2016 ANNUAL REPORT
PRAIRIE PROVINCES WATER BOARD

CANADA • ALBERTA • SASKATCHEWAN • MANITOBA

Prairie Provinces Water Board
Annual Report 2016

FOR THE FISCAL YEAR
APRIL 1, 2016 TO MARCH 31, 2017

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December 19, 2017

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 from April 1, 2016 to March 31, 2017.

The annual report summarizes the activities of the PPWB, its Secretariat and its four technical committees. It confirms that jurisdictional commitments for water apportionment and water quality were met in 2016-2017.

During the period covered by this report the PPWB discussed and made progress on a number of important fronts. The PPWB:

- Continued its work on the development of a groundwater schedule (Schedule F) to the *Master Agreement on Apportionment* (*MAA*);
- Continued to be engaged in a review of apportionment methods to ensure apportionment monitoring and calculations are accurate;
- Approved the report titled "Long-Term Trends in Water Quality Parameters at Twelve Transboundary River Reaches". The report provides long-term water quality data that has been collected from the PPWB transboundary sites since the beginning of the monitoring program; and,
- Sponsored and organized a workshop held in the fall of 2016 focusing on water quality issues related to nutrients and emerging chemicals. This was the first workshop of its kind for the PPWB and brought together approximately 50 water quality specialists and managers from participating jurisdictions to provide a technical forum for participants.

The PPWB administers the *Master Agreement on Apportionment* (*MAA*), which serves as a model for dealing with interjurisdictional issues and has enabled the equitable sharing and protection of interprovincial streams while developing a consensus approach through collaboration and information sharing towards preventing interprovincial surface and groundwater conflicts.

Sincerely,

Cheryl Baraniecki
Chair, Prairie Provinces Water Board
Environment and Climate Change Canada Member

Honourable Catherine McKenna
Minister of the Environment
and Climate Change
Ottawa, Ontario

Honourable Lawrence MacAulay
Minister of Agriculture
and Agri-Food
Ottawa, Ontario

Honourable Dustin Duncan
Minister Responsible for
the Saskatchewan Water
Security Agency
Regina, Saskatchewan

Honourable Shannon Phillips
Minister of Alberta
Environment and Parks
Edmonton, Alberta

Honourable Rochelle Squires
Minister of Sustainable
Development
Winnipeg, Manitoba

Honourable Ron Schuler
Minister of Manitoba Infrastructure
Winnipeg, Manitoba

MESSAGE FROM THE CHAIR

The Prairie Provinces Water Board (PPWB) continues to be a vital institution of governance in the prairies that facilitates the sound and collaborative management of shared water resources.

In 2016-2017, the PPWB continued to be guided by its Strategic Plan, approved in 2006 and revised in 2012 and 2016. This Strategic Plan ensures that PPWB delivers on its mandate to monitor whether the commitments made in the *Master Agreement on Apportionment* (*MAA*) have been met by the Signatory Parties.

Further to its core mandate, the PPWB continued to track and respond to other important water management issues. A number of initiatives took place in 2016 to enhance the ability of the PPWB to deliver on its mandate:

- Evaporation Study: A measurement of evaporation using eddy covariance techniques. The study will provide direct measurement of lake evaporation, which can be used to verify evaporation estimates;
- Dissolved Oxygen Monitoring: The monitoring of dissolved oxygen (DO), biological oxygen demand and field measurements of ice depth, snow cover and river depth on low flow rivers during winter months. This study will be used in preparation for the next water quality objectives review;
- Development of spring runoff maps and ways of improving data and model sharing information; and,
- The continued discussion on the development of an Agreement on Transboundary Aquifers to be proposed for addition to the *MAA*.

Finally, the PPWB continued to provide a cooperative forum for discussion on transboundary water issues including droughts, floods and the growing risk of invasive species in prairie watersheds.

I wish to thank Susan Ross for her participation on the Board. Susan Ross, Alternate Board Member representing Saskatchewan was replaced by Sam Ferris in October 2016. I welcome Sam Ferris to the Board and look forward to working with him.

The success of the PPWB is dependent on the work of the Secretariat and the four standing committees, including the Committee on Hydrology (COH), the Committee on Water Quality (COWQ), the Committee on Groundwater (COG) and the Committee on Flow Forecasting (COFF). Dedication and engagement by Board members, jurisdictional representatives on committees, and the Secretariat are essential, and much appreciated.

Cheryl Baraniecki
Chair, PPWB

MESSAGE FROM THE **EXECUTIVE DIRECTOR**

During 2016-2017, the work of the PPWB Secretariat and four standing committees focused of achieving the goals outlined in the PPWB Strategic Plan and activities listed in the 2015-2016 to 2020-2021 Work Plan.

During 2016, agreed transboundary apportionment of flows on all eastward flowing streams was achieved for all river reaches. Lodge Creek did experience a deficit for the first half of the year; however, rain events in late summer resulted in final apportionment requirements being met.

Adherence to the *MAA*'s water quality objectives was excellent.

The Committee on Hydrology (COH) continued work on the review of apportionment methods and associated documentation to ensure apportionment monitoring and calculations are accurate. During the year, two contracts were issued to review the Saskatchewan and the Qu'Appelle river basins. The Saskatchewan River Basin Review is expected to be completed in 2017 and the Qu'Appelle River Basin Review in 2018.

Evaporation estimates are an important part of apportionment calculations. The COH began a field study using Newton Lake in Saskatchewan and Shellmouth Reservoir in Manitoba to measure lake evaporation using eddy covariance techniques.

The Committee on Groundwater (COG) prepared a draft Agreement on Transboundary Aquifers to be added as Schedule F to the *MAA*. A comprehensive legal review of the proposed agreement by all jurisdictions is ongoing.

In October 2016, the Committee on Water Quality (COWQ) organized a workshop which focused specifically on water quality issues related to nutrients and emerging chemicals. This was the first PPWB workshop of this kind.

The newly formed Committee on Flow Forecasting (COFF) finalized its work plan in 2016 and began to look at harmonizing spring runoff potentials. This work is ongoing.

The Board continued its role in helping to ensure coordination of water management and planning that may have transboundary implications. The Board continued to provide a forum for sharing information, including progress on actions to address Saskatchewan-Manitoba drainage issues, the impact of sediment transport from the Carrot River on the Saskatchewan River, drought and flood management and invasive species management in the prairie provinces.

Mike Renouf
Executive Director, PPWB

SUMMARY OF PERFORMANCE RESULTS

During 2016-2017, apportionment responsibilities of the Board were met through:

- Reviewing and approving the apportionment monitoring network comprised of hydrometric and meteorological stations;
- Confirming apportionment obligations were met on Cold Lake, North Saskatchewan River, South Saskatchewan River below the Red Deer River, Battle Creek, Lodge Creek, Middle Creek, Churchill River, Saskatchewan River, Red Deer River (Saskatchewan), Qu'Appelle River, Assiniboine River, and Pipestone Creek;
- Continuing work on the process of reviewing apportionment methods in all basins. Two apportionment procedure reviews were undertaken and are ongoing, the Saskatchewan River Basin and the Qu'Appelle River Basin, both on the Saskatchewan-Manitoba boundary;
- Drafting of criteria to document the rationale by which the PPWB determines which basins are subject to apportionment monitoring and the frequency of this monitoring; and,
- Continuing with the initiatives to further study evaporation estimation methods. As an example, a field study began in 2016, to measure evaporation using eddy covariance techniques.

In 2016, the overall adherence rate to the interprovincial water quality objectives was, on average, 96.5 %. This adherence rate is based on the comparison of 5,298 water quality results to water quality objectives.

- In 2016, work continued on quantifying non-point and point nutrient sources in two river basins, the Carrot River (Saskatchewan-Manitoba boundary) and the Red Deer River (Alberta-Saskatchewan boundary). A contract was issued to Golder Associates in 2015 and continued in 2016. The assessment is expected to be finalized in 2017;
- The first water quality workshop focusing specifically on water quality issues related to nutrients and emerging chemicals was held in October 2016. The workshop provided a technical forum and technical learning opportunity for the participants. The workshop was a success with fifty participants in attendance;
- The PPWB determined that dissolved oxygen (DO) levels on low flow rivers such as the Battle, Beaver and Carrot rivers require further review. DO loggers were installed in the three rivers as part of a pilot study to review winter DO levels. The study is ongoing and the results will be used in the preparation for the next water quality objectives review; and,
- The PPWB is preparing for the next water quality objectives review. The focus on the next review will be on outstanding issues from the last comprehensive review and is expected to be completed by 2020.

SUMMARY OF **PERFORMANCE RESULTS** *continued*

The Committee on Groundwater (COG) developed a draft Agreement on Transboundary Aquifers to be added as Schedule F to the *MAA*.

- A legal review of the proposed draft Agreement began in 2014 and progresses. The proposed agreement will provide a cooperative framework for managing transboundary aquifers using a risk informed approach;
- A mapping inventory for aquifers for the Alberta-Saskatchewan boundary and the Saskatchewan-Manitoba boundary was completed so that the PPWB can finalize a list of aquifers that will be considered transboundary and are located within 30 km either side of the provincial boundaries; and,
- Work to develop evaluation criteria to support the Risk Informed Management (RIM) approach continues. The criteria will be used to assess transboundary aquifers and to determine which actions to take in the management of transboundary aquifers.

Work activities for the PPWB's newest technical committee, the Committee on Flow Forecasting (COFF), were finalized in 2016. One of the committee's key activities will be to harmonize spring runoff potentials across the three prairie provinces. This will include the production of maps and forecast harmonization.

In 2016, low flow conditions were experienced on Lodge Creek. Quarterly reports for Lodge Creek showed a deficit in delivery by Alberta for the first and second quarter. However, rain events in late summer resulted in a recovery in the delivery of flow and by the third and fourth (final) quarter, apportionment requirements were not impacted.

During the year, the Board discussed the following transboundary issues:

- Water quality in Lake Winnipeg;
- Downstream impacts of drainage in Saskatchewan upon Manitoba;
- Manitoba's concern related to sediment transport in the Carrot River; and,
- Management of invasive species across the prairie provinces.

1. INTRODUCTION

This report summarizes the activities of the Prairie Provinces Water Board (PPWB), its Secretariat, and four standing committees that supported PPWB activities for the period April 1, 2016 to March 31, 2017.

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 the 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 2016-2017 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 2016-2017.

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 2016 apportionable flow data. Appendices III and IV present the water quality parameters that were monitored by Environment and Climate Change Canada and the 2016 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.

The *MAA* was signed in 1969 by Canada and the governments of Alberta, Saskatchewan, and Manitoba in recognition of the need to cooperatively share and manage interprovincial waters for the benefit of present and future generations.

2. PERFORMANCE RESULTS

Update

All activities in the 2012-2017 PPWB work plans target achieving the eight goals in the PPWB's Strategic Plan. Progress made in 2016-2017 is discussed below for each of these goals.

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 *MAA*'s Schedule A and Schedule B.

Apportionment Monitoring of Rivers

The *MAA* states that all eastward flowing streams are subject to apportionment. Currently, the Board conducts apportionment monitoring of Cold Lake, North Saskatchewan River, South Saskatchewan River below the Red Deer River confluence, 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.

Water Quantity Monitoring

The PPWB is required to assess and report on whether apportionment requirements were met. Environment and Climate Change Canada conducts the water quantity monitoring in accordance with the terms of the *MAA*. In 2016, the PPWB Secretariat calculated apportionable flows using monitoring data from 95 hydrometric stations, 25 meteorological stations and several third party diversion measurements. (Appendix 1)

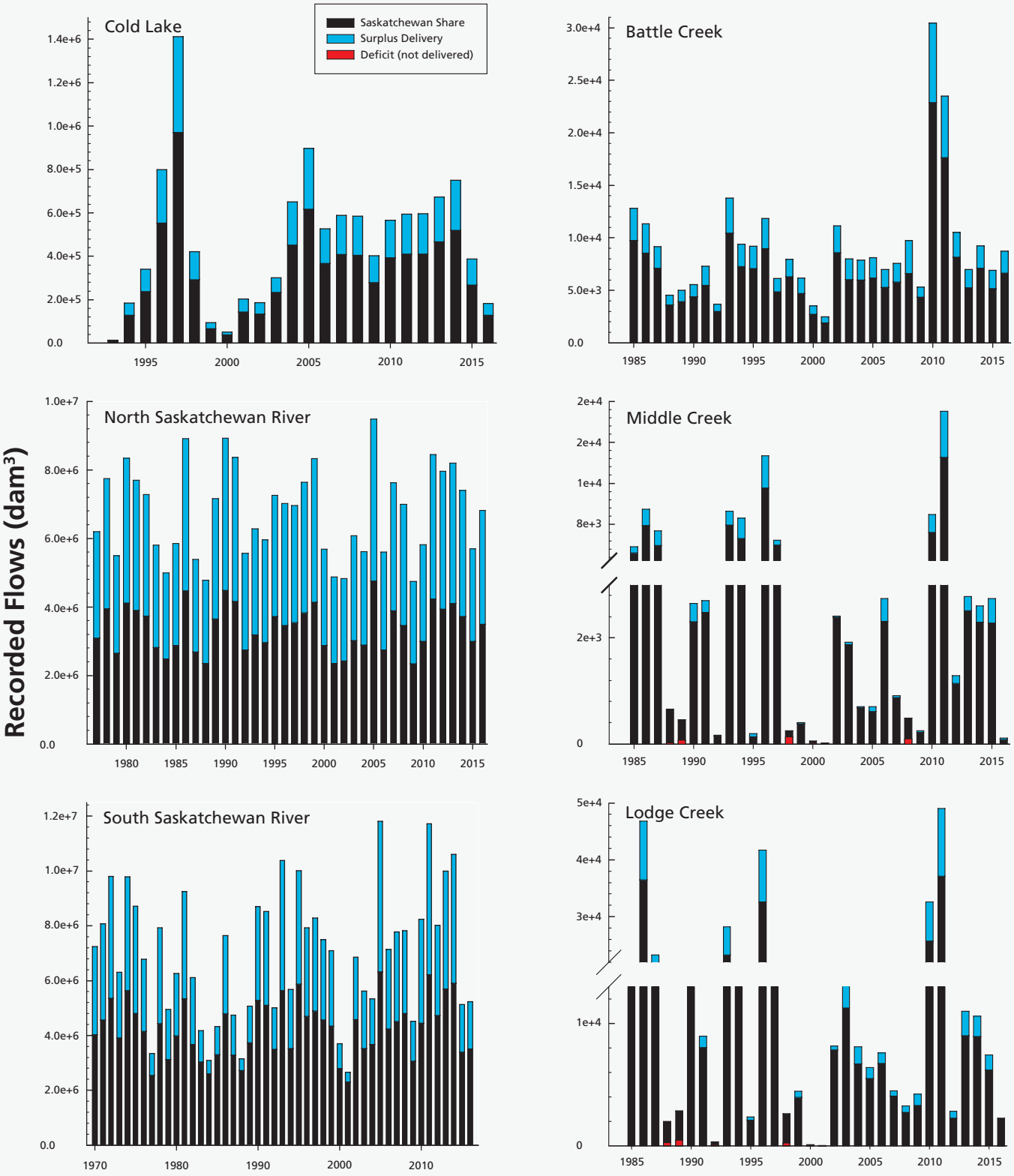
Figures 1 and 2 illustrate the apportionment balance through the history of PPWB apportionment monitoring for each basin. The black bars illustrate the amount of apportionable flows that were required to be delivered by Alberta to Saskatchewan (Figure 1) and by Saskatchewan to Manitoba (Figure 2). The blue and red bars indicate the flow surplus and deficits.

For rivers with surplus flows, the combined black (provincial share) and blue (surplus) stacked bars show the total recorded flows. The red bars indicate deficits. For rivers showing a deficit, the required provincial share is the combined height of the black and red bars. The analysis suggests that large surpluses are fairly common for many of the rivers, and annual flow volumes vary considerably over the years. Because flows vary so much, scientific notation is used on the y-axis to show the magnitude of differences of flows across rivers.

Only two streams have experienced deficits throughout the historical record: Middle and Lodge Creeks. For Middle Creek, five minor deficits occurred in 1988, 1989, 1998, 2000 and 2008. Deficits were, however, so small in 1988 and 2000 that they are not obvious in Figure 1. For Lodge Creek, five minor deficits were found in 1988, 1989, 1992, 1998 and 2000. Deficits were also not obvious in Figure 1 in 1992 and 2000. As these creeks are also part of the international agreement between Canada and the United States, Alberta must pass 75% of the flow to Saskatchewan and then Saskatchewan must pass 50% to Montana. This means that any early season use within Alberta puts Alberta at a risk of deficit if the remainder of the year is dry. Alberta and Saskatchewan worked cooperatively to address these deficits and continue to evaluate long-term solutions, including improvements to the accuracy of interim water use reporting.

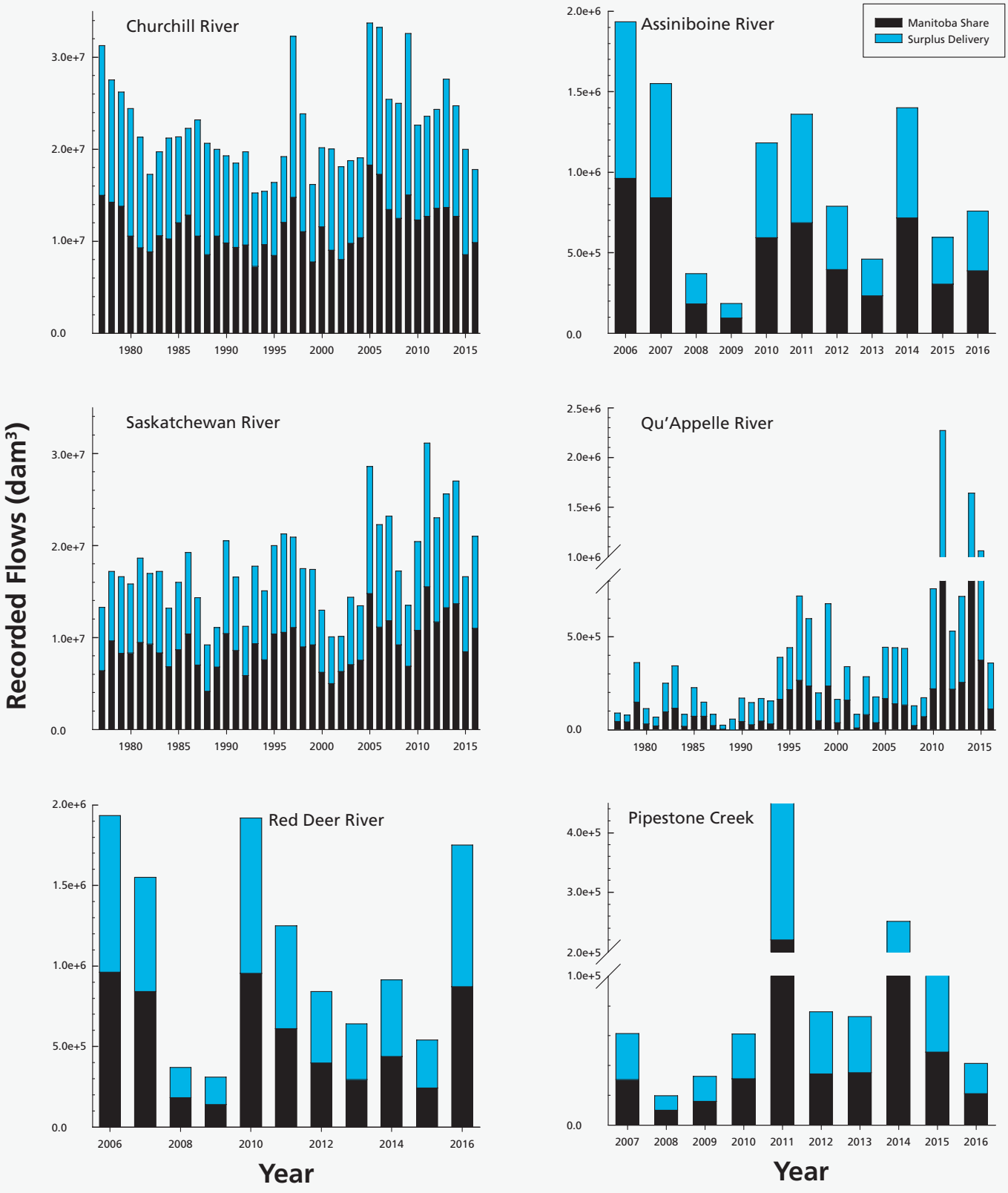
In November 2016, the Board reviewed and endorsed the monitoring stations lists for 2017-2018. There are no changes to the 2016-2017 monitoring lists with the exception of clearer labeling on six meteorological stations. Six stations that are currently labelled as "South Saskatchewan River" will be identified as "Saskatchewan River".

FIGURE 1. HISTORIC RIVER FLOWS ON THE ALBERTA-SASKATCHEWAN BOUNDARY



[1]The number following the e in the Scientific Notation indicates how many zeros should be placed before the decimal.

FIGURE 2. HISTORIC RIVER FLOWS ON THE SASKATCHEWAN-MANITOBA BOUNDARY



2. PERFORMANCE RESULTS *continued*

Flows Reported in 2016

Interim flow reporting was completed for four basins in 2016. Quarterly reports presented interim recorded and apportionable flows for the South Saskatchewan River, Middle Creek and Lodge Creek. One semi-annual report from January to June was completed for Cold Lake.

Appendix II presents the final monthly and total apportionment results. For all apportioned rivers and creeks the recorded flow at the interprovincial boundary was higher than the amount that the upstream province was required to deliver, and all apportionment requirements were met in the 2016 calendar year.

The combined daily recorded flows for the South Saskatchewan and Red Deer Rivers at the Alberta-Saskatchewan boundary exceeded the minimum flow requirement of 42.5 m^3/sec (1,500 cfs) at all times in 2016. This is the only basin for which a daily flow requirement is in place. The last time the daily minimum flow requirement was not met was in November 2011. At that time investigations were undertaken into the conditions when the low flow occurred, which was similar to previous occurrences and coincided with the freeze up of the river. The conclusion of the investigation was that the short term drop in flow to below the minimum flow rate was attributed to natural processes at play during freeze up. The Committee on Hydrology is reviewing the need for protocols when low flow incidents occur. These protocols could include notification requirements, as well as steps that must be taken during low flow situations to confirm the conditions of the *MAA* are being adhered to.

Improving Apportionment Methods

Apportionment Procedure Review

The Committee on Hydrology (COH) continued to be engaged in a 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 work to examine the apportionable flow calculation methods for all of the 12 interprovincial basins which PPWB actively apportions is expected to take approximately ten years.

In 2016, two apportionment procedure reviews were underway, the Saskatchewan River Basin and the Qu'Appelle River Basin, both at the at the Saskatchewan-Manitoba boundary. Both basin reviews were contracted to Optimal Solutions Ltd. The Qu'Appelle River apportionable flow calculation review 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 Saskatchewan River Basin Review is expected to be completed in 2017, while the Qu'Appelle River Basin Review is expected to be completed in 2018.

The COH is in the process of determining which basin will be the next to undergo review.

Apportionment Monitoring Criteria

A sub-committee of the COH was formed to establish formal criteria by which the PPWB determines which interprovincial basins are subject to apportionment monitoring, as well as the frequency of monitoring for those basins that are selected. The sub-committee envisions that such criteria could be implemented following the completion of each basin review, as well as for periodic review of basins which are not currently subject to apportionment monitoring. The sub-committee has drafted a criteria document and is working on testing the application of the criteria to various basins.

Modernizing Apportionment Software

The PPWB Secretariat currently uses a suite of FORTRAN programs to compute transboundary apportionable flows. The COH is modernizing this practice by moving to a customized apportionable flow calculation platform called the River Basin Assessment Tool (RBAT).

2. PERFORMANCE RESULTS *continued*

The consultant, Optimal Solutions Ltd., provided the final version of the RBAT software in November 2014. A warranty and help desk portion of the contract ended in November 2016. However, due to some issues with RBAT, the consultant agreed to extend the warranty period to November 2017 to complete the final testing of the software program.

Evaporation Investigations

Evaporation is an important component of apportionment calculations used to ensure equitable distribution of water between Alberta, Saskatchewan and Manitoba. As such, the COH has an interest in continually improving lake/reservoir evaporation estimation methods. In 2015, the COH formed an evaporation working group to look at the problem. The working group consists of members representing each of the jurisdictions, as well as the PPWB Secretariat and Meteorological Service of Canada (MSC).

In spring of 2016, 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 field study is using specialized equipment, on loan from Environment and Climate Change Canada's National Hydrology Research Centre. The study will provide direct measurement of lake evaporation, which can be used to verify evaporation estimates from various models and calibrate model parameters for optimized results. Results from this study will help better understand lake evaporation in the Canadian prairie environment and improve PPWB apportionment calculations.

In June 2016, after only one month of data collection, an act of vandalism destroyed the equipment that had been installed at Newton Lake. New equipment was then deployed in August 2016.

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 second phase will then be required to compare the field measured evaporation with estimated evaporation and from there make recommendations on which evaporation estimation methods provide the best approximation, as well as possible refinements to those methods. The COH will be determining the next steps for the evaporation study during 2017.

Review of Hydrometric Network

The federal-provincial hydrometric program is undergoing a risk assessment review process. The PPWB has been asked by Environment and Climate Change Canada to participate in the review process. A network committee has been established and a COH representative has been identified to work with the network committee on behalf of the PPWB.

2. PERFORMANCE RESULTS *continued*

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

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

The *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 2016.

Groundwater Schedule F

Development and Consultation

In October 2007, the Board directed the Committee on Groundwater (COG) to proceed towards the creation of 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.

Implementation

A Risk Informed Management (RIM) approach is proposed to be used to cooperatively manage transboundary aquifers. The RIM is intended to be an Annex to Schedule F. Under the proposed RIM approach, the vulnerability and risk to transboundary aquifers from development and human activities will be assessed and aquifers will be categorized as class one to four. These categories will be used by the PPWB as the basis for determining the correct bilateral, multilateral, and jurisdictional actions for the cooperative management of transboundary aquifers.

Scenarios

An internal review of the proposed Schedule F by each of the signatories to the *MAA* began in 2014 and is progressing. This review is required due diligence by each party to ensure that they are aware of the implications to their jurisdiction/department as a result of the proposed Schedule. 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. In addition to the mock scenarios, the COG is also developing a document that summarizes the roles and responsibilities of all parties once the proposed Schedule is in force.

2. PERFORMANCE RESULTS *continued*

Aquifer Inventory

The COG is working on an initial inventory of aquifers along the Alberta-Saskatchewan and Saskatchewan-Manitoba boundaries that will be targeted for the first review cycle when Schedule F is ratified. These lists will include all the major fresh water aquifers, but will not be exhaustive of all transboundary aquifers that are captured under this agreement. Other aquifers may be added at the discretion of the Board at any time.

Transboundary Aquifer Assessment Criteria

The COG continues to work towards developing the aquifer assessment criteria that will be used to classify transboundary aquifers based on the management categories described in the RIM document.

Cold Lake Drought Contingency Plan

Past studies have indicated that groundwater pumping may affect lake levels of Cold Lake and apportionable flow delivered to Saskatchewan from Alberta. One of the recommendations from PPWB technical report No. 173, Basin Review: Calculation of Apportionable Flow for the Cold River at the Outlet of Cold Lake is the need to develop a drought contingency plan to address potential effects of groundwater pumping on Cold Lake during times of drought. To address this recommendation a COH-COG working group with representatives from Alberta and Saskatchewan has been formed to investigate this question.

Voluntary Provisions of Transboundary Withdrawals

Provincial COG members have contacted their respective water rights offices to inform them of the need to report groundwater projects with significant withdrawals to the neighbouring province.

The COG is also looking at a formalized system for tracking of voluntary information and notification to adjacent jurisdictions of projects with potential transboundary impacts to support the implementation of Schedule F.

2. PERFORMANCE RESULTS *continued*

GOAL 3: Agreed Transboundary *MAA* Water Quality Objectives Are Achieved

The PPWB's 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 watercourses at the Alberta-Saskatchewan and Saskatchewan-Manitoba boundary locations.

Each fall a water quality monitoring program is approved by the PPWB. Monitoring results are compared annually to the objectives to determine if any excursions to the objectives occurred. If there are excursions, the Committee on Water Quality (COWQ) will prepare 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 *MAA*'s water quality monitoring locations are shown in Appendix I. The *MAA*'s water quality monitoring parameters are shown in Appendix III.

In 2016, in accordance with the terms of the *MAA*, Environment and Climate Change Canada conducted water quality monitoring at 12 sites as requested by the PPWB. The water quality monitoring program for 2016 included:

- On-going monthly sampling of nutrient, physical/other, major ion, metal and biota (bacteria) 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, March, July and October);
- Pesticide parameters such as acid herbicides, neutral herbicides, organo-chlorines and glyphosate sampled:
  - o Monthly on the Carrot and Assiniboine Rivers;
  - o Eight samples (in February, April, May, June, July, August, October, and December) on the Saskatchewan and Qu'Appelle Rivers (Saskatchewan-Manitoba boundary) as part of the annual rotation for pesticide sampling;
- Sampling for acid herbicides on the South Saskatchewan River and the Battle River continued eight times per year as part of the normal pesticide monitoring in 2016.

The 2016 monitoring program was completed as approved by the Board at their October 23rd, 2015, Meeting No. 114, with a few exceptions:

- In July 2016, the Carrot River on the Saskatchewan-Manitoba boundary was not sampled because the station was inaccessible as a result of flooding.
- In March 2016, acid and neutral herbicides samples for the Carrot and Assiniboine rivers were lost (during preparation in the laboratory) and therefore could not be determined.

Environment and Climate Change Canada undertook a total of 135 water sampling events at the 12 PPWB river sites in 2016. Details of the 2016 PPWB Report on Excursions of Interprovincial Water Quality Objectives, January-December 2016, can be found in Appendix IV.

Adherence or Excursions to Transboundary Water Quality Objectives

In 2015 the PPWB established water quality objectives for individual parameters based on values that protect aquatic life, source water, recreation, agriculture uses and fish consumption.

A total of 5,298 water quality parameter values were compared to transboundary water quality objectives to determine whether any excursions to the objectives occurred in 2016.

In 2016, the transboundary water quality objectives were adhered to, on average, 96.5 % for all parameters. Overall, adherence rates from 2016 are similar to those of previous years. Most rivers show an approximately 5% variation in adherence rates over the past ten years. In 2016 the Beaver River had the highest adherence rate at 99% and the Red Deer River (Saskatchewan-Manitoba boundary) had the lowest adherence rate at 92.5%. Of the 12 transboundary rivers, the greatest inter-annual variation occurred on the Battle and Red Deer (Alberta-Saskatchewan boundary) rivers.

Excursions for nutrients, biota (bacteria), total dissolved solids (TDS) and major ions were the most common among sites. Excursions for total metals and major ions were more prevalent at the Saskatchewan-Manitoba boundary sites. The highest

2. PERFORMANCE RESULTS *continued*

number of excursions occurred on Red Deer River, Assiniboine River and the Qu'Appelle River on the Saskatchewan-Manitoba boundary.

The results of the PPWB Report on Excursions of Interprovincial Water Quality Objectives, January-December 2016 indicate that there are a number of areas that require further investigation. There is a need to better understand factors affecting nutrient concentrations and pesticides including the relationship between pesticide concentration, total suspended solids, flow and seasonality in the different rivers. Development of an action plan to assess the risks and causes of excursions and potential mitigation by the respective jurisdictions is ongoing.

Quantifying Non-Point and Point Nutrient Sources in Interprovincial Watersheds

The COWQ identified nutrients as priority parameters for further investigation across the Prairie Provinces due to increasing trends in some river reaches, exceedances of water quality objectives at some locations and the general importance of nutrients on aquatic ecosystems. To better understand factors affecting nutrients in prairie rivers the PPWB put out a request for proposals for an assessment of the state of knowledge on the major nutrient sources and to determine the current understanding of major influences to, and causes of, nutrient concentrations and trends in two watersheds with PPWB monitoring stations. These watersheds were the Red Deer River (Alberta-Saskatchewan) and the Carrot River. In July 2015, the contract was awarded to Golder Associates.

Golder Associates provided the first draft of the report in June 2016. Comments were provided by COWQ and the consultant is working to address the comments and provide a final draft report in 2017. The contract has been extended from March 2017 to March 2018 to provide the COWQ time to review the final draft report.

Fish Tissue Report and Fish Monitoring Program

To better understand the utility of using biological indicators of riverine health, the COWQ recently compiled and reviewed fish tissue data collected by PPWB from 1992 to 2004. The committee determined that a report, authored by a fish biologist, which provided recommendations on the fish tissue monitoring program, would be of benefit. Completion of this report would provide data to the jurisdictions, the pubic and other interest groups and provide information on the utility of this type of biological monitoring program for meeting objectives of the PPWB.

A competitive contract for this fish tissue work is expected to be issued in 2017.

Water Quality Objectives Review

The PPWB has committed to reviewing the water quality objectives every five years. The revised objectives from the last review were adopted in 2015. The focus of the next water quality review will be on outstanding issues from the last comprehensive review. Objectives were not established for a number of parameters because the committee agreed during the last comprehensive review that the use of protective objectives were not appropriate and/or there was insufficient information to support development of site specific objectives for certain parameters. These parameters included:

- DO on the Battle, Beaver, and Carrot rivers during the ice covered season
- Dissolved manganese on the Battle, Beaver, Assiniboine, Carrot and Qu'Appelle rivers;
- Dissolved iron on the Carrot River
- Total cadmium on the Red Deer River (Alberta-Saskatchewan boundary)
- Total copper on the Red Deer River (Alberta-Saskatchewan boundary)

2. PERFORMANCE RESULTS *continued*

- Sodium Absorption Ratio (SAR) on the Battle, Carrot and Qu'Appelle rivers

The committee has been working to better understand water quality conditions and requirements needed to resolve the "under review" status for the above referenced parameters. The next water quality review will focus on:

- Reviewing current PPWB objectives that are derived from use-specific criteria by comparing them with other agencies or jurisdictions that may have recently updated their objectives
- Establishing site specific objectives and/ or justification for not having objectives for:
  - o dissolved manganese on certain rivers, dissolved iron on the Carrot River;
- Establishing objectives and/ or justification for not establishing objectives for:
  - o SAR on certain rivers, total cadmium and total copper on the Red Deer River (Alberta-Saskatchewan boundary), winter objectives for DO on the Battle, Beaver and Carrot rivers;
- Identifying processes to exempt sites from toxicology-based objectives and identifying options for setting alternative objectives; and,
- Assessing options for different approaches to developing site-specific objectives.

The review is expected to be complete by 2020.

Dissolved Oxygen Monitoring

Presently, there are no ice-covered (winter) objectives for dissolved oxygen (DO) in the Battle, Beaver, and Carrot rivers. These three rivers typically have low winter flows and low water volumes between the bottom sediment and ice and consequently DO reaches low levels, typically less than 1 mg/L on the Carrot and close to 0 mg/L on the Battle and Beaver rivers. The committee determined that dissolved oxygen (DO) was a parameter that required further information and review to better assess the applicability of an appropriate objective. As part of a pilot study, Environment and Climate Change Canada installed continuous DO loggers in the three rivers throughout the winter season. Additional winter analyses were undertaken on the water samples to measure biological oxygen demand. As well, field measurements were made of ice depth, snow cover and river depth.

In spring 2016, loggers and corresponding data were retrieved for the Battle and Carrot rivers. There were no reliable data for the Beaver River, as the data logger on this river was damaged. A main objective of the continuous monitoring is to understand how different conditions affect winter oxygen depletion rates. This study is ongoing and will be used in preparation for the next water quality objectives review.

Long-Term Trends at Transboundary River Reaches

In 2016, the Board approved the PPWB technical report No. 176, titled "Long-Term Trends in Water Quality Parameters at Twelve Transboundary River Reaches". The report provides information on long-term trends in water quality data that have been collected from the PPWB transboundary sites since the beginning of the long-term monitoring program up to 2008. This report complements PPWB technical report No. 174 titled "Review of the 1992 Interprovincial Water Quality Objectives and Recommendations for Change", approved by the Board in November 2015.

The committee is working on a new long term trend report with data up to 2013.

2. PERFORMANCE RESULTS *continued*

Water Quality Workshop

Workshops are an important part of enabling the Board to fulfill its mandate by providing the means to share information, knowledge and research among jurisdictions. On October 4-5, 2016, in Regina, Saskatchewan, the PPWB sponsored and organized a workshop focusing specifically on nutrients and emerging water quality issues in prairie water management. This was the first workshop of its kind for the PPWB. The intent of the workshop was to provide a technical forum and technical learning opportunity for participants.

Fifty participants of the workshop included representatives from each of the provincial and federal water and agricultural ministries/departments and academic researchers. Speakers from each member agency outlined nutrient work being done within their jurisdictions; keynote speakers discussed trending methods and nutrient dynamics within the prairies. The workshop also included small group discussion on three strategic themes: Science Needs, Data and Methods, and Management and Policy. Groups discussed their thoughts on solutions to critical questions related to understanding and managing nutrient issues on the prairies.

The workshop was considered to be a success. The participants voiced strong support for similar future workshops. A summary report on the workshop was prepared by S. L. McLeod Consulting and has been approved by the PPWB as Technical Report No. 177 titled "Prairie Water Quality Workshop with a Focus on Nutrients".

2. PERFORMANCE RESULTS *continued*

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

The PPWB'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 spills or unusual water quality conditions as well as emergency or unusual surface water quantity or groundwater quantity and quality events 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.

Trail Creek Biodiesel Spill
In June 2016, Alberta distributed a notice that there was a spill on Tail Creek, a tributary to the Red Deer River, as a result of a tanker trailer combination roll over. The tanker trailer combination unit was carrying approximately 50 m^3 of biodiesel fuel. An estimated 25 m^3 of product was released into Tail Creek as a result of the tanker breach. There was minimal impact on the Red Deer River.

North Saskatchewan River Husky Oil Spill
In July 2016, Saskatchewan's Water Security Agency distributed a notice related to a Husky Oil pipeline oil spill from a 16" blend line into the North Saskatchewan River approximately 50 km downstream of the Alberta-Saskatchewan boundary. The spill took place on the riverbank of the North Saskatchewan River. The total volume estimate was between 200 and 250 m^3 of oil spilled. An investigation is ongoing. Members of several of the Board's committees worked collaboratively together during the response to this spill.

Flood Conditions in the Prairies

There were forty heavy rain storm events in the prairie provinces in the summer of 2016. Heavy rains in Alberta caused significant flooding in areas north and west of Edmonton in August 2016. Fifty to 75 millimeters of rainfall was received in the area.

In Saskatchewan, the Carrot River experienced a flooding event in July 2016 as a result of a heavy rainfall event. In two hours, 100 millimeters of rain fell in the Carrot River. A state of emergency was called in the towns of Arborfield and Carrot River, the rural municipality of Arborfield and Shoal Lake First Nations, Saskatchewan. The city of Estevan also experienced flooding in July 2016 after receiving as much as 130 millimeters of rain in some areas.

Manitoba experienced 240 severe weather events which include large hail, strong winds, heavy rain and tornadoes.

Drought Conditions in the Prairies

In northern Alberta, Fort McMurray experienced the driest winter-spring in 72 years of weather recordings. Snow cover disappeared early in the season and the dry conditions and strong winds led to fire that then blew out of control.

In Alberta and Saskatchewan, both the South Saskatchewan and North Saskatchewan Rivers experienced low flow conditions in the spring/summer of 2016 due to lower than normal 2015-2016 snowpack and spring precipitation.

Northwestern Manitoba experienced moderate to severely dry conditions in the spring and summer months of 2016. However, the area recovered in late summer due to normal precipitation events in north central Saskatchewan.

2. PERFORMANCE RESULTS *continued*

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

The PPWB's 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.

The Committee Terms of Reference were finalized in 2015 and the work plan activities for 2016-2021 were finalized in 2016. Initial activities that the COFF is undertaking include collaboration on spring runoff potential forecasts and investigation of harmonization opportunities, discussion of mechanisms for improved data and information sharing between agencies, opportunities for knowledge sharing, exploration of optimized modeling techniques and platforms, and improving linkages with Environment and Climate Change Canada and Agriculture and Agri-Food Canada.

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. Concern over excess nutrient loading in Lake Winnipeg has risen in recent years, with reports of increased frequency, duration and intensity of algal blooms. The Province of Manitoba, Environment and Climate Change Canada and many other partners have been engaged in numerous initiatives to address water quality issues in Lake Winnipeg.

The PPWB provides a forum to exchange information on Lake Winnipeg initiatives with the Provinces of Manitoba, Saskatchewan and Alberta. In addition, Canada and Manitoba signed a Memorandum of Understanding (MOU) in September 2010 to continue their collaborative partnership in support of Lake Winnipeg into the long-term. In 2015, the MOU was extended to 2020.

The goal of the MOU is to establish a long term collaborative and coordinated approach between two governments to support the sustainability of Lake Winnipeg and its contribution to economic activities, recreation and watershed functions. Specific goals are to coordinate science, information sharing and any activities that support the MOU. The MOU Steering Committee met in May and September 2016, and in March 2017.

2. PERFORMANCE RESULTS *continued*

The Board was informed about activities of Environment and Climate Change Canada's Lake Winnipeg Basin Initiative (LWBI). The LWBI focused on three areas: Transboundary partnerships to manage nutrients in the basin; scientific research, modeling and monitoring; and a stewardship fund for stakeholder-led projects that reduce nutrient loads in the lake and basin.

The LWBI ended in March 2017. As per the Minister of Environment and Climate Change Canada's 2015 mandate letter, a priority was identified to renew the federal government's commitment to protect water quality in the Lake Winnipeg Basin and those considerations are underway.

Carrot River Sediment Concerns

Saskatchewan, with the support of Manitoba, continues to explore opportunities to investigate the reduction of channel capacity in the Saskatchewan River near The Pas, Manitoba, as a result of sediment transport from the Carrot River. However, at the Committee on Hydrology meeting in September 2016, Manitoba reported that there has been no loss of channel capacity on the Carrot River near Turnberry, although, a rise in suspended solids has been noted. Manitoba and Saskatchewan are discussing a path forward.

Saskatchewan-Manitoba MOU respecting Water Management

Saskatchewan and Manitoba signed an 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. The intent of the MOU is not to duplicate efforts but to make use of existing mechanisms for coordination and cooperation when dealing with water management.

A Terms of Reference (TOR) and protocol to deal with drainage issues was drafted. Although drainage does not fall directly within the mandate of the PPWB, the Board has been involved in drainage issues over the years.

The MOU acknowledges the important work of the PPWB and agrees to work through the PPWB where it is the appropriate existing mechanism.

2. PERFORMANCE RESULTS *continued*

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

The PPWB's Strategic Goal 6 is to keep 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 brochures and fact sheets, technical reports, and the PPWB website. 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.

2. 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.

Invasive Species

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

The first case of whirling disease in Canada was confirmed in August 2016 in Johnson Lake, Banff National Park, Alberta. Whirling disease is an infectious disease and it is caused by Myxobolus cerebralis, a myxosporean parasite of salmonids (salmon, trout, whitefish). Whirling disease afflicts juvenile fish and causes skeletal deformation and neurological damage.

Alberta Environment and Parks issued a Ministerial Order in September 2016 under the provincial Fisheries (Alberta) Act.

The Canadian Food Inspection Agency (CFIA) declared the Bow River watershed as "infected" with whirling disease in February 2017. Alberta Environment and Parks is working with the CFIA to develop a long term detection and surveillance plan to protect Alberta's waters and fishery.

Some of the sites confirmed with whirling disease are PPWB sites. Environment and Climate Change Canada, Water Survey Division are taking extra precautions through a risk management approach to minimize the potential spread of the disease.

At their Meeting No. 117, held in November 2016, the Board supported the idea of bringing expertise within each jurisdiction to provide information on the jurisdiction's invasive species program. As meetings rotate from one jurisdiction to another, expertise from that location will be invited to present information on their invasive species program. In February 2017, PPWB Meeting No. 120 was held in Winnipeg, Manitoba. A representative from Manitoba's Department of Sustainable Development, Wildlife and Fisheries Branch, was invited to present information on Manitoba's aquatic invasive species program.

2. PERFORMANCE RESULTS *continued*

GOAL 8: PPWB Business is Conducted Effectively

The PPWB's Strategic Goal 8 focuses primarily on administration, work planning, and financial management. Goal 8 ensures that work planning and budgeting is consistent amongst jurisdictions, day to day activities are administered effectively, there is effective communication, 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 at Room 300, 2365 Albert St., Regina, Saskatchewan. 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.

Six Board and eight Committee meetings were held throughout the 2016-2017 fiscal year. The Board invites the various Committee members to participate in Board meetings. This practice is common with all of the Board Committees, thereby improving communication and understanding between the Board and the Committees.

PPWB
- Meeting No. 116B. April 8, 2016 – Teleconference
- Meeting No. 117. November 9, 2016 – Teleconference
- Meeting No. 118A. November 22, 2016 – Teleconference
- Meeting No. 118B. December 14, 2016 – Teleconference
- Meeting No. 119. February 7, 2017 – Teleconference
- Meeting No. 120. February 8-10, 2017 – Winnipeg

COH
- Meeting No. 133. September 27-28, 2016 – Val Marie, Saskatchewan
- Meeting No. 134. January 26, 2017 – Videoconference

COWQ
- Meeting No. 130. October 3-4, 2016 – Regina
- Meeting No. 131. January 30-31, 2017 – Videoconference

COG
- Meeting No. 70. September 23, 2016 – Teleconference
- Meeting No. 71. February 2, 2017 – Teleconference

COFF
- Meeting No. 3. September 13-14, 2016 – Winnipeg
- Meeting No. 4. January 24, 2017 – Videoconference

2. PERFORMANCE RESULTS *continued*

The Board approves the annual budget for the PPWB. The budget for 2016-2017 was $992,084 and final expenditures were $711,648 as shown in Appendix VII. Final expenditures were below the approved budget due to a number of delays with deliverables for existing contracts, and also due to delays in initiating the contracting process for the Qu'Appelle River basin review contract.

The Board conducts budget planning early in the year and has a substantial discussion on the budget at the fall meetings. This discussion facilitates early input by the Board into the budget processes of the PPWB member governments.

The PPWB Work Plan is a standing item on regular Board meeting agendas to review items that are discussed which are derived from the Work Plan. The Board approved the Work Plan for fiscal years 2016-2017 to 2020-2021.

The purpose of the work plan is to:

- position the Board to anticipate and plan for future work priorities and resource requirements;
- guide the Board in its work over 5 years, ensuring that activities target fulfilling the Goals in the PPWB Strategic Plan;
- feed into multi-year work plans for the four Standing Committees and the Secretariat; and
- provide the foundation for communication with Ministers and senior officials within each government.

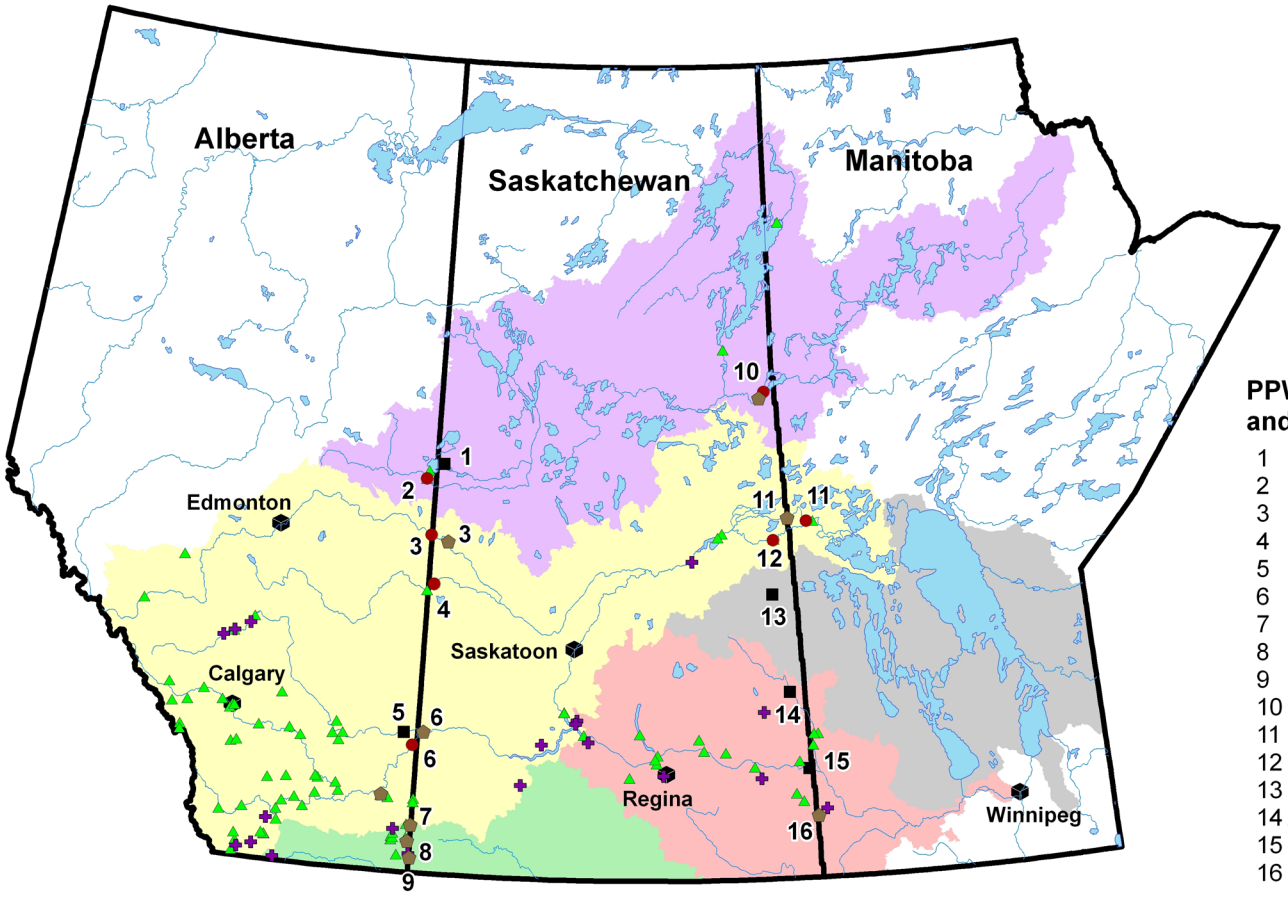
In 2016, the Board discussed holding a planning meeting to discuss future work priorities and resource requirements. The Board will be scheduling the planning meeting to coincide with their annual fall meeting in 2017.

Renewal and Modernizing of PPWB Documents

To modernize, enhance, streamline and avoid duplication, the Board reviews PPWB documents periodically. The Strategic Plan and Charter underwent a review in 2012 as part of the work plan renewal process to evaluate whether current government priorities were reflected in the PPWB activities. These documents were approved at the Board's fall 2012 meeting. In February 2017, the Board reviewed and updated the Strategic Plan and Charter documents to reflect the addition of the newly formed Committee on Flow Forecasting under Goal 5. The PPWB By-Laws and PPWB Rules and Procedures also underwent a review and included minor revisions such as updating government name changes. The Board will be reviewing other core documents in 2017.

Further information on the history and administration of the PPWB can be found in Appendix VIII.

APPENDIX I: PPWB Monitoring Stations for 2016-2017



PPWB Apportionment and Water Quality Sites

1 Cold River
2 Beaver River
3 North Saskatchewan River
4 Battle River
5 Red Deer River A/S
6 South Saskatchewan River
7 Battle Creek
8 Middle Creek
9 Lodge Creek
10 Churchill River
11 Saskatchewan River
12 Carrot River
13 Red Deer River S/M
14 Assiniboine River
15 Qu'Appelle River
16 Pipestone Creek

Basins

- Assiniboine River
- Churchill River
- Lake Winnipeg
- Missouri River
- Saskatchewan River

Type of Monitoring

- Hydrometric
- Meteorological
- Quality
- Apportionment
- Apportionment and Quality

APPENDIX II: 2016 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	192000	215000	254000	174000	287000	369000	344000	434000	285000	399000	469000	245000	3670000
CONSUMPTIVE USE	2910	2650	2720	212000	383000	449000	307000	121000	112000	4070	1910	1340	1600000
CHANGE IN RESERVOIR STORAGE	-56000	-44200	-36000	66600	212000	96300	34000	-9560	-36000	40700	-57100	-65800	145000
INTERBASIN TRANSFER*	0	0	0	1590	13400	13300	22800	19600	12300	8350	0	0	91300
APPORTIONABLE FLOW	151000	174000	219000	360000	893000	911000	783000	578000	368000	476000	422000	173000	5510000

* 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	42700	54400	156000	115000	71000	80000	206000	263000	252000	176000	112000	48600	1580000
CONSUMPTIVE USE	0	0	0	0	160	4340	1450	3690	2650	0	0	0	12300
CHANGE IN RESERVOIR STORAGE	-19100	-21100	-28600	-15800	30500	35900	31400	10800	2640	-750	-1240	-21200	3500
INTERBASIN TRANSFER**	0	0	0	-1590	-13400	-13300	-22800	-19600	-12300	-8350	0	0	-91300
APPORTIONABLE FLOW	21700	34600	128000	93200	73600	116000	220000	260000	244000	167000	111000	30100	1500000

** 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	235000	269000	411000	290000	358000	449000	550000	697000	537000	574000	581000	294000	5250000
APPORTIONABLE FLOW	173000	209000	347000	454000	967000	1030000	1000000	838000	612000	643000	533000	203000	7010000
SASKATCHEWAN SHARE (50%)	86500	105000	174000	227000	484000	515000	500000	419000	306000	322000	267000	102000	3510000
EXCESS (+) OR DEFICIT (-) DELIVERY	149000	164000	237000	63000	-126000	-66000	50000	278000	231000	252000	314000	192000	1730000
CUMULATIVE EXCESS OR DEFICIT	149000	313000	550000	613000	487000	421000	471000	749000	980000	1230000	1540000	1730000	1730000

Recorded flow was 75% of the apportionable flow. Alberta is required to deliver 50% of the apportionable flow to Saskatchewan. Alberta is also required to deliver to Saskatchewan flows not less than 42.5 m^3/s below the confluence with the Red Deer River. Alberta always met the minumum flow requirement in 2016. Apportionment of flow in the South Saskatchewan River is specified in Article 4, Schedule A of the *MAA*. Apportionable flow calculations are based on the methodology described in the report entitled "South Saskatchewan River Below Red Deer River – Natural Flow", April 1985 (PPWB Report No. 45). Flows have been routed and, as a result, the values presented in the table cannot be exactly balanced on a monthly basis. Final numbers might differ due to rounding to three signficant figures.

NORTH SASKATCHEWAN RIVER-ALBERTA-SASKATCHEWAN BOUNDARY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
ESTIMATED FLOW	386000	411000	610000	645000	486000	425000	602000	970000	817000	621000	451000	396000	6820000
APPORTIONABLE FLOW	125000	162000	316000	464000	565000	718000	1160000	1400000	1010000	594000	343000	142000	7000000

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.

BATTLE CREEK-ALBERTA-SASKATCHEWAN BOUNDARY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
RECORDED FLOW	N/A	310	970	920	1160	932	1020	1290	646	1480	N/A	N/A	8730
APPORTIONABLE FLOW	N/A	310	970	940	1190	992	1020	1290	646	1470	N/A	N/A	8830

Recorded flow was 99% 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.

LODGE CREEK-ALBERTA-SASKATCHEWAN BOUNDARY

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
RECORDED FLOW	N/A	144	720	83	120	94	121	468	4	496	N/A	N/A	2250
APPORTIONABLE FLOW	N/A	234	1113	83	159	346	121	468	3	496	N/A	N/A	3020

Recorded flow was 77% of the apportionable flow. Alberta is required to deliver 75% of the apportionable flow to Saskatchewan. Values reported for Novemeber include the time period up to Novemeber 4th only, due to the unavailability of data beyond that date for some of the reservoirs in the Lodge Creek basin required to complete the calculation of apportionable flow. The total recorded flow for Lodge Creek near the Alberta boundary for November was 708 dam^3. Hydrometric data is collected only 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	2	22	18	15	13	10	12	8	8	N/A	N/A	110
APPORTIONABLE FLOW	N/A	2	22	18	15	13	10	12	8	8	N/A	N/A	110

Recorded flow was 100% 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.

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	12100	12900	14400	14600	18100	24600	24300	18700	12900	11300	12200	6900	183000
APPORTIONABLE FLOW	12500	13200	14800	14900	18500	25000	24700	19100	13300	11600	12500	7200	187000

Recorded flow was 98% of the apportionable flow. Alberta is required to deliver 68.4% of the apportionable flow to Saskatchewan.

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	1350000	1220000	1270000	1280000	1450000	1090000	1570000	1710000	1230000	1500000	1990000	2110000	17800000
APPORTIONABLE FLOW	1020000	910000	951000	1000000	1400000	1470000	2030000	2230000	2070000	1840000	2330000	2430000	19700000

Estimated flow includes recorded flow at Sandy Bay, SK and estimated inflow from Sandy Bay to the Saskatchewan-Manitoba Boundary. Estimated flow was 90% 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	1150000	1170000	1250000	1940000	1710000	1350000	1860000	1920000	2140000	2290000	2520000	1720000	21000000
APPORTIONABLE FLOW	792000	874000	1240000	2080000	1750000	1710000	2190000	2300000	2630000	2530000	2530000	1410000	22000000

Estimated flow at the Saskatchewan-Manitoba boundary is calculated using the recorded flow of the Saskatchewan River at The Pas minus 1.31 times 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.

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

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTALS
RECORDED FLOW	25600	22100	38600	29800	22100	29300	25400	20400	26200	52800	45600	21200	359000
APPORTIONABLE FLOW													225000

Recorded flow was 160% of the apportionable flow. Known issues with the current calculation method cause an underestimate of the apportionable flow, which exaggerates the percent delivery for the Qu'Appelle River. The PPWB is currently undertaking a study to revise the calculation procedures to fix these problems. 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	12500	9100	20400	345000	202000	35500	303000	169000	85800	346000	195000	29200	1750000
APPORTIONABLE FLOW	12500	9050	20200	346000	201000	34000	300000	168000	85300	344000	194000	29000	1740000

Recorded flow was 101% 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	7200	6660	25800	298000	139000	25900	41500	40700	15600	62900	69700	26100	759000
APPORTIONABLE FLOW	7170	6640	27500	308000	140000	26600	42900	42500	15900	64000	69700	26100	777000

Recorded flow was 98% of the apportionable flow. 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	735	1043	4590	7195	3110	6518	6799	936	650	3482	4096	2258	41400
APPORTIONABLE FLOW	777	1080	4720	7160	3140	6550	6840	979	693	3510	4140	2300	41900

Recorded flow was 99% of apportionable flow. Saskatchewan is required to deliver 50% of the apportionable flow to Manitoba.

APPENDIX III: PPWB WATER QUALITY MONITORING 2016 PARAMETER LIST

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

ALKALINITY, phenol & total
ALUMINUM, diss. & total ϴ
AMMONIA, total ϴ
ANTIMONY, diss. & total
ARSENIC, diss. ϴ & total
BARIUM, diss. & total ᵛ
BERYLLIUM, diss. & total
BICARBONATE, calc.
BISMUTH, diss. & total
BORON, diss. ϴ & total
CADMIUM, diss. & total ϴ
CALCIUM, diss.
CARBON, diss. organic
CARBON, part. organic
CARBON, total organic, calcd.
CARBONATE, calcd.
CHLORIDE, diss. ϴ
CHROMIUM, diss. & total ϴ
COBALT, diss. & total ϴ
COLIFORMS FECAL ϴ
COLOUR TRUE
COPPER, diss. & total ϴ
E. COLI
FLUORIDE, diss. ϴ
FREE CO_2, calcd.
GALLIUM, diss. & total
HARDNESS NON-CARB. (CALCD.)
HARDNESS TOTAL (CALCD.) CACO3
IRON, diss. ϴ & total
LANTHANUM, diss. & total
LEAD, diss. & total ϴ
LITHIUM, diss. & total
MAGNESIUM, diss.
MANGANESE, diss. ϴ & total
MOLYBDENUM, diss. & total
NICKEL diss. & total ϴ
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
RUBIDIUM, diss. & total
SELENIUM, diss. ϴ & total
SILVER, diss. & total
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
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 the Saskatchewan, Carrot, Qu'Appelle, Assiniboine and Churchill Rivers in 2016

◆ Collected from the South Saskatchewan and Battle Rivers in 2016

APPENDIX IV: PPWB REPORT ON EXCURSIONS OF **INTERPROVINCIAL WATER QUALITY OBJECTIVES**

JANUARY-DECEMBER 2016

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SUMMARY

This 2016 report fulfills requirements of the *Master Agreement on Apportionment* (*MAA*) to report on the protection of water quality for major interprovincial prairie rivers. During 2016, water quality samples were collected on 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 with excursion rates similar to recent years. Based on the evaluation of excursions in 2016 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 is an ongoing need to better understand the processes affecting nutrient concentrations in rivers. Such information will improve understanding regarding the cause of excursions and trends. Better understanding nutrient dynamics has been designated as a priority area for investigation in these rivers because increasing levels of nutrients can lead to more eutrophic waters, which can affect ecosystem function. The Committee's on-going work to understand nutrient sources and trends will continue in 2017.
- Common use pesticides, such as 2,4-D, dicamba, 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. To better understand the inter-annual variability and seasonal pattern of pesticide concentrations additional acid herbicide monitoring has been implemented in the Battle, South Saskatchewan, Qu'Appelle and Saskatchewan rivers. The COWQ has also recommended working with the jurisdictions to better understand the potential effects to the aquatic environment and users of these waters. Given low level but frequent occurrence of certain pesticides, understanding the aquatic and use implications continues to be a priority.
- Exceedences in metals at several sites appear to be related to peaks in suspended solids, and sometimes flow. Trends in metal concentrations and relationships to physical parameters, including flow and suspended solids, should be examined for select rivers to gain further understanding on how these factors influence metal concentrations in transboundary rivers.

INTRODUCTION

The governments of Alberta, Saskatchewan, Manitoba and Canada entered into the *Master Agreement on Apportionment* in 1969. Schedule E, agreement on water quality, was added to the Agreement in 1992. The Agreement is administered by the Prairie Provinces Water Board (PPWB) which 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, recreation, agricultural uses (livestock watering and irrigation) and fish consumption. The Alberta-Saskatchewan and Saskatchewan-Manitoba boundary's each have six river sites (Figure 1).

Water quality monitoring includes a range of physical, chemical and biological parameters at one site in each of the river reaches. These include nutrients, major ions, metals, fecal coliforms, physical characteristics and pesticides. This report presents adherences of the 2016 water quality data to the 2015 interprovincial water quality objectives.

Field Program – Summary of (2016) Sampling.

Environment and Climate Change Canada (ECCC) undertook a total of 135 water sampling events at the 12 PPWB river sites in 2016. The monitoring program for 2016 was completed, as approved by the PPWB (Appendix 2), with the following exceptions: the Carrot River on the Saskatchewan-Manitoba boundary was not sampled in July because the site was inaccessible due to road flooding. The acid herbicides and neutral herbicides in March 2016 for the Carrot and Assiniboine rivers were lost (samples were either spilt or broken) during preparation in the laboratory and therefore results could not be determined.

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

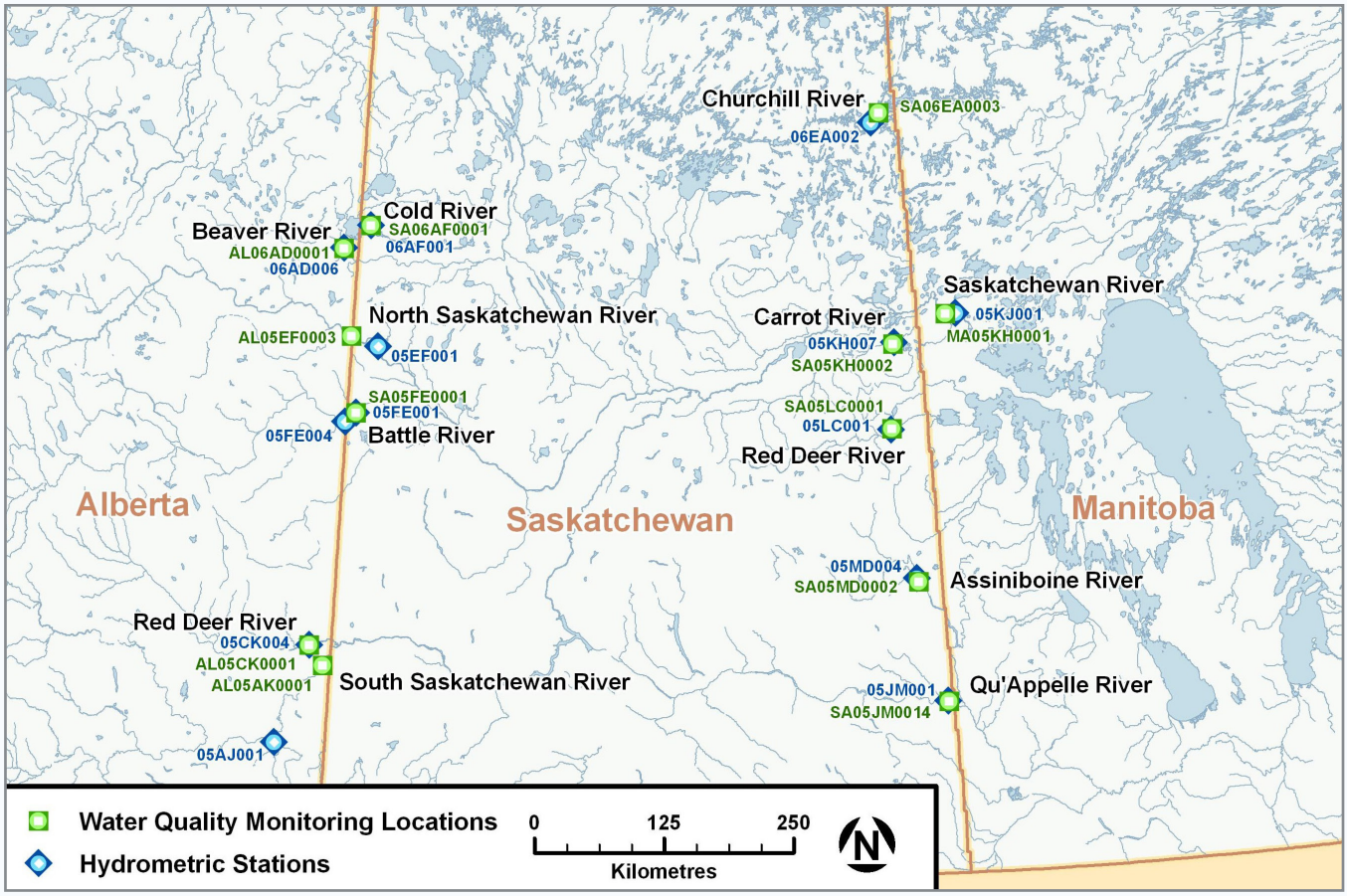


Table 1: PPWB water quality station information

RIVER	STATION NUMBER	LATITUDE	LONGITUDE	HYDROMETRIC SITE(S)
Alberta-Saskatchewan				
Battle	SA05FE0001	52° 56′25.008″	109° 52′23.988″	05FE004
Beaver	AL06AD0001	54° 21′15.012″	110° 12′42.984″	06AD006
Cold	SA06AF0001	54° 34′00.000″	109° 50′10.000″	06AF001
North Saskatchewan	AL05EF0003	53° 36′05.004″	110° 00′29.988″	05EF001
Red Deer (Bindloss)	AL05CK0001	50° 54′10.008″	110° 17′48.984″	05CK004
South Saskatchewan	AL05AK0001	50° 44′15.000″	110° 05′44.016″	05AJ001*
Saskatchewan-Manitoba				
Assiniboine	SA05MD0002	51° 31′59.016″	101° 53′20.004″	05MD004
Carrot	SA05KH0002	53° 36′00.000″	102° 07′00.012″	05KH007
Churchill	SA06EA0003	55° 36′29.016″	102° 11′44.016″	06EA002**
Qu'Appelle	SA05JM0014	50° 29′02.004″	101° 32′35.016″	05JM001
Red Deer (Erwood)	SA05LC0001	52° 52′00.012″	102° 10′59.016″	05LC001
Saskatchewan	MA05KH0001	53° 50′30.012″	101° 20′03.984″	05KJ001***

*Estimated flow for the PPWB South Saskatchewan site is based on recorded flow at Medicine Hat plus the flow from Seven Person 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 the apportionment flow for the Carrot River that is calculated from the measured flow at 05KH007 multiplied by 1.31.

RESULTS

Overall Adherence to Interprovincial Water Quality Objectives

The overall adherence rate to the interprovincial water quality objectives was, on average, 96.5% in 2016 (Figure 2). This adherence rate is based on the comparison of 5,298 water quality results to water quality objectives.

Overall adherence rates from 2016 are similar to those from previous years (Figure 3). While this is the second year that the new 2015 water quality objectives have been applied to the PPWB river reaches, adherence rates were calculated retroactively for 2003 through 2014 with the new water quality objectives to understand how rates would have changed over a longer period of time. This analysis allows for comparison of adherence rates for 2016 with previous years using the same 2015 water quality objectives.

Most rivers show little variation in adherence rates among years (approximately 5%). The Battle and Red Deer (Bindloss) rivers had the greatest variability in adherence rate among years. For the Battle River this variability is due to high and low adherence rates in 2006 and 2003, respectively. The lower adherence rate in 2003 was in part due to more excursions of major ions. For the Red Deer (Bindloss) high and low adherence rates were observed in 2004 and 2005, respectively. The lower adherence rate in 2005 was not specifically attributable to a single variable or one group of variables. From 2015 to 2016, half the rivers (six) showed an increase in the overall adherence rate ranging from 0.40% on the Beaver River to 1.5% on the South Saskatchewan River. Six rivers, showed a decrease in overall adherence rate ranging from 0.6 to 4.4% from 2015 to 2016. The Red Deer River at Erwood (SK/MB) showed the greatest reduction in adherence rate due to excursions in nutrients, TDS, TSS and bacteria.

The 2016 adherence rate for each river was similar to the 13-year median adherence rate for the respective river (all within 1.8%, with seven sites within less than 1%). There are no acute water quality concerns apparent from review of the overall adherence rate values for 2016.

Examination of Specific Parameter Excursions for 2016

Alberta-Saskatchewan Boundary

For the Alberta-Saskatchewan transboundary rivers, there were excursions of nutrients (total phosphorus (TP), total nitrogen (TN), and total dissolved phosphorus (TDP)), metals (cadmium, copper, iron and zinc), major ions (chloride, sodium, sulphate and total dissolved solids (TDS)), bacteria (fecal coliforms and *E. coli*), total suspended solids (TSS) 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. It is not unexpected to see elevated levels of nutrients, total metals and coliform bacteria associated with elevated TSS concentrations. Elevated TSS concentrations are typical during spring runoff and other episodic events such as high flows following summer storms. Total suspended solids in the water column may be due to a variety of causes such as erosion of soil and river banks and re-suspension of bottom sediments. Flow has an influential effect on water quality and is therefore important to consider when understanding inter- and intra-annual changes in water quality.

Figure 2: Percent adherences to interprovincial water quality objectives in 2016 (n=total number of comparisons per site).

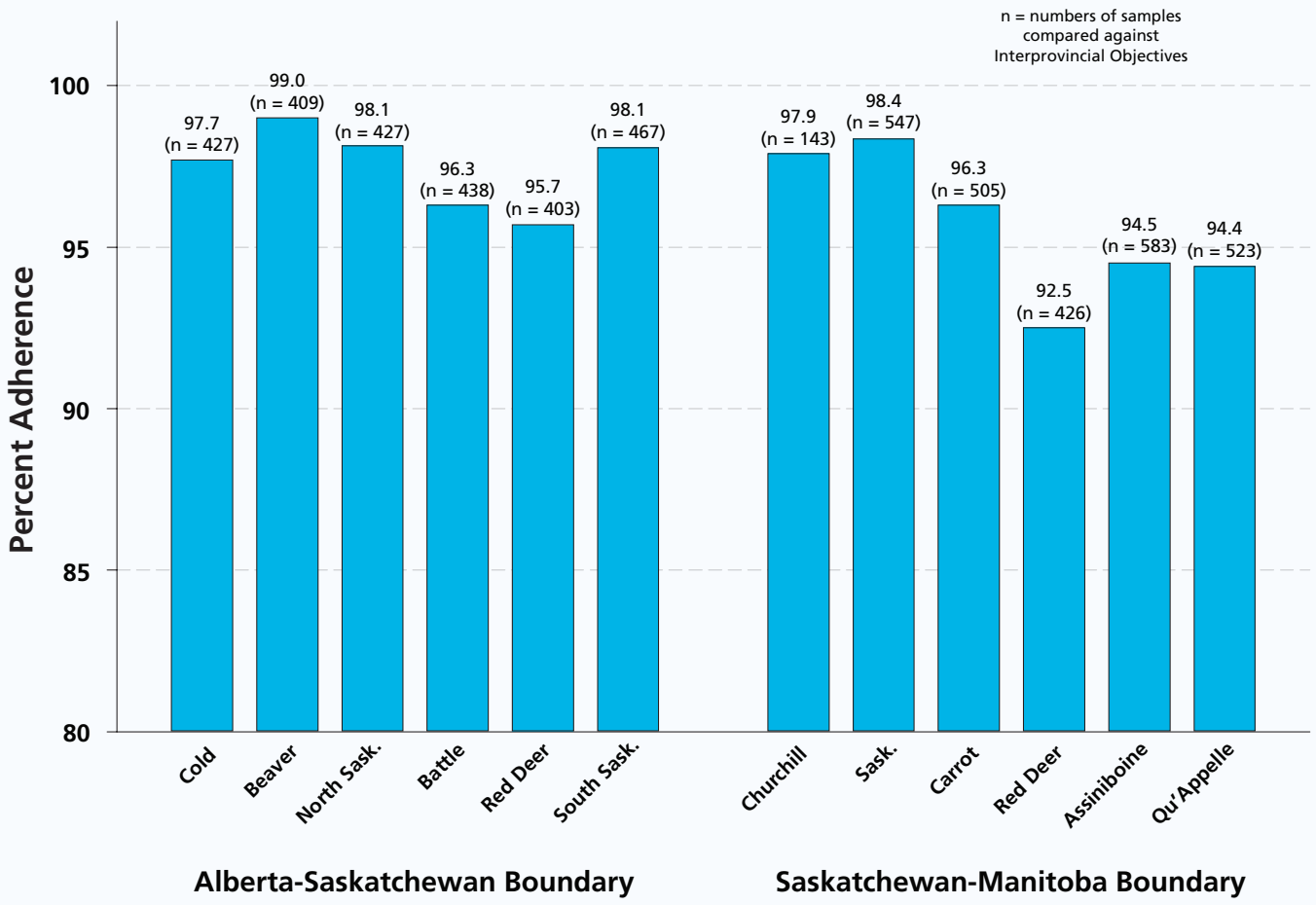
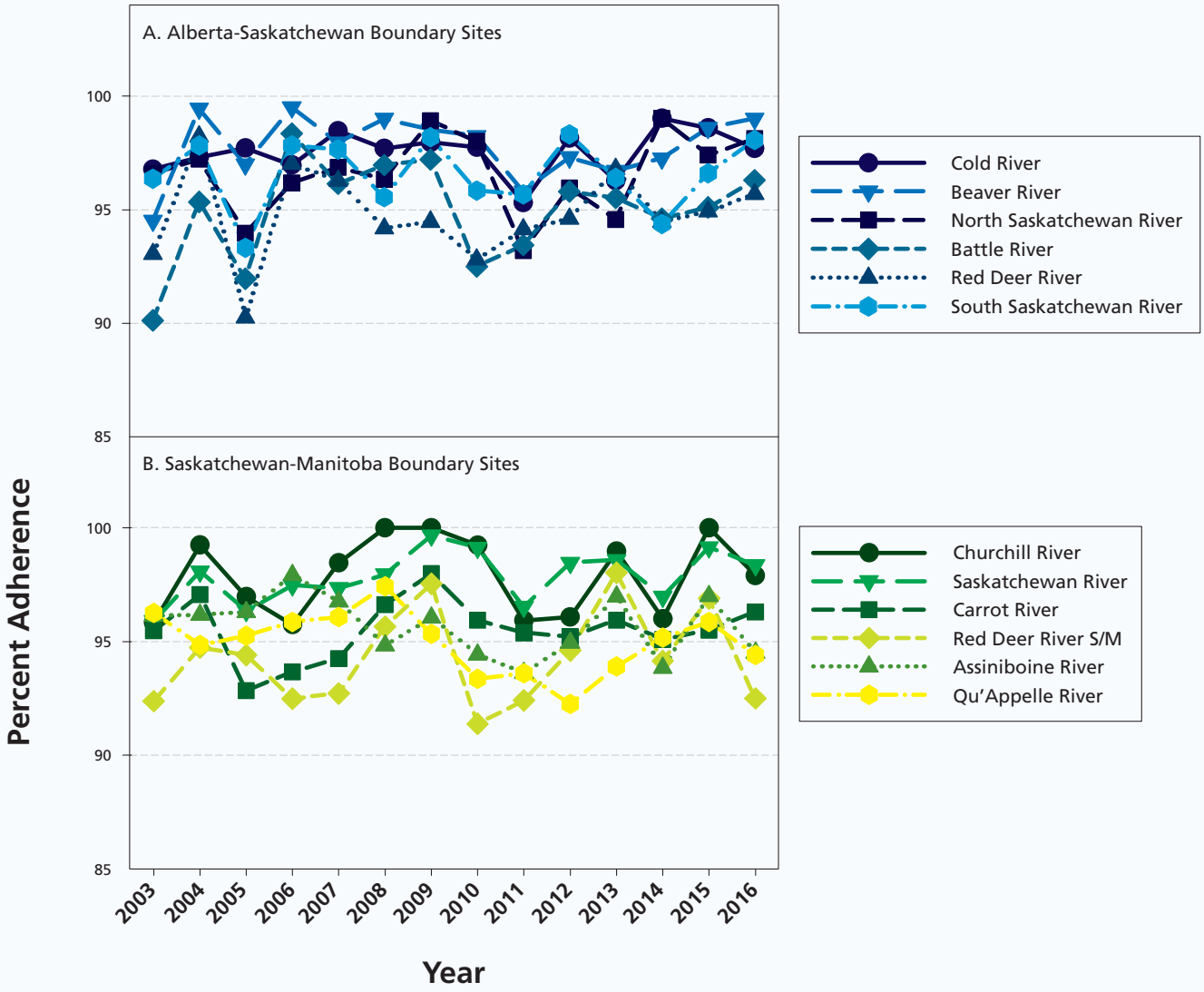


Figure 3: Percent adherences to interprovincial water quality objectives for (A) the Alberta-Saskatchewan and (B) the Saskatchewan-Manitoba boundaries from 2003 to 2016.



RESULTS *continued*

Site-specific nutrient objectives were established for TP, TDP and TN using a statistical approach that evaluated the long-term data from each site. It is expected that there will be a certain proportion of excursions over the long term. Typically these are more frequent in some years and less frequent in other years. Nutrient excursions occurred in three of the six rivers at the Alberta-Saskatchewan boundary in 2016 (Tables 2 and 6). Nutrient objectives for TP, TDP and TN are based on seasonal background concentrations, and in 2016 the nutrient excursions occurred primarily during the ice-covered season. The Red Deer River (near Bindloss) had the most number of nutrient excursions of all the Alberta-Saskatchewan transboundary river sites in 2016, which was similar to 2015.

For the Red Deer River, all TP, TN and TDP excursions, with the exception of one TP and TN excursion on July 6th, occurred in the winter months during ice cover (January, February, November and December). These winter nutrient excursions for the most part in 2016 do not appear to be related to spikes in TSS. However, excursions of the TN and TP background objectives that occurred in July 2016 did correspond with a spike in TSS. While the July TP and TN excursion corresponded to a substantial spike in TSS, there was only a slight rise in flow based on a comparison of the water quality sample date to the river hydrograph. However, it was also noted that on July 6th, 2016 several other water quality variables in addition to nutrients and TSS increased including *E. coli*, fecal coliforms, dissolved iron and manganese. The Committee continues to work towards gaining a better understanding of nutrient dynamics and sources to the Red Deer River (AB/SK), notably whether there are sub-watersheds that more strongly influence downstream nutrient concentrations.

The Committee did also identify the Red Deer River for further investigation and analysis following a number of atypical excursions and water quality conditions in 2015. Since the 2015 annual report, when the COWQ identified this river for further investigation, a recently published research paper has found elevated metal concentrations are explained by erosion of natural soils and high instream sediment mass; dissolved metals (i.e., the more bioavailable form) concentrations remain lower, with no evidence of widespread soil contamination (Kerr and Cooke, 2017). In 2016, only two metals, iron (dissolved) and zinc (total) exceeded the interprovincial water quality objectives, but the COWQ will continue to follow up on excursions on the Red Deer River and is working with the upstream jurisdiction.

During spring freshet, the Battle River had excursions of the TN, TP and TDP objectives. While there was a rise in the hydrograph in March during spring freshet, peak flow on this river occurred in June of 2016. The June flow peak coincided with a modest increase of TSS but no TN or TP excursions. Total nitrogen also exceeded the background objective in December 2016, of which almost all the nitrogen was in the dissolved form (1.79 mg/L TN versus 1.72 mg/L TDN). The Cold River was the third river on the Alberta-Saskatchewan boundary with excursions to the nutrient objectives. Total nitrogen exceeded the objectives four times throughout the ice covered season in 2016 (January, February, March and November). Most of the nitrogen (94 to 97%) in the samples with TN excursions was comprised of total dissolved nitrogen, which in turn was largely dissolved organic nitrogen. For TDP, an excursion to the background objective occurred in October. In 2016 for the three rivers with nutrient excursions, 80% of these excursions occurred during the ice-covered season.

Four metals (cadmium, copper, iron, and zinc) exceeded water quality objectives on the Alberta-Saskatchewan transboundary rivers in 2016 (Table 2). Of the six rivers monitored on this boundary, four had at least one exceedance to a metal objective. The Battle River and the Cold River were the two rivers that did not have any excursions to the metal objectives in 2016. The objectives are for the total metal with the exception of iron and manganese, which are in the dissolved form.

RESULTS *continued*

The South Saskatchewan River had excursions of cadmium and copper in June and August 2016. Both of these excursions coincided with distinctly elevated TSS levels. For the Red Deer River, zinc exceeded the water quality objective in June, and iron exceeded its objective in July. While neither of the metal excursions appeared to be related to flow, they did coincide with an elevated TSS level, notably for iron. For the North Saskatchewan River and the Beaver River, cadmium exceeded the objective in February under ice conditions. The Beaver River also had excursions of iron in January and April. The elevated iron level in January may be the result of low dissolved oxygen levels (0.01 mg/L), although the oxygen levels remained low in this river throughout February and March and no exceedance of the iron (dissolved) objective was observed. The April level was likely a result of spring freshet related to the increase in flow. In general, comparatively higher concentrations of total metals, as compared to dissolved forms, are observed in prairie rivers particularly during times when total suspended solids are elevated.

Sodium, sulphate and TDS exceeded the water quality objectives in the Battle River during the ice-cover season. These exceedances were likely a result of low flows in the Battle River in late winter under ice conditions. However, chloride exceeded the water quality objective in April. However, this value for chloride appears to be anomalous, as it was higher than would be expected for this river. The chloride value in April was not consistent with the TDS for this river, and the ion balance (cations to anions) did not balance which appears to be due to the elevated chloride concentration. For these reasons the chloride value was flagged as an exceedance but likely an erroneous value. There was also an excursion of TDS on the Red Deer River in December under ice conditions with low flow.

In 2015, fluoride was the other major ion that exceeded site-specific water quality objectives in each of the South Saskatchewan River (in March, May and August) and the North Saskatchewan River (in March). However, no exceedances to the fluoride objective were observed in 2016.

All rivers on the Alberta-Saskatchewan boundary, except the Cold River, exceeded the fecal coliform bacteria water quality objective in 2016. Sources of fecal coliform are numerous and include wildlife and pet 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 not unexpected in surface waters, particularly in response to rainfall events that can transport fecal bacteria through runoff.

In the case of the South Saskatchewan River, Red Deer River, North Saskatchewan River and Battle River, the detection of bacteria did appear to be related to an increase in TSS. The Beaver River was the only river on this boundary in 2016, where the detection of bacteria did not appear to be related to any significant increase in TSS or peak flow, but could have been a small local event. All bacteria detections with the exception of the February sample on the North Saskatchewan River and the March sample of the Battle River occurred during the open water season. Escherichia coli (*E. coli*), is also a measure of fecal contamination in water supplies and is often the preferred indicator rather than fecal coliform bacteria. In 2016, *E. coli* exceeded the water quality objectives once in the South Saskatchewan River, North Saskatchewan River and the Red Deer River. The *E. coli* excursions occurred during July for the Red Deer River and August for the South and North Saskatchewan rivers.

Of note for the Cold River were the low levels of TSS (Table 2) throughout the open water season. Objectives for TSS were set using the 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. 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

RESULTS *continued*

term (10% lower and 10% upper). Five observed excursions for this river were a result of low TSS concentrations, and this resulted in not meeting the lower TSS objective. These low concentrations of TSS are not unexpected given the water quality is monitored at the 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. The Cold River also had excursions to the TN and TDP objectives in 2016.

Pesticide monitoring on the transboundary rivers is conducted on a rotational basis with each river being monitored once every four years. In 2016, as a result of this rotational sampling, the full suite of pesticide monitoring was not conducted on the Alberta-Saskatchewan boundary rivers. However, the acid herbicides were measured on the Battle and South Saskatchewan rivers on the Alberta-Saskatchewan boundary as part of the additional acid herbicides monitoring implemented on select rivers with more frequent excursions. MCPA and dicamba are two acid herbicides commonly used throughout the prairie provinces. A review of recent PPWB pesticide data for the Alberta-Saskatchewan rivers (2006 to 2013) showed that these herbicides are often detected at low concentrations in water samples and frequently exceed the PPWB water quality objectives. MCPA exceedances of the PPWB objective have ranged from 0 to 30% since 2006 and dicamba has ranged from 20 to 50% in the years the South Saskatchewan River has been monitored for pesticides. Similarly, for the Battle River exceedances of MCPA have ranged from 25 to 43% and dicamba from 0 to 14% for the years it has been monitored (PPWB Report #175, 2016).

In 2016, excursions were observed for MCPA and dicamba (Table 4). Dicamba exceeded the water quality objective twice in the South Saskatchewan River during the summer months (July and August). These two excursions did coincide with an increase in TSS and water flow for this river. MCPA exceeded the irrigation objective on the Battle River in June, which also corresponded to peak water inflows into this river. The Committee will continue to do follow-up work with the jurisdictions on the presence of these pesticides in the transboundary river systems.

Saskatchewan-Manitoba Boundary

Along the Saskatchewan-Manitoba boundary in 2016, there were excursions of nutrients (TP, TDP, TN), metals (arsenic, cadmium, copper and uranium), major ions (sulphate, TDS), physicals and others (TSS, dissolved oxygen), bacteria (E.coli and fecal coliforms) and pesticides (MCPA and dicamba) (Tables 3, 5, 7 and 9). For the Saskatchewan-Manitoba transboundary rivers, peak flows and high TSS concentrations were frequently correlated. Similarly, high flow and high TSS were frequently associated with increased concentrations of some metals and nutrients.

Total suspended solids objectives were exceeded on at least one occasion for five of the six Saskatchewan-Manitoba boundary river sites in 2016. All five rivers with excursions to the TSS objective in 2016 exceeded the upper TSS objective. No exceedances were observed during the open water season for the Churchill River. Similar to 2015, the Assiniboine River exceeded the TSS objectives during higher flows in the spring and again in late summer. The Carrot River exceeded the TSS objective twice during the open water season in August and September. The Qu'Appelle River had TSS excursions throughout the summer months (June, July, August, September and October) in 2016. Similarly, the Red Deer River had TSS excursions throughout the summer months (May to August) and in the fall (October). The Saskatchewan River had one excursion to the upper TSS objective in September 2016. While this excursion occurred during a rise in flow, additional excursions were not found during peak flows in the spring or additional high flow episodes in 2016.

RESULTS *continued*

Total suspended solids and nutrient objectives were established with a statistical approach that evaluated the long-term data from each site. It is expected that there will be a certain proportion of excursions over the long term. Typically these are more frequent in some years and less frequent in other years. Thus, it is important to consider the overall trend and excursion frequency pattern. There were multiple nutrient excursions at all sites on the Saskatchewan-Manitoba boundary in 2016 (Tables 3 and 7).

The Red Deer River, the Carrot River and the Qu'Appelle River had a number of excursions to the nutrient objectives in 2016. The Red Deer and the Carrot rivers had excursions of all three site-specific nutrient objectives (TN, TP and TDP), while the Qu'Appelle River had excursions to the phosphorus objectives (TP and TDP).

In 2016, the Red Deer River (Erwood) had the highest number of nutrient excursions; TP and/or TDP exceeded the background objectives throughout the spring, summer and fall months (March to August, October and November), while excursions of TN occurred throughout the summer months (June, July and August). Some of the highest TP and TDP excursions on the Red Deer River appeared to occur during peak flows.

The Carrot River also had a number of TP and TDP excursions in 2016. As the Carrot River has shown statistically significant increasing trends in phosphorus (TP and TDP), site specific objectives were established for each representing 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 occurred in June, August and September. When this objective is exceeded, the lowest running 10 year 90th percentile objective (lower objective) will also be exceeded (Table 7). In October, while the 90th percentile background objective was not exceeded the lower objective did exceed its seasonal objective. Similarly, TDP also exceeded both the site specific objectives in June, July and September. However, the lowest running 10 year objective also exceeded the seasonal objective in January, April, May, October, November and December.

The Carrot River TN also had excursions for the lower TN objective in late summer. The Carrot River has also shown statistically significant increasing trends in TN. As follow-up to better understand nutrient dynamics in the Carrot River, the COWQ selected the Carrot Watershed as one of the two watersheds being examined by a contractor to determine the current understanding of major influences to, and causes of, nutrient concentrations and trends in prairie rivers. Completion of this initial work is anticipated in 2017. The Carrot River was also selected as a case study at the October COWQ hosted workshop by guest presenter Dr. Robert Hirsch of the United States Geological Survey. Dr. Hirsch presented on trend analysis and assessing variability of surface water quality.

The Qu'Appelle River also had a number of excursions to the TP and/or TDP objectives. Excursions occurred throughout the summer months until mid-winter (June to December in 2016). No excursions to the TN objective were observed for the Qu'Appelle River.

Nutrients continue to be a priority for prairie river systems by all jurisdictions. The Committee has for the last several years focused 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 and held a workshop in October 2016 to discuss prairie nutrient issues (PPWB Report #177, 2017).

RESULTS *continued*

Four metals (arsenic, cadmium, copper and uranium) exceeded water quality objectives on the Saskatchewan-Manitoba boundary sites in 2016. Five of the six transboundary rivers had at least one excursion, with the Churchill River being the only river not to exceed a metal objective. Metal exceedances also frequently coincided with elevated TSS and/or higher flow, although this did not explain all the exceedances observed for the metals.

Three of the metals (total arsenic, total copper and total uranium) exceeded the water quality objectives on the Assiniboine River (Table 3). Total arsenic and copper each exceeded the water quality objective on one occasion in the summer of 2016 (August) in the Assiniboine River, while uranium exceeded the water quality objective in November. Elevated concentrations of uranium do not occur regularly on the Assiniboine River, and during the past 13 years (when the water quality data are compared to the 2015 water quality objectives) excursions were only previously observed in 2010 and 2012. The median concentration of uranium in the Assiniboine River during this period was 5 µg/L, while the current water quality objective is 10 µg/L. The exceedance in 2016 was at a level of 10.1 µg/L. The highest concentrations of uranium in this river during the past 13 years appear to occur either in the spring or late autumn, with the highest uranium concentrations occurring within the last six years. One exception, was an elevated uranium concentration of 9.53 µg/L measured in a sample from October of 2004. The Committee will evaluate whether similar excursions occur in 2017.

Cadmium exceeded water quality objectives in three rivers in 2016 including the Carrot River (June, August and September), the Red Deer River (April and July) and the Saskatchewan River (September and October). For all three rivers, the elevated cadmium level coincided with higher TSS. Similarly, copper exceeded its water quality objective for the same sampling dates as cadmium for the Saskatchewan River. Total copper concentrations in eight of the 12 water samples from the Qu'Appelle River exceeded the water quality objective. Exceedances of the copper objective are typical for the Saskatchewan River, although in 2016 total copper concentrations remained slightly above the objective for longer than in previous years. These copper exceedances also occurred with high TSS levels, although these did not seem to coincide with peaks in flow. In 2016, among the different sites with excursions, total cadmium and copper excursions generally occurred in conjunction with high TSS. Many metal concentrations, including copper and cadmium, are thought to be correlated with TSS. If this is the case, then such excursions are not unexpected. The Committee is proposing to examine the natural variations and the relationships between metals and TSS to better understand why metal concentrations occasionally exceed water quality objectives in these rivers.

Concentrations of sulphate and TDS exceeded objectives on multiple occasions in the Assiniboine River, once each on the Qu'Appelle River and TDS exceeded on four occasions in the Red Deer River in 2016. For the Assiniboine River, sulphate and TDS 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. On the Assiniboine, 33% of samples exceeded the TDS objective and 58% exceeded the sulphate objective. In 2016, sulphate constituted, on average, about 40% of TDS (by mass). Given both these parameters on the Assiniboine are based on a statistically-based background approach, since one had high exceedances, it is not unexpected that the other did as well. Sulphate and TDS exceeded the background objectives on the Assiniboine throughout the later winter and into the summer.
As expected, both parameters decreased in concentration during spring freshet suggesting that the input of flow to the river at the time was low in salinity. The cause of the higher sulphates is not clear but this pattern for this river was similar to the results observed in 2015. Analysis of data suggests that

RESULTS *continued*

sulphate and TDS tend to have greater concentration in the Assiniboine River at the transboundary site when a higher portion of the flow is from one of its major tributaries, the Whitesand River (John-Mark Davies (per. comm)).

For the Qu'Appelle River, similar to the Assiniboine River, site specific objectives for TDS and sulphate were established based on historical background data. In 2016, for the Qu'Appelle River, one excursion to each the TDS objective and the sulphate objective occurred in December 2016.

There were four TDS excursions on the Red Deer (Erwood) River, with all four occurring in winter (January, February, March and December). The highest TDS concentration on the Red Deer River in 2016 was 541 mg/L. Assessment of long-term data from the Red Deer (Erwood) River found that half of winter samples (January to March) typically are greater than the objective value of 500 mg/L TDS. The 2016 frequency of TDS excursions is similar to what has been observed in previous years.

Concentrations of the pesticides dicamba and MCPA were found to exceed water quality objectives in 2016 (Table 5). Dicamba was detected above the water quality objective in the Assiniboine River on one occasion (December), while concentrations of MCPA exceeded the water quality objective three times throughout the open water season (June, July and August). The Qu'Appelle River had excursions of MCPA in June and July, and the Carrot River had two excursions to the MCPA objective, one each in the spring and fall (April and November).

MCPA and dicamba belong to a group of pesticides known as acid herbicides. A recent report of the PPWB pesticide data by the Committee (PPWB Report 175, 2016), highlighted that MCPA and dicamba exhibit regular patterns of excursions to the water quality objectives on the Carrot and Assiniboine rivers. Other rivers are not sampled annually for acid herbicides and consequently the excursion frequency and patterns are more difficult to evaluate for those other rivers. The report highlighted that the pesticide exceedances occur primarily during the spring and summer months and made several recommendations for follow-up actions. These recommendations included:

(1) The PPWB should notify each jurisdiction about the regular occurrence of acid herbicide (MCPA and dicamba) excursions to the interprovincial water quality objectives. The PPWB should request feedback from each of the jurisdictions on the awareness of the pesticide concerns and any actions/programs that are being undertaken within the jurisdictions to address this issue.

(2) It is also recommended that PPWB request any additional, available pesticide data and potential impacts from the Alberta, Saskatchewan, and Manitoba provincial jurisdictions to expand the current data set and increase insight on pesticide prevalence and impacts in surface water on the prairies. In this case, the provincial jurisdictions should compile and review their data and report back to the PPWB.

(3) Annual monitoring in the Assiniboine and Carrot rivers should be maintained, but acid herbicide monitoring should be increased for the rivers that most frequently exhibit pesticide excursions. This includes the Battle, Red Deer (Bindloss), South Saskatchewan, Saskatchewan and Qu'Appelle rivers. The non-acid herbicide groups should continue to be monitored according to current protocol.

Glyphosate is a nonselective systemic herbicide that is used extensively throughout the prairies. The PPWB does not currently have a numerical objective for glyphosate, but given its extensive use throughout the prairies has chosen to report detections of this herbicide. In 2016, glyphosate was monitored on the Saskatchewan, Qu'Appelle, Carrot and Assiniboine rivers. For the Qu'Appelle, Carrot and Assiniboine rivers glyphosate was detectable in all water samples collected

RESULTS *continued*

throughout the year, while for the Saskatchewan River glyphosate was detected in half the water samples (four of eight samples) collected in 2016. Of the four rivers monitored in 2016, the Assiniboine River had the highest glyphosate concentration detected at 269 ng/L. Peak concentrations in glyphosate varied for each of the rivers depending on the river reach. For the Saskatchewan and Qu'Appelle rivers, the peak concentrations occurred during the late spring, while for the Assiniboine River the peak concentrations occurred during runoff (March, April) and summer (August). However for the Carrot River, the peak concentrations occurred in November and December.

The glyphosate breakdown product AMPA was also found to be present at higher concentrations than glyphosate in all water samples collected from the four rivers. Although the PPWB does not currently have an objective for glyphosate or AMPA, the Committee will continue to report detections of this pesticide.

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	0(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	0(12)	1(12)	0(12)	1(12)	---	2(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	0(12)	0(12)	0(12)	0(12)	---	2(12)
IRON DISSOLVED	0(12)	2(12)	0(12)	0(12)	1(12)	0(12)
LEAD TOTAL	0(12)	0(12)	0(12)	0(12)	0(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	0(12)	0(12)	0(12)	0(12)	1(12)	0(12)
NUTRIENTS						
AMMONIA UN-IONIZED	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
PHOSPHORUS TOTAL *	1(12)	0(12)	0(12)	0(12)	4(12)	0(12)
PHOSPHORUS TOTAL DISSOLVED *	2(12)	0(12)	1(12)	0(12)	2.5(12)	0(12)
NITROGEN TOTAL *	2(12)	0(12)	4(12)	0(12)	4(12)	0(12)
NITROGEN DISSOLVED NO3 and NO2	0(12)	0(12)	0(12)	0(12)	0(12)	0(12)
MAJOR IONS						
CHLORIDE DISSOLVED	1(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	1(12)	0(12)	0(12)	0(12)	0(12)	0(12)
SULPHATE DISSOLVED	1(12)	0(12)	0(12)	0(12)	0(12)	0(12)
TOTAL DISSOLVED SOLIDS	3(12)	0(12)	0(12)	0(12)	1(12)	0(12)
BIOTA						
COLIFORMS FECAL	4(12)	1(12)	0(12)	2(12)	2(12)	2(12)
ESCHERICHIA COLI	0(12)	0(12)	2912)	2(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 ABSORPTION RATIO	---	0(12)	0(12)	1(12)	0(12)	0(12)
TOTAL SUSPENDED SOLIDS	0(7)	0(7)	5(7)	3(7)	1(7)	0(7)
Number of Excursion Comparisons		**0(7)**	**5(7)**	**3(7)**	**1(7)**	**0(7)**
Total Number of Excursions Observed	**15**	**4**	**10**	**8**	**17.5**	**7**
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(11)	---	0(12)	---	---
ARSENIC TOTAL	1(12)	---	0(4)	---	0(12)	0(12)
BARIUM TOTAL	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
BERYLLIUM TOTAL	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
BORON TOTAL	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
CADMIUM TOTAL	0(12)	3(11)	0(4)	0(12)	2(12)	2(12)
CHROMIUM TOTAL	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
COBALT TOTAL	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
COPPER TOTAL	1(12)	0(11)	0(4)	8(12)	0(12)	2(12)
IRON DISSOLVED	0(12)	---	0(4)	0(12)	2(12)	0(12)
LEAD TOTAL	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
LITHIUM TOTAL	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
MANGANESE DISSOLVED	---	---	0(4)	---	0(12)	0(12)
MOLYBDENUM TOTAL	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
NICKEL DISSOLVED	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
SELENIUM TOTAL	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
SILVER TOTAL	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
THALLIUM TOTAL	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
URANIUM TOTAL	1(12)	0(11)	0(4)	0(12)	0(12)	0(12)
VANADIUM TOTAL	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
ZINC TOTAL	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
NUTRIENTS						
AMMONIA UN-IONIZED	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
PHOSPHORUS TOTAL *	1(12)	3.5(11)	1(4)	5.5(12)	6.5(12)	2(12)
PHOSPHORUS TOTAL DISSOLVED *	0(12)	6(11)	1(4)	2.5(12)	7.5(12)	0(12)
NITROGEN TOTAL *	4(12)	1(11)	1(4)	0(12)	3(12)	1(12)
NITROGEN DISSOLVED NO3 and NO2	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
MAJOR IONS						
CHLORIDE DISSOLVED	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
FLUORIDE DISSOLVED	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
SODIUM DISSOLVED/FILTERED	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
SULPHATE DISSOLVED	7(12)	0(11)	0(4)	1(12)	0(12)	0(12)
TOTAL DISSOLVED SOLIDS	4(12)	0(11)	0(4)	1(12)	4(12)	0(12)
BIOTA						
COLIFORMS FECAL	3(12)	0(11)	0(4)	3(12)	2(12)	1(12)
ESCHERICHIA COLI	2(12)	0(11)	0(4)	1(12)	2(12)	0(12)
PHYSICALS and OTHERS						
OXYGEN DISSOLVED	0(12)	1(5)	0(4)	0(12)	0(12)	0(12)
PH	0(12)	0(11)	0(4)	0(12)	0(12)	0(12)
SODIUM ABSORPTION RATIO	0(12)	---	0(4)	---	0(12)	0(12)
TOTAL SUSPENDED SOLIDS	4(7)	2(6)	0(3)	5(7)	5(6)	1(7)
Number of Excursion Comparisons	**415**	**352**	**143**	**403**	**426**	**427**
Total Number of Excursions Observed	**28**	**16.5**	**3**	**27**	**32**	**9**
Sampling Frequency (no./year)	**12**	**11**	**4**	**12**	**12**	**12**

* 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	Not Sampled	Not Sampled	0(8)
ATRAZINE	NA)					NA
BROMOXYNIL	0(8)					0(8)
DICAMBA	0(8)					2(8)
DICLOFOP-METHYL	NA					NA
ENDOSULFAN	NA					NA
GAMMA-BENZENEHEXACHLORIDE	NA					NA
HEXACHLOROBENZENE	NA					NA
MCPA	1(8)					0(8)
METOLACHLOR	NA					NA
METRIBUZIN	NA					NA
PENTACHLOROPHENOL (PCP)	---					NA
PICLORAM	0(8)					0(8)
SIMAZINE	NA					NA
TRIALLATE	NA					NA
TRIFLURALIN	NA					NA
GLYPHOSATE	Not sampled					Not sampled
Number of Excursion Comparisons	**40**					**40**
Total Number of Excursions Observed	**1**					**2**
Sampling Frequency (no./year)	**8**					**8**

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(10)		0(8)		0(8)
ATRAZINE	0(11)	0(10)		0(8)		0(8)
BROMOXYNIL	0(11)	0(10)		0(8)		0(8)
DICAMBA	1(11)	0(10)		0(8)		0(8)
DICLOFOP-METHYL	0(11)	0(10)		0(8)		0(8)
ENDOSULFAN	0(12)	0(11)		0(8)		0(8)
GAMMA-BENZENEHEXACHLORIDE	0(12)	0(11)		0(8)		0(8)
HEXACHLOROBENZENE	0(12)	0(11)		0(8)		0(8)
MCPA	3(11)	2(10)	Not Sampled	2(8)	Not Sampled	0(8)
METOLACHLOR	0(11)	0(10)		0(8)		0(8)
METRIBUZIN	0(11)	0(10)		0(8)		0(8)
PENTACHLOROPHENOL (PCP)	---	---		---		---
PICLORAM	0(11)	0(10)		0(8)		0(8)
SIMAZINE	0(11)	0(10)		0(8)		0(8)
TRIALLATE	0(11)	0(10)		0(8)		0(8)
TRIFLURALIN	0(11)	0(10)		0(8)		0(8)
GLYPHOSATE	12(12)[a]	11(11)[a]		8(8)[a]		4(8)[a]
Number of Excursion Comparisons	**168**	**153**		**120**		**120**
Total Number of Excursions Observed	**4**	**2**		**2**		**0**
Sampling Frequency (no./year)	**11/12**	**10/11**		**8**		**8**

a= Detected at low levels, 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	0(7) 1(5)	0(7) 1(5)	1(7) 1(5)		0(7) 2(5)		36	5
BEAVER RIVER	Open Water Ice-Covered	0(7) 0(5)		0(7) 0(5)	0(7) 0(5)	0(7) 0(5)		36	0
COLD RIVER	Open Water Ice-Covered	0(7) 0(5)		1(7) 0(5)		0(7) 4(5)	0(7) 4(5)	36	5
NORTH SASK. RIVER	Open Water Ice-Covered	0(7) 0(5)	0(7) 0(5)	0(7) 0(5)	0(7) 0(5)	0(7) 0(5)	0(7) 0(5)	36	0
RED DEER RIVER A/S	Open Water Ice-Covered	1(7) 4(5)	1(7) 2(5)	0(7) 3(5)	0(7) 2(5)	1(7) 3(5)		36	10.5
SOUTH SASK. RIVER	Open Water Ice-Covered	0(7) 0(5)	0(7) 0(5)	0(7) 0(5)	0(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 grey boxes = decreasing trend; blue 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) plus the arithmetic average of the trend (blue or grey 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	1(7) 0(5)		0(7) 0(5)		1(7) 3(4)		36	5
CARROT RIVER	Open Water Ice-Covered	4(5) 0(6)	3(5) 0(6)	5(5) 4(6)	3(5) 0(6)	2(5) 0(6)	0(5) 0(6)	36	10.5
CHURCHILL RIVER	Open Water Ice-Covered	1(3) 0(1)		1(3) 0(1)		1(3) 0(1)		12	3
QU'APPELLE RIVER	Open Water Ice-Covered	4(6) 2(6)	4(6) 1(6)	2(6) 2(6)	0(7) 0(5)	0(6) 0(6)		36	8
RED DEER RIVER S/M	Open Water Ice-Covered	6(6) 1(6)	5(6) 1(6)	6(6) 3(6)	0(7) 2(5)	3(6) 0(6)		36	17
SASK. RIVER	Open Water Ice-Covered	2(7) 1(5)	0(7) 1(5)	0(7) 0(5)	0(7) 0(5)	1(7) 0(5)		36	3

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.

	ALBERTA-SASKATCHEWAN BOUNDARY					
	BATTLE RIVER	BEAVER RIVER	COLD RIVER	NORTH. SASK. RIVER	RED DEER RIVER A/S	SOUTH SASK. RIVER
CATEGORY						
METALS	0(228)	3(228)	0(240)	1(240)	2(216)	4(240)
NUTRIENTS (TN, TP, TDP)	5(36)	0(36)	5(36)	0(36)	10.5(36)	0(36)
NUTRIENTS (TOXICITY)	0(24)	0(24)	0(24)	0(24)	0(24)	0(24)
MAJOR IONS	6(60)	0(60)	0(60)	0(60)	1(60)	0(60)
BIOTA	4(24)	1(24)	0(24)	3(24)	3(24)	3(24)
PHYSICAL and OTHER	0(26)	0(37)	5(43)	4(43)	1(43)	0(43)
PESTICIDES	1(40)	ND	ND	ND	ND	2(40)
Number of Excursion Comparisons	**438**	**409**	**427**	**427**	**403**	**467**
Total Number of Excursions Observed	**16**	**4**	**10**	**8**	**17.5**	**9**
Sampling Frequency (no./year)	**12**	**12**	**12**	**12**	**12**	**12**
Overall Adherence Rate	**96.3**	**99.0**	**97.7**	**98.1**	**95.7**	**98.1**

Table 9: Overall excursion summary, by category, for Saskatchewan-Manitoba water quality stations.

	SASKATCHEWAN-MANITOBA BOUNDARY					
	ASSINIBOINE RIVER	CARROT RIVER	CHURCHILL RIVER	QU'APPELLE RIVER	RED DEER RIVER S/M	SASK. RIVER
CATEGORY						
METALS	3(228)	3(198)	0(80)	8(228)	2(240)	4(240)
NUTRIENTS (TN, TP, TDP)	5(36)	10.5(33)	3(12)	8(36)	17(36)	3(36)
NUTRIENTS (TOXICITY)	0(24)	0(22)	0(8)	0(24)	0(24)	0(24)
MAJOR IONS	11(60)	0(55)	0(20)	2(60)	4(60)	0(60)
BIOTA	5(24)	0(22)	0(8)	4(24)	4(24)	1(24)
PHYSICAL and OTHER	4(43)	3(22)	0(15)	5(31)	5(42)	1(43)
PESTICIDES	4(168)	2(153)	ND	2(120)	ND	0(120)
Number of Excursion Comparisons	**583**	**505**	**143**	**523**	**426**	**547**
Total Number of Excursions Observed	**32**	**18.5**	**3**	**29**	**32**	**9**
Sampling Frequency (no./year)	**12**	**11**	**4**	**12**	**12**	**12**
Overall Adherence Rate	**94.5**	**96.3**	**97.9**	**94.4**	**92.5**	**98.4**

CONCLUSION

Interprovincial water quality objectives set 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 96.5% of the time in 2016. The Committee concluded that water quality objectives were met in the transboundary rivers the majority of the time in 2016 and consequently water uses were protected. There is an expectation that objectives will be exceeded occasionally (particularly for those set with the background method) and that some exceedances will occur naturally (for example, during high flow events).

The adherence rate to interprovincial water quality objectives ranged from 99.0% (Beaver River) to 92.5% (Red Deer River, Erwood SK/MB) indicating that water quality was generally suitable for the intended water uses for these rivers. Overall, each of the 12 transboundary river reaches has shown little variation in adherence rate during the past 13 years. However, of the 12 rivers the Battle and Red Deer rivers on the Alberta-Saskatchewan boundary have shown the greatest variation in compliance to the water quality objectives.

Excursions for nutrients, biota (bacteria), TSS and major ions were the most common among sites. Excursions for total metals and major ions were more prevalent at the Saskatchewan-Manitoba boundary sites in 2016. Excursions of TDS, sulphate and pesticides occurred at specific rivers. In 2016, the highest numbers of excursions, to the interprovincial water quality objectives, were observed on four of the Saskatchewan-Manitoba boundary sites. For the Saskatchewan-Manitoba boundary, the rivers with the highest number of excursions in 2016 included the Red Deer, Qu'Appelle, Assiniboine and Carrot rivers. For the Alberta-Saskatchewan boundary, the rivers with the highest number of excursions in 2016 included the Battle and Red Deer rivers. 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.

- Nutrients remain the highest priority for the PPWB. The Committee's work to understand sources and trends in nutrients is ongoing. The Committee held a nutrient workshop in 2016 and continues to work on the Carrot River, Red Deer River (AB/SK) pilot project. In 2017, the Committee will continue to discuss and follow up on nutrient issues in the transboundary rivers.
- For pesticides, the frequent exceedance of MCPA and dicamba objectives in prairie rivers is suggestive of a generally low-concentration but wide spread presence of pesticides in the environment. This observation warrants further exploration to better understand the prevalence of pesticides and potential effects. The COWQ recommended that the acid herbicides be monitored annually in a number of selected rivers to better understand the inter-annual variability and seasonal pattern of pesticide concentration at these sites. This has now been implemented and the COWQ will also continue to work with the jurisdictions to better understand the effects to the aquatic environment and users of these waters.
- Relationships to physical parameters including suspended solids and flow, should be examined on select rivers to gain further understanding on how these factors influence metal concentrations in transboundary rivers. While TSS and flow appear to be related to spikes in metals it does not explain all the exceedances or variation observed with metals.

A number of the prairies rivers have higher saline waters and constituent ions that vary based on precipitation and groundwater inputs. Total dissolved solids and sulphate are the two parameters that appear to exceed water quality objectives most often in select transboundary rivers. In addition, increasing trends have been noted in a number of rivers. The COWQ will continue to track these parameters and evaluate as more data becomes available.

ON-GOING

Interprovincial water quality objectives have been reviewed for all transboundary river reaches and revised objectives were approved by Ministers responsible for the PPWB on July 8th, 2015. The revised objectives adopted an approach 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 second year that the PPWB is reporting against these water quality objectives. However, the Committee will continue to work on updating water quality objectives, particularly in those areas where objectives were not established for select parameters and rivers, including several metals and dissolved oxygen. It is anticipated that the objectives will continue to be revised with new objectives proposed for the transboundary rivers in 2020.

The COWQ also continues to work on the review of excursions to the approved interprovincial water quality objectives and prioritization of any potential issues for further consideration or actions. Several areas have been flagged by the COWQ including nutrients, which have been assessed as a priority. While nutrients have been assigned the highest priority in all transboundary watersheds, there is a focus on investigating nutrient levels in two transboundary watersheds as a pilot program: the Red Deer River (AB/SK) and Carrot River watersheds. This work is nearing completion and should be finalized in 2017. Once this work has been completed, the Committee will assess the next steps to address nutrient issues.

Other areas of interest to the Committee include pesticides that have also been identified as a priority area for future work. The COWQ has completed a review of all available pesticide data for the PPWB transboundary rivers (PPWB Report #175, 2016), and will continue to follow up on pesticides with the jurisdictions with particular emphasis on the acid herbicides, which are the most frequently detected pesticides in transboundary rivers. One recommendation from the report was to increase acid herbicide monitoring to every year on select rivers which have had a number of observed detections. Environment and Climate Change Canada has implemented annual monitoring for the acid herbicides to address this recommendation.

In the 2015 Excursion report, the Committee recommended a further review of the Red Deer River (AB/SK) following a number of excursions on that river, and some observed unusual water quality conditions. Alberta Environment and Parks will review the provincial data and assess the potential causes of the non-compliance. This work has been initiated and is on-going. Once the available information has been reviewed, the Committee will make recommendations on whether further investigation is warranted.

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.

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. http://www.ppwb.ca/information/115/index.html

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

PPWB Report #177. 2017. Prairie water quality workshop with a focus on nutrients. Prepared by S. L. McLeod Consulting pp. 32.

APPENDIX 1: WATER QUALITY OBJECTIVES
Table A1: AB/SK

	2015 Interprovincial Water Quality Objectives – AB/SK Boundary					
PARAMETER	**BATTLE RIVER**	**BEAVER RIVER**	**COLD RIVER**	**NORTH SASK. RIVER**	**RED DEER RIVER (ERWOOD)**	**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	Under Review	3	Under Review	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	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

APPENDIX 1: WATER QUALITY OBJECTIVES

Superscripts

a. Ammonia guideline: Expressed as mg unionized ammonia per L. This would be equivalent to 0.0156 mg/L ammonia-nitrogen. Guideline for total ammonia is temperature and pH dependent, please consult the Canadian Water Quality Guidelines for the Protection of Aquatic Life Ammonia factsheet for more information.

b. Guideline is crop-specific 500 to 6000 µg/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 (hardness)]+0.0584}*0.997

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

Table A2: AB/SK

2015 Interprovincial Water Quality Objectives – AB-SK Boundary						
PARAMETER	**BATTLE RIVER**	**BEAVER RIVER**	**COLD RIVER**	**NORTH SASK. RIVER**	**RED DEER RIVER (ERWOOD)**	**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 (µg/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

APPENDIX 1: WATER QUALITY OBJECTIVES
Table A3: SK/MB

	2015 Interprovincial Water Quality Objectives – SK/MB Boundary						
PARAMETER	ASSINIBOINE RIVER	CARROT RIVER		CHURCHILL RIVER	QU'APPELLE RIVER	RED DEER RIVER (ERWOOD)	SASK. 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	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

APPENDIX 1: WATER QUALITY OBJECTIVES

Superscripts

a. Ammonia guideline: Expressed as mg unionized ammonia per L. This would be equivalent to 0.0156 mg/L ammonia-nitrogen. Guideline for total ammonia is temperature and pH dependent, please consult the Canadian Water Quality Guidelines for the Protection of Aquatic Life Ammonia factsheet for more information.

b. Guideline is crop-specific 500 to 6000 µg/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 (hardness)]+0.0584}*0.997

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

Table A4: SK/MB

	2015 Interprovincial Water Quality Objectives – AB/SK Boundary						
PARAMETER	ASSINIBOINE RIVER	CARROT RIVER		CHURCHILL RIVER	QU'APPELLE RIVER	RED DEER RIVER (ERWOOD)	SASK. 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 (µg/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

APPENDIX 1: WATER QUALITY OBJECTIVES
Table A5: AB/SK

PARAMETER	2015 Interprovincial Water Quality Objectives – AB/SK Boundary					
	BATTLE RIVER	BEAVER RIVER	COLD RIVER	NORTH SASK. RIVER	RED DEER RIVER (ERWOOD)	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
Table A6: SK/MB

PARAMETER	2015 Interprovincial Water Quality Objectives – SK/MB Boundary						
	ASSINIBOINE RIVER	CARROT RIVER		CHURCHILL RIVER	QU'APPELLE RIVER	RED DEER RIVER (ERWOOD)	SASK. 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

Table A7: Site-specific nutrient objectives, both boundaries

Nutrient Objectives								
Proposed 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 90th % of 10yr Running	Increasing Trend – Lowest 90th % of 10yr Running

APPENDIX 1: WATER QUALITY OBJECTIVES

Table A7: Site-specific nutrient objectives, both boundaries *continued*

Nutrient Objectives								
Proposed 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 90th % of 10yr Running	Increasing Trend – Lowest 90th % of 10yr Running

APPENDIX 2: WATER QUALITY OBJECTIVES
PPWB Water Quality Monitoring 2016

The water quality monitoring program is provided in the attached table and includes the previous monitoring program (2015) and the recommended 2016 monitoring program. The changes to be implemented for 2016 from 2015 are highlighted.

In 2016, pesticide sampling is recommended on the Saskatchewan River and the Qu'Appelle River in addition to the annual sampling at the Carrot and Assiniboine Rivers. The Committee on Water Quality (COWQ) in 2013 also recommended that the acid herbicide pesticides be sampled on the Battle River and South Saskatchewan River due to a number of detections of these pesticides on these two rivers. The Committee recommends that acid herbicide sampling continue on the Battle River and the South Saskatchewan River in 2016. In 2015, the COWQ had also recommended that the acid herbicide pesticides be monitored on the Saskatchewan River and the Qu'Appelle River again due to frequent detections of this group of pesticides on these rivers. This monitoring will be captured in the regular rotational pesticide sampling program in 2016. In addition, monitoring of the biological oxygen demand (BOD) is recommended for the Battle, Beaver and Carrot Rivers in 2016 due to low dissolved oxygen levels in these rivers during the winter months.

PPWB MONITORING 2016: Alberta-Saskatchewan Sites

SITE	NUTRIENTS and PHYSICALS/BOD; MAJOR IONS/ SAR; METALS (Total and Dissolved); BACTERIA (Fecal and E. coli)	PESTICIDES (AH, NH, OC's, Glyphosate)
Site 1 Cold River	2016 : 12x / year 2015 : 12x / year	2016 : none 2015 : none
Site 2 Beaver River	2016 : 12x / year 2015 : 12x / year	2016 : none 2015 : none
Site 3 North Saskatchewan River	2016 : 12x / year 2015 : 12x / year	2016 : none 2015 : none
Site 4 Battle River	2016 : 12x / year 2015 : 12x / year	2016 : 8x/ year[2] 2015 : 8x / year1
Site 5 Red Deer River A/S	2016 : 12x / year 2015 : 12x / year	2016 : none 2015 : 8x / year[1]
Site 6 South Saskatchewan River	2016 : 12x / year 2015 : 12x / year	2016 : 8x / year[2] 2015 : 8x / year[2]

[1]Months sampled = All Pesticides in Feb, Apr, May, June, July, Aug, Oct, Dec
[2]Pesticides = Acid Herbicides (AH) only in Feb, Apr, May, June, July, Aug, Oct, Dec; Pesticides: (AH = Acid Herbicides; NH = Neutral Herbicides; OC's = Organochlorine)
Highlighting indicates changes from previous year's sampling schedule.

APPENDIX 2: WATER QUALITY OBJECTIVES
PPWB Water Quality Monitoring 2016 *continued*

PPWB MONITORING 2016: Saskatchewan-Manitoba Sites

SITE	NUTRIENTS and PHYSICALS/BOD; MAJOR IONS/ SAR; METALS (Total and Dissolved); BACTERIA (Fecal and E. coli)	PESTICIDES (AH, NH, OC's, Glyphosate)
Site 7 Churchill[1]	2016 : 4x / year 2015 : 4x / year	2016: none 2015 : none
Site 8 Saskatchewan River	2016: 12x / year 2015: 12x / year	2016: 8x / year[1] 2015 : 8x / year[2]
Site 9 Carrot River	2016 : 12x / year 2015 : 12x / year	2016 : 12x / year 2015 : 12x / year
Site 10 Red Deer River S/M	2016 : 12x / year 2015 : 12x / year	2016 : none 2015 : none
Site 11 Assiniboine River	2016 : 12x / year 2015 : 12x / year	2016 : 12x / year 2015 : 12x / year
Site 12 Qu'Appelle River	2016 : 12x / year 2015 : 12x / year	2016 : 8x / year[1] 2015 : 8x / year[2]

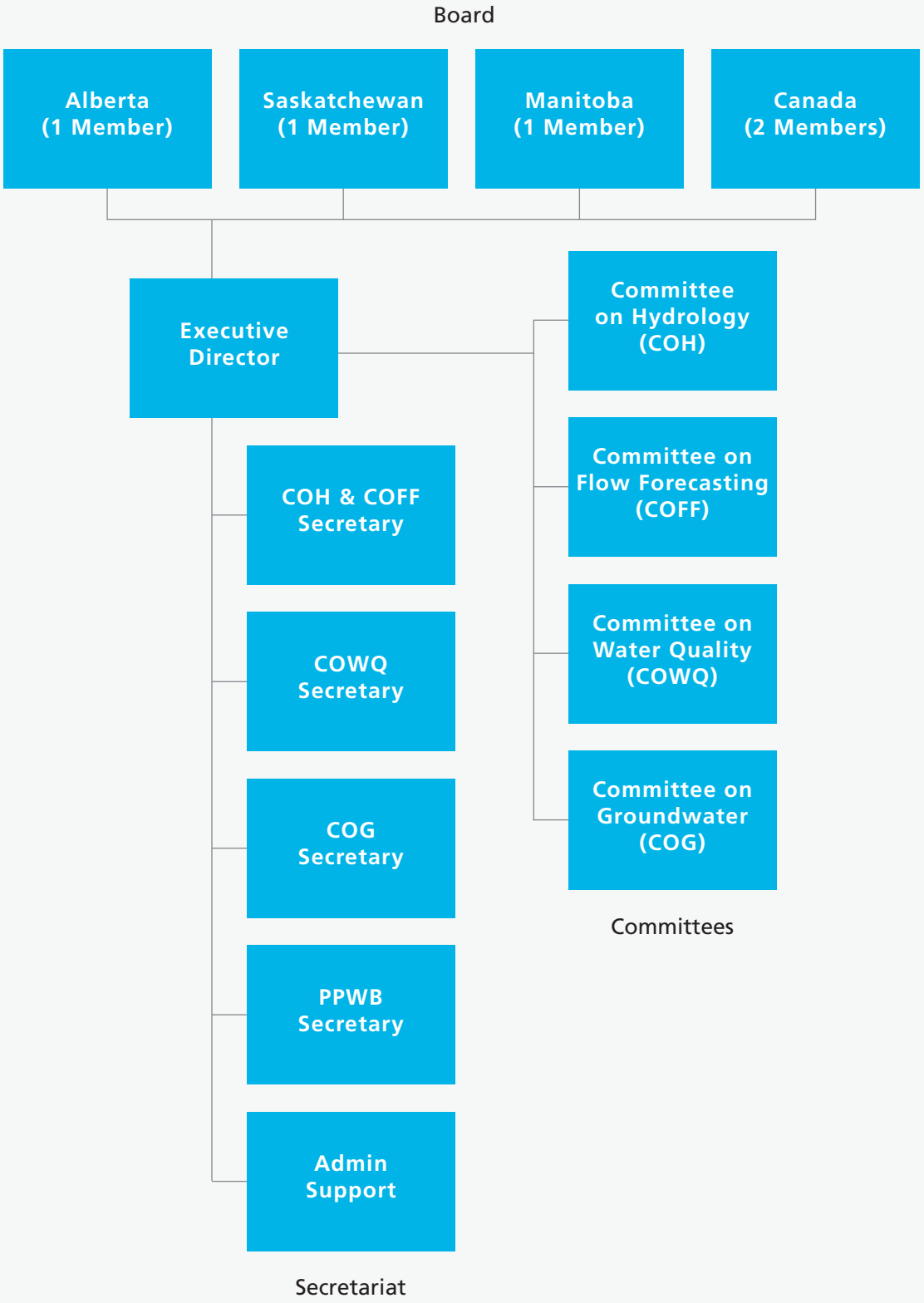
[1] Months sampled = All Pesticides in Feb, Apr, May, June, July, Aug, Oct, Dec
[2] Pesticides = Acid Herbicides (AH) only in Feb, Apr, May, June, July, Aug, Oct, Dec; Pesticides: (AH = Acid Herbicides; NH = Neutral Herbicides; OC's = Organochlorine)
Highlighting indicates changes from previous year's sampling schedule.

Other Objectives

Monitoring was not recommended for radionuclides, total residual chlorine, cyanide and mercury in 2016. 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. For example, radionuclides have not been monitored since January 1984.

Monitoring is not recommended for contaminants in fish in 2016. 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 V:
PPWB Organizational Chart



APPENDIX VI:
Board / Committee Membership 2016-2017

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	Cheryl Baraniecki	Associate Regional Director General West & North Environment and Climate Change Canada
	Lynden Hillier	Director General Asset Management and Capital Planning Corporate Management Branch Agriculture and Agri-Food Canada
	Brian Yee	Director Transboundary Waters Secretariat Alberta Environment and Parks
	Steve Topping	Executive Director Hydrologic Forecasting & Water Management Manitoba Infrastructure
	Vacant (Sept/15 to current)	Water Security Agency (Saskatchewan)

SECRETARIAT

EXECUTIVE DIRECTOR	Mike Renouf	Transboundary Waters Unit Prairie Provinces Water Board
SECRETARY	Lynne Quinnett-Abbot	Transboundary Waters Unit Prairie Provinces Water Board

APPENDIX VI:
Board / Committee Membership 2016-2017 *continued*

PPWB ALTERNATE BOARD MEMBERS

Vacant	Environment and Climate Change Canada
Dave Zapshala	Director, Water Infrastructure Division Corporate Management Branch Agriculture and Agri-Food Canada
Carmen de la Chevrotière	Transboundary Water Quantity Specialist Transboundary Water Secretariat Alberta Environment and Parks
Susan Ross (Aug/15 to Oct/16)	Senior Vice President Legal, Regulatory and Aboriginal Affairs Division Water Security Agency (Saskatchewan)
Sam Ferris	Executive Director Environmental and Municipal Management Services Division Water Security Agency (Saskatchewan)
Nicole Armstrong	Director Water Science and Management Branch Department of Sustainable Development (Manitoba)

APPENDIX VI:
Board / Committee Membership 2016-2017 *continued*

COMMITTEE ON HYDROLOGY

Terms of Reference: Mandate

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	Mike Renouf	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	Surface Water Management Department of Sustainable Management
	Bart Oegema	Hydrology Services Water Security Agency (Saskatchewan)
	Anthony Liu	Meteorological Service of Canada Environment and Climate Change Canada
SECRETARY	Megan Garner (2014 to May/16)	Transboundary Waters Unit Prairie Provinces Water Board
	Erin Zoski (May/16 to current)	Transboundary Waters Unit Prairie Provinces Water Board
	Marie Hyde (May/16 to current)	Transboundary Waters Unit Prairie Provinces Water Board

APPENDIX VI:
Board / Committee Membership 2016-2017 *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 2016-2017 *continued*

COMMITTEE ON WATER QUALITY MEMBERS

CHAIR	Mike Renouf	Executive Director Prairie Provinces Water Board
MEMBERS	Paul Klawunn	Science and Technology Branch Environment and Climate Change Canada
	Nicole Armstrong	Water Science and Management Branch Department of Sustainable Development (Manitoba)
	John-Mark Davies	Water Quality Services Water Security Agency (Saskatchewan)
	Gongchen Li	Transboundary Waters Secretariat Alberta Environment and Parks
	Sharon Reedyk	Science and Technology Branch Agriculture and Agri-Food Canada
SECRETARY	Joanne Sketchell	Transboundary Waters Unit Prairie Provinces Water Board

APPENDIX VI:
Board / Committee Membership 2016-2017 *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	Mike Renouf	Executive Director Prairie Provinces Water Board
MEMBERS	Garth van der Kamp	Groundwater Hydrology Water Science and Technology Directorate Environment and Climate Change Canada
	Anthony Cowen	Science and Technology Branch Agriculture and Agri-Food Canada
	Steve Wallace (Mar/15 to Feb/17)	Groundwater Policy Alberta Environment and Parks
	Guy Bayegnak	Groundwater Policy Specialist Alberta Environment and Parks
	Kei Lo	Hydrology and Groundwater Services Water Security Agency (Saskatchewan)
	Graham Phipps	Groundwater Section Department of Sustainable Development (Manitoba)

APPENDIX VI:
Board / Committee Membership 2016-2017 *continued*

SECRETARY	Megan Garner (2014 to May/16)	Transboundary Waters Unit Prairie Provinces Water Board
	Erin Zoski (May/16 to current)	Transboundary Waters Unit Prairie Provinces Water Board
	Marie Hyde (May/16 to current)	Transboundary Waters Unit Prairie Provinces Water Board
	Jackie Lukey Sept/15 to Sept/16)	Transboundary Waters Unit Prairie Provinces Water Board

APPENDIX VI:
Board / Committee Membership 2016-2017 *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	Mike Renouf	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
	Patrick Cherneski	National Agroclimate Information Services Agriculture and Agri-Food Canada
	Fishaha S. Unduche	Hydrologic Forecasting & Coordination Manitoba Infrastructure
	Curtis Hallborg	Flow Forecasting & Operations Planning Water Security Agency (Saskatchewan)
	Bernard Trevor	Watershed Resilience and Mitigation Alberta Environment and Parks
SECRETARY	Megan Garner 2014 to May/16)	Transboundary Waters Unit Prairie Provinces Water Board
	Erin Zoski (May/16 to current)	Transboundary Waters Unit Prairie Provinces Water Board

APPENDIX VII:
Statement of Final Expenditures 2016-2017

	2016-2017	
	Budget	Actual
Salary Component		
PY's	5.000	5.042
Base Salary	$476,320	$443,478
BPE	$95,264	$88,695
Total Salary	$571,584	$532,173
O&M Component		
Contracts & Students		
Goal 1		
Cont. Improvement	$153,500	$106,713
Goal 2		
Cont. Improvement	$50,000	$0
Goal 3		
Cont. Improvement	$157,000	$46,167
Goal 7		
Core Activities	$20,000	$0
Sub-total contracts	$380,500	$152,880
Operating Expenses	$40,000	$26,595
Total O&M	$420,500	$179,475
Grand Total	$992,084	$711,648

APPENDIX VIII:
History of the PPWB

The Prairie Provinces Water Board (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 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 *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.

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 Board's 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.

APPENDIX VIII:
History of the PPWB *continued*

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.

In November 2015, a costed multi-year Work Plan was renewed and approved by the Board to identify activities and projected budgets for 2016-2021.

The 2006 PPWB Charter and Strategic Plan were reviewed in 2012 as part of the Work Plan review. These documents were approved at the fall 2012 Board Meeting. The Strategic Plan and Charter were revised and approved in February 2017 to incorporate the Committee on Flow Forecasting, the PPWB's most recent technical committee.

In February 2009, the *MAA*, By-laws, and Rules and Procedures were published in an updated document that included all changes made to date. In February 2017 revisions were made to update the agencies name changes. Other key documents have been tabled for review in 2016-2017. The review is expected to be ongoing for the next couple of years.

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