South Saskatchewan Region

Status of Management Response for Environmental Management Frameworks

- Air Quality Management Framework
- Surface Water Quality Management Framework

As of May 2016

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Executive Summary

As part of the Integrated Resource Management System, this report outlines the status of the Government of Alberta's management response to the air triggers for the year 2014 and surface water quality triggers from April of 2014 to March of 2015 in the South Saskatchewan Region. This fulfils commitments made to Albertans in the *South Saskatchewan Region Air Quality Management Framework for Nitrogen Dioxide (NO2), Ozone (O3) and Fine Particulate Matter (PM2.5)* and the *South Saskatchewan Region Surface Water Quality Management Framework for the Mainstem Bow, Milk, Oldman and South Saskatchewan Rivers (Alberta)*. In this 2014 reporting period there were no limits exceeded for air and surface water quality indicators under the framework. This means that the state of environmental health remains within the range of acceptable conditions, and that air and surface water quality objectives identified in the South Saskatchewan Regional Plan are being met.

However, some proactive triggers were crossed. As a result, the Ministry of Environment and Parks is leading the required management response. This report communicates the status of the response to 2014 trigger exceedances. The following is a summary of some key findings and key activities planned or initiated as responses to date:

Air Quality

- Acquire further understanding and knowledge of regional air quality issues through investigation into ambient monitoring trends and anthropogenic source contribution.
- Regional emissions inventory and modelling studies demonstrate non-point sources as the common largest contributor of primary indicator emissions and precursors.
- Continue to support and leverage existing stakeholder connections and management initiatives underway such as the Calgary Region Airshed Zone Particulate Matter and Ozone Management Plan.
- Explore emissions reduction tools in the current regulatory process such as continuous improvement plans.
- Conduct a review of tools used for air quality management by other jurisdictions for areas with stressed airsheds.

Surface Water Quality

- Continue the preliminary assessment work to assess trends and determine the influence river flows may have had on parameters where there were trigger exceedances

The status of this management response will be further updated annually and will be publicly available on the Environment and Parks website.

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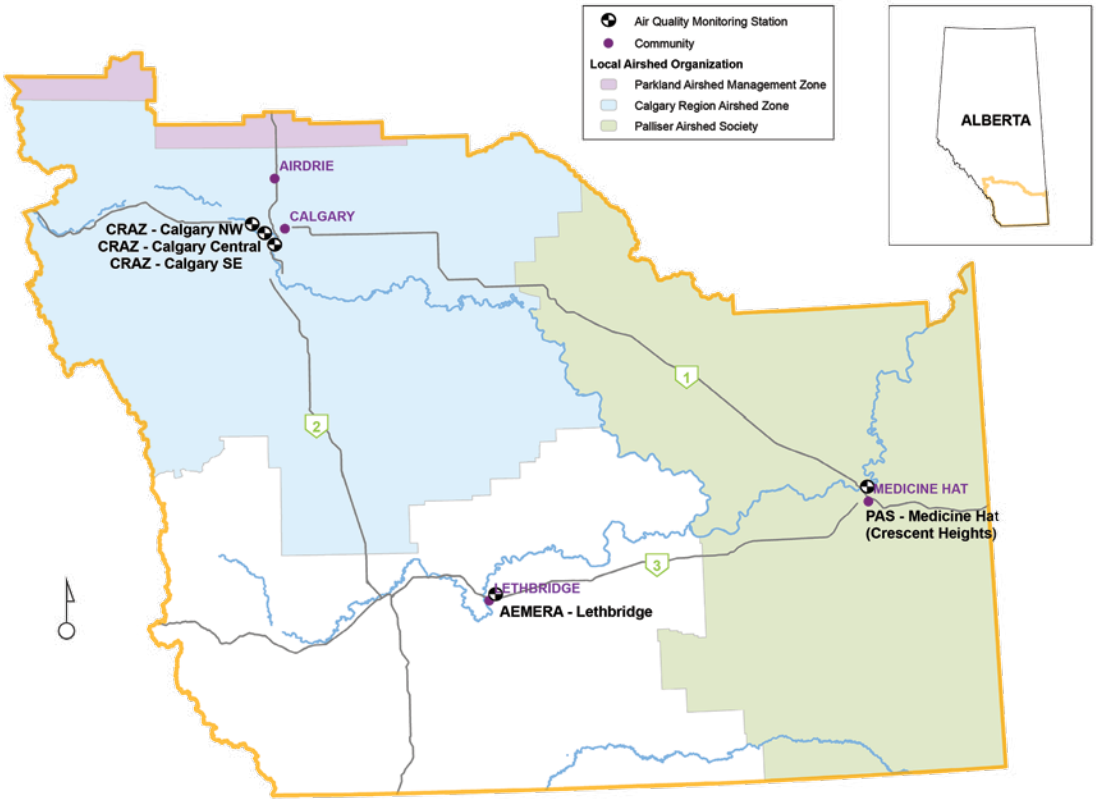
1.0 Introduction

Under the South Saskatchewan Regional Plan, a management response is initiated when a trigger or limit has been exceeded, as determined by the Minister of Environment and Parks. Part of the management response is determining the need for management action(s). Figure 1 presents the ambient air monitoring stations in the South Saskatchewan Region whose data is used for the annual assessment. This is the first status report produced since the South Saskatchewan Regional Plan came into effect in September 2014.

The Minister's Determination for 2014 confirmed that no limits were exceeded for nitrogen dioxide (NO_2). However, air quality triggers for NO_2 were crossed in 2014 at the Calgary Central and Calgary Northwest stations, resulting in the assignment of ambient air quality levels described in the 2014 Status of Ambient Environmental Condition Report (AEMERA, 2016) (Figure 1, Table 1). Management levels have not yet been assigned for fine particulate matter ($PM_{2.5}$) and ozone (O_3) for 2014 (2012-2014 reporting period) because analysis is still underway. However, work has been initiated based on the 2011-2013 Canadian Ambient Air Quality Standards (CAAQS) results (Table 1), released by Environment and Parks in September 2015, and will be discussed in this status report.

This status report summarizes work that has been completed to date on the management response. Environment and Parks is the lead coordinator in undertaking the management response and will work with other government organizations (e.g. Alberta Energy Regulator (AER) and Alberta Environmental Monitoring, Evaluation and Reporting Agency (AEMERA)) and external parties as required.



** In April 2014, the new Calgary Southeast station started to collect data. However, since no data was collected in early 2014, the Calgary Southeast station did not meet the completeness criteria for 2014.*

Figure 1. Location of Continuous Ambient Air Monitoring Stations in the South Saskatchewan Region (AEMERA, 2016).

Table 1. Ambient levels assigned to air quality monitoring stations in the South Saskatchewan Region for 2014 based on triggers and limits established in the framework for the Average of the Annual Hourly data and Interim Upper Range of Hourly Data triggers for NO_2 and 2011-2013 CAAQS Assessment Management Levels for the Ozone, $PM_{2.5}$ 24-hour and $PM_{2.5}$ Annual Metrics (AEMERA, 2016).

	NO_2 2014 Levels		CAAQS Management Levels for 2011-2013**		
Station	**Annual Average**	**Upper Range**	**Ozone**	**$PM_{2.5}$ 24-hour**	**$PM_{2.5}$ Annual**
Calgary Central	3	2	1	n/a***	n/a***
Calgary Northwest	2	2	2	3	3
Medicine Hat	1	1	2	2	3
Lethbridge	1	1	2	2	3

* The NO_2 trigger level numbers in the table indicate the management level assigned under the SSRP Air Quality Management Framework.

- Management Level 4: Ambient air quality exceeding the air quality limit
- Management Level 3: Ambient air quality below but approaching the air quality limits
- Management Level 2: Ambient air quality below air quality limits
- Management Level 1: Ambient air quality well below air quality limits

** The CAAQS trigger level numbers in the table are not directly relevant to the CAAQS but are included for comparison to the NO_2 levels.

*** The 3-year average cannot be calculated because only one year of data is available.

- Management Level 4 (Red): Actions for Achieving Air Zone CAAQS
- Management Level 3 (Orange): Actions for Preventing CAAQS Exceedance
- Management Level 2 (Yellow): Actions for Preventing Air Quality Deterioration
- Management Level 1 (Green): Actions for Keeping Clean Areas Clean

***The 3-year average cannot be calculated because only one year of data is available

2.0
Management Response

The description of the management system is described in the South Saskatchewan Region Air Quality Management Framework. The management response is a set of seven steps that must be undertaken (in full or in part) when an ambient air quality trigger is crossed or limit is exceeded. Initial steps include verification, preliminary assessment and an investigation to determine the need for management actions. Based on the 2014 Status of Ambient Environmental Condition Report (AEMERA, 2016) the South Saskatchewan region is assigned both the trigger into level 3 and level 2 for NO_2 in Calgary. The 2011-2013 CAAQS assessment results place the region into level 3 for $PM_{2.5}$ and level 2 for Ozone The level 3 and level 2 management intents are to proactively maintain air quality below the limit and to plan and improve knowledge and understanding.

The management response for air considers a variety of factors such as the type and location of the monitoring station, averaging time (hourly, 24 hour or annual) and the ambient air quality trigger or limit that was exceeded.

This report provides the initial status of the management response to 2014 NO_2 trigger exceedances and some information on the response to the 2011-2013 $PM_{2.5}$ and Ozone CAAQS exceedances.

Steps of the Management Response

2.1 Verification and Preliminary Assessment

Verification and preliminary assessment of the 2014 data for NO_2 is complete. This work was undertaken by AEMERA in preparation of the 2014 Status of Ambient Environmental Condition report. Data were downloaded from Alberta's ambient air quality data warehouse and the average of the annual hourly data and the upper range (as represented by the 99th percentile of the hourly data) were calculated and compared against triggers and limits.

For the 2011-2013 $PM_{2.5}$ and O_3 assessment, the methodology and procedures set out in the *Guidance Document on Achievement Determination Canadian Ambient Air Quality Standards for Fine Particulate Matter and Ozone* (CCME, 2012) was followed to determine the CAAQS achievement status. This includes examination of data for transboundary flows and exceptional events (i.e., forest or grass fires).

2.2 Investigation

Analysis of ambient concentrations and trends and the identification of potential emission sources leading to elevated ambient concentrations is ongoing.

Initial actions are:

- Analyze trends in ambient concentrations.
- Assess the adequacy of existing ambient air quality monitoring in the region.
- Identify potential anthropogenic and natural sources contributing to elevated ambient concentrations.
- Assess existing air quality management initiatives and plans in the region and province for their contribution to addressing issues linked to current trigger exceedances.

The initial work completed to date includes: completion of an ambient air monitoring network assessment to identify the strengths and weaknesses of the existing SSR ambient air monitoring network and evaluate its ability to meet its monitoring objectives. The monitoring network objectives focused on a regional approach to monitoring, primarily for the purpose of air quality management using a cumulative effects management system (Sonoma Technology Inc., 2014). A set of recommendations was presented to help the network better meet the stated monitoring objectives. Several additional considerations, such as availability of resources, jurisdictional boundaries and historical objectives, which were not accounted for in the study, influence which if any of the recommendations should be implemented by the regional stakeholders.

Some of the recommendations from the network assessment have already been implemented. To date, this includes: the relocation of the Calgary Central station away from its urban canyon location; improving spatial coverage with the planning and siting of a new permanent Airdrie station and a temporary location in Brooks; and, co-location of passive measurement sites with continuous stations in Calgary for quality assurance. The adjustments to the overall regional monitoring network contribute to ensuring that the network continues to provide valuable information to inform air quality management.

Other work that will inform the investigation is the 2008 Alberta Air Emissions Inventory that provides emissions information by sector for selected parameters. Emissions inventories can help identify potential sources contributing to ambient conditions. Summaries of primary emissions by major source sector are provided in Figure 2 and Table 2. While these data are a few years old, they represent the best known data, including non-point sources and small sources (AEP, 2015).
The inventory indicates that the largest contributors of NOx emission sources are from the transportation and industry sectors. The largest contributors of primary $PM_{2.5}$ are from road dust, construction operations and agriculture. Anthropogenic volatile organic compounds (VOCs), an O_3 precursor, are dominated by the agriculture sector as well as the transportation and oil and gas sectors.

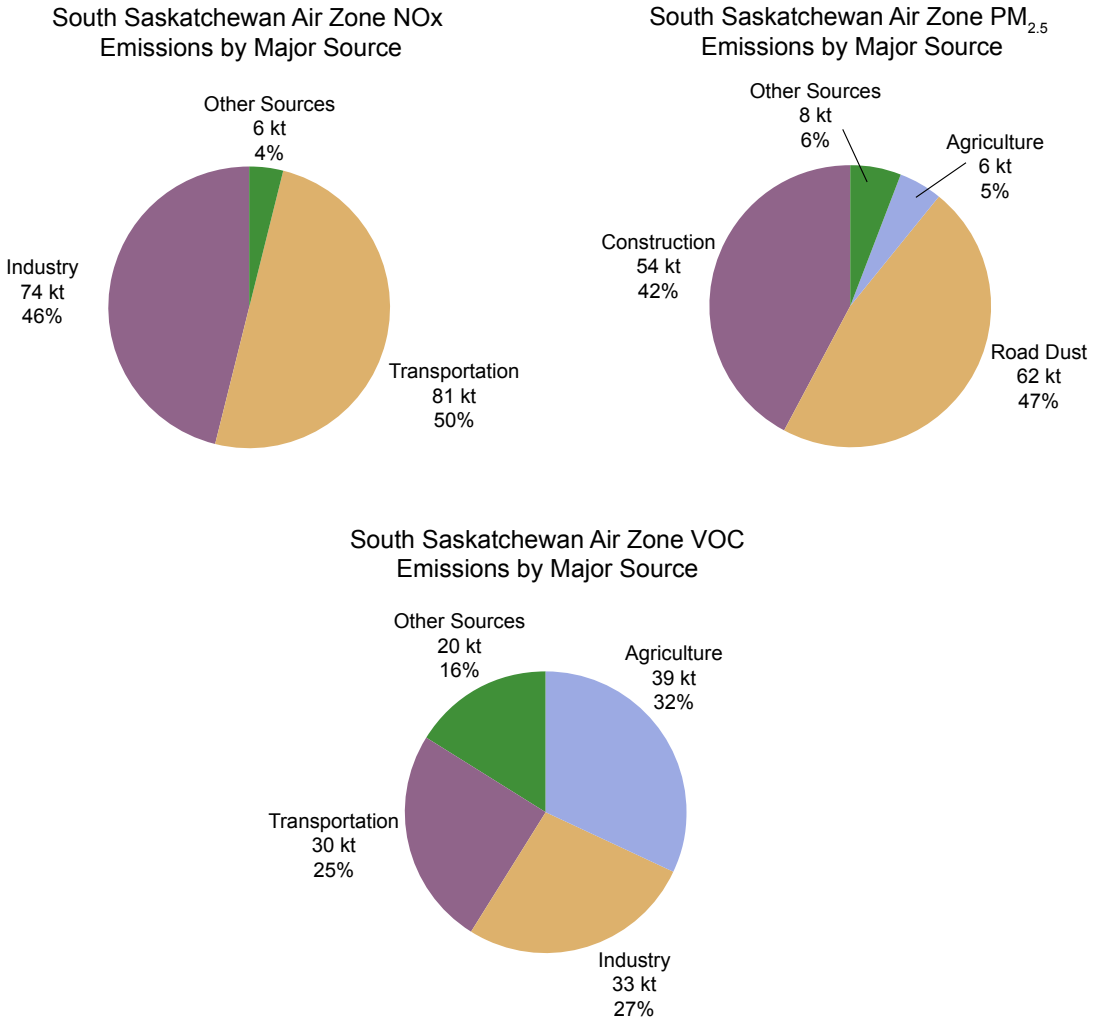


Figure 2. Major primary sources of NOx, $PM_{2.5}$ and VOCs in the South Saskatchewan Region, (AEP, 2015)

Table 2. Primary Emission Sources by Sector for the South Saskatchewan Region, (AEP, 2015)

Emission Sector	$PM_{2.5}$ tonnes (Fine Particulate Matter)	NOx tonnes (Oxides of Nitrogen)	VOCs tonnes (Volatile organic Compounds)
Agriculture	6,292	-	39,113
Cement and Concrete	642	3,967	16
Chemical	59	751	20
Construction	54,336	124	-
Conventional Oil and Gas	649	58,846	26,817
Electrical Power Generation	190	5,569	146
Fertilizer	73	3,535	476
Road Dust	61,836	-	-
Transportation	3,408	81,095	30,280
Wood Products	19	98	1,313
Other Sources	1,187	857	22,870
Non-industrial Sources	1,753	3,431	1,957
Natural Sources	6	2,333	333,596

Overall, non-point sources are the largest contributors to primary emission sources (and their precursors) of the framework indicators. Management of non-point sources in inherently complex: it is an intergovernmental and cross-jurisdictional issue. While this inventory provides an indication of emission source contribution on a regional level, further work is needed to better understand emission source contribution at a local scale in the vicinity of the air monitoring stations.

Regional air quality modelling of the South Saskatchewan Region using the Community Multiscale Air Quality (CMAQ) modelling system was completed in 2012. Modelling was performed to understand the spatial distribution of predicted concentrations and to estimate contribution of local sources to air quality in the region. The evaluation of source sector impacts on NO_2, O_3 and $PM_{2.5}$ concentrations attributed the biggest change in predicted concentrations when emissions from non-point sources (transportation, construction, road dust sectors) were removed (ENVIRON, 2013). The modelling demonstrated non-point sources as the common largest contributor of primary indicator emissions and precursors in the region.

3.0
Management Actions

Ongoing investigation and studies will continue to inform and establish necessary and appropriate mitigative actions. The preliminary findings suggest that management of point and non-point source emissions will be required. A number of actions are already underway:

- Participation in the CASA Non-point Source Project. The Project goal is *"To help address non-point source air emissions contributing to ambient $PM_{2.5}$ and O_3 standard non-achievement in Alberta"* (CASA, 2014) by developing an evaluated list of recommended management actions for non-point source air emissions. When completed the recommendations from the project will inform the SSRP Air Quality Management Framework management response in subsequent years.
- Exploration of existing emissions reduction tools in the regulatory process. Particularly continuous improvement plans outlining adaptation and improvement towards enhanced environmental performance at regulated industrial facilities.
- Acquisition of consultant support to conduct a jurisdictional review of tools used to manage air quality in areas that persistently exceed ambient air quality standards. This information will be used by Alberta Environment and Parks to inform policy and tool development for stressed airsheds in Alberta.
- Continued support and collaboration with existing stakeholder connections and management actions underway such as the Calgary Region Airshed Zone Particulate Matter and Ozone Management Plan (CRAZ, 2014). In addition, the designation of the orange level (*Actions for Preventing CAAQS Exceedance;* level 3 in the framework) for $PM_{2.5}$ at the Lethbridge and Medicine Hat stations will require a review with Palliser Airshed Zone and other stakeholders of the applicability of management initiatives identified for the Calgary area to these new locations. A regional management action plan will be developed by fall 2017.

To complement and support regional response, the Government of Alberta is also developing a province-wide action plan to address emissions sources contributing to fine particulate matter issues across the province. This will include actions for all sectors including the industrial and transportation sectors.

4.0
Next Steps

AEP will work with specific stakeholders to inform the investigation and assist in identifying management actions that may be necessary to address point and non-point source emissions. This work will be reported on in the next South Saskatchewan Region Status of Air Quality Management Response report.

5.0 References

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Status of Surface Water Quality Management Response

Figures

Tables

1.0 Introduction

Under the South Saskatchewan Regional Plan, a management response must be initiated when a trigger or limit has been exceeded, as determined by the Minister of Environment and Parks. Part of the management response is determining the need for management action(s). There are nine ambient water quality monitoring stations in the South Saskatchewan Region whose data are used for the annual assessment (Figure 1). This is the first status report produced since the South Saskatchewan Regional Plan came into effect in September 2014.

Figure 1. Location of nine Long-term River Network Water Quality Monitoring Stations included in the South Saskatchewan Regional Plan Water Quality Monitoring Framework.

The Minister's Determination for 2014/2015 (monthly water quality data collected and assessed for the period April 2014 to March 2015) confirmed that no limits were exceeded by indicator seasonal medians. However, the following trigger exceedances were reported (Alberta Environmental Monitoring, Evaluation and Reporting Agency, 2016):

- Bow River at Cochrane station exceedance of Total Nitrogen median trigger for the winter period.
- Bow River at Carseland station exceedance of the Specific Conductance peak triggers for both the open water and winter periods.
- Oldman River at Brocket station exceedance of the pH peak triggers for both the open water and winter periods.
- Oldman River at Highway 36 station exceedance of the Specific Conductance median trigger for both the open water and winter periods.

The four trigger exceedances observed in 2014/15 resulted in the assignment of these indicators to a Level 2 at those locations. The management intent for the ambient surface water quality levels is described fully in the Framework, and the management intent for Level 2 is highlighted in Table 1. Level 2 conditions are statistically defined and do not necessarily signal additional risk to the aquatic environment or water uses.

Table 1. Description of Ambient Surface Water Quality Levels.

Level	Description	Management Intent
3	Indicator seasonal median values exceed water quality limits.	Management actions required to improve ambient water quality to below limits.
Limit		
2	Indicator seasonal median and/or peak values statistically higher than trigger values.	Management response and determination of risk and urgency for management action to maintain water quality below limits. Investigation of cause and effects; evaluation and implementation of management actions
Trigger		
1	Median and peak water quality conditions at or better than historical water quality conditions.	Apply standard regulatory and non-regulatory approaches to manage water quality.

This status report summarizes work that has been completed to date on the management response. Environment and Parks is the lead coordinator in undertaking the management response and will work with other government organizations and external parties as required.

2.0
Management Response

A full description of the management system is found in the South Saskatchewan Region Surface Water Quality Management Framework. The management response is a set of seven steps that must be undertaken (in full or in part) when an ambient water quality trigger or limit is exceeded. Initial steps include verification and preliminary assessment to determine the need for further investigation and management actions.

The management response for surface water quality will consider a variety of factors including the number and location of monitoring stations where exceedances were reported, a qualitative assessment of risk to the aquatic environment or water uses of the exceedances, any unusual circumstances, natural or human-caused, including flow and trends to the data.

2.1 Verification and Preliminary Assessment

Verification of the 2014/2015 data is complete. The 2014/2015 data were downloaded from Alberta Environment and Park's Water Data System and the median and 90th percentile values were calculated and compared against historic triggers and limits. This work was undertaken by AEMERA in preparation of the 2014/2015 Status of Ambient Environmental Condition report.

The preliminary assessment of triggers that were exceeded also involved looking at all data available since April 1999. This included additional data from April 2009 to March 2014 that were not included in AEMERA's 2014/2015 Status of Ambient Environmental Condition report. These additional 5 years of data were included in the preliminary assessment data examination since they represent recent water quality.

Steps of the Management Response

Total Nitrogen – Bow River at Cochrane, Winter Median Trigger Exceedance

Nitrogen is an essential nutrient for life, although excessive amounts can contribute to increased growth of algae and aquatic plants. Total nitrogen is therefore used as an indicator of eutrophication and productivity of a water body. There are no quantitative limits (water quality guidelines) available for total nitrogen as the susceptibility to increased nutrients is water body specific. Existing narrative guidelines instead focus attention to the prevention of detrimental changes to recreational quality, algal and aquatic plant communities, dissolved oxygen levels, and aquatic biodiversity.

A statistically significant increase in the measure of central tendency for the 2014/15 winter (compared to the 1999-2009 historical data) was found for total nitrogen at the Bow River at Cochrane station.

Examination of the dataset revealed total nitrogen has a considerable amount of variability from year to year and the winter median value for 2014/2015 is similar to what has been observed in other winters in the dataset (Figure 2). An increasing trend is not apparent in data since 1999.

The total nitrogen concentrations in the Bow River at Cochrane are similar to those seen in the corresponding most upstream station (Brocket) in the Oldman River.

Further analysis is needed to evaluate the influence of river flow on total nitrogen concentrations observed at this station and to confirm there is no statistical trend. Reviews of aquatic productivity measures as well as biodiversity and dissolved oxygen data are also needed to determine if related negative impacts are being observed.

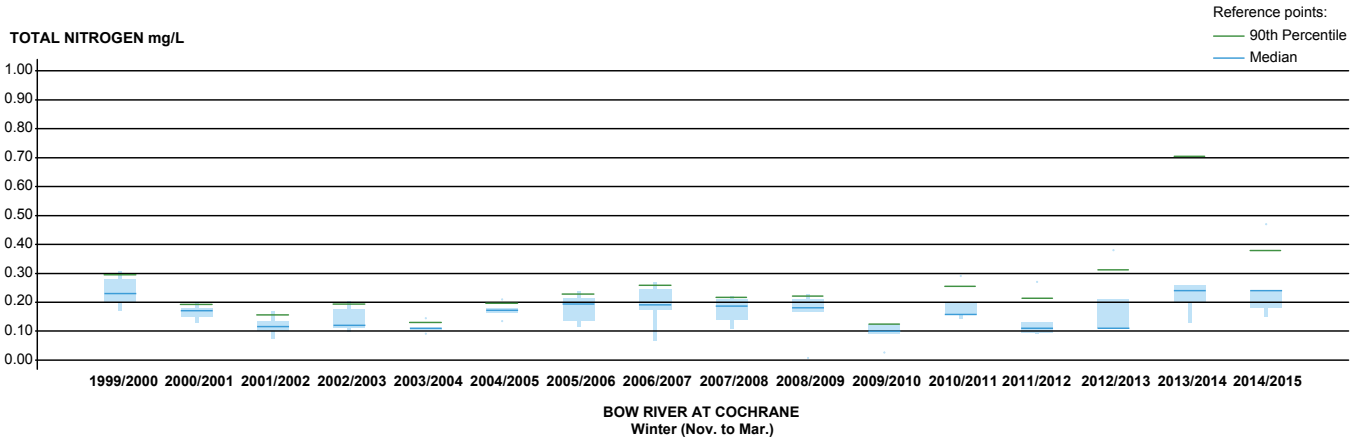


Figure 2. Box Plots of the Total Nitrogen Data at the Bow at Cochrane Station During Winter from April 1999 to March 2015.

Specific Conductance – Bow River at Carseland, Open Water and Winter Peak Trigger Exceedances.

Specific conductance is an indicator of the concentration of dissolved ions (salts) in the water. When more ions are present in the water, the specific conductance is higher. When water with high specific conductance is applied to land it may negatively affect soil stability or sensitive crop species. In an aquatic environment, changes in specific conductance can eventually have a negative impact on the ability of aquatic organisms to regulate cell water (osmosis).

Statistically significant increases in the 2014/2015 open water and winter 90th percentile values (compared to the 1999-2009 historical values) were found for specific conductance at the Bow River at Carseland station.

Examination of the dataset revealed that although the 2014/15 medians are the highest observed in the dataset for this station, the maximum values observed are approximately half the 1000 µS/cm limit value. The data for specific conductance at the Carseland station has the appearance of an upward trend since 1999 in both the open water and winter periods (Figure 3).

The specific conductance values in the Bow River at Carseland appear higher than the upstream station (Cochrane) and generally lower than the downstream sites (Cluny, Ronalane). Similar values are found in the Oldman River.

This pattern suggests further data analysis is needed to determine if the trends are statistically significant and what the influence of river flow has on specific conductance values. Analysis of related parameters (chloride, nitrate, sulfate, sodium, etc.) that comprise specific conductance is also needed to understand what may be driving higher peak values in recent years.

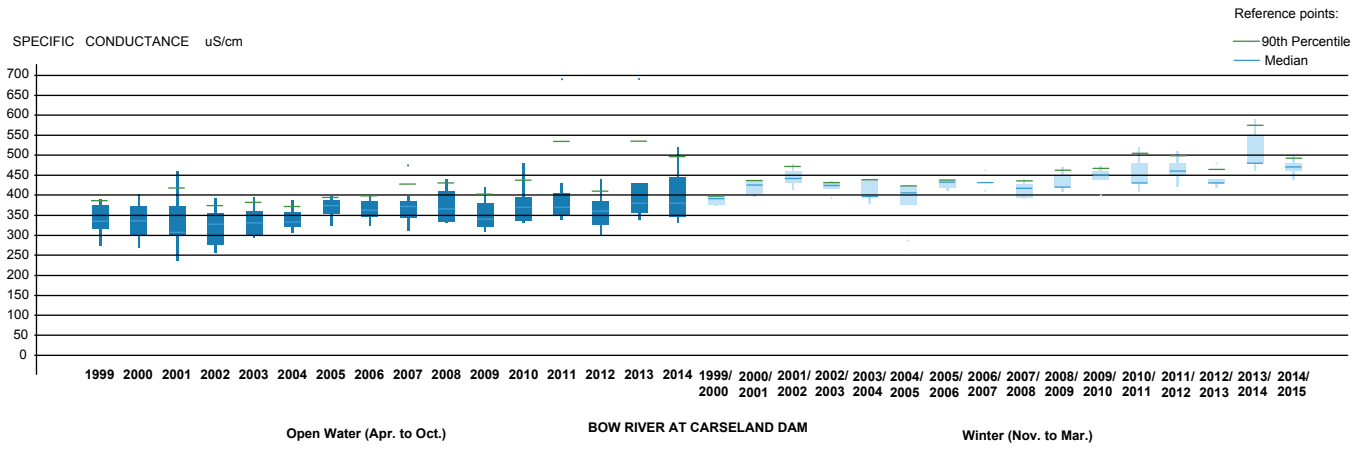


Figure 3. Box Plots of the Specific Conductance Data at the Bow River at Carseland Station During Open Water and Winter from April 1999 to March 2015.

pH – Oldman River at Brocket, Open Water and Winter Peak Trigger Exceedances.

pH is a measurement of hydrogen ions and determines whether a solution is acidic or basic. pH is measured on a logarithmic scale and is generally reported from 0 to 14 where a value of 7 is neutral, values below 7 are acidic and above 7 basic. Deviation in the pH of water outside of normal ranges (higher or lower) should be closely examined because of the affects pH changes could have on toxicity to aquatic life.

Statistically significant increases in the 2014/2015 open water and winter 90th percentile values (compared to the 1999-2009 historical values) were found for pH at the Oldman River at Brocket station.

Examination of the dataset revealed pH has a considerable amount of variability from year to year and the 2014/15 90th percentile values are not the highest detected in the dataset for this station and the maximum values observed are also not the highest (Figure 4). The maximum identified value is 8.54 in 2011 and it is below the upper pH (9.0) limit value. It is important to reiterate that pH is measured on a logarithmic scale. It is unclear whether an increasing trend is apparent in data since 1999 for both seasons.

The pH values in the Oldman River at Brocket are within the range observed at the other water quality management framework stations in the South Saskatchewan River basin.

Further data analysis is needed to determine if there is a statistically significant trend and what the influence of river flow has on pH levels. Moreover, the Brocket station is below the outlet of the Oldman Dam and further assessment will be considered regarding the dams influence on pH at Brocket.

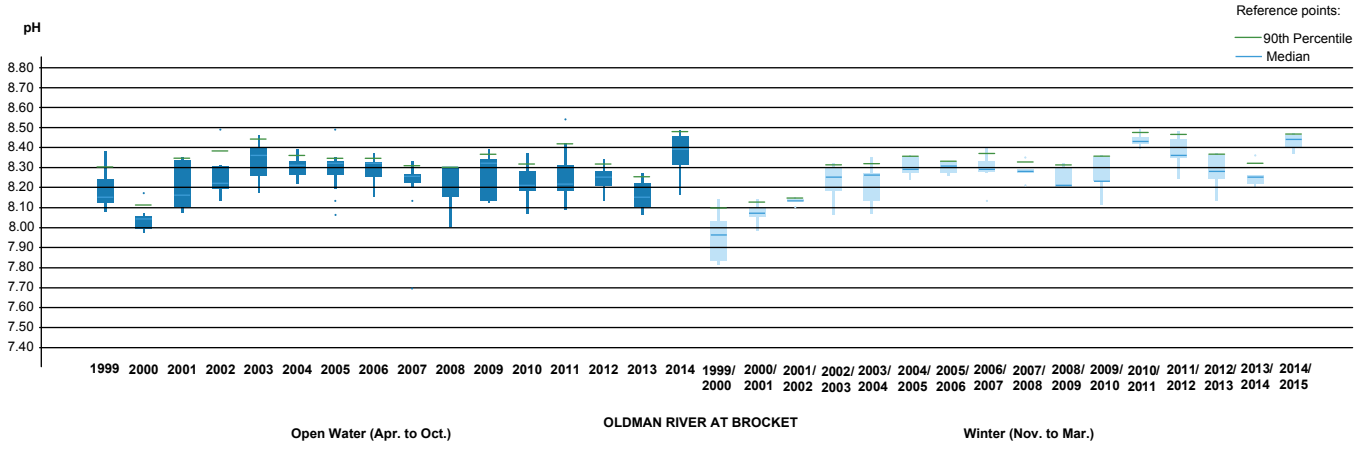


Figure 4. Box Plots of the pH Data at the Oldman River at Brocket Station During Open Water and Winter from April 1999 to March 2015 *(note: pH range is 0-14, however, for visual detail the graph scale only shows 7.4-8.8)*.

Specific Conductance – Oldman River at Hwy 36 Open Water and Winter Median Trigger Exceedances.

Statistically significant increases in the measure of central tendancy for the 2014/2015 open water and winter (compared to the 1999-2009 historical data) were found for specific conductance at the Oldman River at Hwy 36 station.

Examination of the dataset revealed that the 2014/15 medians are not the highest observed in the dataset for this station and the maximum values observed are also approximately half the 1000 µS/cm limit value (exception of 680 µS/cm in the winter of 2011/12). However, the data for specific conductance at the Hwy 36 station has the appearance of an upward trend since 1999 in both the open water and winter periods (Figure 5).

The specific conductance values in the Oldman River at Hwy 36 appear higher than the upstream stations (Brocket and Hwy 3). Similar values are found in the Bow River.

This pattern suggests further data analysis is needed to determine if the trends are statistically significant and what the influence of river flow has on specific conductance values. Analysis of related parameters (chloride, nitrate, sulfate, sodium etc.) that comprise specific conductance is also needed to understand what may be driving higher peak values in recent years.

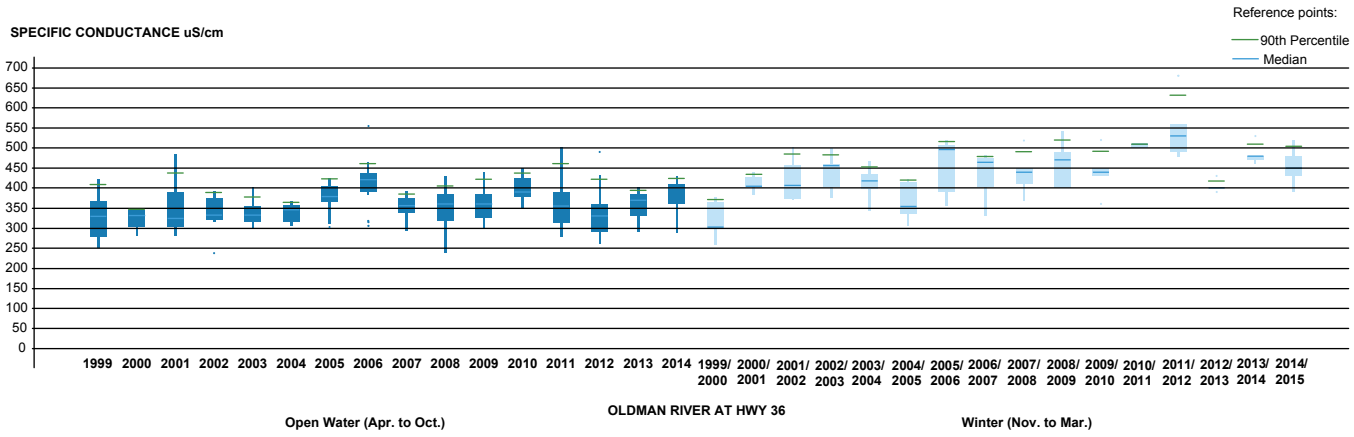


Figure 5. Box Plots of the Specific Conductance Data at the Oldman River at Hwy 36 Station During Open Water and Winter from April 1999 to March 2015.

3.0
Next Steps

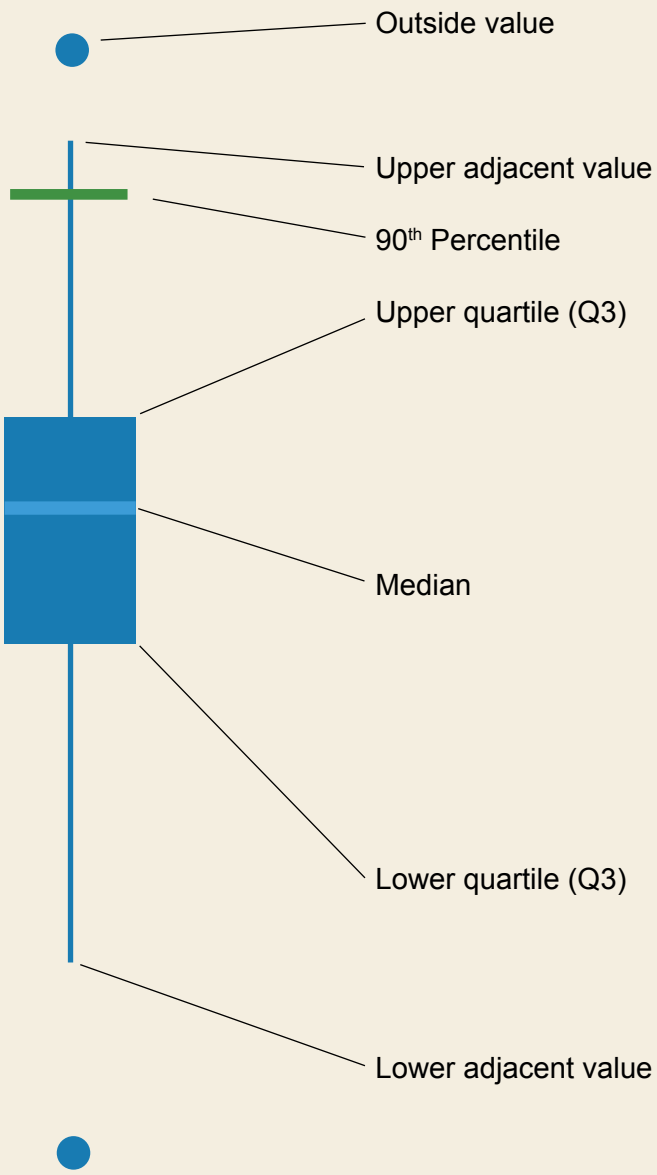
Alberta Environment and Parks will conduct the additional data analysis described to assess the influence of river flow on the indicators and their exceedances at those stations, along with completing statistical testing for trends. Additionally, trend assessments will be completed for specific conductance at the remaining 7 stations used in the Water Quality Management Framework. A closer data examination of all three parameters at all the stations will be done to ensure overarching patterns are not missed. This analysis work will complete the preliminary assessment phase and help determine whether an investigation is required and what, if any, management actions are required.

This work will be reported on in the next South Saskatchewan Region Status of Surface Water Quality Management Response report.

4.0
References

Alberta Environmental Monitoring, Evaluation and Reporting Agency (AEMERA), 2016. 2014/2015 Status of Water Quality, South Saskatchewan Region, Alberta.

5.0
Appendix


Outside value
Upper adjacent value
90th Percentile
Upper quartile (Q3)
Median
Lower quartile (Q3)
Lower adjacent value