	Under Review		3	Under Review	3	3
Total Suspended Solids (mg/L)	5.0-69.2	6.08-98.2		2.2-6.2	22.6-122.2	1.0-19.7	27.0-125.0
BIOTA							
E. Coli (No./100 mL)	200	200		200	200	200	200
Coliforms Fecal (No./100 mL)	100	100		100	100	100	100
METALS							
Arsenic Total (µg/L)	5	No Objective		5	No Objective	5	5
Arsenic Dissolved (µg/L)	No Objective	50		No Objective	50	No Objective	No Objective
Barium Total (µg/L)	1000	1000		1000	1000	1000	1000
Beryllium Total (µg/L)	100	100		100	100	100	100
Boron Total (µg/L)	500[b]	500[b]		500[b]	500[b]	500[b]	500[b]
Cadmium Total (µg/L)	Calculated[c]	Calculated[c]		Calculated[c]	Calculated[c]	Calculated[c]	Calculated[c]
Chromium Total (µg/L)	50	50		50	50	50	50
Cobalt Total (µg/L)	50	50		50	50	50	50
Copper Total (µg/L)	Calculated[c]	Calculated[c]		Calculated[c]	Calculated[c]	Calculated[c]	Calculated[c]
Iron Dissolved (µg/L)	300	Under Review		300	300	300	300
Lead Total (µg/L)	Calculated[c]	Calculated[c]		Calculated[c]	Calculated[c]	Calculated[c]	Calculated[c]
Lithium Total (µg/L)	2500	2500		2500	2500	2500	2500
Manganese Dissolved (µg/L)	Under Review	Under Review		50	Under Review	50	50
Molybdenum Total (µg/L)	10[d]	10[d]		10[d]	10[d]	10[d]	10[d]
Nickel Dissolved (µg/L)	Calculated[c]	Calculated[c]		Calculated[c]	Calculated[c]	Calculated[c]	Calculated[c]
Selenium Total (µg/L)	1	1		1	1	1	1
Silver Total (µg/L)	0.1	0.1		0.1	0.1	0.1	0.1
Thallium Total (µg/L)	0.8	0.8		0.8	0.8	0.8	0.8
Uranium Total (µg/L)	10	10		10	10	10	10
Vanadium Total (µg/L)	100	100		100	100	100	100
Zinc Total (µg/L)	30	30		30	30	30	30

Table A4: SK-MB

PARAMETER / PESTICIDES	2015 Water Quality Objectives – SK-MB Boundary						
	ASSINIBOINE RIVER	CARROT RIVER		CHURCHILL RIVER	QU'APPELLE RIVER	RED DEER RIVER (ERWOOD)	SASKATCHEWAN RIVER
		OPEN	CLOSED				
ACID HERBICIDES							
2,4-D (µg/L)	4	4		4	4	4	4
Bromoxynil (µg/L)	0.33	0.33		0.33	0.33	0.33	0.33
Dicamba (µg/L)	0.006	0.006		0.006	0.006	0.006	0.006
MCPA (µg/L)	0.025	0.025		0.025	0.025	0.025	0.025
Picloram (µg/L)	29	29		29	29	29	29
ORGANOCHLORINE PESTICIDES IN WATER							
Endosulfan (µg/L)	0.003	0.003		0.003	0.003	0.003	0.003
Hexachlorocyclohexane (gamma-HCH) (Lindane) (µg/L)	0.01	0.01		0.01	0.01	0.01	0.01
Hexachlorobenzene (µg/L)	0.52	0.52		0.52	0.52	0.52	0.52
Pentachlorophenol (PCP) (µg/L)	0.5	0.5		0.5	0.5	0.5	0.5
NEUTRAL HERBICIDES IN WATER							
Atrazine (µg/L)	1.8	1.8		1.8	1.8	1.8	1.8
Diclofopmethyl (Hoegrass)* (µg/L)	0.18	0.18		0.18	0.18	0.18	0.18
Metolachlor (µg/L)	7.8	7.8		7.8	7.8	7.8	7.8
Metribuzin (µg/L)	0.5	0.5		0.5	0.5	0.5	0.5
Simazine (µg/L)	0.5	0.5		0.5	0.5	0.5	0.5
Triallate (µg/L)	0.24	0.24		0.24	0.24	0.24	0.24
Trifluralin (µg/L)	0.2	0.2		0.2	0.2	0.2	0.2
OTHER							
Glyphosate (ng/L)	Report Detections	Report Detections		Report Detections	Report Detections	Report Detections	Report Detections

Legend

Protection of Aquatic Life	Ag-Livestock	Ag-Irrigation	Recreation	Treatability	Ag-Irrigation + Treatability	Ag-Irrigation and Livestock	Fish Consumption

Superscripts

a. Ammonia guideline: Expressed as mg un-ionized ammonia per L. This would be equivalent to 15.6 mg/L ammonia-nitrogen. Guideline for total ammonia is temperature and pH dependent.

b. Guideline is crop-specific 500 to 6000µg/L.

c. Value is a function of hardness (mg/L) in the water column. The objective is a calculated value.
Cadmium Concentration = $10^{0.86[\log10(\text{hardness})]-3.2}$ µg/L
Copper Concentration = $e^{0.8545[\ln(\text{hardness})-1.465}$ *0.2 µg/L.
The copper objective is a minimum of 2 µg/L regardless of water hardness. If the water hardness is not known, the objective is 2 µg/L. The Objective maximum is 4 µg/L
Lead Concentration = $e^{1.273[\ln \text{hardness})]-4.705}$ µg/L The objective is a minimum of 1 µg/L regardless of water hardness. If the water hardness is not known, the objective is 1 µg/L.
Nickel Concentration = $\exp^{\{0.8460[\ln(\text{hardness})]+0.0584\}*0.997}$µg/L.

d. Molybdenum guideline = up to 50 µg/L for short-term use on acidic soils.

APPENDIX 1: Water Quality Objectives continued

Table A5: AB-SK

PARAMETER	2015 Water Quality Objectives – Alberta-Saskatchewan Boundary					
	BATTLE RIVER	BEAVER RIVER	COLD RIVER	NORTH SASK. RIVER	RED DEER RIVER (BINDLOSS)	SOUTH SASK. RIVER
PHYSICALS AND OTHER						
Reactive Chlorine Species (mg/L)	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
Cyanide (free) (mg/L)	0.005	0.005	0.005	0.005	0.005	0.005
METALS						
Mercury (total) (µg/L)	0.026	0.026	0.026	0.026	0.026	0.026
FISH TISSUE						
Mercury in Fish (muscle) (µg/kg)	200	200	200	200	200	200
Arsenic in fish (muscle) (µg/kg)	3500	3500	3500	3500	3500	3500
Lead In fish (muscle) (µg/kg)	500	500	500	500	500	500
DDT (total) in fish (muscle) (µg/kg)	5000	5000	5000	5000	5000	5000
AQUATIC BIOTA CONSUMPTION						
PCB in fish (muscle) mammalian (µg TEQ/kg diet wet weight)	0.00079	0.00079	0.00079	0.00079	0.00079	0.00079
PCB in fish (muscle) avian (µg TEQ/kg diet wet weight)	0.0024	0.0024	0.0024	0.0024	0.0024	0.0024
DDT total in fish (muscle) (µg/kg diet wet weight)	14	14	14	14	14	14
Toxaphene in fish (muscle) (µg/kg diet wet weight)	6.3	6.3	6.3	6.3	6.3	6.3
RADIOACTIVE						
Cesium-137 (Bq/L)	10	10	10	10	10	10
Iodine-131 (Bq/L)	6	6	6	6	6	6
Lead-210 (Bq/L)	0.2	0.2	0.2	0.2	0.2	0.2
Radium-226 (Bq/L)	0.5	0.5	0.5	0.5	0.5	0.5
Strontium-90 (Bq/L)	5	5	5	5	5	5
Tritium (Bq/L)	7000	7000	7000	7000	7000	7000

Legend

Protection of Aquatic Life	Treatability	Fish Consumption

APPENDIX 1: Water Quality Objectives continued

Table A6: SK-MB

PARAMETER	2015 Water Quality Objectives – SK-MB Boundary						
	ASSINIBOINE RIVER	CARROT RIVER		CHURCHILL RIVER	QU'APPELLE RIVER	RED DEER RIVER (ERWOOD)	SASKATCHEWAN RIVER
		OPEN	CLOSED				
PHYSICALS AND OTHER							
Reactive Chlorine Species (mg/L)	0.0005	0.0005		0.0005	0.0005	0.0005	0.0005
Cyanide (free) (mg/L)	0.005	0.005		0.005	0.005	0.005	0.005
METALS							
Mercury (total) (µg/L)	0.026	0.026		0.026	0.026	0.026	0.026
FISH TISSUE							
Mercury in Fish (muscle) (µg/kg)	200	200		200	200	200	200
Arsenic in fish (muscle) (µg/kg)	3500	3500		3500	3500	3500	3500
Lead In fish (muscle) (µg/kg)	500	500		500	500	500	500
DDT (total) in fish (muscle) (µg/kg)	5000	5000		5000	5000	5000	5000
AQUATIC BIOTA CONSUMPTION							
PCB in fish (muscle) mammalian (µg TEQ/kg diet wet weight)	0.00079	0.00079		0.00079	0.00079	0.00079	0.00079
PCB in fish (muscle) avian (µg TEQ/kg diet wet weight)	0.0024	0.0024		0.0024	0.0024	0.0024	0.0024
DDT total in fish (muscle) (µg/kg diet wet weight)	14	14		14	14	14	14
Toxaphene in fish (muscle) (µg/kg diet wet weight)	6.3	6.3		6.3	6.3	6.3	6.3
RADIOACTIVE							
Cesium-137 (Bq/L)	10	10		10	10	10	10
Iodine-131 (Bq/L)	6	6		6	6	6	6
Lead-210 (Bq/L)	0.2	0.2		0.2	0.2	0.2	0.2
Radium-226 (Bq/L)	0.5	0.5		0.5	0.5	0.5	0.5
Strontium-90 (Bq/L)	5	5		5	5	5	5
Tritium (Bq/L)	7000	7000		7000	7000	7000	7000

Legend

Protection of Aquatic Life	Treatability	Fish Consumption

APPENDIX 1: Water Quality Objectives continued

Table A7: Site-specific nutrient objectives, both boundaries.

Nutrient Objectives							
OBJECTIVES FOR NUTRIENTS		TOTAL PHOSPHORUS (MG/L)		TOTAL DISSOLVED PHOSPHORUS (MG/L)		TOTAL NITROGEN (MG/L)	
Alberta-Saskatchewan Boundary							
BATTLE RIVER NEAR UNWIN	Open Water	0.267	0.335	0.051		2.260	
	Ice-covered	0.075	0.100	0.045		1.550	
BEAVER RIVER AT BEAVER CROSSING	Open Water	0.171		0.043	0.060	1.140	
	Ice-covered	0.127		0.042	0.060	1.862	
COLD RIVER AT OUTLET OF COLD LAKE	Open Water	0.023		0.010		0.453	0.460
	Ice-covered	0.024		0.017		0.452	0.467
NORTH SASKATCHEWAN RIVER AT HIGHWAY 17	Open Water	0.253	0.278	0.026	0.046	1.169	1.230
	Ice-covered	0.063	0.115	0.048	0.101	1.175	1.225
RED DEER RIVER NEAR BINDLOSS	Open Water	0.315	0.563	0.023	0.035	2.320	
	Ice-covered	0.035	0.069	0.008	0.024	0.860	
SOUTH SASKATCHEWAN RIVER	Open Water	0.159	0.246	0.014	0.018	1.073	1.114
	Ice-covered	0.054	0.110	0.010	0.067	1.638	1.771

Legend

No Trend – 90th % of Database	90th % of Database	Decreasing Trend – Lowest Running 10-year 90th Percentile	Increasing Trend – Lowest Running 10-year 90th Percentile

APPENDIX 1: Water Quality Objectives continued

Table A7: Site-specific nutrient objectives, both boundaries.

Nutrient Objectives								
OBJECTIVES FOR NUTRIENTS		TOTAL PHOSPHORUS (MG/L)		TOTAL DISSOLVED PHOSPHORUS (MG/L)		TOTAL NITROGEN (MG/L)		
Saskatchewan - Manitoba Boundary								
ASSINIBOINE RIVER AT HWY 8 BRIDGE	Open Water	0.311		0.186		1.801		
	Ice-covered	0.180		0.115		2.252		
CARROT RIVER NEAR TURNBERRY	Open Water	0.099	0.140	0.027	0.057	1.087	1.417	
	Ice-covered	0.170	0.266	0.031	0.059	1.814	2.052	
CHURCHILL RIVER BELOW WASAWAKASIK	Open Water	0.025		0.010		0.484		
	Ice-covered	0.021		0.010		0.411		
QU'APPELLE RIVER	Open Water	0.278	0.304	0.156	0.190	1.822		
	Ice-covered	0.221	0.290	0.129	0.249	1.767		
RED DEER RIVER AT ERWOOD	Open Water	0.052	0.066	0.021	0.029	1.195		
	Ice-covered	0.074	0.161	0.025	0.055	1.998		
SASKATCHEWAN RIVER	Open Water	0.088	0.124	0.014	0.018	0.838		
	Ice-covered	0.028	0.034	0.011	0.017	0.761		

Legend

No Trend – 90th % of Database	90th % of Database	Decreasing Trend – Lowest Running 10-year 90th Percentile	Increasing Trend – Lowest Running 10-year 90th Percentile

APPENDIX 2: Water Quality Monitoring

PPWB Water Quality Monitoring 2019

The recommended water quality monitoring for 2019 is provided in the attached tables. The changes to be implemented for 2019 from 2018 are highlighted.

In 2019, pesticide sampling is recommended on the Battle River and Red Deer River (A/S) in accordance with the standard rotation of the pesticide sampling program, in addition to the annual sampling at the Carrot and Assiniboine rivers.

Annual acid herbicides monitoring should include the following transboundary rivers; Battle, South Saskatchewan North Saskatchewan, Red Deer River (AB/SK), Saskatchewan, and Qu'Appelle rivers and that the acid herbicides continue to be monitored on the Assiniboine and Carrot rivers on an annual basis. For the 2019 monitoring program glyphosate and AMPA monitoring was recommended to be included with the rivers that have acid herbicide monitoring as this pesticide is widely used pesticide throughout the prairie region. Monitoring for the other pesticide groups (neutral herbicides and organochlorines) is recommended to continue on a rotational sampling basis, with the exception of the Assiniboine and Carrot rivers which are recommended to remain as an annual sampling program.

In addition, the continued monitoring of the biological oxygen demand (BOD) is recommended for the Battle, Beaver and Carrot Rivers in 2019 due to low dissolved oxygen levels in these rivers during the winter months.

The 2018 monitoring program is also provided for reference in separate tables.

Other Objectives

Monitoring was not recommended for radionuclides, total residual chlorine, cyanide and mercury in 2019. Water quality objectives are available in Schedule E for radionuclides, total residual chlorine, cyanide and mercury. However, these water quality objectives were included in Schedule E in the event of a future water quality issue or emergency but are not intended to be routinely monitored due to low risk. Radionuclides have not been monitored since January 1984.

Monitoring is not recommended for contaminants in fish in 2019. The historical data set of contaminants in fish for the transboundary sites has been compiled and is currently being reviewed by the Committee. Any future fish monitoring program will reflect the results of the previous program.

APPENDIX 2: Water Quality Monitoring continued

PPWB MONITORING 2019: Alberta-Saskatchewan Sites

SITE	NUTRIENTS and PHYSICALS/BOD; MAJOR IONS/ SAR; METALS (Total and Dissolved); BACTERIA (Fecal and *E. coli*) CHLOROPHYLL *a*	PESTICIDES			
		Acid Herbicides	Neutral Herbicides	Organochlorine	Glyphosate
Site 1 Cold River	12x / year	—	—	—	—
Site 2 Beaver River	12x / year	—	—	—	—
Site 3 North Saskatchewan River	12x / year	8x/year	—	—	8x/year
Site 4 Battle River	12x / year	8x/year	8x/year	8x/year	8x/year
Site 5 Red Deer River A/S	12x / year	8x/year	8x/year	8x/year	8x/year
Site 6 South Saskatchewan River	12x / year	8x/year	—	—	8x/year

Pesticides sampled 8x / year in Feb, Apr, May, June, July, Aug, Oct, and Dec.
Highlighting indicates changes from previous year's sampling schedule

PPWB MONITORING 2019: Saskatchewan-Manitoba Sites

SITE	NUTRIENTS and PHYSICALS/BOD; MAJOR IONS/ SAR; METALS (Total and Dissolved); BACTERIA (Fecal and *E. coli*) CHLOROPHYLL *a*	PESTICIDES			
		Acid Herbicides	Neutral Herbicides	Organochlorine	Glyphosate
Site 7 Churchill River[1]	4x / year	—	—	—	—
Site 8 Saskatchewan River	12x / year	8x/year	—	—	8x/year
Site 9 Carrot River	12x / year	12x/year	12x/year	8x/year	12x/year
Site 10 Red Deer River S/M	12x / year	—	—	—	—
Site 11 Assiniboine River	12x / year	12x/year	12x/year	8x/year	12x/year
Site 12 Qu'Appelle River	12x / year	8x/year	—	—	8x/year

[1] Churchill River Months sampled = Feb, May, July, Oct
Pesticides sampled 8x/year in Feb, Apr, May, June, July, Aug, Oct, and Dec
Highlighting indicates changes from previous year's sampling schedule

APPENDIX 2: Water Quality Monitoring continued

PPWB MONITORING 2018: Alberta-Saskatchewan Sites

SITE	NUTRIENTS and PHYSICALS/BOD; MAJOR IONS/ SAR; METALS (Total and Dissolved); BACTERIA (Fecal and *E. coli*) CHLOROPHYLL *a*	PESTICIDES			
		Acid Herbicides	Neutral Herbicides	Organochlorine	Glyphosate
Site 1 Cold River	4x / year	8x/year	8x/year	8x/year	8x/year
Site 2 Beaver River	12x / year	—	—	—	—
Site 3 North Saskatchewan River	12x / year	8x/year	8x/year	8x/year	8x/year
Site 4 Battle River	12x / year	8x/year	—	—	—
Site 5 Red Deer River A/S	12x / year	8x/year	—	—	—
Site 6 South Saskatchewan River	12x / year	8x/year	8x/year	8x/year	8x/year

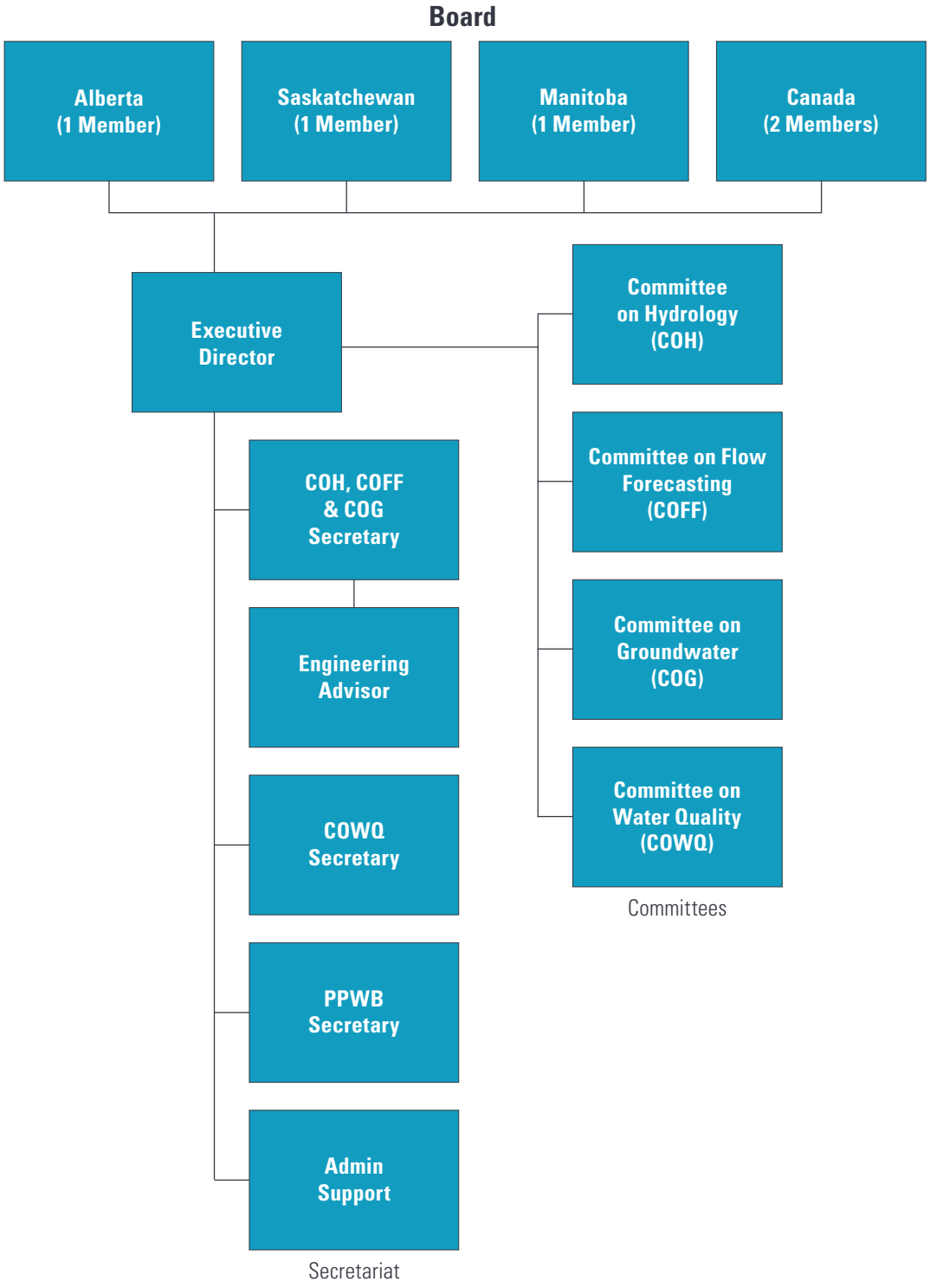
Pesticides sampled 8x / year in Feb, Apr, May, June, July, Aug, Oct, and Dec.

PPWB MONITORING 2018: Saskatchewan-Manitoba Sites

SITE	NUTRIENTS and PHYSICALS/BOD; MAJOR IONS/ SAR; METALS (Total and Dissolved); BACTERIA (Fecal and *E. coli*) CHLOROPHYLL *a*	PESTICIDES			
		Acid Herbicides	Neutral Herbicides	Organochlorine	Glyphosate
Site 7 Churchill River[1]	4x / year	—	—	—	—
Site 8 Saskatchewan River	12x / year	8x/year	—	—	—
Site 9 Carrot River	12x / year	12x/year	12x/year	8x/year	12x/year
Site 10 Red Deer River S/M	12x / year	—	—	—	—
Site 11 Assiniboine River	12x / year	12x/year	12x/year	8x/year	12x/year
Site 12 Qu'Appelle River	12x / year	8x/year	—	—	—

[1] Churchill River Months sampled = Feb, May, July, Oct
Pesticides sampled 8x/year in Feb, Apr, May, June, July, Aug, Oct, and Dec

APPENDIX V: PPWB Organizational Chart



APPENDIX VI: Board / Committee Membership 2019-2020

PRAIRIE PROVINCES WATER BOARD

Manitoba, Saskatchewan, Alberta and Canada agree to establish and there is hereby established a Board to be known as the Prairie Provinces Water Board to consist of five members to be appointed as follows:

(a) two members to be appointed by the Governor General in Council, one of whom shall be Chairman of the Board, on the recommendation of the Minister of Energy, Mines and Resources,

(b) one member to be appointed by the Lieutenant Governor in Council of each of the Provinces of Manitoba, Saskatchewan and Alberta.

Schedule C, Section 1
Master Agreement on Apportionment

PPWB BOARD MEMBERS

CHAIR	Nadine Stiller (Apr 2018 to current)	Associate Regional Director General West & North Environment and Climate Change Canada
	Vacant (2018 to current)	Agriculture and Agri-Food Canada
	Brian Yee (Jul 2014 to Feb 2020)	Director Transboundary Waters Secretariat Alberta Environment and Parks
	Vacant (Nov 2017 to current)	Manitoba
	Sam Ferris (Sep 2018 to current)	Senior Vice President Regulatory Division Water Security Agency (Saskatchewan)

APPENDIX VI: Board / Committee Membership 2019-2020 continued

SECRETARIAT

EXECUTIVE DIRECTOR	Mike Renouf (Apr 2008 to Mar 2020)	Transboundary Waters Unit Prairie Provinces Water Board
EXECUTIVE DIRECTOR	Patrick Cherneski (Oct 2019 to current)	Transboundary Waters Unit Prairie Provinces Water Board
SECRETARY	Lynne Quinnett-Abbott (Mar 2013 to Sept 2019)	Transboundary Waters Unit Prairie Provinces Water Board

PPWB ALTERNATE BOARD MEMBERS

Paula Siwik (Nov 2017 to current)	Manager, Regional Program Integration Environment and Climate Change Canada
Dave Zapshala (Feb 2016 to current)	Director, Water Infrastructure Division Corporate Management Branch Agriculture and Agri-Food Canada
Carmen de la Chevrotière (Aug 2014 to current)	Transboundary Water Quantity Specialist Transboundary Waters Secretariat Alberta Environment and Parks
John Fahlman (Sep 2018 to current)	Senior Vice President Technical Services and Chief Engineer Water Security Agency (Saskatchewan)
Nicole Armstrong (May 2013 to current)	Director Water Science and Watershed Management Branch Agriculture and Resource Development (Manitoba)

APPENDIX VI: Board / Committee Membership 2019-2020 continued

COMMITTEE ON HYDROLOGY

At the request of, and under the direction of the PPWB, the Committee on Hydrology (COH) shall investigate, oversee, review, report and recommend on matters pertaining to hydrology of interprovincial or interjurisdictional basins.

The committee may consider such things as natural flow; forecasting; network design; collection, processing and transmission of data; basin studies and other items of interprovincial interest involving hydrology.

The COH will engage the Committee on Groundwater, the Committee on Flow Forecasting and the Committee on Water Quality on items of mutual interest or when the expertise of those committees will assist the COH.

PPWB Board Minute 92-65 (Oct. 7, 2009)

COMMITTEE ON HYDROLOGY MEMBERS

CHAIR	Patrick Cherneski (incoming)/ Mike Renouf (outgoing)	Executive Director Prairie Provinces Water Board
MEMBERS	Malcolm Conly	Hydrometric Operations Environment and Climate Change Canada
	Ron Woodvine	Corporate Management Branch Agriculture and Agri-Food Canada
	Carmen de la Chevrotière	Transboundary Waters Secretariat Alberta Environment and Parks
	Mark Lee	Water Science and Watershed Management Branch Agriculture and Resource Development (Manitoba)
	Bart Oegema	Hydrology Services Water Security Agency (Saskatchewan)
	Anthony Liu	Meteorological Service of Canada Environment and Climate Change Canada
SECRETARY	Megan Garner/ Marie Hyde	Transboundary Waters Unit Prairie Provinces Water Board

APPENDIX VI: Board / Committee Membership 2019-2020 continued

COMMITTEE ON WATER QUALITY

Terms of Reference: Mandate

Under the direction of the Prairie Provinces Water Board (PPWB), the Committee on Water Quality (COWQ) shall investigate, oversee, review, report, recommend and advise the Board on matters pertaining to the water quality and aquatic ecosystem integrity of interprovincial waters.

The responsibilities of the committee shall include directing, planning, and coordinating a water quality monitoring and trend assessment program by identifying monitoring requirements and overseeing transboundary monitoring and synoptic surveys. The committee shall promote an ecosystem approach to water quality management and the protection and enhancement of interprovincial waters by ensuring the compatibility of water quality guidelines, objectives, sampling and analytical protocols, monitoring approaches, quality assurance and data bases. It shall interpret data and identify, investigate and define existing and potential interprovincial water quality problems through the application of PPWB Water Quality Objectives, trend assessment and other approaches. The committee shall inform the Board and member agencies, through the PPWB contingency plan, of any spills or unusual water quality conditions that have the potential to adversely affect interprovincial streams. It shall assess the implications of these problems and may recommend remedial or preventative measures for avoiding and resolving water quality issues and if required, additional synoptic water quality monitoring.

The committee shall foster awareness and understanding of the importance of effective water quality management, encourage the use of "state of the art" procedures for evaluating water quality and identify research needs pertinent to water quality management on the prairies. The committee shall facilitate effective water quality management practices through integration of agency initiatives and the promotion of joint planning on interprovincial streams.

The COWQ will engage the Committee on Hydrology, Committee on Flow Forecasting and the Committee on Groundwater on items of mutual interest or when the expertise of those committees will assist COWQ.

PPWB Board Minute 92-65 (Oct. 7, 2009)

APPENDIX VI: Board / Committee Membership 2019-2020 continued

COMMITTEE ON WATER QUALITY MEMBERS

CHAIR	Patrick Cherneski (incoming)/ Mike Renouf (outgoing)	Executive Director Prairie Provinces Water Board
MEMBERS	Paul Klawunn	Science and Technology Branch Environment and Climate Change Canada
	Elaine Page	Water Science and Watershed Management Branch Agriculture and Resource Development (Manitoba)
	John-Mark Davies	Water Quality Services Water Security Agency (Saskatchewan)
	Gongchen Li	Transboundary Waters Secretariat Alberta Environment and Parks
	Claudia Sheedy	Lethbridge Research and Development Centre Agriculture and Agri-Food Canada
SECRETARY	Joanne Sketchell	Transboundary Waters Unit Prairie Provinces Water Board

APPENDIX VI: Board / Committee Membership 2019-2020 continued

COMMITTEE ON GROUNDWATER

Terms of Reference: Mandate

Recognizing the inter-relationship between surface and groundwater, the Committee on Groundwater shall, at the request of, and under the direction of the Prairie Provinces Water Board, investigate, oversee, review, report, and recommend on matters pertaining to quantity and quality of groundwater at or near interprovincial boundaries.

Responsibilities of the committee may include: exchange of information; compilation and interpretation of existing data; recommendations on groundwater information and monitoring requirements; determination of implications of proposed projects which may impact the quantity and/or quality of waters at interprovincial boundaries; and other items of interjurisdictional interest involving groundwater.

The COG will engage the Committee on Hydrology, Committee on Flow Forecasting and the Committee on Water Quality on items of mutual interest or when the expertise of those committees will assist the COG.

PPWB Board Minute 92-65 (Oct. 7, 2009)

COMMITTEE ON GROUNDWATER MEMBERS

CHAIR	Patrick Cherneski (incoming)/ Mike Renouf (outgoing)	Executive Director Prairie Provinces Water Board
MEMBERS	Garth van der Kamp (to Feb 2020)	Groundwater Hydrology Water Science and Technology Directorate Environment and Climate Change Canada
	Yves Michaud (Feb 2020 to current)	Geological Survey of Canada Natural Resources Canada
	Tony Cowen	Science and Technology Branch Agriculture and Agri-Food Canada
	Guy Bayegnak	Groundwater Policy Specialist Alberta Environment and Parks
	Kei Lo	Hydrology and Groundwater Services Water Security Agency (Saskatchewan)
	Graham Phipps	Water Science and Watershed Management Branch Agriculture and Resource Development (Manitoba)
SECRETARY	Megan Garner/ Marie Hyde	Transboundary Waters Unit Prairie Provinces Water Board

APPENDIX VI: Board / Committee Membership 2019-2020 continued

COMMITTEE ON FLOW FORECASTING

Terms of Reference: Mandate

At the request of, and under the direction of the Prairie Provinces Water Board (PPWB), the Committee on Flow Forecasting (COFF) shall investigate, oversee, review, report and improve the accuracy of flow forecasting at the interprovincial boundaries; and, recommend on matters pertaining to streamflow forecasting of interprovincial basins.

The committee may consider such things as flow forecasting methods, hydraulic and hydrologic basin forecast models, tools and techniques, inter-jurisdictional communications, provision and transmission of data, studies, and other items of interprovincial interest involving streamflow forecasting.

The COFF will engage the Committee on Hydrology, Committee on Groundwater and the Committee on Water Quality on items of mutual interest or when the expertise of those committees will assist the COFF.

PPWB Board Minute 115-27 (November 2-3, 2015)

COMMITTEE ON FLOW FORECASTING MEMBERS

CHAIR	Patrick Cherneski (incoming)/ Mike Renouf (outgoing)	Executive Director Prairie Provinces Water Board
MEMBERS	Bruce Davison	National Hydrologic Services Meteorological Service of Canada (Hydrology) Environment and Climate Change Canada
	Anthony Liu	Meteorological Service of Canada (Meteorology) Environment and Climate Change Canada
	Trevor Hadwen/ Patrick Cherneski	National Agroclimate Information Service Agriculture and Agri-Food Canada
	Fisaha Unduche	Hydrologic Forecasting & Coordination Manitoba Infrastructure
	Curtis Hallborg	Flow Forecasting & Operations Planning Water Security Agency (Saskatchewan)
	Colleen Walford/ Bernard Trevor	Watershed Resilience and Mitigation Alberta Environment and Parks
SECRETARY	Megan Garner/ Marie Hyde	Transboundary Waters Unit Prairie Provinces Water Board

APPENDIX VII: Statement of Final Expenditures 2019-2020

For the year 2019-20	Budget	Actual
Salary Component		
PY'S (person years)	4.80	4.00
Base Salary	$ 530,684	$ 397,760
BPE (benefits)	$ 106,137	$ 79,552
Total Salary	**$ 636,821**	**$ 477,312**
O&M Component		
Contracts & Students		
Goal 1	$ 40,000	$ 0
Goal 2	$ 0	$ 0
Goal 3	$ 57,988	$ 38,890
Goal 5	$ 14,165	$ 0
Goal 7	$ 20,000	$ 13,167
Sub-total	**$ 132,153**	**$ 52,057**
Operating Expenses	**$ 22,000**	**$ 42,228**
Total O&M	**$ 154,153**	**$ 94,285**
Grand Total	**$ 790,974**	**$ 571,597**

APPENDIX VIII: History of the PPWB

The PPWB was formed on July 28, 1948 when Canada and the Provinces of Alberta, Saskatchewan, and Manitoba signed the Prairie Provinces Water Board Agreement. This Agreement established a Board to recommend the best use of interprovincial waters, and to recommend allocations between provinces.

From 1948 to 1969, the Engineering Secretary to the Board was a Prairie Farm Rehabilitation Administration (PFRA) employee. The support staff for studies and office accommodation during these years was provided by the PFRA in Regina at no charge.

After twenty years, changes in regional water management philosophies resulted in a need to modify the role of the Board. Consequently, the four governments entered into the *Master Agreement on Apportionment (MAA)* on October 30, 1969. This Agreement provided an apportionment formula for eastward flowing interprovincial streams, gave recognition to the problem of water quality, and reconstituted the Prairie Provinces Water Board.

The *MAA* has five schedules which form part of the Agreement. These Schedules are:

1. Schedule A. An apportionment agreement between Alberta and Saskatchewan.
2. Schedule B. An apportionment agreement between Saskatchewan and Manitoba.
3. Schedule C. The Prairie Provinces Water Board Agreement describes the composition, functions and duties of the Board.
4. Schedule D. A list of Orders-in-Council for allocations of interprovincial waters made before 1969.
5. Schedule E. A Water Quality Agreement describes the role of the PPWB in interprovincial water quality management and established Water Quality Objectives for 12 interprovincial river reaches. This Schedule became part of the Master Agreement in 1992 and was updated in 2015.

APPENDIX VIII: History of the PPWB *continued*

Under Schedule C, the PPWB was reconstituted and was given the responsibility of administering the agreement. Schedule C also provided for the necessary Board staff, accommodation, and supplies to be jointly financed by the four participating governments. Following the reconstitution of the PPWB, the members also agreed to the establishment of a semi-autonomous Board Secretariat.

The PPWB's change in administration policy was implemented when an Executive Director was appointed on July 1, 1972. The By-laws, and Rules and Procedures also came into effect on this date.

On April 2, 1992, the *MAA* was amended to include a Water Quality Agreement that became Schedule E to the Master Agreement. The Agreement sets interprovincial water quality objectives at 12 transboundary river reaches and commits each of the Parties to take reasonable and practical measures to maintain or improve existing water quality.

At the March 1995 meeting, the Board agreed that full time Secretariat staff was no longer necessary and that functional support would be provided by staff of Environment and Climate Change Canada. The process of disbanding the PPWB Secretariat and integrating its functions into Environment and Climate Change Canada was completed during 1995-1996.

The portion of time each Environment and Climate Change Canada staff person spends on PPWB activities is charged to the PPWB and cost-shared by the members.

The Board currently operates through its Executive Director, supported by four standing committees: the Committee on Hydrology, the Committee on Groundwater, the Committee on Water Quality and the Committee on Flow Forecasting.

The Board approves an annual PPWB budget with one-half the operating budget being provided by Canada and one-sixth by each of the three provinces. The Government of Canada is responsible to conduct and pay for the costs of water quantity and quality monitoring.

Prairie Provinces Water Board
10th Floor, Alvin Hamilton Building,
1783 Hamilton Street, Regina, SK S4P 2B6
www.ppwb.ca