South Saskatchewan Region

Status of Management Response for Environmental Management Frameworks, as of December 2020

Alberta

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Acknowledgments

Air Quality

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Surface Water Quality

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Executive Summary

Air Quality

This report communicates the status of the Government of Alberta's management response to exceedances of air quality triggers for the years 2015 to 2019.This fulfils commitments made to Albertans in the South Saskatchewan Region Air Quality Management Framework for Nitrogen Dioxide (NO_2), Ozone (O_3), and Fine Particulate Matter ($PM_{2.5}$). The report informs engaged stakeholders, Indigenous Peoples and those involved in the implementation of the Air Quality Management Framework and is available to the public.

Since the initial reporting period of 2014, no limits have been exceeded for air quality under the framework. This means that air quality objectives identified in the South Saskatchewan Regional Plan are being met. However, some triggers have been crossed ($PM_{2.5}$ triggered into Level 3 at two stations; ozone triggered into Level 3 at five stations). As a result, the Ministry of Environment and Parks is leading the required management response, which is focused on improving knowledge and understanding of what is contributing to the observed air quality, and proactively maintaining air quality below the limit, in alignment with the applicable management intents. This report communicates the status of the response as of December 2020, and includes an update on the management response initiated in previous years.

The following is a summary of some key findings and the management response to date:

- Investigation findings to date suggest that urban non-point source emissions have a major influence on the air quality surrounding the monitoring stations. However, further investigation into particulate matter composition and the spatial and temporal variations of pollutants are recommended to confirm this initial finding.
- Identified regional management actions range from policy or regulatory initiatives to reduce emissions, to voluntary actions and raising awareness and education surrounding air quality. The focus of the management actions includes gathering baseline information, improving scientific understanding and knowledge, learning from other jurisdictions, and identifying initiatives that are already committed to or underway that can lead to future management of air quality. Some actions apply to the province as a whole, while others will be undertaken locally.

Surface Water Quality

This report communicates the status of the Government of Alberta's management response to five water quality indicators exceeding a trigger and one water quality indicator exceeding a limit in 2019/2020. This fulfils commitments made to Albertans in the South Saskatchewan Region Surface Water Quality Management Framework: for the Mainstem Bow, Milk, Oldman and South Saskatchewan Rivers (Alberta). The report informs engaged stakeholders, Indigenous Peoples and those involved in the implementation of the framework and is available to the public.

The following is a summary of some key findings and the management response to date:

- Based on water quality monitored during 2019/2020, median triggers exceedances occurred for four indicators (chloride, specific conductance, nitrate, total dissolved solids) at two stations, and peak triggers exceedances occurred for five indicators (chloride, sulphate, specific conductance, nitrate, total dissolved solids) at five stations. Trigger exceedances occurred primarily at stations on the Bow River. A limit exceedance was detected for total dissolved solids during the winter in the Milk River at Hwy 880. There were no exceedances of guideline values for secondary indicators. Exceedances were identified in the Status of Surface Water Quality, South Saskatchewan Region, Alberta for April 2019 – March 2020 (Chung et. al, 2021).

- Ongoing investigations include the following parameters: total dissolved solids and specific conductance in the Milk River to address the winter limit exceedances at Hwy 880. This includes work to further understanding the risk current conditions pose for aquatic life and other uses and the need for management actions.

- An investigation is being initiated in the Bow River to address the total dissolved solids, specific conductance, sulphate, chloride, nitrate and total nitrogen trigger exceedances reported among the four Bow River stations since 2014.

- After preliminary assessment, the management response was closed for indicators at the following locations: total selenium (Oldman River at Hwy 36, Milk River at Hwy 880 and South Saskatchewan River Medicine Hat Hwy 1), sodium adsorption ratio (Oldman at Hwy 3), specific conductance (Oldman at Hwy 36, South Saskatchewan River Medicine Hat Hwy 1).

- Preliminary assessment is ongoing for the pH in the Oldman at Brocket (2014/2015) trigger crossing to help determine the need for investigation and management actions; and flow-adjusted trend assessments on the indicators with trigger crossings in 2018/2019 and 2019/2020.

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Part 1: Air Quality

1.0 Introduction to Air Quality

Under the *South Saskatchewan Regional Plan* (SSRP) (GoA, 2018), a management response is initiated when the Minister of Environment and Parks determines a trigger or limit as identified in the South Saskatchewan Region Air Quality Management Framework (AESRD, 2014) has been exceeded.

Alberta Environment and Parks (AEP) is the lead coordinator of the management response, and works with other government branches and regulators (e.g. Alberta Energy Regulator) and external parties, as required, to identify and implement a management response.

Presently, three substances (nitrogen dioxide, ozone, and fine particulate matter) are reported annually under the South Saskatchewan Region Air Quality Management Framework (AESRD, 2014) using data collected at monitoring stations in Airdrie, Calgary, Lethbridge, and Medicine Hat, as shown in Figure 1.

Alignment with Canadian Ambient Air Quality Standards (CAAQS)

Through the Canadian Council of Ministers of the Environment (CCME), Alberta agreed to implement a national Air Quality Management System (AQMS), which included reporting annually on NO_2, SO_2, O_3, and $PM_{2.5}$ against the Canadian Ambient Air Quality Standards (CAAQS) in the Alberta Air Zone Report.

The intent is to update the South Saskatchewan Region Air Quality Management Framework to align with the CAAQS indicators and thresholds.

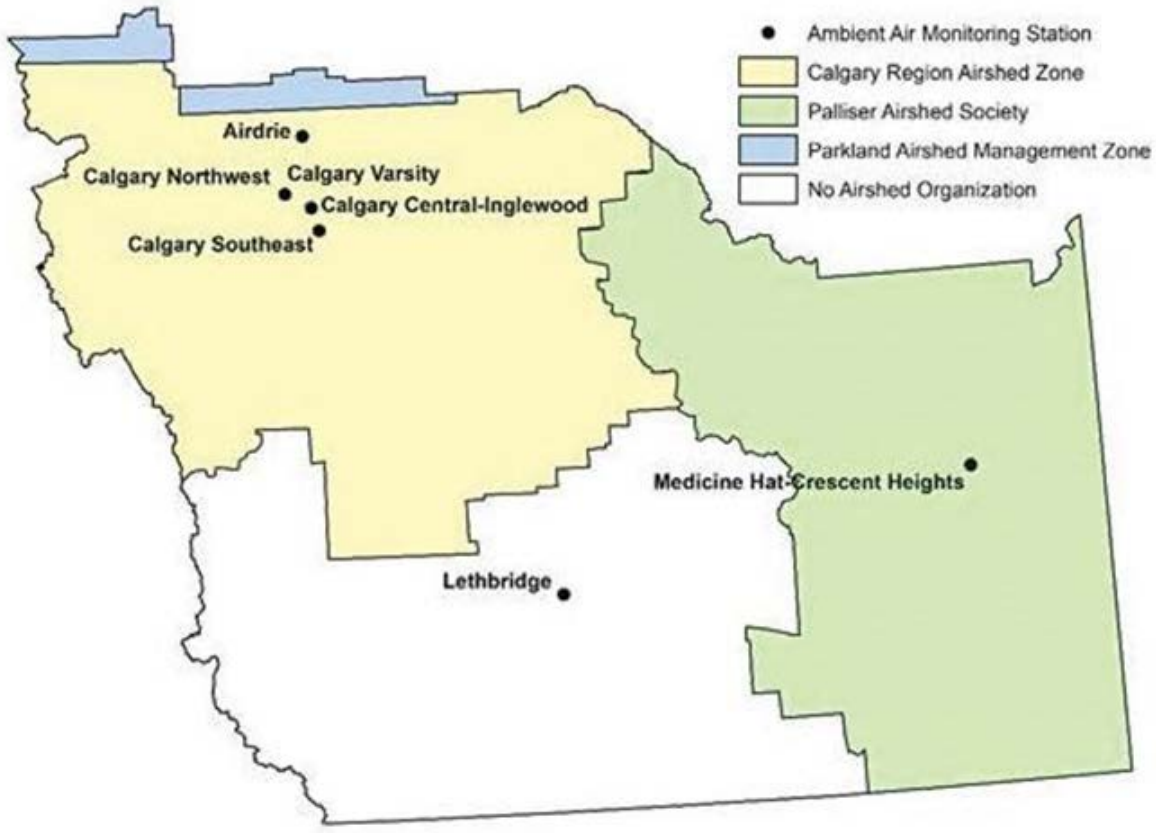

Figure 1: Map of the continuous monitoring stations in the South Saskatchewan Region used in the current assessment and reporting.

A management response was initiated for the South Saskatchewan Region after triggers were crossed for NO_2, O_3 and $PM_{2.5}$ during the first reporting cycle. As each annual report on conditions becomes available, the management response is re-evaluated and updated based on new information.

This report provides an update on the management response since the last status report in October 2019. This is the fifth status report produced since the South Saskatchewan Regional Plan came into effect in September 2014.

A full description of the management system can be found in the South Saskatchewan Region Air Quality Management Framework (AESRD, 2014). Initial steps include verification, preliminary assessment, and an investigation to determine the need for management actions. These steps are taken, in full or in part, when an ambient air quality trigger is crossed or limit is exceeded.

The management response for air quality 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.

The framework, as well as all condition and management response reports are on the Open Government portal as well as AEP website: https://www.alberta.ca/south-saskatchewan-regional-planning.aspx.

1.1 Understanding the Nature of Air Quality Pollutants

In order to effectively develop a management response, it is important to first understand the nature of the pollutant(s) of concern and the potential cause(s).

Nitrogen dioxide (NO_2) is a reddish-orange-brown gas with an irritating, harsh, pungent odour. NO_2 occurs both naturally in the environment, (e.g. as a result of forest fires or atmospheric lightning), or can be human-caused, mainly the result of combustion processes, (e.g. combustion of fuel for vehicles or combustion of coal, oil, and natural gas for heating or industrial processes). NO_2 can be directly released into the air, but is more often produced by the conversion of nitric oxide (NO_x), which is released from combustion processes. In sunlight, NO_2 can lead to the formation of ozone, nitric acid, and nitrate-containing particles ([AEP, 2011).

Ground-level ozone is a colourless gas, which can come from natural causes, such as vegetative processes, or from human-caused emissions. Ozone is not directly emitted into the atmosphere; it is formed through complex chemical reactions between emissions of nitrogen oxides (NO_x) and volatile organic compounds (VOCs) in the presence of heat and sunlight.

Particulate matter refers to solid or liquid particles suspended in the atmosphere. The size distribution and composition of particulate matter is a significant factor in determining risks posed to human health. Fine particulate matter ($PM_{2.5}$) has a diameter less than 2.5 µm. These smaller particles can penetrate deeper into the lungs, irritating the respiratory system and reducing the effective surface area for oxygen exchange. These particles can also transfer toxic compounds into the bloodstream (AEP, 2013).

$PM_{2.5}$ comes from both natural and human-caused sources. Natural sources of $PM_{2.5}$ include wind-blown dust and forest or grass fires. Examples of human-caused sources include transportation, industrial processes, home heating, and burning of vegetation for land clearing (AEP, 2013). $PM_{2.5}$ can be emitted directly into the atmosphere (known as primary $PM_{2.5}$) or derived as secondary $PM_{2.5}$ which is formed in the atmosphere from chemical reactions involving other gases under specific meteorological conditions (e.g. sulphur dioxide [SO_2], nitrous oxides [NO_x], and volatile organic compounds [VOCs]). Management actions for $PM_{2.5}$ need to consider primary emissions of $PM_{2.5}$ as well as the gases that contribute to the formation of secondary $PM_{2.5}$.

Air pollution from nitrogen dioxide, ozone, and fine particulate matter can have serious impacts on human and environmental health. Health impacts linked to these pollutants include chronic bronchitis, asthma, and premature death (Canadian Council of the Ministers of the Environment [CCME], 2017). Air pollution also results in increased costs and pressure on the health care system. Environmental effects of the framework indicators include reduced visibility, crop damage, and greater vulnerability to disease in some tree species (CCME, 2017).

Steps of the management response

2.0 Summary of Ambient Levels Assigned for Air Quality

2.1 Verification and Preliminary Assessment

AEP conducts the annual assessment of ambient air quality data gathered from continuous ambient air monitoring stations in the South Saskatchewan Region. Data is downloaded from Alberta's air data warehouse and checked for accuracy and completeness. Once the data have been verified, the air quality metrics are used to assess ambient conditions relative to the triggers and limits in the South Saskatchewan Region Air Quality Management Framework.

Verification and preliminary assessment are reported in the 2019 Status of Air Quality, South Saskatchewan Region, Alberta (Thi, 2021).

The methodology and procedures set out in the Guidance Document on Achievement Determination Canadian Ambient Air Quality Standards (CAAQS) for Fine Particulate Matter and Ozone (CCME, 2012) were followed to determine the CAAQS achievement status. This includes examination of data for transboundary flows and exceptional events (e.g. forest or grass fires).

More information on the methodology, procedures, and preliminary assessments are reported in the 2019 Status of Air Quality, South Saskatchewan Region, Alberta (Thi, 2021).

The Airdrie monitoring station began operations in April of 2017. The station meets the NO_2 data completeness criteria for the current reporting period (2019) but has not collected enough data to meet the $PM_{2.5}$ and O_3 data completeness criteria for the 2016-2018 reporting period. In Calgary, the Northwest Station was required to relocate, due to land redevelopment, and was subsequently decommissioned. The new location, approximately 100 metres away, is named Calgary Varsity and started operation in June of 2018.The station only reported for NO_2 this assessment period (2019) as it too did not meet data completeness for $PM_{2.5}$ and O_3 for the 2016-2018 reporting period.

2.2. Minister's Determination

The Minister's Determination for 2019 confirmed that no air quality limits were exceeded in the South Saskatchewan Region. However, air quality triggers were crossed at several of the monitoring stations in 2019, resulting in assigning ambient air quality levels described in the 2019 Status of Air Quality South Saskatchewan Region Report (Thi, 2021) and below (Table 1).

2.2.1 Nitrogen Dioxide

Based on the 2019 Status of Air Quality South Saskatchewan Region Report, Level 2 is assigned at Calgary Central-Inglewood, Calgary Southeast and Calgary Varsity stations, for the annual average of the hourly data for nitrogen dioxide (NO_2). Level 1 for the annual average of the hourly data is assigned in Airdrie, Medicine Hat and Lethbridge.

Four monitoring stations (Airdrie, Calgary Central-Inglewood, Calgary Southeast and Calgary Varsity) measured ambient concentrations of NO_2 above the upper range trigger for Level 2. Two stations (Lethbridge and Medicine Hat) had ambient air quality concentrations below the trigger for Level 2.

2.2.2 Ozone and Fine Particulate Matter

To maintain consistency with reporting on achievement of the Canadian Ambient Air Quality Standards (CAAQS) under the national Air Quality Management System (AQMS), O_3 and $PM_{2.5}$ are reported for three-year periods. The 2018 (2016-2018 reporting period) CAAQS assessment results are presented below. Management levels have not yet been assigned for $PM_{2.5}$ and O_3 for the 2017-2019 reporting period because analysis is still underway.

For the 2016-2018 reporting years, $PM_{2.5}$ levels at the Calgary Central–Inglewood and Calgary Southeast stations have triggered into a Level 3. Levels for $PM_{2.5}$ at Calgary Northwest, Lethbridge and Medicine Hat have remained at Level 2 or lower, consistent with the previous three reporting years. As mentioned previously, Airdrie and Calgary Varsity did not meet data completeness requirements for the 2016-2018 reporting period.

For O_3, the Airdrie, Calgary Central-Inglewood, Lethbridge and Medicine Hat stations triggered into a Level 3 for the most recent reporting period (although for Airdrie one of the three years of the assessment period did not meet completeness criteria thus it is not considered for the region's metric.). Levels at the Calgary Northwest and Calgary Southeast stations reported at a Level 2 for O_3, respectively.

TABLE 1: AMBIENT LEVELS ASSIGNED TO AIR QUALITY MONITORING STATIONS IN THE SOUTH SASKATCHEWAN REGION FOR 2015-2019 BASED ON TRIGGERS ANDS LIMITS ESTABLISHED IN THE FRAMEWORK

Station	NO_2 Levels*									
	Annual Average					Upper Range				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
Airdrie				1	1				2	2
Calgary Central - Inglewood		2	2	3	2		2	2	2	2
Calgary Northwest	2	2	2	n/a[a]		2	2	2	n/a[a]	
Calgary Southeast	2	2	2	2	2	2	2	2	2	2
Calgary Varsity				n/a[a]	2				n/a[a]	2
Medicine Hat	1	1	1	1	1	1	1	1		1
Lethbridge	1	1	1	1	1	1	1	1	1	1

Station	CAAQS Management Levels**														
	Ozone					$PM_{2.5}$ 24-hour					$PM_{2.5}$ Annual				
	2012 - 14	2013 - 15	2014 - 16	2015 - 17	2016 - 18	2012 - 14	2013 - 15	2014 - 16	2015 - 17	2016 - 18	2012 - 14	2013 - 15	2014 - 16	2015 - 17	2016 - 18
Airdrie				n/a[a]	3[b]				n/a[a]	n/a[a]				n/a[a]	n/a[a]
Calgary Central – Inglewood			3[b]	2	3			n/a[a]	2	3			n/a[a]	2	3
Calgary Northwest	2	2	2	2	2[b]	3	3	2	2	2[b]	3	3	2	2	2[b]
Calgary Southeast	n/a[a]	2	2	2	2	n/a[a]	n/a[a]	2	2	3	n/a[a]	n/a[a]	2	2	3
Calgary Varsity				n/a[a]	n/a[a]				n/a[a]	n/a[a]				n/a[a]	n/a[a]
Medicine Hat	2	2	2	3	3	2	2	2	2	2	2	2	2 or lwr[c]	2 or lwr[c]	2 or lwr[c]
Lethbridge	2	2	2	2	3	2	3	2	2	2	2	3	2	2	2 or lwr[c]

* NO_2 trigger levels 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 O_3 and $PM_{2.5}$ trigger levels in the table were assigned based on the annual CAAQS assessments as outlined in the SSRP Air Quality Management Framework.
Management Level 4: CAAQS refers to these as Actions for Achieving Air Zone CAAQS, or Red Management Level
Management Level 3; CAAQS refers to these as Actions for Preventing CAAQS Exceedance, or Orange Management Level
Management Level 2: CAAQS refers to these as Actions for Preventing Air Quality Deterioration, or Yellow Management Level
Management Level 1: CAAQS refers to these as Actions for Keeping clean Areas Clean, or Green Management Level

a Data completeness criteria were not met for the reporting period.
b One of the three years of the assessment period did not meet completeness criteria. The 3-year average is based on two years and is not considered for the region's metric.
c Transboundary flows and exceptional events (TF/EE) analysis is completed for all stations in level 3 or 4 management levels. The 2014-2016, 2015-2017 and 2016-2018 assessments identifies stations in level 2 management level as level "2 or lower" if TF/EE analysis may have brought the station to a level 1 management level.

STATION WAS NOT IN OPERATION

3.0 Status of Management Response for Air Quality

The management response is a set of steps taken, in full or in part, when an ambient trigger or limit is exceeded. The management response supports the management intent associated with each trigger or limit exceeded (Table 2 and Table 3). A full description of the management system is found in the South Saskatchewan Air Quality Management Framework (AESRD, 2014). The status of management response is reported on a regular basis and may be supported by supplemental technical reports.

TABLE 2: DESCRIPTION AND MANAGEMENT INTENT FOR AVERAGE OF ANNUAL DATA FOR NO_2, $PM_{2.5}$ AND O_3 AMBIENT AIR QUALITY

Level	Description	Management Intent
4	Ambient air quality exceeding the air quality limit	Improve ambient air quality to below the limit
	Limit	
3	Ambient air quality below but approaching the air quality limits	Proactively maintain air quality below the limit
	Trigger into Level 3	
2	Ambient air quality below air quality limits	Improve knowledge and understanding, and plan
	Trigger into Level 2	
1	Ambient air quality well below air quality limits	Maintain air quality through standard regulatory and non-regulatory approaches

TABLE 3: DESCRIPTION AND MANAGEMENT INTENT FOR UPPER RANGE OF THE HOURLY DATA AMBIENT AIR QUALITY LEVELS FOR NO_2

Level	Description	Management Intent
4	Peak ambient air quality concentrations are likely exceeding the hourly objective	Reduce probability that hourly objectives are exceeded during peak events
	Trigger into Level 4	
3	Peak ambient air quality concentrations may be approaching or exceeding the hourly objective	Maintain air quality to reduce probability that objectives are exceeded during peak events
	Trigger into Level 3	
2	Peak ambient air quality concentrations below hourly objective	Improve knowledge and understanding, and plan
	Trigger into Level 2	
1	Peak ambient air quality concentrations are well below hourly objective	Maintain air quality through standard regulatory and non-regulatory approaches

3.1 Investigation

The purpose of investigation is to determine the likely factors influencing the performance of an indicator and inform decisions about management actions. The scale of the investigation depends on the management level as well as the complexity of the issue identified. Support from the public, industry, non-governmental groups, government at multiple levels, and regulatory agencies may all be important for understanding regional issues and exploring options to address the ambient air quality issues. Analysis of ambient concentrations and trends, and the identification of potential emission sources leading to elevated ambient concentration are ongoing. A summary of the work completed is described below.

3.1.1 Nitrogen Dioxide (NO_2)

For the current assessment period, analysis of the NO_2 data was not conducted as the levels were below the trigger into Level 3 at all reporting stations in Calgary, Lethbridge and Medicine Hat. Detailed data analysis was undertaken for preceding reporting periods as detailed in previous management response reports.

In general, past evaluations indicated that the seasonal variation was similar between the NO_2 data measured at all the air monitoring stations in the South Saskatchewan Region. While elevated concentrations may be observed throughout the year, they were more likely measured in the winter months and during lower wind speed conditions. Lower wind speeds inhibit dispersion of NO_2 and other pollutants. This was consistent for Airdrie, Calgary, Lethbridge, and Medicine Hat. Overall, the land use around stations and the time of day when elevated concentrations are occurring implies that traffic emissions could be a notable contributor to elevated NO_2 concentrations.

3.1.2 Fine Particulate Matter ($PM_{2.5}$)

The 2016-2018 data were analyzed from the Calgary Central-Inglewood and the Calgary Southeast air monitoring stations as these stations triggered into a Level 3 during the current reporting period. The data analysis explored temporal variations of $PM_{2.5}$ events and associated meteorological conditions. Elevated concentrations or 'events' were defined as 1-hour averaged $PM_{2.5}$ concentrations greater than 19 $\mu g/m^3$ (the trigger into Level 3).

As part of the CAAQS assessment, the sample days with identified transboundary and exceptional events (which includes days identified as impacted by forest or grass fires) were removed from the data in order to isolate the contribution from human-caused concentrations.

The seasonal $PM_{2.5}$ variation was similar for 2016-2018 between the Calgary Central-Inglewood and the Calgary Southeast monitoring stations. Although elevated concentrations may be observed throughout the year, such concentrations were more likely

in the colder winter months (November through March) and least likely to be observed in the summer. Although high and low concentrations were observed to occur for a number of wind speeds, high concentrations were more likely to be observed during lower wind speed conditions. Boundary layer effects, detailed in previous management response reports, influence $PM_{2.5}$ concentrations and the land use and time of day when elevated concentrations are occurring implies that motor vehicle traffic emissions could be a notable contributor to measured elevated concentrations. These findings are similar to those reported in the previous management response reports.

3.1.3 Ozone (O_3)

The 2016-2018 data were analyzed from the Airdrie, Calgary Central-Inglewood, Calgary Southeast, Lethbridge, and Medicine Hat air monitoring stations. Since the Airdrie and Calgary Varsity stations are new monitoring locations, Airdrie data availability was limited to two years and Calgary Varsity was not included in the analysis, as data did not meet data completeness criteria for the entire reporting period. The data analysis explored temporal variations of O_3 events and associated meteorological conditions.

Elevated concentrations or 'events' were defined as 1-hour averaged O_3 concentrations greater than 56 ppb (the trigger into Level 3).

As part of the CAAQS assessment, the sample days with identified transboundary and exceptional events (which includes days identified as impacted by forest or grass fires) were removed from the data in order to isolate the contribution from human-caused concentrations.

Since O_3 is a photochemical produced pollutant (produced in the presence of heat and sunlight as described in Section 1.1), it is expected that elevated concentrations are most often observed during the warmest part of the day, midafternoon. The analysis conducted confirms this pattern, as shown in Figure 2.

Similarly, elevated O_3 concentrations occur most often during the warmer months of the year March through September, with a large proportion occurring in April through August (Figure 3). A peak of elevated concentrations occurred in July for the Medicine Hat station, which could be due to residual forest fire effects, which were not identified for exclusion by the transboundary and exceptional events identification criteria, as part of the CAAQS data processing, although they are adjacent to days that were experiencing forest fire smoke events and excluded.

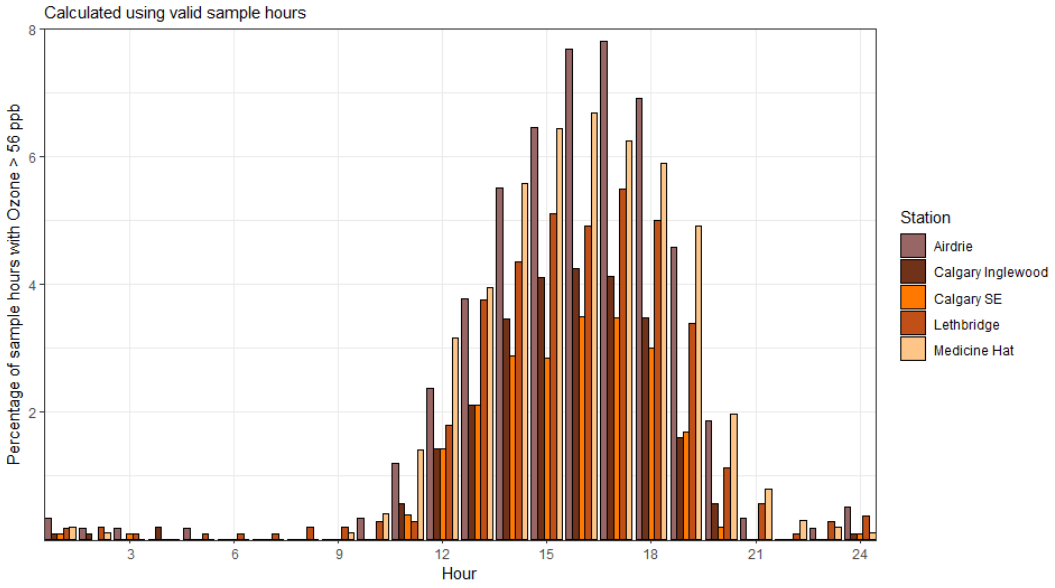

Figure 2: Percentage of one hour O_3 samples with concentrations greater than 56 ppb for each hour of the day at the Airdrie, Calgary Central-Inglewood, Calgary Southeast, Lethbridge, and Medicine Hat monitoring stations for the years 2016-2018.

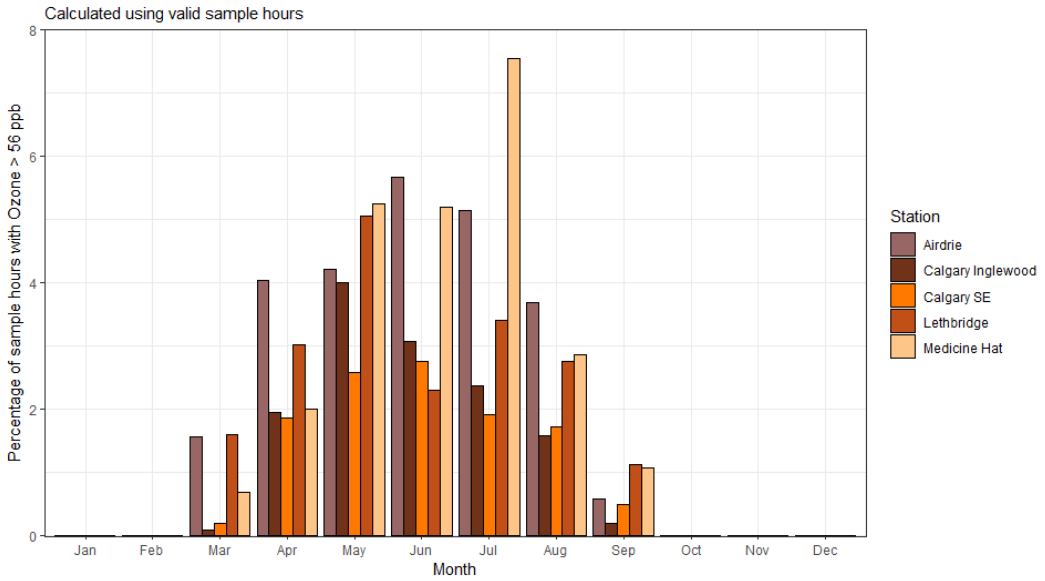

Figure 3: Percentage of one hour O_3 samples with concentrations greater than 56 ppb for each month of the year at the Airdrie, Calgary Central-Inglewood, Calgary Southeast, Lethbridge, and Medicine Hat monitoring stations for the years 2016-2018.

Elevated ozone concentrations occurred in all years of the time period studied, with 2018 having a higher occurrence of elevated concentrations and 2016 having the least amount of elevated concentration occurrence of the study period (Figure 4). Overall, the elevated O_3 concentrations occur in the daily and seasonal warm periods as expected due to the nature of the formation of the substance.

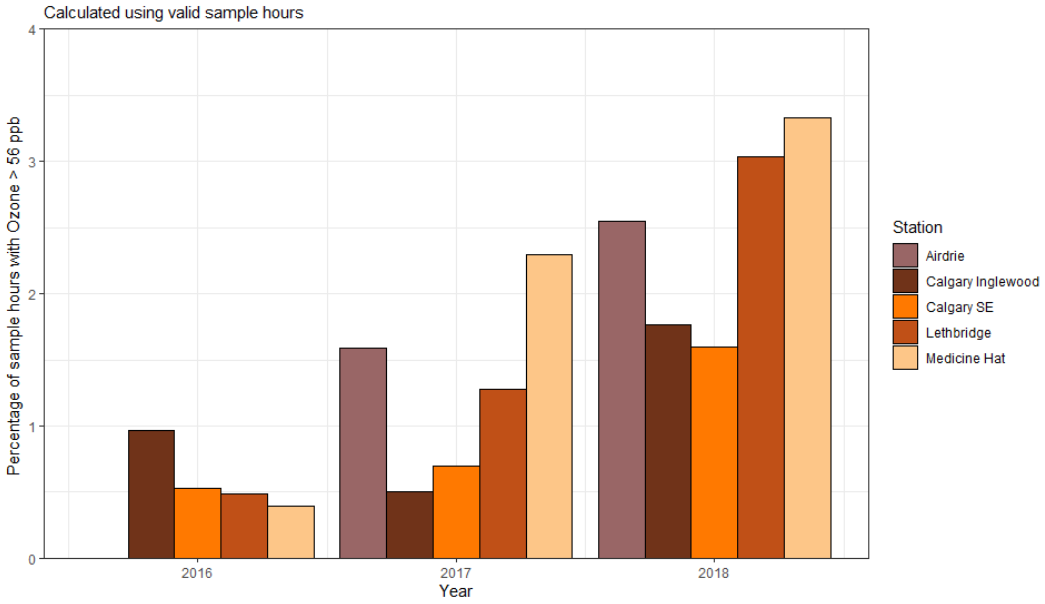

Figure 4: Percentage of one hour O_3 samples with concentrations greater than 56 ppb by year at the Airdrie, Calgary Central-Inglewood, Calgary Southeast, Lethbridge, and Medicine Hat monitoring stations for the years 2016-2018.

It is difficult to assess O_3 trends because measured concentrations not only depend on available precursors during the short warmer period but also on conducive meteorological conditions. Due to its nature as a secondary pollutant (not directly emitted), pollutant transport into the region often has a role in O_3 concentrations, be it the precursors that lead to O_3 formation or O_3 itself.

This further complicates understanding of potential elevated O_3 concentrations. A focus study investigating O_3 characterization and potential drivers across the South Saskatchewan Region has been initiated.

3.1.4 Investigation Summary

The investigation completed to date provides valuable information to better understand the factors contributing to elevated NO_2, $PM_{2.5}$ and O_3 concentrations in the region. Similar boundary layer effects are impacting $PM_{2.5}$ concentrations at the Calgary Central-Inglewood and Calgary Southeast monitoring stations. Traffic emissions could be a driver for elevated concentrations of $PM_{2.5}$ given the time of day they occur and the land uses around the stations. The seasonal variation was similar between the two Calgary monitoring stations, while elevated concentrations of $PM_{2.5}$ may be observed throughout the year; such concentrations were more likely in the winter months during calm wind conditions. The seasonal variation of event days and the association of event days with lower wind speeds suggest that dispersion limiting mechanisms are likely driving $PM_{2.5}$ events.

For the Airdrie, Calgary Central-Inglewood, Calgary Southeast, Lethbridge, and Medicine Hat stations, elevated O_3 concentrations occur most frequently during the warmest, sunniest part of the day as well as the warmer months of the year. This is expected because of the formation of O_3 from the interaction of NO_x and VOCs with sunlight. A more detailed investigation into the possible drivers for O_3 in the South Saskatchewan Region has been initiated and will be reported on in the next status of the management response report.

Overall, the investigation findings to date suggest that effective management around South Saskatchewan Region reporting monitoring stations should focus on urban non-point source (e.g. transportation) emissions, however further investigation into particulate matter composition and the spatial and temporal variations of pollutants are recommended to confirm this finding.

3.2 Identification of Management Actions

Achieving the goal of the management actions within the South Saskatchewan Region requires a proactive and future focused approach. Management actions support, rather than replace existing policies and regulations.

Management actions may range from policy or regulatory initiatives to reduce emissions, to voluntary actions, and raising awareness and understanding surrounding air quality. Knowledge improvement actions include gathering baseline information, improving scientific understanding and knowledge and learning from other jurisdictions.

When identifying possible management actions, consideration needs to be given to the management intent associated with each trigger or limit exceeded. The South Saskatchewan Region has frequently triggered into a Level 2, with occasional excursions into Level 3, thus management actions currently focus on improving our knowledge and assessing and planning potential management actions while taking opportunities to reduce emissions when available.

A list of the management actions identified in this and previous years and the progress to date under each action is provided in the following section. It is important to recognize that some management actions can take a number of years to initiate and the impact of implementing certain actions may take several additional years to be realized. For example, management of non-point source emitters is inherently complex; it is an inter-governmental and cross-jurisdictional issue. Collaboration of all stakeholders is key to the success of the proactive management actions.

Ongoing investigation and studies will continue to inform and establish necessary and appropriate mitigative actions are required.

3.3 Oversight and Delivery of Management Actions

Management actions are categorized into Knowledge Improvement Actions, Policy Actions, Regulatory Process Actions, and Engagement Actions. Several of the policies and management actions listed can also apply provincially to improve protection of air quality.

Knowledge Improvement Actions

Alberta Environment and Parks will work with local airshed organizations and other partners to advance knowledge in priority areas and use collected information to determine management approaches.

Action	Description	Status	Progress Update
Ambient data analysis	Environment and Parks will conduct analysis of ambient data as required to inform the investigation including: -Analyze available monitoring data to investigate possible causes or influences on elevated concentrations, look at links to meteorology (wind/wind direction) and covariance between pollutants, identify any long term trends etc. -Review available information (NAPS data collected at Calgary Central-Inglewood, existing studies in similar urban centres) on particulate matter composition to identify possible emission sources.	Ongoing	-During previous Status of the Management Response for Environmental Management Frameworks reports, analysis of ambient NO_2 and $PM_{2.5}$ data was presented and analysis of ambient O_3 data was limited to Medicine Hat as Medicine Hat was the only station that had reached a Level 3 for O_3 at the time. For the 2016-2018 reporting period, O_3 reached a Level 3 at the Calgary, Lethbridge and Medicine Hat monitoring stations, so ambient data analysis for O_3 was conducted for Calgary, Lethbridge and Medicine Hat stations and is included in Section 3.1.3 of this Status of the Management Response Report. Further investigation to characterize ozone concentrations throughout the year across the South Saskatchewan Region has been initiated. -Work planning and scheduling has been initiated for analysis of existing PM composition data collected in Calgary and prioritization of potential future PM composition data collection locations.
Additional ambient air monitoring	Environment and Parks and partners will conduct additional ambient air quality monitoring as required to inform the investigation including, for example, the following: -Palliser Airshed Society (PAS) mobile Airpointer ambient monitor sited temporarily at the Medicine Hat Trap Club to assess air quality northeast of Medicine Hat.	Ongoing	-The Palliser Airshed Society (PAS) mobile Airpointer ambient monitor was sited temporarily at the Medicine Hat Trap Club to assess air quality northeast of Medicine Hat. The airpointer is scheduled to relocate in fall of 2020 to an alternate location in the Palliser Airshed to further augment the existing spatial understanding of air quality.

Action	Description	Status	Progress Update
	-Calgary Region Airshed Zone (CRAZ) deployment of portable air monitoring laboratory (PAML) to address monitoring gaps and provide the Air Quality Health Index (AQHI) in previously unmonitored areas.		-The CRAZ PAML was deployed for four month rotations starting in Cochrane in November of 2018, Foothills County in spring 2019 and Canmore in fall of 2019. In spring of 2020 the PAML was re-deployed to Cochrane for a survey in an alternate season The PAML is scheduled to relocate to the Chestermere/Strathmore corridor in fall of 2020.
Alberta Air Quality Management Action Toolbox	Environment and Parks, in collaboration with partners, is working on the development of an inventory of possible management actions for addressing air quality. This inventory is filterable by the source sectors and the criteria air contaminants addressed by each management action. Inclusion of information on whether the action is already being implemented in Alberta and various selection criteria (including cost-effectiveness and public support) is also planned. When complete, the intent of the tool will be to support the informed selection of various management actions for inclusion in the management response.	In-Progress	The development of the toolbox was initiated in July 2019 as a collaboration across multiple AEP Divisions. Phase I of the project was to compile available information from jurisdictional reviews that have been contracted by Environment and Parks in the past to develop an initial draft inventory of possible actions. Phase I was completed in November 2019. The planned next steps are to further refine the information already contained in the draft Toolbox, add additional information on management actions that are already underway in the region, and include information on cost effectiveness. The possibility of developing a user interface for the tool is also being considered.

Policy Actions

Alberta is assessing policies that can be applied in air zones that have triggered the need for management. While some of these actions may not be directly applicable to the South Saskatchewan air zone, pollution can be transported long distances, so actions taken in one air zone may lead to air quality improvements in others as well. Technology and equipment standards and policy for point sources, such as large industry, and non-point sources, such as transportation, will be assessed.

Action	Description	Status	Progress Update
Action on non-point air emission sources such as transportation.	The Government of Alberta continues to undertake initiatives to address non-point source air emissions. Some examples include:	Ongoing	

Action	Description	Status	Progress Update
	-The Government collaborated with industry, non-government organizations, and airsheds cross-provincially through the Clean Air Strategic Alliance (CASA) to develop consensus-based recommendations for management actions on non-point sources such as transportation and wood burning		-The CASA report, Recommendations to Reduce Non-Point Source Air Emissions in Alberta (available at https://www.casahome.org/past-projects/non-point-source-project-team-37/), is helping to inform action on non-point sources. -A CASA ROVER III Project, recommended by the CASA Non-Point Source Report, commenced in May 2018 with roadside vehicle emissions testing planned to occur in Spring 2020. However, the COVID-19 pandemic disrupted timelines as testing personnel and equipment are from the United States. The field work is intended to proceed when possible.
	-The Government has been taking steps to manage non-point source emissions such as through funding to help reduce transportation emissions. -The Government has been collaborating with federal/provincial/territorial jurisdictions on actions to help reduce transportation emissions.		-The Government of Alberta is considering additional non-point source work through CASA. Funding examples have included $1.2 million for the Peaks to Prairies Southern Electric Charging Network and $1.53 billion for the Calgary Green Line LRT. -Alberta is working with other jurisdictions on the Canadian Council of Ministers of the Environment (CCME) Mobile Sources Working group to inform transportation emissions management actions in Alberta.
Establish provincial air emission policy, including defining standards / tools to apply to reduce emissions in air zones that require management based on environmental framework trigger exceedances.	Environment and Parks has contracted a jurisdictional review of regulatory strategies, tools and practices used to manage and improve air quality in “non-attainment” areas.	Ongoing	The International Review of Non-Attainment Area Air Quality Management Tools and Techniques Report is available at: https://open.alberta.ca/publications/9781460130148. The information contained in the report was used in the development of the Air Quality Management Toolbox (see above).
Establish and update source standards for both industrial sectors and equipment to reduce emissions.	Environment and Parks is working on the development of more stringent equipment standards for new boilers and heaters.	Ongoing	These standards are undergoing internal review.

Action	Description	Status	Progress Update
Update Alberta Ambient Air Quality Objectives	Alberta's Ambient Air Quality Objectives (AAAQOs) are intended to provide protection of the environment and human health to an extent technically and economically feasible, as well as socially and politically acceptable. The department has been reviewing these objectives through multi-stakeholder consultation since 2000. Alberta now has air quality objectives for more than 30 substances that could be released to the atmosphere.	Ongoing	Work is continuing on review of objectives for, nitrogen dioxide, sulphur dioxide and development of a guideline for total reduced sulphur compounds through government collaboration in the Clean Air Strategic Alliance. More information is available at https://www.casahome.org/current-initiatives/aaqo-52/.
Update approaches to management of emissions from electricity generation	Originally developed in 2002, the third five-year review of the CASA Emissions Management Framework for the Alberta Electricity Sector was initiated in 2018.	In-Progress	The project team will reconvene the ongoing third five-year review in Fall 2020. Once the review is complete, the project team will provide a final report to the Government of Alberta, and recommendations for tasks to be covered in the next five-year review.
Review EPEA codes of practice for needed updates	For less complex industrial operations, registrations under codes of practice are used as a regulatory tool in place of site-specific approvals and do not expire. Codes of practice for designated activities provide province-wide environmental requirements for consistency across a sector.	In-Progress	A review and update of the Code of Practice for Asphalt Paving Plants has been initiated to modernize requirements to achieve environmental outcomes, and reduce red tape where possible.

Regulatory Process Actions

Industrial facilities in Alberta regulated by the *Environmental Protection and Enhancement Act* operate under the terms and conditions stipulated in their respective approval documents, which include emission control standards. These standards are typically updated when the facility approval is renewed on a 10-year cycle. Efforts are ongoing to ensure principles of continuous improvement are incorporated into the approval process to support environmental outcomes. The Government of Alberta is committed to taking actions to reduce emissions from existing sources and requires control technologies on par with leading jurisdictions for major new sources.

Action	Description	Status	Progress Update
Action on industrial emissions	The Alberta Energy Regulator and Environment and Parks are requesting more stringent emissions standards be applied to all industrial sources in industrial approval applications that are in air zones which require management based on Environmental Management Frameworks or the CCME Air Quality Management System.	Ongoing	More stringent emission standards are being applied to industrial sources on an ongoing basis through continuous improvement in the approvals process.

Update Alberta Air Quality Model Guideline (AQMG)	Results from air dispersion modelling are used to predict if an air pollutant source is in compliance with ambient air quality objectives. Alberta Environment and Parks is proposing to update the current 2013 AQMG.	In-Progress	A draft proposal of an update to the AQMG was posted to the department website in June 2020 at https://www.alberta.ca/air-quality-modelling-overview.aspx for public comment.

Engagement Actions

Air quality management is multi-faceted, requiring the participation of numerous affected people, industries, and agencies. Engagement Actions involve working with stakeholders in the region to clearly define air quality challenges and identify management opportunities and educating the public on the state of air quality, how it impacts them, and what they can do to help.

Action	Description	Status	Progress Update
Develop a provincial air literacy program.	Alberta Environment and Parks will update and develop, as required, suitable air quality literature for the public (i.e. social media campaigns to encourage being idle free, alternative transportation modes, fuel efficiency, vehicle maintenance etc.). As a part of this work, Environment and Parks will undertake the development of an Air Literacy Strategy. The Air Literacy Strategy will reflect input from internal staff and partners to ensure strategic alignment and pragmatic implementation.	In-Progress	Environment and Parks' Engagement and Education Branch recently developed an Air Literacy Strategy for the province. The air literacy strategy strives for the following goals: • Ultimate or long term goal: 5+ years: Albertans have awareness, understanding, ability, and motivation to take action themselves and to support action by others to improve air quality where they live, work and play. • Medium-term goal: 2-5 years: AEP works with partners and GoA to influence attitudes and develop skills needed for target audiences to take action to mitigate the human impacts on air quality. • Short-term goal: 1-2 years: AEP works with partners and GoA to develop tools that increases the knowledge of target audiences on air, the air management system, and the effect of human activities on air quality.
Collaborate with existing stakeholder connections and support management actions underway.	Environment and Parks collaborates with stakeholders through the Calgary Region Airshed Zone (CRAZ), Palliser Airshed Society (PAS) and directly with stakeholders not currently involved in these organizations. This includes:	Ongoing	

Action	Description	Status	Progress Update
	-Reaching out to stakeholders one-on-one to understand initiatives that are already underway in the SSR that address air quality or have air quality co-benefits.		-In the summer of 2018, and again in the summer of 2020, Environment and Parks reached out to area stakeholders to develop an inventory of management actions already underway in the SSR. This inventory is a living document that is very helpful for understanding what area stakeholders are doing to contribute to air quality management. AEP appreciates the support of area stakeholders in developing and maintaining this inventory.
	-Hosting a regular forum to update stakeholders on progress made under the management response and next steps.		-The first SSR Air Forum was hosted by Environment and Parks via Zoom technology in November 2018. Invitations were sent to members of the Calgary Region Airshed Zone (CRAZ) and the Palliser Airshed Society (PAS) as well as to Lethbridge area stakeholders. The next forum is currently being planned for AEP fiscal 2020/2021.
Calgary Region Airshed Zone (CRAZ) Air Quality Management Plan	The Calgary Region Airshed Zone (CRAZ) Air Quality Management Plan is a multi-stakeholder plan to address air quality in the CRAZ region that was first developed in 2008.	Ongoing	CRAZ works toward the implementation of its Air Quality Management Plan on an ongoing basis and conducts regular reviews and updates of the plan. The most recent review and plan update was undertaken by CRAZ throughout 2018 and 2019. Environment and Parks will continue to support the implementation of the CRAZ Air Quality Management Plan by a multi-stakeholder group for the Calgary Region.
CASA Working Group on CAAQS in Alberta Workshop and Report	The Government is seeking to engage CASA members to promote stakeholder awareness of CAAQS air quality issues, both broadly and on nitrogen dioxide specifically.	In-Progress	This action is in planning stages. The goal of this engagement will first be to document and confirm existing knowledge on emissions and trigger crossings. Afterwards, through hosting one or more workshops or symposia recommendations to reduce emissions will be developed and documented in a final report.

4.0 Next Steps for Air Quality

Environment and Parks will continue to oversee the delivery of the identified management actions while also continuing the investigation into the trigger crossings, particularly at the stations triggering into Level 3. A primary focus of the management actions is on knowledge improvement to better understand possible contributors to the elevated air quality concentrations around the reporting monitoring stations in the South Saskatchewan Region.

Although stations in the SSR recorded no higher than a Level 2 for NO_2 for the 2019 reporting period, with the adoption of the more stringent NO_2 CAAQS in 2020 it is expected that higher management levels will be observed. In addition, NO_2 is an important contributor to the formation of both $PM_{2.5}$ and O_3. Further work is planned to gain a better understanding of the NO_2 emission source sectors, such as upstream oil and gas and transportation, which modelling has shown are possible significant contributors to NO_2 concentrations across the South Saskatchewan Region. AEP is also engaging CASA members by forming a working group on CAAQS in Alberta, both broadly and on NO_2 specifically, to confirm existing knowledge on emissions and exceedances and develop approaches to reduce emissions.

$PM_{2.5}$ variations observed for the Calgary Central-Inglewood and the Calgary Southeast monitoring stations were similar to those reported in previous management response reports. Briefly, elevated concentrations are typically observed in the colder winter months and during lower wind speed conditions. The time of day when elevated concentrations are occurring implies that motor vehicle traffic emissions could be a notable contributor to measured elevated concentrations. Work planning and scheduling has been initiated for analysis of existing PM and VOC composition data collected in Calgary and prioritization of potential future PM composition data collection locations in the South Saskatchewan Region.

For O_3, South Saskatchewan Region stations have lingered at or just below the trigger into Level 3 in recent years and for the current reporting period O_3 reached a Level 3 at the Calgary, Lethbridge and Medicine Hat monitoring stations. A focus study to characterize ozone concentrations throughout the year as well as conditions that are conducive to elevated concentrations across the South Saskatchewan Region has been initiated.

Next steps will also include supporting implementation of the Alberta Environment and Parks (AEP) Air Literacy Strategy which will be leveraged to provide tools to raise awareness of poor air quality, air quality management and to promote action. Additionally, continuing to compile an inventory of possible management actions and identifying effective actions that are reasonable for implementation in the management response are also planned.

AEP will continue to work with specific stakeholders to inform the investigation and assist in improving the current environmental management system and in identifying any additional management actions that may be necessary to address point and non-point source emissions. Progress updates on the work outlined in this report will be communicated to the public in subsequent Status of the Management Response Reports.

Air Quality References

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Air Quality Glossary

Air Quality	The composition of air, with respect to quantities of substances therein, and/or a measure of the health-related and visual characteristics of the air used most frequently in connection with standards against which the contribution of the particular source can be compared.
Air Quality Objective	A numerical concentration, value or narrative statement which is intended to provide protection of the environment and human health to the extent that is technically and economically feasible, and is socially and politically acceptable.
Airshed organization	Regional partnership associations that include government, industry, environmental groups and the public. These partnerships are responsible for air quality monitoring and, in some cases, air quality management for a specific region of Alberta. Alberta presently has nine local airshed organizations.
Air Zone	Air zones are geographic areas identified through the national Air Quality Management System to facilitate effective air quality management at a local scale. In Alberta, the air zones align with the regional Land-use Framework boundaries, with the exception of Peace Air Zone which includes both Upper Peace and Lower Peace Regions.
Alberta's Ambient Air Quality Data Warehouse	Alberta's central repository for ambient air quality data collected in the province, made available online to the public. Currently known as the air data warehouse.
Ambient Air	Outside air - any portion of the atmosphere not confined by walls and a roof to which the public has access.
Canadian Ambient Air Quality Standards (CAAQS)	Ambient air quality standards applied across Canada that are designed to provide a uniform measure of protection for human health and the environment.
Exceptional Events	Emission sources that influence ambient concentrations such as forest fires, grass fires or other non-controllable or accidental releases etc., that are outside the control of provinces or territories.
Fine Particulate Matter	Fine particulate matter refers to airborne solid or liquid particles that are 2.5 microns or less in diameter. It is either emitted directly (primary PM) or formed in the atmosphere from precursor emissions (secondary PM). Important precursors of secondary PM are nitrogen oxides, sulphur dioxide, ammonia, and volatile organic compounds. The chemical composition of particles can vary widely and depends on location, time of year, and weather.
Indicators	Parameters that are measured to provide information about environmental condition; metrics are applied to the measurements to compare with defined triggers and limits.
Limits	Numerical thresholds at which the risk of adverse effects on health or environmental quality is becoming unacceptable.
Metric	A procedure for processing monitoring data to determine an indicator value to compare to triggers and limits. In the AQMF, metrics specify the averaging periods and statistics applied to the ambient air quality data

Nitrogen Dioxide (NO_2)	Toxic pungent reddish-brown gas formed by the reaction of atmospheric ozone with the nitric oxide produced from combustion.
Nitrogen Oxides (Oxides of Nitrogen, NO_x)	A general term pertaining to compounds of NO, NO_2, and other oxides of nitrogen. Nitrogen oxides are created during combustion processes and are major contributors to smog formation and acid deposition.
Ozone (O_3)	Ozone is a chemical whose effect on the environment is either beneficial or detrimental depending on where it occurs. Stratospheric ozone (the layer of the earth's atmosphere above the troposphere, extending to about 50km above the earth's surface) protects us from the sun's UV light, but tropospheric ozone (the lowest region of the atmosphere, extending from the earth's surface to a height of about 6-10km), can be toxic. Ozone is a highly reactive, colourless gas that is normally present in the troposphere as a result of naturally occurring photochemical and meteorological processes. It has a sharp, clean odour that can often be detected around running electric motors, after lightning storms, and around new mown hay.
Parameter	Chemical or physical characteristics of air that are measured as part of monitoring for air quality.
Primary pollutants	Primary pollutants are those, which are emitted directly from sources (e.g., sulphur dioxide emitted from a combustion process). Secondary pollutants are atmospheric contaminants, which form due to the reaction or transformation of primary pollutants and other atmospheric compounds in the atmosphere (e.g., ground-level ozone is formed through photochemical reactions of nitrogen dioxide and volatile organic compounds in the atmosphere).
Secondary pollutants	Secondary pollutants are atmospheric contaminants, which form due to the reaction or transformation of primary pollutants and other atmospheric compounds in the atmosphere (e.g., ground-level ozone is formed through photochemical reactions of nitrogen dioxide and volatile organic compounds in the atmosphere).
Source (of Emissions)	There are many sources of emissions, but these have generally been grouped into two categories: emissions from point and non-point sources. A point source is a stationary location or fixed facility from which substances are discharged; e.g., a smokestack. A non-point source is a pollution source that is not recognized to have a single point of origin. Common non-point emission sources are agriculture, forestry, urban, mining, construction, and city streets.
Sulphur Dioxide (SO_2)	A colourless gas that is formed primarily by the combustion of fossil fuels containing sulphur. Sour gas processing plants, oil sands processing plants and coal-fired power generating plants are major sources of SO_2.
Transboundary (Transport)	The long-range movement of emissions and substances across political or pre-determined spatial borders. Transboundary pollution refers to substances that originate in one jurisdiction, but have adverse effects in another area/jurisdiction at such a distance that it is not generally possible to distinguish the contribution of individual emission sources or groups of sources.
Triggers	Numerical thresholds set in advance of limits as early warning signals for evaluation and proactive management.

Part 2: Surface Water Quality

5.0 Introduction to Surface Water Quality

Under the *South Saskatchewan Regional Plan* (GoA, 2018) a management response is initiated when the Minister of Environment and Parks determines the condition of one of the 15 primary indicators (Table A1) has exceeded a trigger or limit as identified in the South Saskatchewan Region surface water quality management framework: for the mainstem Bow, Milk, Oldman and South Saskatchewan Rivers (Alberta); (SSR SWQMF) (AESRD, 2014). Management responses may also be undertaken for secondary indicators (Table A1) that exceed relevant surface water quality guidelines (AEP 2018a) as identified in the Framework. The SSR SWQMF triggers and limits apply to nine stations in the region (Figure 5); however, additional stations may be used to support a management response. The framework follows the water year, with assessments completed each year for the open water season (April to October) and winter season (November to March).

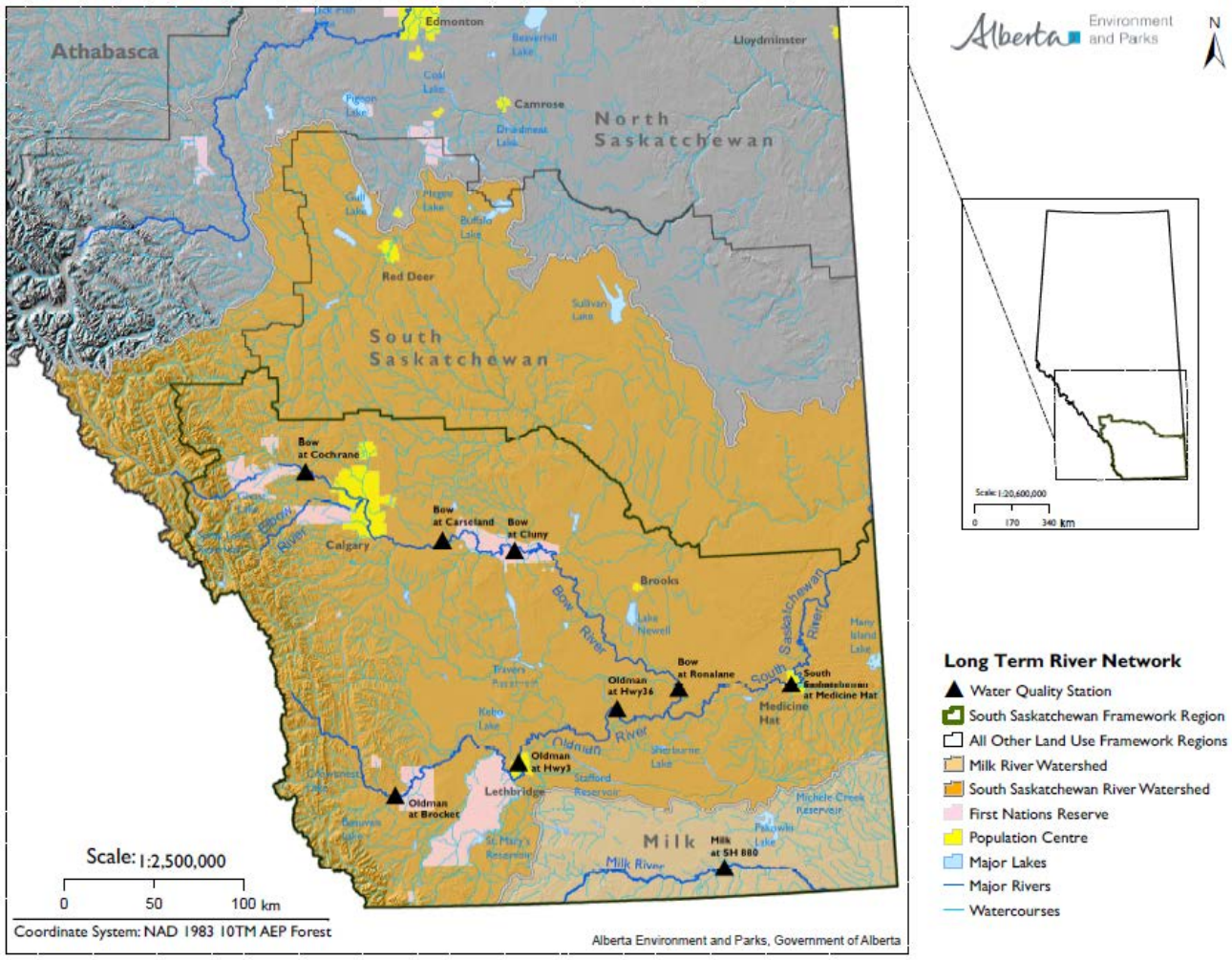

Figure 5: Map of surface water quality monitoring stations used in the 2019/2020 SSR SWQMF assessment.

Alberta Environment and Parks (AEP) is the lead coordinator of the management response, and works with other government branches and regulators (e.g. Alberta Energy Regulator) and external parties, as required, to identify and implement a management response.

A management response was initiated for the SSR after triggers were crossed for chloride, nitrate, sulphate, specific conductance and total dissolved solids during 2019/2020 (Chung et.al, 2021). As each annual report on status of conditions becomes available (AEP 2017b; Kerr et al., 2018a; Kerr et al., 2018b; Chung et al., 2019; Taube and Kerr, 2020; Chung et al., 2021), the management response is re-evaluated and updated based on new information.

This report provides an update on the management response since the last status report (AEP 2020b). This is the fifth status report produced since the SSR SWQMF came into effect in September 2014 (AEP 2017a, AEP 2018, AEP 2020a, AEP 2020b).

A full description of the management response can be found in the SSR SWQMF (AESRD, 2014). Initial steps include preliminary assessment, to determine the need for investigation and management actions. These steps are taken, in full or in part, when a surface water quality threshold is exceeded.

Part of the management response is determining the need for management action(s). The management response for surface water quality may consider a variety of factors including: the number and location of monitoring stations where exceedances were reported, trends in the data for multiple timeframes to understand variability in time, assessment of the potential impact on the aquatic environment or water uses, and any additional influences or sources that lead to a deterioration. As the status of condition report becomes available, the management response is re-evaluated and updated based on new information.

The framework, as well as all condition and management response reports are available at https://www.alberta.ca/south-saskatchewan-regional-planning.aspx and on the Open Government Portal: https://open.alberta.ca/publications.

Steps of the management response

6.0 Summary of Trigger and Limit Exceedances

6.1 Minister's Determination

The Minister's Determination for 2019/2020 confirmed that monitoring detected trigger exceedances for chloride (Bow River at Carseland, Cluny and Ronalane; South Saskatchewan River at Medicine Hat Hwy 1), nitrate (Bow River at Cochrane and Carseland), sulphate (Bow River at Cochrane and Carseland), specific conductance (Bow River at Cochrane, Carseland, Cluny and Ronalane) and total dissolved solids (Bow River at Cochrane, Carseland and Ronalane) in the SSR. A limit exceedance was detected for total dissolved solids during the winter in the Milk River at Hwy 880 (Table 4). There were no exceedances of guideline values for secondary indicators (Chung et.al, 2021).

Exceedances from previous assessment periods are summarized in Table A2 of the Appendix.

TABLE 4: THRESHOLD EXCEEDANCES FOR SURFACE WATER QUALITY IN THE SOUTH SASKATCHEWAN REGION FOR 2019/2020 BASED ON TRIGGERS AND LIMITS ESTABLISHED IN THE FRAMEWORK.

Parameter	Station	Trigger Exceedance		Limit Exceedance	
		Open Water	Winter	Open Water	Winter
Chloride	South Saskatchewan River (Medicine Hat)	Peak	Peak	-	-
	Bow River (Carseland)	Median/Peak	Median/Peak	-	-
	Bow River (Cluny)	Peak	Peak	-	-
	Bow River (Ronalane)	Peak	Median/Peak	-	-
Sulphate	Bow River (Cochrane)	Peak	Peak	-	-
	Bow River (Carseland)	Peak	Peak	-	-
Nitrate	Bow River (Cochrane)	-	Peak	-	-
	Bow River (Carseland)	Median	Median	-	-
Specific Conductance	Bow River (Cochrane)	Peak	Peak	-	-
	Bow River (Carseland)	Median/Peak	Median/Peak	-	-
	Bow River (Cluny)	Peak	Peak	-	-
	Bow River (Ronalane)	Median/Peak	Median/Peak	-	-
Total Dissolved Solids	Bow River (Cochrane)	-	Median	-	-
	Bow River (Carseland)	Median Peak	Median/Peak	-	-
	Bow River (Ronalane)	Peak	Peak	-	-
	Milk River (Hwy 880)	-	-	-	Median

7.0 Preliminary Assessment for Surface Water Quality

Once trigger exceedances have been identified, a preliminary assessment is undertaken to determine whether the exceedances represent changing ambient conditions, or are within the expected range of variability. This may include understanding if the exceedances are representative of change in an undesirable direction or if they can be attributed to rare events or natural circumstances. Comparison with historical data sets, the use of various trend assessments and evaluating the influence of flow are some approaches that may be used to make this distinction and understand the environmental significance of the exceedance.

If the preliminary assessment identifies that the trigger exceedance is indicative of changing ambient conditions, the indicator is placed in Level 2 (Table 5) and a management response and investigation into cause is initiated.

Preliminary assessments include trend analyses on unadjusted, seasonally-adjusted and flow-adjusted data to survey for undesirable trends in water quality.

The recently updated results of the preliminary assessment for indicators exceeding a trigger, limit, or guideline in 2014/2015, 2015/2016, 2016/2017 and 2017/2018 are reported in Appendix C (Tables A3 to A5). Further trend analysis is ongoing for pH in the Oldman at Brocket (2014/2015) to help determine the need for investigation and management actions. The available results of the preliminary assessment for all indicators exceeding a trigger, limit, or guideline in 2018/2019 are available as Table 7 in AEP 2020b.

The recently available results of the preliminary assessment for all indicators exceeding a trigger, limit, or guideline in 2019/2020 are in reported in Appendix C (Table A6) and data visualizations (box plots) are in Appendix D (Figures A1 to A16). Flow-adjusted trend assessments on the indicators with trigger crossings in 2018/2019 and 2019/2020 will commence once validated flow data are available.

The following exceedances remain in preliminary assessment for continued analysis to determine the need for investigation (Table A2). Analyses will continue when validated flow data are available.

- Bow River at Cluny pH
- Oldman River at Brocket pH
- Oldman River at Hwy 3 E.coli
- Oldman River at Hwy 3 Sulphate
- South Saskatchewan River at Medicine Hat - Hwy 1 Chloride

Based on the results of preliminary assessment to date, management responses have been closed for the following exceedances (Table A2).

- Oldman River at Hwy 3 Sodium Adsorption Ratio
- Oldman River at Hwy 36 Specific Conductance
- Oldman River at Hwy 36 Total Selenium
- South Saskatchewan River at Medicine Hat - Hwy 1 Specific Conductance
- South Saskatchewan River at Medicine Hat - Hwy 1 Total Selenium
- Milk River at Hwy 880 Total Selenium

Indicators that have been moved into investigation are discussed in Section 8.1 and listed in Table A2

8.0 Status of Management Response for Surface Water Quality

The management response is a set of steps taken, in full or in part, when an ambient trigger or limit is exceeded. The management response will support the management intent associated with each level (Table 5). Levels are set through evaluation of indicator once a threshold has been exceeded, limit exceedances move parameters directly to investigation, whereas trigger exceedances are evaluated through preliminary assessment prior to a decision on setting a level. A full description of the management system is found in the South Saskatchewan Region Surface Water Quality Management Framework (AESRD, 2014). The status of management response is reported on a regular basis and may be supported by supplemental technical reports (e.g. Gaas and Kromrey, 2021).

This section of the report provides an update on the investigation, identifies potential mitigative management actions, and summarizes progress made on the management response.

TABLE 5: SURFACE WATER QUALITY LEVELS – DESCRIPTION AND MANAGEMENT INTENT.

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 Exceedance		
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 Exceedance		
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

8.1 Investigation

The purpose of investigation is to determine factors likely influencing a water quality indicator (i.e. source identification) and inform decisions about management actions. The scale of the investigation depends on the management level as well as the complexity of the issue. Investigation may include considering the number and location of monitoring stations where exceedances were reported or guidelines crossed, trends in the data for multiple timeframes to understand changes over time, the potential impact of the exceedances to the aquatic environment or water uses, and any additional potential influences (natural or human-caused) including the influence of flow.

An investigation is ongoing for TDS and specific conductance in the Milk River at Hwy 880 due to their winter limit exceedances (management level 3) in current and past years. An investigation of cause (source identification) has been completed (Gaas and Kromrey, 2021) and determination of risk and urgency as well as an evaluation of possible management actions is underway. An investigation in the Bow River has been initiated (management level 2) to address the multiple TDS, specific conductance, sulphate, chloride, nitrate and total nitrogen trigger exceedances reported among the four Bow River stations since 2014 (Table 6). An investigation of cause (source identification) and a determination of risk and urgency is being initiated. Further details on these investigations are provided in Appendix E.

TABLE 6: LOCATION, MANAGEMENT LEVELS FOR INDICATORS UNDER INVESTIGATION AND MANAGEMENT INTENT FOR THE ASSOCIATED PARAMETERS.

Location	Indicator	Management Level	Current Intent
Milk River	TDS	Level 3	Under investigation
Milk River	specific conductance	Level 3	Under investigation
Bow River	TDS	Level 2	Under investigation
Bow River	specific conductance	Level 2	Under investigation
Bow River	sulphate	Level 2	Under investigation
Bow River	chloride	Level 2	Under investigation
Bow River	nitrate	Level 2	Under investigation
Bow River	total nitrogen	Level 2	Under investigation

8.2 Identification of Management Actions

Now that there is adequate understanding of the various influences on total dissolved solids and specific conductance from the investigation in the Milk River, work is underway to assess the risk to the various water uses. That risk assessment, being done by AEP with input from the Milk River Watershed Council Canada and other stakeholders, will be used to help determine future management actions (if any) needed to maintain and protect water uses now and in the future in the Milk River.

Support from the public, Indigenous Peoples, industry, non-governmental groups, and various levels of government is important to understand regional issues and explore options to achieve the surface water quality management objectives. Management actions support, rather than replace existing policies and regulations. Management actions may range from policy or regulatory initiatives to reduce effluent inputs, to voluntary actions, and raising awareness and understanding surrounding surface water quality. Knowledge improvement actions include gathering baseline information, improving scientific understanding and knowledge and learning from other jurisdictions.

Ongoing investigation and studies will continue to inform and establish necessary and appropriate mitigative actions.

9.0 Next Steps for Surface Water Quality

Alberta Environment and Parks will complete the preliminary assessment for all indicators exceeding a trigger or limit in 2019/2020 and in previous reporting periods. This includes:

- further analysis on pH in the Oldman at Brocket (2014/2015) to help determine the need for investigation and management actions.
- flow-adjusted trend assessments on the indicators with trigger crossings in 2018/2019 and 2019/2020, at the stations where the crossing occurred; and

The following indicators are in the investigation phase:

- TDS and specific conductance in the Milk River to address the winter limit exceedances at Hwy 880
- Triggers exceeded in the Bow River to address the TDS, specific conductance, sulphate, chloride, nitrate and total nitrogen exceedances reported among the four Bow River stations since 2014

Next steps in the management response for TDS and specific conductance on the Milk River will focus on further understanding the risk current conditions pose for aquatic life and other uses. Recommended steps include:

- Evaluating the risk current conditions pose for aquatic life and other winter water uses.
- Conducting a more detailed risk assessment for the limit for TDS based on an irrigation guideline, noting that the exceedances happen during the winter period, so the anticipated risk is low.
- Evaluating the need for development of site-specific water quality objectives for the parameters that exceeded limits at the Milk River at Hwy 880 station.
- Considering adjusting the seasons at the Milk River at Hwy 880 station, to reflect the timing of water diverted from the St Mary River, when the framework is updated.
- Identifying whether any management actions are required to mitigate any environmental impacts.

Next steps in the investigation for triggers exceeded in the Bow River will focus on source identification and understanding the risk current conditions pose for aquatic life and other uses. Recommended steps include:

- An in-depth literature review
- Additional data gathering and analysis of surface water quality including tributary inputs, groundwater water, water flow influences and effluent discharged to the Bow River may follow.
- An investigation of cause (source identification), and
- Determination of risk and urgency for possible management action

If management actions are identified, AEP will continue to oversee the implementation, while also continuing preliminary assessment and investigation work.

AEP will work with specific stakeholders and Indigenous Peoples, as appropriate, to inform the preliminary assessment and investigation and assist in improving the current environmental management system and identifying management actions that may be necessary to address factors influencing surface water quality. Progress update on the work outlined in this report will be communicated to the public in subsequent Status of the Management Response Reports.

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Surface Water Quality Glossary

Contaminant/ Pollutant	A substance in a concentration or amount that adversely alters the physical, chemical, or biological properties of the natural environment
Ecosystem Health	A healthy aquatic ecosystem is an aquatic environment that sustains its ecological structure, processes, functions, and resilience within its range of natural variability.
Indicator	Parameters that are measured to provide information about environmental condition; metrics are applied to the measurements to compare with defined triggers and limits.
Limits	Numerical thresholds at which the risk of adverse effects on health or environmental quality is becoming unacceptable.
Metric	A procedure for processing monitoring data to determine an indicator value to compare to triggers and limits. In the SWQualMF, metrics summarize parameter measurements over a specific timeframe at a specific location.
mg/L	milligrams per liter
Non-point Source Pollutant	Pollution that enters a water body from diffuse or undefined sources and is usually carried by runoff.
Parameter	Chemical, physical, or biological characteristics of water that are measured as part of monitoring for water quality.
Point Source Pollution	Pollution that originates from an identifiable cause or location, such as a sewage treatment plant.
Substance	From the framework, a 'substance' is defined as: i) Any matter that: a. Is capable of becoming dispersed in the environment, or b. Is capable of being transformed in the environment into matter refered to in a., ii) Any sound, vibration, heat, radiation or other form of energy, and iii) Any combination of things referred to in i) and ii).
TDS	total dissolved solids
Toxicity	The adverse effect on the growth, reproduction, or survival of an organism.
Triggers	Numerical thresholds set in advance of limits as early warning signals for evaluation and proactive management.
Wastewater	The liquid waste generated through various industrial and municipal processes.
Water Uses	For the purpose of the framework these include: protection of aquatic life, drinking water, recreation and aesthetics, agricultural, and industrial.
µS/cm	microsiemens per centimeter

Appendices for Surface Water Quality

Appendix A: Surface Water Quality Indicators for the South Saskatchewan Region

TABLE A1: LIST OF PRIMARY AND SECONDARY INDICATORS FOR THE SOUTH SASKATCHEWAN REGION SURFACE WATER QUALITY MANAGEMENT FRAMEWORK.

Primary Indicators	
Total Ammonia	Specific Conductance
Chloride	Total Dissolved Solids
Nitrate	Total Organic Carbon
Total Nitrogen	Total Suspended Solids
Total Dissolved Phosphorus	Turbidity
Total Phosphorus	pH
Sulphate	*Escherichia coli*
Sodium Adsorption Ratio (SAR)	
Secondary Indicators	
Mercury	Dicamba
Selenium	Methylchlorophenoxyacetic acid (MCPA)
2,4-Dichlorophenoxyacetic acid (2,4-D)	Mecoprop (MCPP)

Appendix B: History of Exceedances

TABLE A2: HISTORY OF MEDIAN AND PEAK GUIDELINE, TRIGGER, OR LIMIT EXCEEDANCES AND STAGE OF MANAGEMENT RESPONSE.

Crossing or Exceedance	2014/2015		2015/2016		2016/2017		2017/2018		2018/2019		2019/2020		Next Steps/Stage of Management Response
	OW	W	OW	W	OW	W	OW	W	OW	W	OW	W	
Bow River at Cochrane Total Nitrogen		M		M									Investigation
Bow River at Cochrane Nitrate												P	Investigation
Bow River at Cochrane Sulphate					P	P	P	P	P	P	P	P	Investigation
Bow River at Cochrane Specific Conductance											P	P	Investigation
Bow River at Cochrane Total Dissolved Solids (TDS)												M	Investigation
Bow River at Carseland Specific Conductance	P	P							P	P	M/P	M/P	Investigation
Bow River at Carseland Sulphate					P	P					P	P	Investigation
Bow River at Carseland Nitrate							P	P	M	M	M	M	Investigation
Bow River at Carseland Total Dissolved Solids (TDS)											M/P	M/P	Investigation
Bow River at Carseland Chloride									P	P	M/P	M/P	Investigation
Bow River at Cluny Total Dissolved Solids (TDS)					M	M							Investigation
Bow River at Cluny Specific Conductance											P	P	Investigation
Bow River at Cluny Chloride											P	P	Investigation
Bow River at Cluny pH									M	M			Further Analysis*^
Bow River at Cluny Nitrate							P	P	M	M			Investigation
Bow River at Ronalane Total Nitrogen			M	M					M	M			Investigation
Bow River at Ronalane Nitrate			M	M					M	M			Investigation
Bow River at Ronalane Specific Conductance							P	P			M/P	M/P	Investigation

TABLE A2. CON'T

Crossing or Exceedance	2014/2015		2015/2016		2016/2017		2017/2018		2018/2019		2019/2020		Next Steps/Stage of Management Response
	OW	W	OW	W	OW	W	OW	W	OW	W	OW	W	
Bow River at Ronalane Total Dissolved Solids (TDS)							P	P			P	P	Investigation
Bow River at Ronalane Chloride									M/P	M/P	P	M/P	Investigation
Oldman River at Brocket pH	P	P											Further Analysis*^
Oldman River at Hwy 3 Sodium Adsorption Ratio			M	M									Close Management Response
Oldman River at Hwy 3 *E.coli*										M/P			Further Analysis*^
Oldman River at Hwy 3 Sulphate									M	M			Further Analysis*^
Oldman River at Hwy 36 Specific Conductance	M	M											Close Management Response
Oldman River at Hwy 36 Total Selenium				G									Close Management Response
South Saskatchewan River at Medicine Hat - Hwy 1 Specific Conductance							M	M					Close Management Response
South Saskatchewan River at Medicine Hat - Hwy 1 Total Selenium								G*					Close Management Response
South Saskatchewan River at Medicine Hat - Hwy 1 Chloride									M/P	M/P	P	P	Further Analysis*^
Milk River at Hwy 880 Specific Conductance								ML		ML			Investigation Continued<
Milk River at Hwy 880 Total Dissolved Solids (TDS)				ML		ML		ML		ML			Investigation Continued<
Milk River at Hwy 880 Total Selenium								G		G			Close Management Response

* Verification complete. Comparison to historical data and up and down-stream stations complete. Unadjusted and seasonally-adjusted trend assessments complete.

^Additional analysis on pause until flow data is available.

< Source attribution for specific conductance and TDS limit exceedances at Milk River Hwy 880 completed as part of investigation. Risk assessment and need for management actions currently underway.

Appendix C: Preliminary Assessment Technical Information

Trend assessments

The results of the preliminary assessment (trends) for indicators exceeding a trigger, limit, or guideline in 2014/2015 and 2015/2016 are available as Tables 8 and 9 in AEP 2020a. Additional assessments (longer timeframe data) for specific conductance in the Oldman at Hwy 36 and SAR in the Oldman at Hwy 3 is in Table A3. Flow-adjusted trend assessments have recently been completed for indicators exceeding a trigger, limit, or guideline in 2016/2017 (Table A4) and 2017/2018 (Table A5). The available results of the initial (unadjusted and seasonally-adjusted) trend assessments for indicators exceeding a trigger, limit, or guideline in 2018/2019 are available as Table 7 in AEP 2020b. Initial trend assessments have recently been completed for all indicators exceeding a trigger, limit, or guideline in 2019/2020 (Table A6). Flow-adjusted trend assessments on the indicators with trigger crossings in 2018/2019 and 2019/2020 will commence once validated flow data are available.

TABLE A3: STATUS OF ADDITIONAL TREND ASSESSMENTS FOR 2014/2015 AND 2015/2016.

NT indicates no trend, + indicates significant (P<0.05) increasing trend, - indicates significant (P<0.05) decreasing trend, blank cells indicate no assessment completed.

Preliminary Assessment - Additional 2014/2015 and 2015/2016 Trend Results						
Trigger Exceedance	Season	Flow-adjusted Trend		Unadjusted Trend (Concentration)		Action
		2009-2018*	2008-2018	2009-2018*	2008-2018	
2014/2015						
Specific Cond. Median Oldman Hwy 36	Open Water	NT	NT	NT	NT	Close Management Response
	Winter	NT	NT	NT	NT	
2015/2016						
SAR Median Oldman Hwy 3	Open Water	NT	NT	NT	NT	Close Management Response
	Winter			NT	NT	

* Caution should be used when interpreting trend results with short timeframes.

TABLE A4: STATUS OF TREND ASSESSMENTS FOR 2016/2017.

NT indicates no trend, + indicates significant (P<0.05) increasing trend, - indicates significant (P<0.05) decreasing trend, blank cells indicate no assessment completed.

Preliminary Assessment 2016/2017 Trend Results								
Exceedance	Season	Flow-adjusted Adjusted Trend			Unadjusted Trend (Concentration)			Action
		1999-2017^	2009-2017	2007-2017*	1999-2017^	2009-2017	2007-2017*	
Trigger Exceedances								
Sulphate Peak	Open Water	+	NT	NT	+	NT	NT	Investigation
Bow Cochrane	Winter	+	+	+	+	+	+	
Sulphate Peak	Open Water	+	NT	NT	+	+	NT	Investigation
Bow Carseland	Winter	+	+	NT	+	NT	NT	
Total Diss. Solids Median	Open Water	+	NT	NT	+	NT	NT	Investigation
Bow Cluny	Winter	+	+	+	+	+	+	
Limit Exceedance								
Total Diss. Solids (Winter only)	Open Water	NT	NT	-	+	NT	NT	Investigation Continued~
Milk Hwy 880	Winter	NT	-	NT	NT	NT	-	

^ Some datasets that have different timeframes (e.g. Milk Hwy 880 TDS 2003-2016).

* Caution should be used when interpreting trend results with short timeframes.

~ Investigation due to winter median crossing the Limit

TABLE A5. STATUS OF TREND ASSESSMENTS FOR 2017/2018.

NT indicates no trend, + indicates significant (P<0.05) increasing trend, - indicates significant (P<0.05) decreasing trend, blank cells indicate no assessment completed.

Preliminary Assessment 2017/2018 Trend Results								
Exceedance	Season	Flow-adjusted Adjusted Trend			Unadjusted Trend (Concentration)			Action
		1999-2018^	2009-2018	2008-2018*	1999-2018^	2009-2018	2008-2018*	
Trigger Exceedances								
Specific Conductance Median SSR Medicine Hat Hwy 1	Open Water	NT	-	NT	NT	NT	NT	Close Management Response
	Winter	NT	NT	NT	NT	NT	NT	
Sulphate Peak Bow Cochrane	Open Water	+	NT	NT	+	+	NT	Investigation
	Winter	+	+	+	+	+	+	
Nitrate Peak Bow Carseland	Open Water	+	NT	NT	NT	NT	NT	Investigation
	Winter	NT	+	NT	NT	+	NT	
Nitrate Peak Bow Cluny	Open Water	+	NT	NT	+	NT	NT	Investigation
	Winter	+	+	+	+	+	+	
Specific Conductance Peak Bow Ronalane	Open Water	+	NT	+	+	NT	+	Investigation
	Winter	+	NT	+	+	NT	+	
Total Dissolved Solids Peak Bow Ronalane	Open Water	+	NT	NT	+	NT	NT	Investigation
	Winter	+	+	+	+	+	+	
Limit Exceedances								
Specific Conductance (Winter only) Milk Hwy 880	Open Water	NT	-	-	NT	NT	NT	Investigation Continued~
	Winter	NT	NT	NT	NT	NT	NT	
Total Dissolved Solids (Winter only) Milk Hwy 880	Open Water	NT	-	-	NT	NT	NT	Investigation Continued~
	Winter	NT	NT	NT	NT	NT	NT	
Guideline Exceedances								
Total Selenium (Winter only) Milk Hwy 880	Open Water	NT	NT[1]	NT	NT	NT	NT	Close Management Response
	Winter	NT	NT	NT	NT	NT	NT	
Total Selenium (Winter only) SSR Medicine Hat Hwy 1	Open Water	NT	NT	NT	NT	NT	NT	Close Management Response
	Winter	NT	NT	NT	NT	NT	NT	

[1]Negative trend was observed for dissolved selenium

^ Some datasets that have different timeframes (e.g. Milk Hwy 880 TDS 2003-2016, Selenium 2004-2016).

* Caution should be used when interpreting trend results with short timeframes.

~ Investigation due to winter median crossing the Limit

TABLE A6. STATUS OF TREND ASSESSMENTS FOR 2019/2020.

NT indicates no trend, + indicates significant (P<0.05) increasing trend, - indicates significant (P<0.05) decreasing trend, blank cells indicate no assessment completed.

Exceedance	Season	Preliminary Assessment 2019/2020 Trend Results Unadjusted Trend 2009-2020	Seasonally Adjusted Trend 2009-2020	Flow-adjusted Trend 2009-2020
Trigger Exceedances				
Chloride Peak SSR Hwy 1	Open Water Winter	+ +	+	Ongoing
Sulphate Peak Bow Cochrane	Open Water Winter	+ +	+	Ongoing
Total Dissolved Solids Median (Winter only) Bow Cochrane	Open Water Winter	NT NT	NT	Ongoing
Specific Conductance Peak Bow Cochrane	Open Water Winter	+ +	+	Ongoing
Nitrate Peak (Winter only) Bow Cochrane	Open Water Winter	NT +	NT	Ongoing
Sulphate Peak Bow Carseland	Open Water Winter	NT +	+	Ongoing
Chloride Median & Peak Bow Carseland	Open Water Winter	NT +	NT	Ongoing
Specific Conductance Median & Peak Bow Carseland	Open Water Winter	NT +	+	Ongoing
Nitrate Median Bow Carseland	Open Water Winter	NT +	+	Ongoing
Total Dissolved Solids Median & Peak Bow Carseland	Open Water Winter	NT +	+	Ongoing
Chloride Peak Bow Cluny	Open Water Winter	+ +	+	Ongoing
Specific Conductance Peak Bow Cluny	Open Water Winter	+ +	+	Ongoing
Specific Conductance Median & Peak Bow Ronalane	Open Water Winter	NT +	NT	Ongoing
Total Dissolved Solids Peak Bow Ronalane	Open Water Winter	NT +	NT	Ongoing
Chloride Median (Winter only) & Peak Bow Ronalane	Open Water Winter	NT +	+	Ongoing

TABLE A6.CON'T

Preliminary Assessment 2019/2020 Trend Results

Exceedance	Season	Unadjusted Trend 2009-2020	Seasonally Adjusted Trend 2009-2020	Flow-adjusted Trend 2009-2020
Limit Exceedance				
Total Dissolved Solids (Winter only) Milk Hwy 880	Open Water		NT	Ongoing
	Winter	NT		

Appendix D: Box Plots of 2019/2020 Exceeded Indicators

South Saskatchewan River at Medicine Hat - Hwy 1 – Chloride Open Water and Winter Peak Trigger Exceedances

Examination of the dataset revealed that the 2019/2020 90th percentile values are not the highest observed in the dataset at this station (Figure A1).

Overall, the chloride concentrations in the South Saskatchewan River at Medicine Hat are higher than the nearest upstream station on the Oldman River at Hwy 36, but are similar to or lower than the nearest upstream station on the Bow River at Ronalane. Further data analysis is needed to determine what influence river flow has on chloride concentrations.

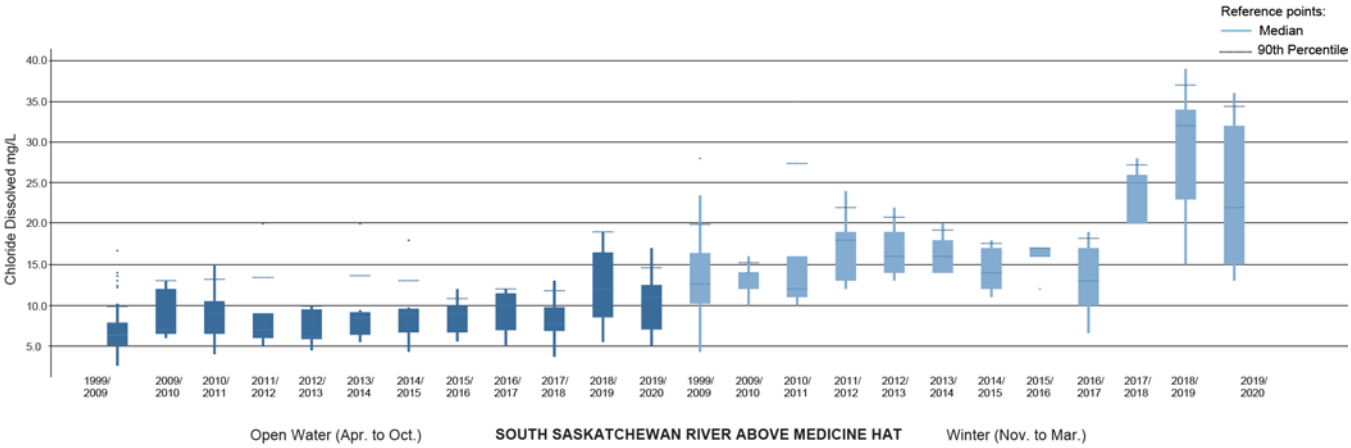

Figure A1: Box plots of the chloride data in the South Saskatchewan River at Medicine Hat – Hwy 1 station during open water and winter from April 1999 to March 2020.

Bow River at Cochrane – Sulphate Open Water and Winter Peak Trigger Exceedances

Examination of the dataset revealed that although the 2019/2020 90th percentile values are the highest observed in the dataset at this station (Figure A2), no samples exceeded the calculated limit value (based on hardness).

Overall, the sulphate concentrations in the Bow River at Cochrane are lower than the downstream stations (Carseland, Cluny, and Ronalane) and are similar to those observed at the corresponding most upstream station (Brocket) on the Oldman River. Further data analysis is needed to determine what influence river flow has on sulphate concentrations.

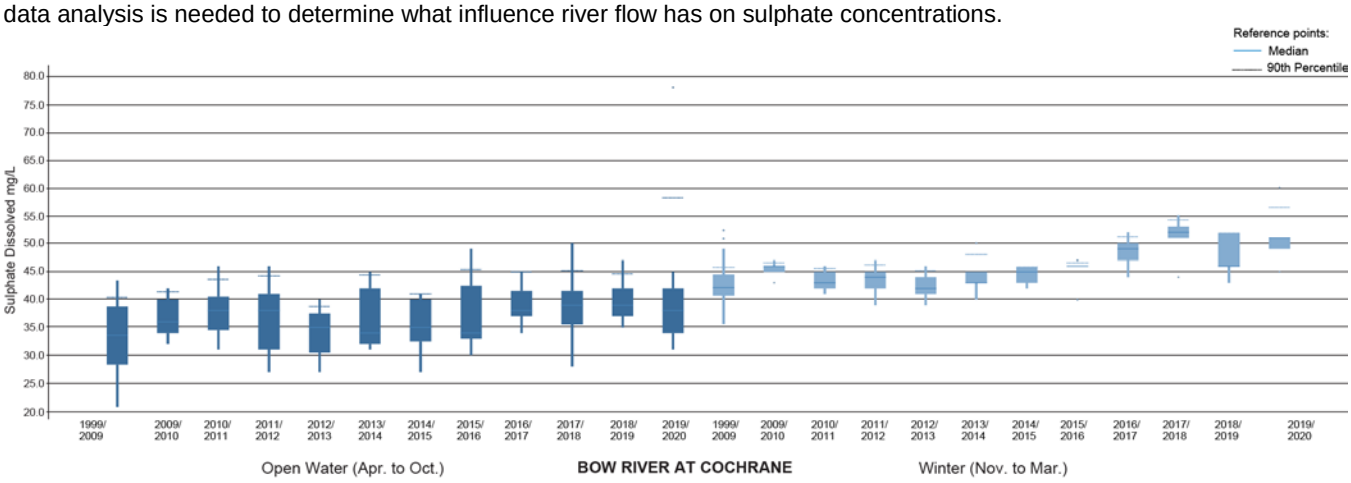

Figure A2: Box plots of the sulphate data in the Bow River at Cochrane station during winter from April 1999 to March 2020.

Bow River at Cochrane – Nitrate Winter Peak Trigger Exceedance

Examination of the dataset revealed that the 2019/2020 90th percentile value is not the highest observed in the dataset at this station (Figure A3).

Overall, the nitrate concentrations in the Bow River at Cochrane are lower than the downstream stations (Carseland, Cluny, and Ronalane) and are similar to those observed at the corresponding most upstream station (Brocket) on the Oldman River. Further data analysis is needed to determine what influence river flow has on nitrate concentrations.

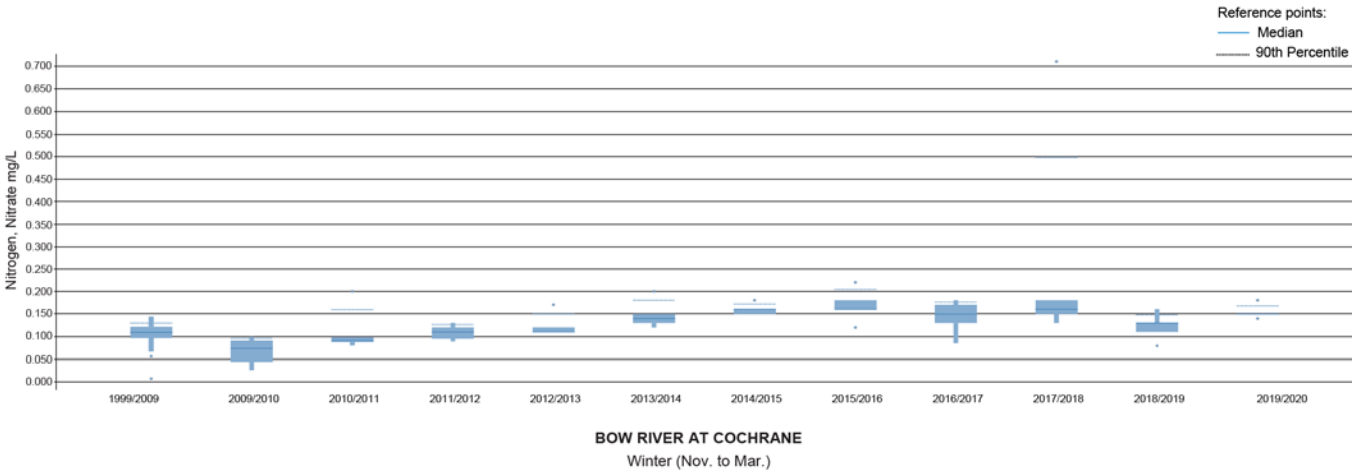

Figure A3: Box plots of the nitrate data in the Bow River at Cochrane station during winter from November 1999 to March 2020.

Bow River at Cochrane – Total Dissolved Solids Winter Median Trigger Exceedance

Examination of the dataset revealed that the 2019/2020 median value is not the highest observed in the dataset at this station (Figure A4).

Overall, the TDS concentrations in the Bow River at Cochrane are lower than the downstream stations (Carseland, Cluny, and Ronalane) and are similar to those observed at the corresponding most upstream station (Brocket) on the Oldman River. Further data analysis is needed to determine what influence river flow has on TDS concentrations.

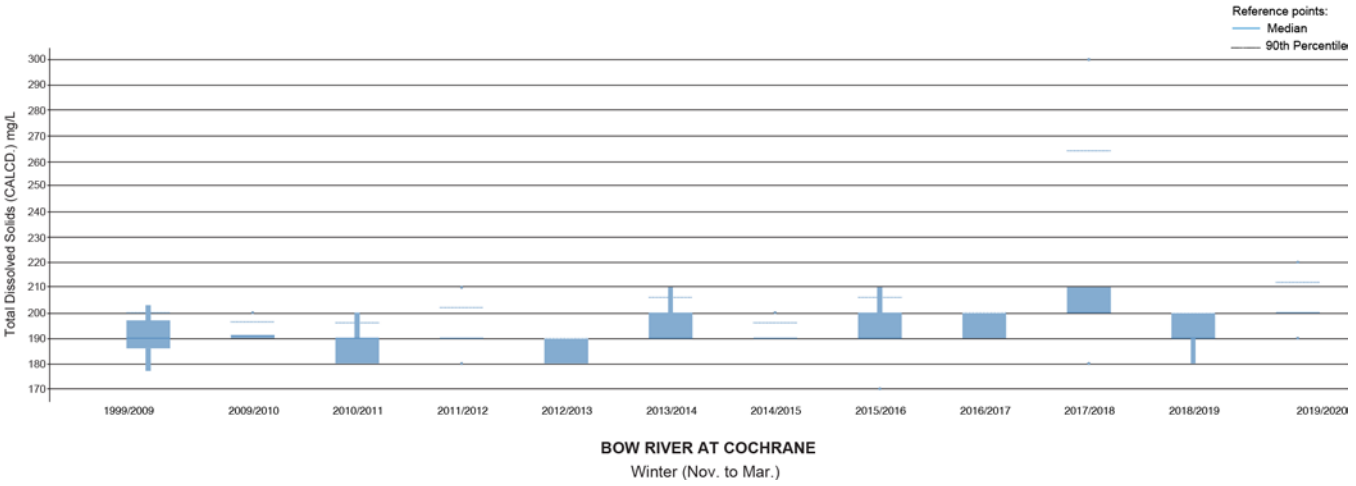

Figure A4: Box plots of the total dissolved solids data in the Bow River at Cochrane station during winter from November 1999 to March 2020.

Bow River at Cochrane – Specific Conductance Open Water and Winter Peak Trigger Exceedances

Examination of the dataset revealed that the 2019/2020 90th percentile values are not the highest observed in the dataset at this station (Figure A5).

Overall, the specific conductance values in the Bow River at Cochrane are lower than the downstream stations (Carseland, Cluny, and Ronalane) and are similar to those observed at the corresponding most upstream station (Brocket) on the Oldman River. Further data analysis is needed to determine what influence river flow has on specific conductance.

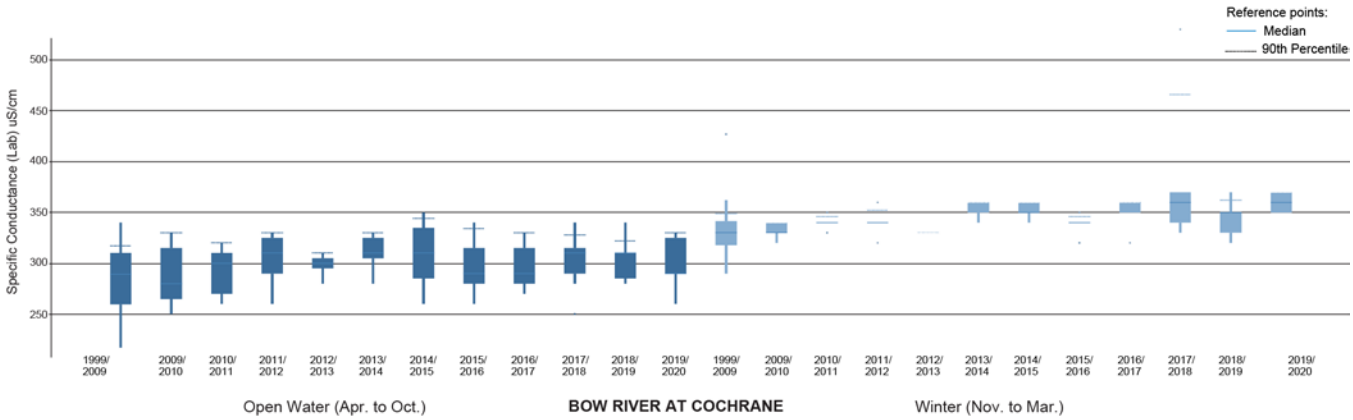

Figure A5: Box plots of the specific conductance data in the Bow River at Cochrane station during open water and winter from April 1999 to March 2020.

Bow River at Carseland – Sulphate Open Water and Winter Peak Trigger Exceedances

Examination of the dataset revealed that the 2019/2020 90th percentile values are not the highest observed in the dataset at this station (Figure A6) and no samples exceeded the calculated limit value (based on hardness).

Overall, the sulphate concentrations in the Bow River at Carseland are higher than the upstream station (Cochrane) but lower than the downstream stations (Cluny and Ronalane) and are similar to those observed at the comparable stations (Hwy 3 and Hwy 36) on the Oldman River. Further data analysis is needed to determine what influence river flow has on sulphate concentrations.

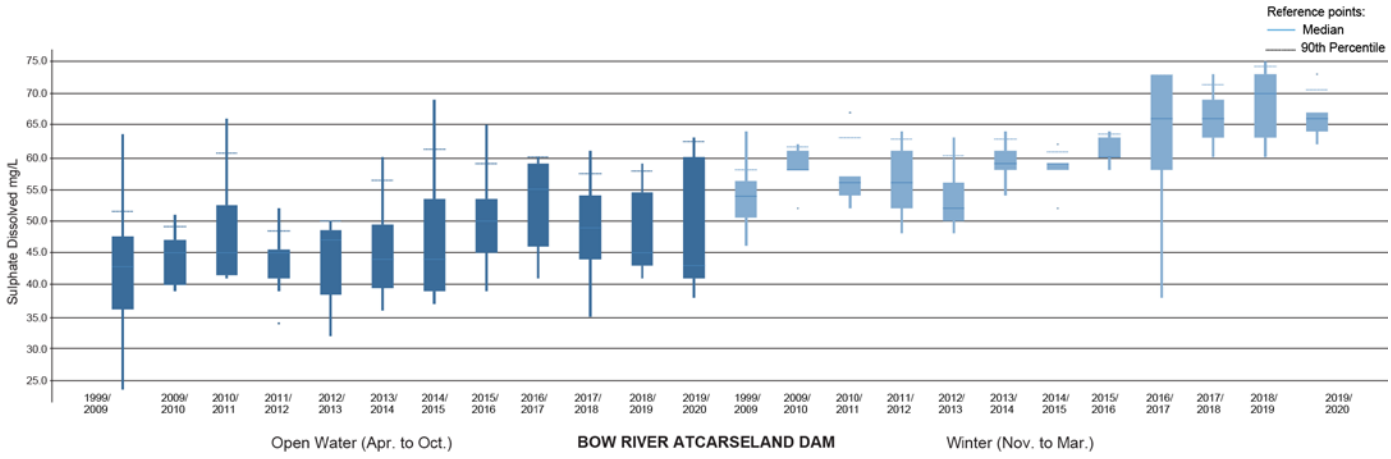

Figure A6: Box plots of the sulphate data in the Bow River at Carseland station during open water and winter from April 1999 to March 2020.

Bow River at Carseland – Nitrate Open Water and Winter Median Trigger Exceedances

Examination of the dataset revealed that the 2019/2020 median values are not the highest observed in the dataset at this station (Figure A7).

Overall, the nitrate concentrations in the Bow River at Carseland are higher than the upstream station (Cochrane) but similar to the downstream stations (Cluny and Ronalane) and are higher than those observed in the Oldman River. Further data analysis is needed to determine what influence river flow has on nitrate concentrations.

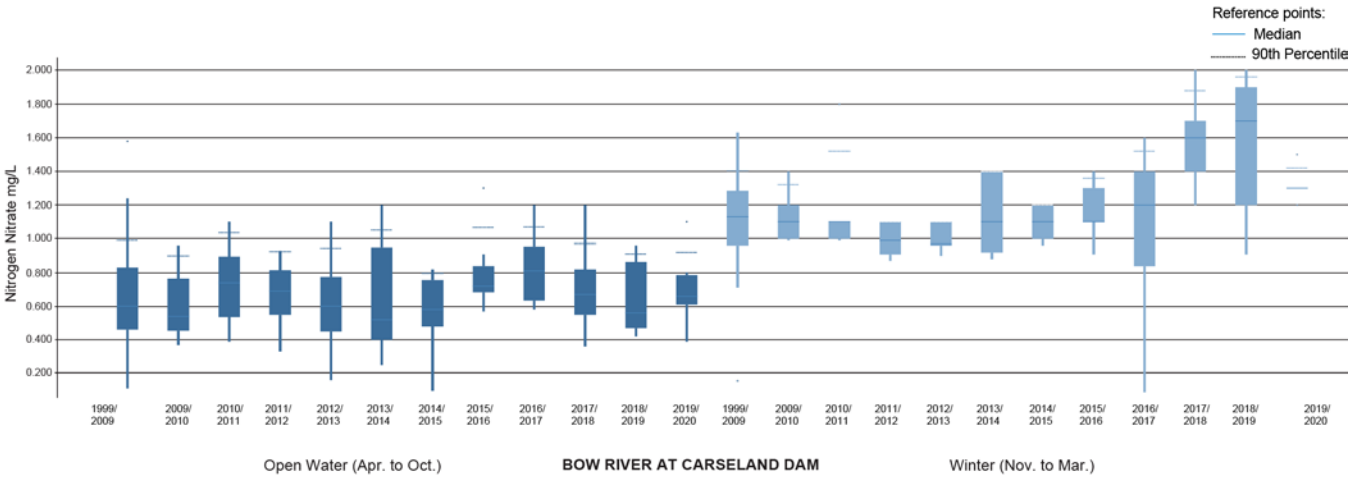

Figure A7: Box plots of the nitrate data in the Bow River at Carseland station during open water and winter from April 1999 to March 2020.

Bow River at Carseland – Chloride Open Water and Winter Median and Peak Trigger Exceedances

Examination of the dataset revealed that the 2019/2020 90th percentile values are not the highest observed in the dataset at this station but the median values are (Figure A8).

Overall, the chloride concentrations in the Bow River at Carseland are higher than the upstream station (Cochrane) but similar to the downstream stations (Cluny and Ronalane) and are higher than those observed in the Oldman River. Further data analysis is needed to determine what influence river flow has on chloride concentrations.

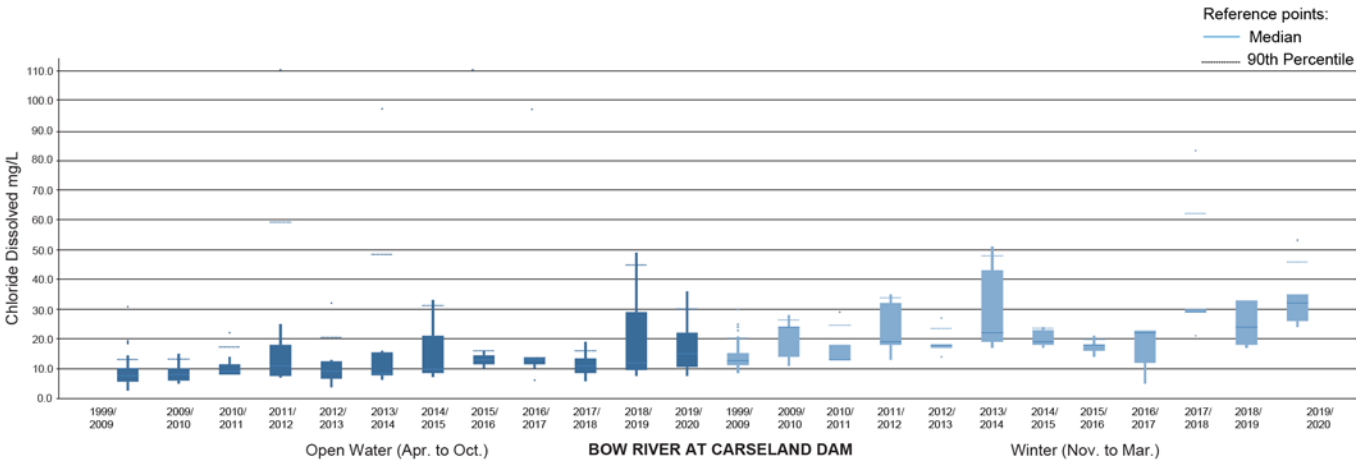

Figure A8: Box plots of the chloride data in the Bow River at Carseland station during open water and winter from April 1999 to March 2020.

Bow River at Carseland – Total Dissolved Solids Open Water and Winter Median and Peak Trigger Exceedances

Examination of the dataset revealed that the 2019/2020 median and 90th percentile values are not the highest observed in the dataset at this station (Figure A9).

Overall, the TDS concentrations in the Bow River at Carseland are higher than the upstream station (Cochrane) but similar to the downstream stations (Cluny and Ronalane) and are similar to those observed at the comparable stations (Hwy 3 and Hwy 36) on the Oldman River. Further data analysis is needed to determine what influence river flow has on TDS concentrations.

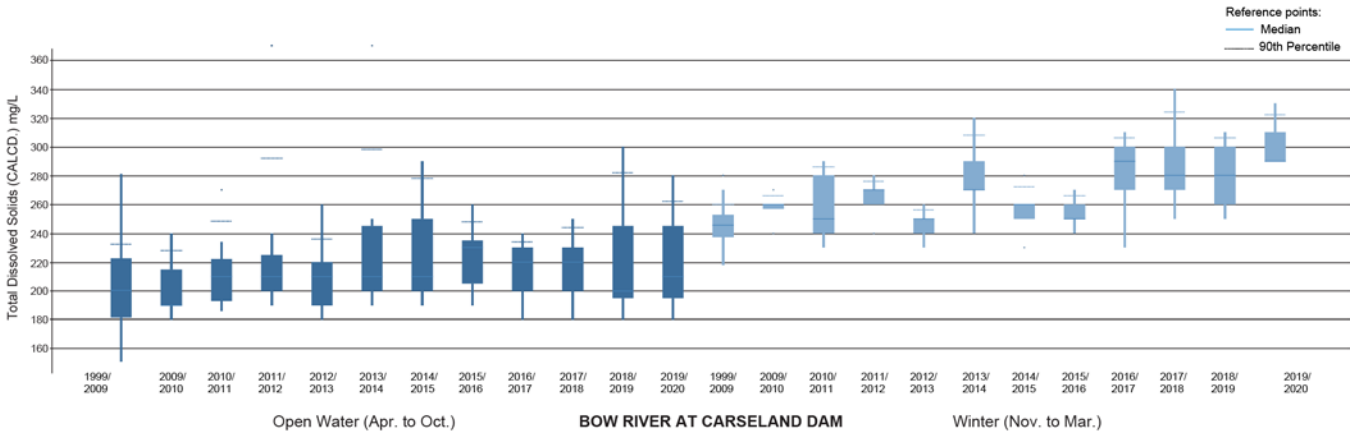

Figure A9: Box plots of the total dissolved solids data in the Bow River at Carseland station during open water and winter from April 1999 to March 2020.

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

Examination of the dataset revealed that the 2019/2020 median and 90th percentile values (except the winter median) are not the highest observed in the dataset at this station (Figure A10).

Overall, the specific conductance values in the Bow River at Carseland are higher than the upstream station (Cochrane) but similar to the downstream stations (Cluny, and Ronalane) and are similar to those observed at the comparable stations (Hwy 3 and Hwy 36) on the Oldman River. Further data analysis is needed to determine what influence river flow has on specific conductance.

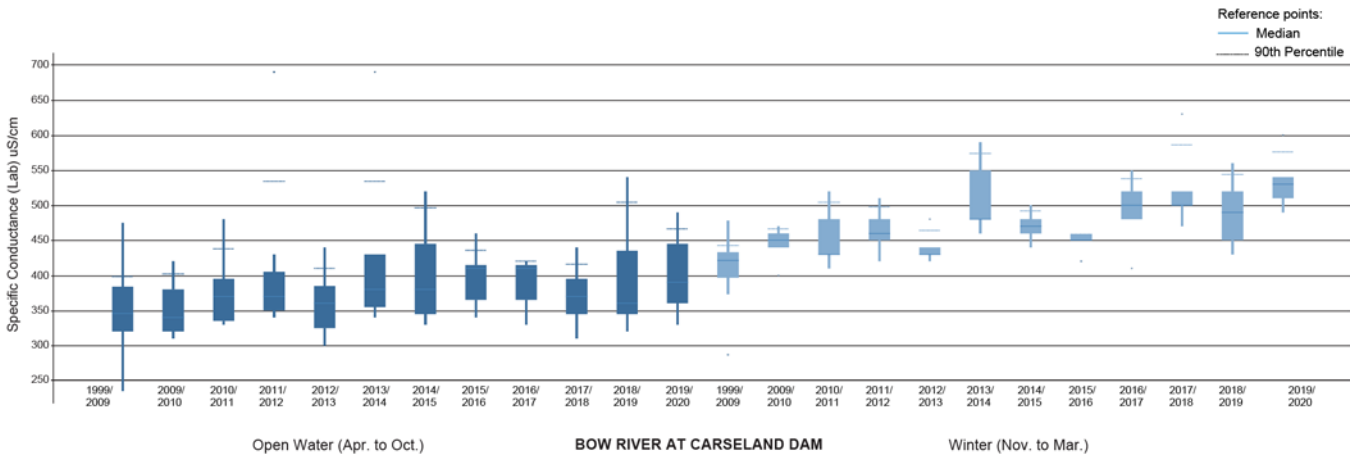

Figure A10: Box plots of the specific conductance data in the Bow River at Carseland station during open water and winter from April 1999 to March 2020.

Bow River at Cluny – Chloride Open Water and Winter Peak Trigger Exceedances

Examination of the dataset revealed that the 2019/2020 90th percentile values are not the highest observed in the dataset at this station (Figure A11).

Overall, the chloride concentrations in the Bow River at Cluny are similar to the upstream and downstream stations (Carseland and Ronalane), are higher than the most upstream station (Cochrane) and are higher than those observed at the comparable stations (Hwy 3 and Hwy 36) on the Oldman River. Further data analysis is needed to determine what influence river flow has on chloride concentrations.

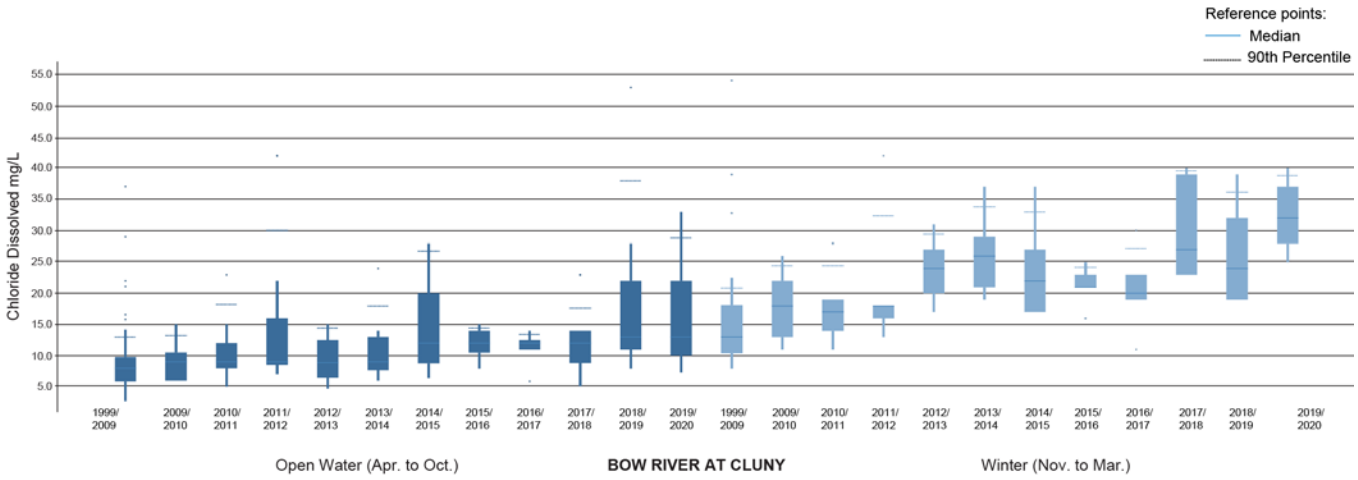

Figure A11: Box plots of the chloride data in the Bow River at Cluny station during open water and winter from April 1999 to March 2020.

Bow River at Cluny – Specific Conductance Open Water and Winter Peak Trigger Exceedances

Examination of the dataset revealed that the 2019/2020 90th percentile values are not the highest observed in the dataset at this station (Figure A12).

Overall, the specific conductance values in the Bow River at Cluny are similar to the upstream and downstream stations (Carseland and Ronalane), are higher than the most upstream station (Cochrane) and are similar to those observed at the comparable stations (Hwy 3 and Hwy 36) on the Oldman River. Further data analysis is needed to determine what influence river flow has on specific conductance.

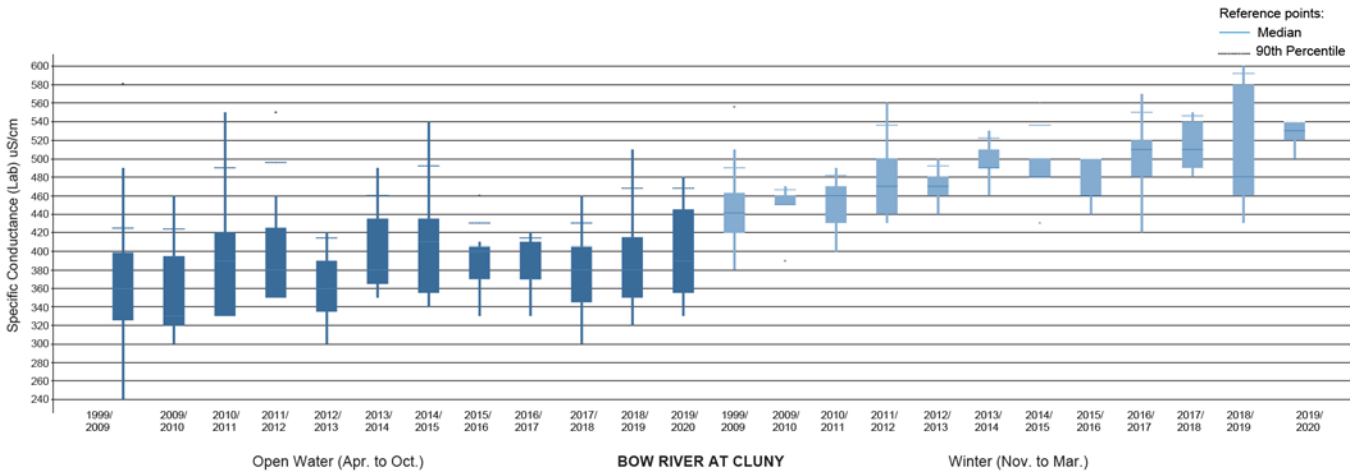

Figure A12: Box plots of the specific conductance data in the Bow River at Cluny station during open water and winter from April 1999 to March 2020.

Bow River at Ronalane – Chloride Open Water and Winter Median and Peak Trigger Exceedances

Examination of the dataset revealed that the 2019/2020 median and 90th percentile values (except the winter median) are not the highest observed in the dataset at this station (Figure A13).

Overall, the chloride concentrations in the Bow River at Ronalane are similar to the upstream stations (Carseland and Cluny), are higher than the most upstream station (Cochrane) and are higher than on the Oldman River. Further data analysis is needed to determine what influence river flow has on chloride concentrations.

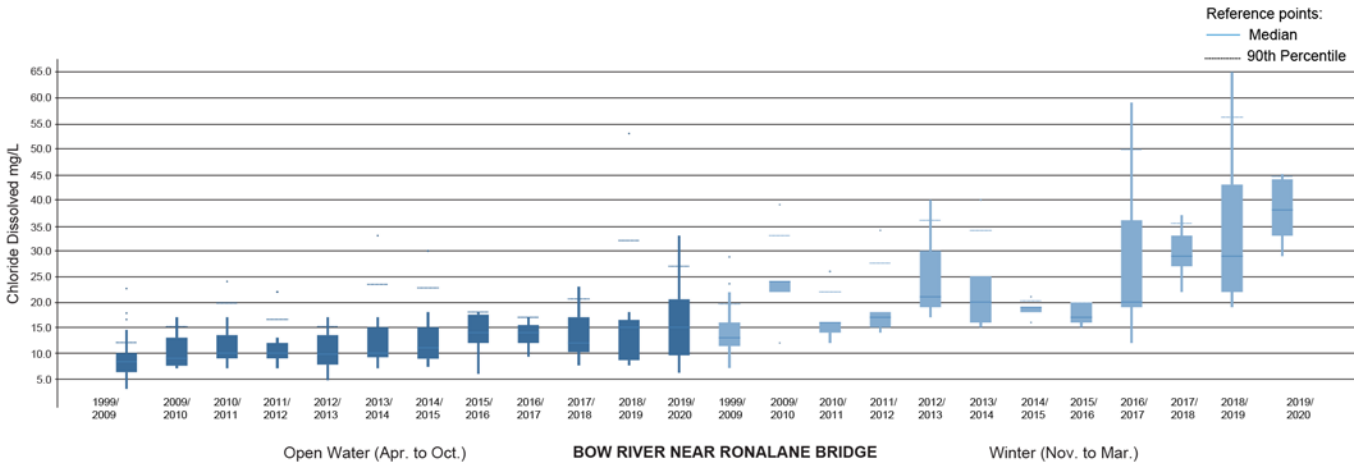

Figure A13: Box plots of the chloride data in the Bow River at Ronalane station during open water and winter from April 1999 to March 2020.

Bow River at Ronalane – Total Dissolved Solids Open Water and Winter Peak Trigger Exceedances

Examination of the dataset revealed that the 2019/2020 90th percentile values are not the highest observed in the dataset at this station (Figure A14).

Overall, the TDS concentrations in the Bow River at Ronalane are similar to the upstream stations (Carseland and Cluny), are higher than the most upstream station (Cochrane) and are similar to those observed at the comparable stations (Hwy 3 and Hwy 36) on the Oldman River. Further data analysis is needed to determine what influence river flow has on TDS concentrations.

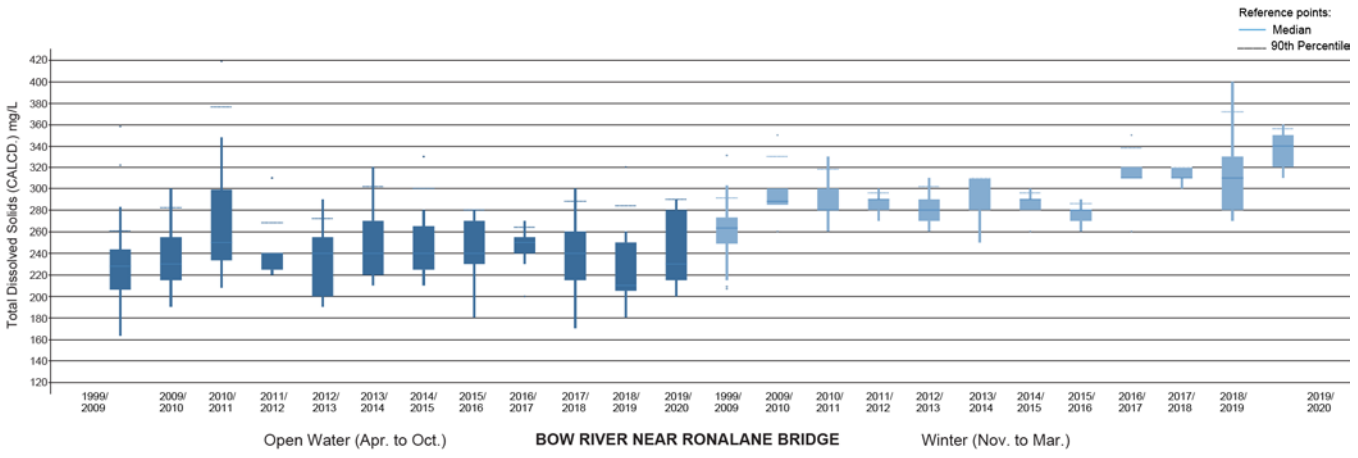

Figure A14: Box plots of the total dissolved solids data in the Bow River at Ronalane station during open water and winter from April 1999 to March 2020.

Bow River at Ronalane – Specific Conductance Open Water and Winter Median and Peak Trigger Exceedances

Examination of the dataset revealed that the 2019/2020 median and 90th percentile values (except the winter median) are not the highest observed in the dataset at this station (Figure A15).

Overall, the specific conductance concentrations in the Bow River at Ronalane are similar to the upstream stations (Carseland and Cluny), are higher than the most upstream station (Cochrane) and are similar to those observed at the comparable stations (Hwy 3 and Hwy 36) on the Oldman River. Further data analysis is needed to determine what influence river flow has on specific conductance concentrations.

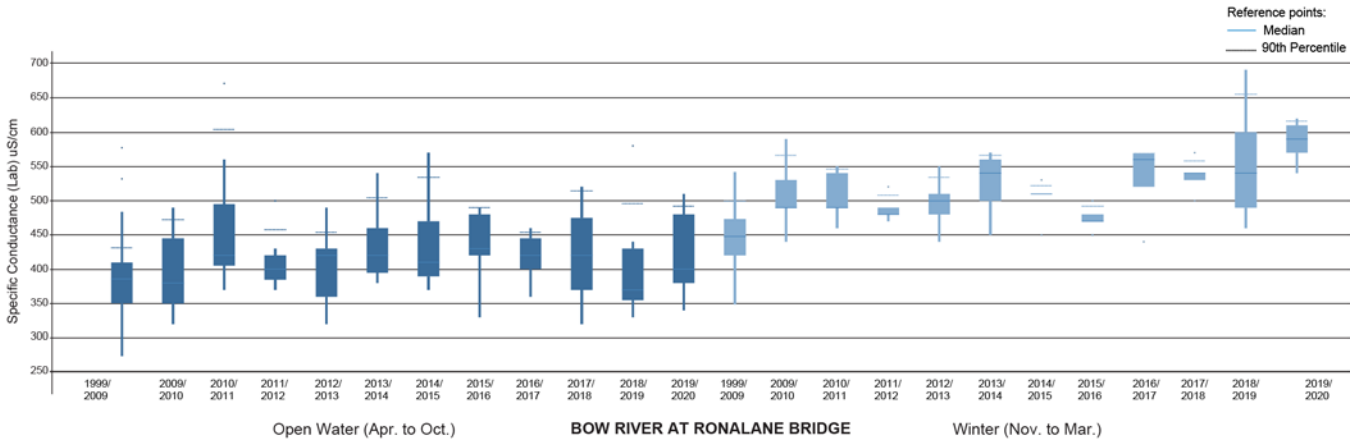

Figure A15: Box plots of the specific conductance data in the Bow River at Ronalane station during open water and winter from April 1999 to March 2020.

Milk River at Hwy 880 – Total Dissolved Solids, Winter Median Limit Exceedance

Examination of the dataset revealed that while the 2019/2020 winter median value is below the winter median trigger value of 606 mg/L and is not the highest observed in the dataset at this station, it is above the 500 mg/L winter median limit value (Figure A16).

Overall, the TDS concentrations in the Milk River at Hwy 880 are higher than those concentrations seen in the Oldman, Bow or South Saskatchewan Rivers. Further data analysis is needed to determine what influence river flow has on TDS concentrations observed at this station for this year.

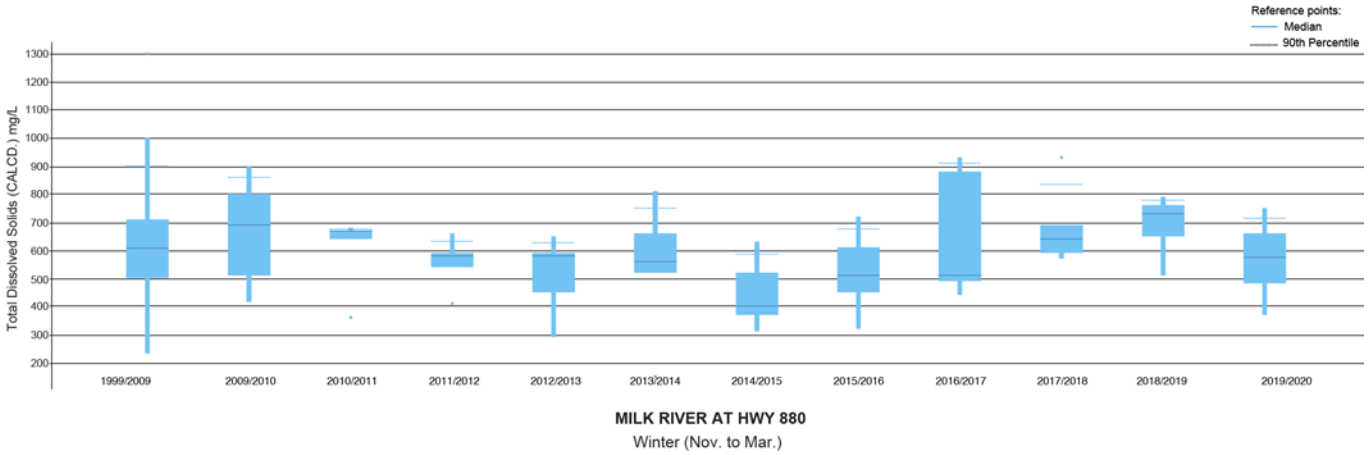

Figure A16: Box plots of the total dissolved solids data in the Milk River at Hwy 880 station during winter from November 2003 to March 2020.

Appendix E: Investigation Technical Information

TDS & Specific Conductance – Milk River Hwy 880

The framework limits for TDS and specific conductance are set at 500mg/L and 1000 µS/cm respectively (AESRD 2014). The seasonal medians exceeded the limit for TDS in the winter (November to March) in 2015/2016, 2016/2017, 2017/2018, 2018/2019 and 2019/2020 as well as specific conductance in the winter in 2017/2018 and 2018/2019 (Kerr et al., 2018a; Kerr et al., 2018b; Chung et al., 2019; Taube and Kerr, 2020; Chung et al., 2021). As a management response, an investigation was initiated which included a literature review and analysis on surface water, groundwater water and water quantity (flow) data. The results of the investigation are provided in a separate report (Gaas and Kromrey, 2021). The report suggests that the winter exceedances are primarily controlled by the lack of dilution water from the St. Mary River which is diverted into the Milk River during the open water months, and that salinity to the Milk River in the winter is likely due to groundwater input.

Trigger exceedances – Bow River

An investigation in the Bow watershed will be initiated to address the TDS, specific conductance, sulphate, chloride, nitrate and total nitrogen exceedances reported among the four Bow River stations since 2014 (Table A2). The investigation will focus on the objectives of; source tracking (i.e. determining the cause of trigger exceedances), determining a need for management actions and, recommendations for management actions (if needed). The initial focus will be on the first objective, starting with an in-depth literature review. Additional data gathering and analysis of surface water quality including tributary inputs, groundwater water, water flow influences and effluent discharged to the Bow River may follow.