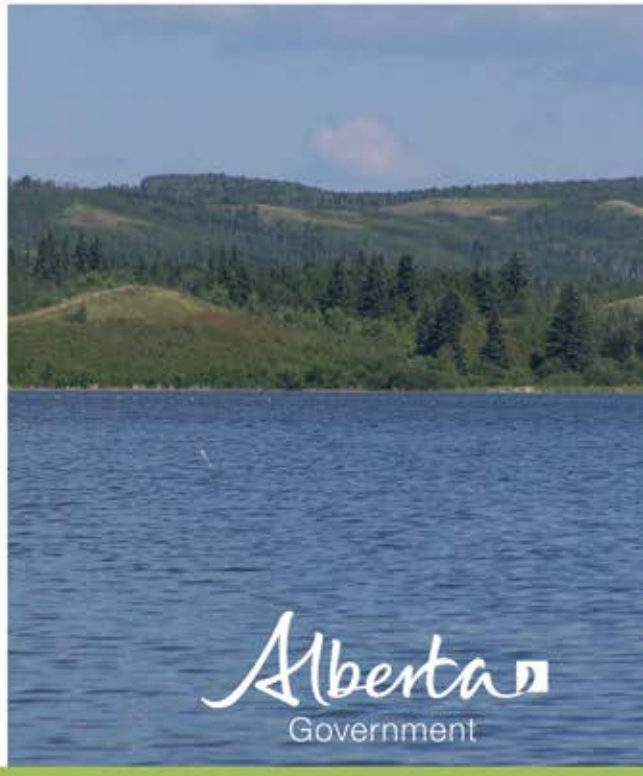
Lower Athabasca Region

Status of Management Response for Environmental Management Frameworks

- Air Quality Management Framework
- Surface Water Quality Management Framework

As of May 2015



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Executive Summary

As part of the Integrated Resource Management System, this report communicates the Government of Alberta's management response to the air and surface water quality triggers for the years 2012, 2013 and 2014 in the Lower Athabasca Region. This fulfils commitments made to Albertans in the *Lower Athabasca Region Air Quality Management Framework for Nitrogen Dioxide (NO_2) and Sulphur Dioxide (SO_2) and the Lower Athabasca Region Surface Water Quality Management Framework for the Lower Athabasca River*.

Between 2012 and 2014, there were no limits exceeded for air and surface water quality indicators. This means that the state of environmental health remains within the range of acceptable conditions, and that air and surface water quality objectives identified in the Lower Athabasca Regional Plan are being met.

However, some proactive triggers were exceeded. As a result, the Ministry of Environment and Parks is leading the required management response. This report communicates the status of the response to 2013 and 2014 trigger exceedances, and includes an update on the management response to 2012 trigger exceedances.

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

Air Quality

- The verification, preliminary assessment steps of the management response for SO_2 and NO_2 trigger exceedances have been completed, as well as, investigation of the 2012 and 2013 trigger exceedances.
- Based on the investigation, management actions have been identified, including monitoring of the ongoing Syncrude Sulphur Emissions Reduction Program
- In addition, data gathering and development of a trend assessment methodology will be undertaken to improve understanding of emission sources and impacts to air quality
- The next step in the management response is to work with the Alberta Energy Regulator (AER) and external parties as required, to confirm and implement the identified management actions. Additional actions may be identified as a result of the investigation of the 2014 air quality data.

Surface Water Quality

- The verification and preliminary assessment steps of the management response have been completed for the surface water quality indicators that exceeded a trigger in 2012 (dissolved lithium, total nitrogen and dissolved uranium)
- Based on the assessment, total nitrogen and dissolved uranium have been moved into the investigation phase
- It has been determined that dissolved lithium is not a concern and therefore will not undergo further investigation
- Verification has been completed for water quality indicators that exceeded a trigger in 2013 (dissolved uranium, total nitrogen, dissolved iron, dissolved aluminum and total lithium) and 2014 (dissolved uranium, dissolved cobalt, sulphate and potassium)
- Preliminary assessment of dissolved iron, dissolved aluminum, dissolved cobalt, sulphate and potassium is underway to determine if these indicators will also be moved into the investigation phase along with total nitrogen and dissolved uranium.

The status of this management response will be further updated annually and will be publicly available on Environment and Parks website. Two technical supporting documents that informed this status report will also be available.

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Status of Air Quality Management Response

Figures

Tables

1.0 Introduction

Under the Lower Athabasca Regional Plan, a management response must be initiated when a trigger or limit has been exceeded, as determined by the Minister of Environment and Parks. Part of the management response is determining the need for management action(s).

The Minister's Determination confirmed that no limits were exceeded. However, air quality triggers were exceeded in both years at several monitoring stations, resulting in the assignment of ambient air quality levels described in the 2012, 2013 and 2014 Status of Ambient Environmental Condition Reports (Environment and Parks, 2016; AEMERA, 2016).

All of the stations that exceeded triggers in 2012 also exceeded triggers in 2013 (Table 1, Figure 1). In addition to these, the Fort McMurray–Patricia McInnes station also exceeded triggers in 2013. No additional stations exceeded triggers in 2014. One station, Buffalo Viewpoint, fell below the trigger to Level 2.

A management response is currently underway based on the Minister's Determination of trigger exceedances in 2012 and levels assigned in the 2012 Report on Ambient Environmental Condition (2012 Ambient Condition Report (Environment and Parks, 2015)). Initial steps of this management response are described in the Lower Athabasca Region Status of Management Response for Environmental Management Frameworks (as of March 2014). Based on the Minister's Determination of trigger exceedences in 2013, the Fort-McMurray-Patricia McInnes station has been added to the management response. No additional stations have been added to the management response in 2014.

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

Table 1
Ambient levels assigned to air quality stations in the Lower Athabasca Region in 2012 and 2013 based on triggers established in the Air Quality Management Framework

Station Name (listed North to South)	Nitrogen Dioxide						Sulphur Dioxide					
	Annual Average			Upper Range			Annual Average			Upper Range		
	2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014
Fort Chipewyan	1	1	1	1	1	1	1	1	1	1	1	1
CNRL Horizon	1	1	1	2	2	2	1	1	1	2	2	2
Shell Muskeg River[1]	2	2	2	2	2	2	1	1	1	2	2	2
Wapasu			1			1			1			1
Bertha Ganter – Fort McKay[2]	1	1	1	2	2	2	1	1	1	2	2	2
Fort McKay South[3]	1	1	1	2	2	2	1	1	1	2	2	2
Mildred Lake							1	1	1	3	2	3
Lower Camp							1	1	1	2	2	2
Buffalo Viewpoint							1	1	1	2	2	1
Mannix							1	1	1	3	3	3
Millennium Mine[4]	2	2	2	2	2	2	1	1	1	2	2	2
Fort McMurray Patricia McInnes	1	1	1	1	2	1	1	1	1	1	2	2
Fort McMurray – Athabasca Valley	2	2	2	2	2	2	1	1	1	1	1	1
Anzac	1	1	1	1	1	1	1	1	1	1	1	1
Maskwa	1	1	1	1	1	1	1	1	1	1	1	1
Cold Lake South	1	1	1	1	1	1	1	1	1	1	1	1

[1] Previously named the Albian Muskeg River station
[2] Previously named the Fort McKay station
[3] Previously named the Syncrude UE1 station
[4] Previously named the Millennium station

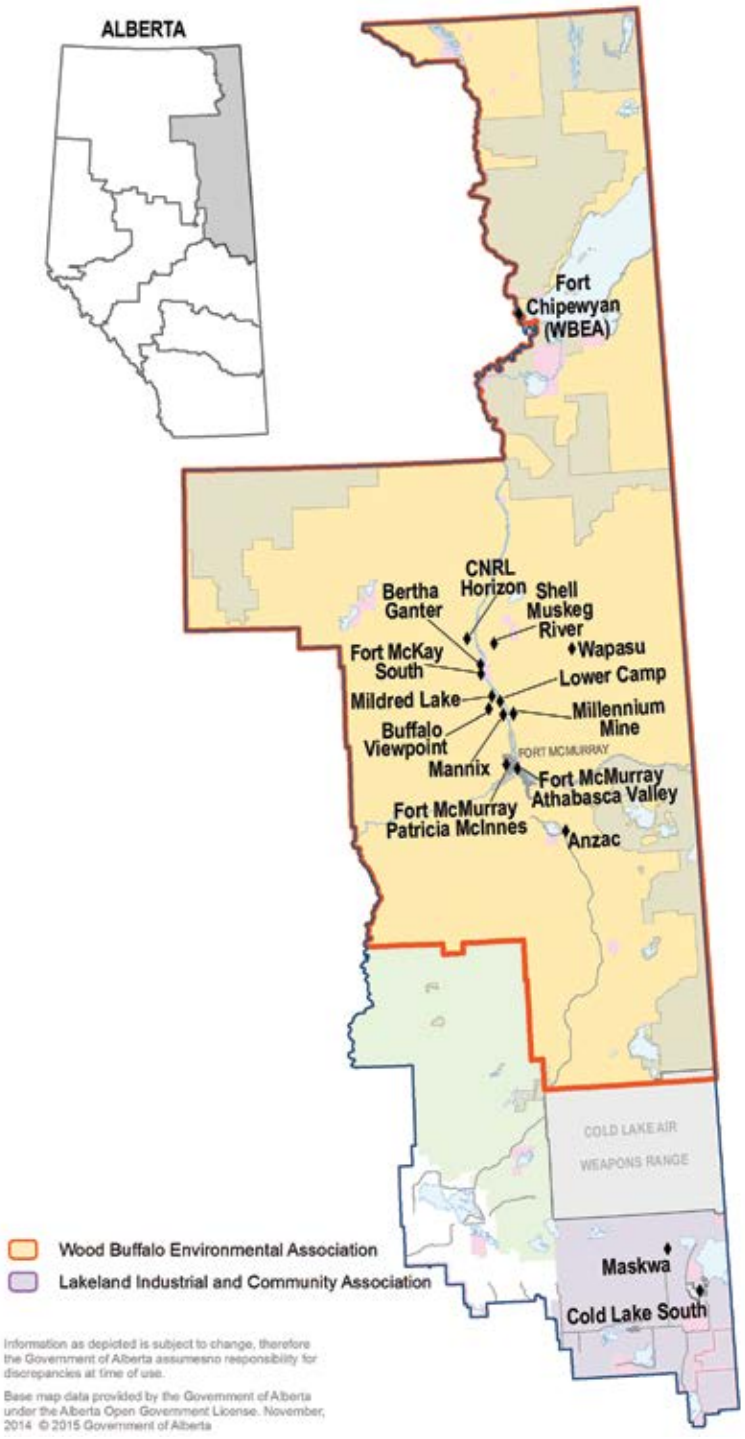

Figure 1
Location of Ambient Air Quality Monitoring Stations in the Lower Athabasca Region (using 2013 station names).

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

There are seven steps in the management response:

- Verification
- Preliminary assessment
- Investigation
- Management Actions
- Oversight/Delivery of management actions
- Evaluation
- Communication

The management response for air will consider a variety of factors including the type and location of the monitoring station, averaging time (hourly or annual) and the ambient air quality trigger or limit that was exceeded.

This report provides: 1) an update on the management response to 2012 trigger exceedances, 2) the initial status of the management response to 2013 and 2014 trigger exceedances, and 3) a list and update on management actions to be undertaken.

2.0
2012 Management Response

This section of the report summarizes progress made on the management response since the release of the *Lower Athabasca Region Status of Management Response for Environmental Management Frameworks (as of March 2014)*. This progress includes completion of the technical supporting document on 2012 air quality in the Lower Athabasca Region (Liu *et al*. 2015), which describes in detail the analyses conducted to support the results and recommended actions presented.

2.1 Verification and Preliminary Assessment

Verification and preliminary assessment were completed as part of the 2012 Ambient Condition Report. Since that reporting, it has been confirmed that no rare or natural circumstances (e.g. forest fires) contributed to the trigger exceedances. The resulting level assignments for SO_2 and NO_2 are shown in Figures 2 and 3, respectively.

2.2 Investigation

A detailed investigation of the ambient concentrations of NO_2 and SO_2 at stations which exceeded Level 2 and Level 3 triggers was completed in 2015.

The majority of the triggers observed in 2012 were for the upper range of the hourly data for both NO_2 or SO_2 (Table 1). This measure of air quality (as represented by the 99th percentile of the hourly data) serves to track the frequency and magnitude of short-term (1-hr) elevated concentrations in NO_2 and SO_2 over time, and supports an assessment of year over year change. An increasing trend signifies that peak concentrations may be increasing in magnitude or occurring more frequently across the region. While unfavorable, neither a trigger nor a trend in upper range of hourly data is a cause for immediate concern; instead these findings allow for proactive management action to be taken and show that the system is working as it should.

The focus of the investigation was on understanding the sources and conditions that have contributed to trigger exceedances in order to inform the identification of any actions needed. For the Level 3 stations the management intent is to prevent the station from moving in to Level 4. For the Level 2 stations, the management intent is to improve our knowledge, understanding and plan. In both cases, there is a need to take into consideration the averaging time (hourly or annual) for ambient air quality triggers.

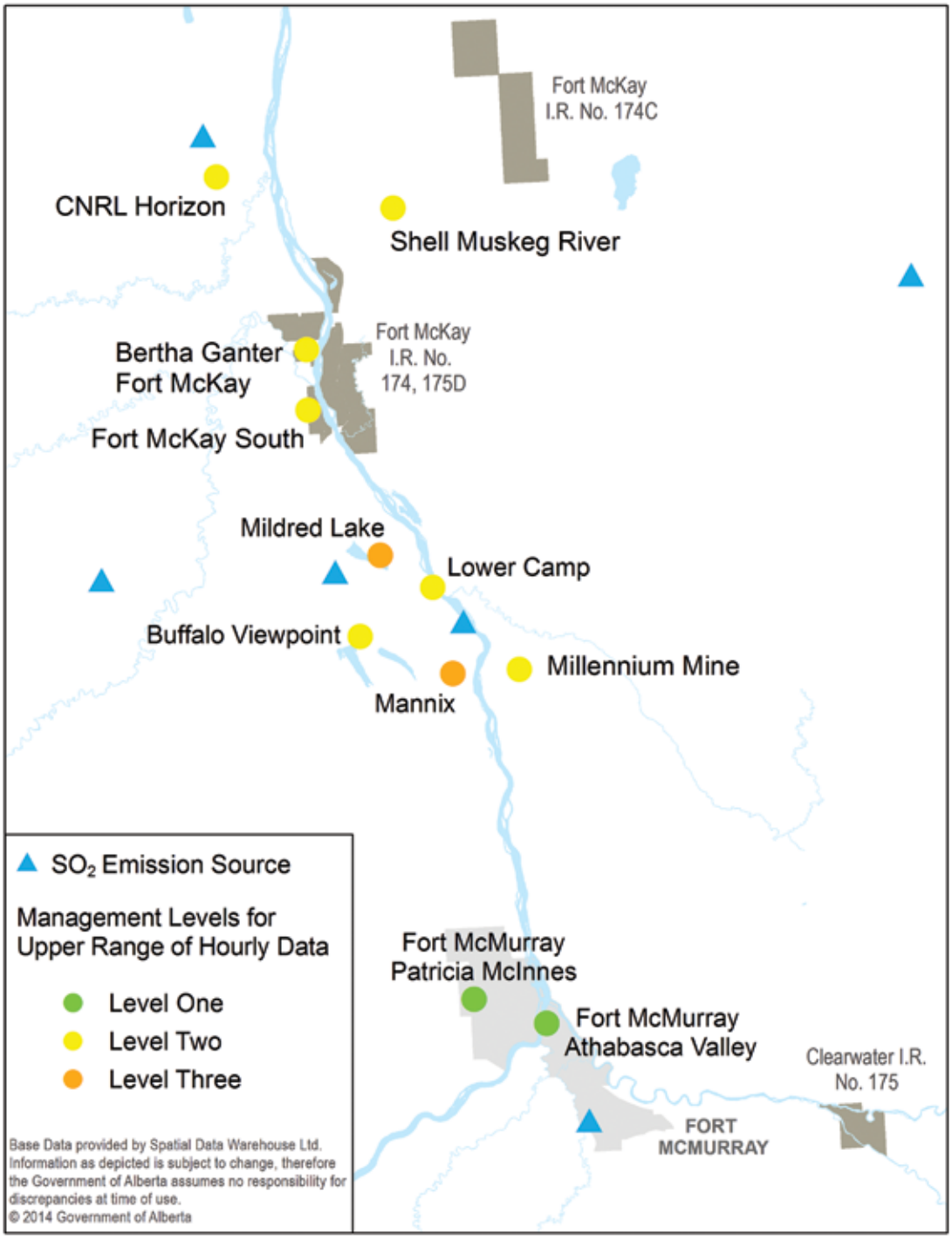

Figure 2
2012 level assignment for SO_2 for the Upper Range of Hourly Data at Ambient Air Quality Monitoring Stations in the Lower Athabasca Region (using 2013 station names).

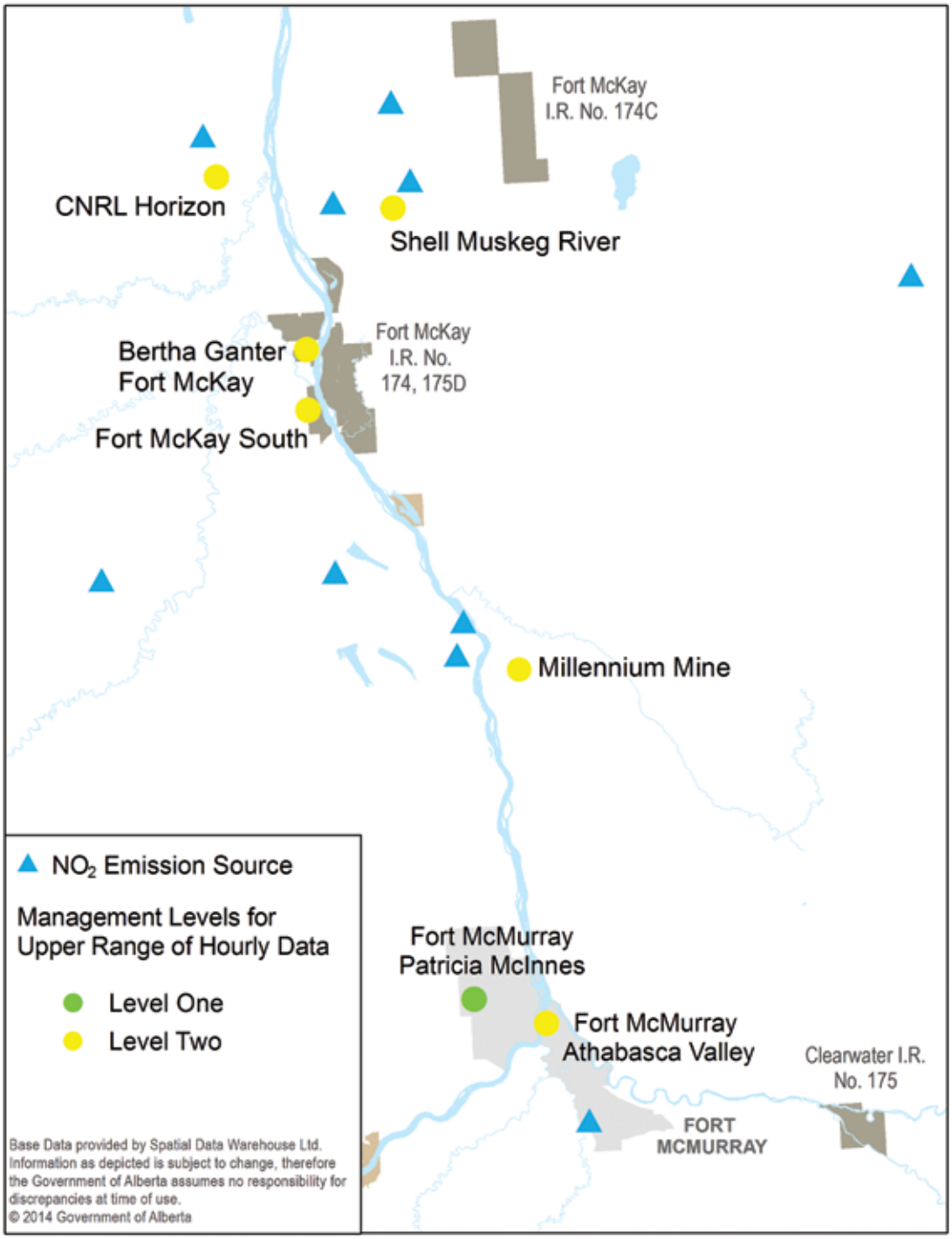

Figure 3
2012 level assignment for NO_2 for the Upper Range of Hourly Data at Ambient Air Quality Monitoring Stations in the Lower Athabasca Region (using 2013 station names).

The preliminary investigation conducted in 2013/14 and documented in the *Lower Athabasca Region Status of Management Response for Environmental Management Frameworks (as of March 2014)* focused on:

- Identifying and quantifying sources of SO_2 and NO_2 in the Lower Athabasca Region;
- Determining the conditions under which higher concentrations of SO_2 and NO_2 are observed (including consideration of meteorological conditions, seasonality and time of day);
- Assessing ambient concentrations in the context of previous years (2003 to 2012)
- Reviewing modelling studies to better understand predictions of future air quality in the Lower Athabasca Region; and
- Identifying the emission reduction programs currently in place or planned for the future.

Subsequently, more extensive investigations were conducted that build on the 2013/14 work and address recommendations made in the *Lower Athabasca Region Status of Management Response for Environmental Management Frameworks (as of March 2014)*. These investigations are documented in the technical supporting document (Liu *et al*. 2015) and resulted in the following key findings:

Sulphur Dioxide

SO_2 – General

For annual average of hourly data, the SO_2 concentrations were at Level 1 for all ambient air monitoring stations indicating that under most conditions the ambient SO_2 concentrations were low. However, a number of short-term (1-hr) elevated SO_2 concentrations at several stations resulted in trigger exceedances for the upper range of SO_2 and the Level 2 or Level 3 assignments. At the Level 3 stations, elevated SO_2 concentration occurred more frequently at higher wind speeds. These stations are located in close proximity to operations and it is likely that they are affected by plume downwash. At the Level 2 stations, elevated SO_2 concentrations were observed more frequently at lower wind speeds, a condition that can limit the effective dispersion of pollutants.

At both the Level 3 and Level 2 stations, strong diurnal effects were observed, with fewer peak events occurring during the night time. This observation is likely because deeper atmospheric mixing during the day time increases the potential for the pollutant plumes to be dispersed to ground level.

SO_2 Emission Sources

Industry point sources are the major source of SO_2 emissions in the Lower Athabasca Region. The association of high SO_2 concentrations with specific wind directions suggests a relationship between trigger exceedances for the upper

range of SO_2 concentrations at several stations and major industry point sources. Specifically, the Level 3 Mannix and Mildred Lake stations are highly influenced by the Suncor and Syncrude upgraders, respectively. These industrial stations are located close to emission sources and represent air quality near the facility and not air quality of the region as a whole. As stated in the Framework, short term peaks are anticipated to be more prevalent at industrial stations due to the influence of point sources, which can be exacerbated by meteorological events.

Year-to-year variations in SO_2

A review of Environment and Parks State of the Environment trend reporting (calculated for annual averages and the upper range of annual SO_2) on all available monitoring data showed either no trend or decreasing trends for all Level 2 and Level 3 stations. This initial finding suggests that peaks are not increasing in magnitude or occurring more frequently at the stations, nor are the annual averages increasing over the period of record for each station.

Modelling Studies

Three modelling studies that generated predictions of future air quality in the Lower Athabasca Region were reviewed (Stantec, 2009; ENVIRON and Stantec, 2012; Golder Associates, 2012). Two of the three studies (Stantec, 2009; ENVIRON and Stantec, 2012) predicted future reductions in SO_2 concentrations in the region, primarily due to the projected completion of the Syncrude Sulphur Emissions Reduction Project. Golder Associates (2012) also generated predictions of future air quality in the Lower Athabasca Region, but did not specifically address the anticipated changes due to Syncrude project.

Current SO_2 Reduction Initiatives

Various initiatives are underway in the region to reduce SO_2 emissions. The most significant of these is the commissioning of the Syncrude Sulphur Emissions Reduction Project. The approved limits for SO_2 emissions at this facility were 250 tonnes per day in 2012. In December 2014, the limits decreased to 150 tonnes per day. In December 2016 when the project is expected to be fully operational, the limits will decrease to 100 tonnes per day. This results in a per cent decrease in approval limits for SO_2 of 60 per cent between operations in 2012 and expected operations in 2017.

Nitrogen Dioxide

NO_2 – General

For annual average of hourly data, the NO_2 concentrations were at Level 2 for three ambient air monitoring stations (Shell Muskeg River, Millennium Mine and Fort McMurray Athabasca Valley); these three stations were also at Level 2 for NO_2 concentrations for the upper range of hourly data. Three additional stations were at Level 2 for NO_2 concentrations for the upper range of hourly data only. In all cases, elevated concentrations were observed more frequently during the colder months, as well as at lower wind speeds, when wider dispersion of NO_2 from emission sources is lessened.

NO_2 – Emission Sources

Industrial NO_2 emissions, including point source emissions (stacks) and non-point source emissions (mine fleets) contribute to more than 90 per cent of total NO_2 emissions in the Lower Athabasca Region. Sources of NO_2 are more diverse and dispersed than sources of SO_2; a notable fraction of NO_2 is emitted by mine fleets as well as commuting vehicles.

Year-to-year variations in NO_2

A review of Environment and Parks State of the Environment trend reporting (calculated for annual averages and the upper range of annual NO_2) for the Level 2 stations showed no trend for Millennium Mine and CNRL Horizon station, and insufficient data for trend assessment at the Shell Muskeg River station. An increasing trend in ambient NO_2 concentrations was shown for three Level 2 NO_2 stations: Fort McMurray Athabasca Valley, Bertha Ganter Fort McKay and Fort McKay South stations (for either annual average to upper range). In all cases, the ambient concentrations are far below the trigger into the next Level.

Modelling Studies

The reviewed modelling studies predict that ambient NO_2 concentration will be increasing in the long term (10 to 20 years) primarily due to planned industry development in the Lower Athabasca Region (Stantec, 2009; ENVIRON and Stantec, 2012; Golder Associates, 2012).

Current Initiatives to Reduce NO_2 and NO_x

Regulations are in place to mitigate nitrogen oxide (NO_x) emissions from large point sources and mine fleets. New boilers, heaters and turbines for the oil sands region are subject to performance targets that represent the approximate level of NO_x emissions achievable using the best NO_x control combustion technology available. AER regulations for mobile NO_x emissions from the heavy haul mine fleets require the use of Tier 4 engines, when they are commercially available, as per the site-

specific oil sands mine approvals. In 2018, the federal government will require that new and imported engines be Tier 4.

Conclusion

The investigation indicates that air quality in the region in 2012 meets the air quality objectives established in the Lower Athabasca Region Air Quality Management Framework. However, proactive management actions should be undertaken to address Level 2 and Level 3 trigger exceedances observed. These are described in detail in Section 4.0.

3.0
2013 Management Response

This section of the report presents progress on the management response to trigger exceedances determined in the 2013 Ambient Condition Report. For indicators and stations that exceeded triggers in both 2012 and 2013, the management response in 2013 is a continuation of the work initiated in response to the 2012 exceedances.

3.1 Verification and Preliminary Assessment

Verification and preliminary assessment of the 2013 air quality monitoring data is complete. This work was predominantly undertaken in the preparation of the 2013 Ambient Condition Report. Data were downloaded from the CASA Data Warehouse and the annual average of the hourly data and the upper range (as represented by the 99th percentile of the hourly data) were calculated and compared against triggers and limits. The preliminary assessment suggests that no rare events or natural circumstances (e.g. forest fires) contributed to trigger exceedances in 2013.

3.2 Investigation

The investigation of 2013 trigger exceedances was focused on stations that were assigned a different level in 2013 than in 2012. Fort McMurray Patricia McInnes station was assigned to Level 2 for the upper range data for both NO_2 and SO_2 concentrations for 2013, up from Level 1 in 2012. In contrast, the level assigned to Mildred Lake station dropped from Level 3 in 2012 to Level 2 in 2013, for the upper range of SO_2 (Table 1). The ambient data collected at these stations in 2013 were analyzed to determine whether the conclusions of the technical supporting document (Liu *et al.* 2015) remain relevant to these stations at their new assigned level, or whether an additional investigation is necessary as part of the 2013 management response.

The preliminary investigation of the 2013 data from Mildred Lake and Fort McMurray Patricia McInnes stations concluded that potential factors influencing the concentrations observed at these stations in 2013 (e.g. meteorological conditions) were consistent with those observed in 2012. Changes in the levels assigned to these stations in 2013 were likely the result of year-to-year natural variation. This type of variation is observed at all stations and therefore trend analyses will continue to be needed to be able to distinguish potential patterns that may emerge for air quality at stations over time.

4.0
2014 Management Response

This section of the report presents progress on the management response to trigger exceedances determined in the 2014 Ambient Condition Report. For indicators and stations that have exceeded triggers in the past, the management response in 2014 is a continuation of the work initiated in response to the 2012 and 2013 exceedances.

4.1 Verification and Preliminary Assessment

Verification and preliminary assessment of the 2014 air quality monitoring data is complete. This work was predominantly undertaken in the preparation of the 2014 Ambient Condition Report. Data were downloaded from the CASA Data Warehouse and the annual average of the hourly data and the upper range (as represented by the 99th percentile of the hourly data) were calculated and compared against triggers and limits. The preliminary assessment suggests that no rare events or natural circumstances (e.g. forest fires) contributed to trigger exceedances in 2014.

4.2 Investigation

The focus for the 2014 investigation will be on NO_2 levels at the Fort McMurray Athabasca Valley station. This station is at a Level 2 and both annual average and upper range levels appear to be increasing. In addition, an exceedance of the one-hour objective was measured on February 23, 2014. Preliminary information suggests that there has been an increase in traffic near the monitoring station. The investigation will focus on the extent to which changes in traffic patterns are contributing to changes in NO_2 concentrations and depending on the result, additional management actions may be identified.

No new stations were added to the management response in 2014. Changes in levels assigned to these stations in 2014 were likely the result of year-to-year natural variation. This variation is observed at all stations and therefore trend analyses will continue to be able to distinguish potential patterns that may emerge for air quality stations over time.

5.0 Management Actions

Following the investigation, the next step in the management response is the identification of management actions.

Environment and Parks has identified a series of recommended management actions based on the analyses of the 2012 and 2013 monitoring data and subsequent investigations *(*Liu *et al.* 2015). These actions take into account ongoing initiatives that are being developed or are in place to reduce emissions in the region and are described below. Upon completion, findings from the 2014 investigation will help inform whether additional management action is required.

5.1 Level 3 Stations – Sulphur Dioxide (Upper Range)

Management Level	Management Intent
Level 4	Improve ambient air quality to below Level 4 trigger
Level 3	Proactively maintain air quality below Level 4 trigger
Level 2	Improve knowledge, understanding, and plan
Level 1	Apply standard regulatory and non-regulatory tools

At Level 3, appropriate management actions are selected to ensure that conditions do not move to a Level 4. Based on our understanding of the sources and conditions that have contributed to the exceedance of the Level 3 triggers for the upper range of hourly data, Environment and Parks has determined that actions should be focused on emissions management.

Emissions Management

Syncrude's planned sulphur emission reduction technology is projected to reduce ambient SO_2 in the oil sands area. The approved limits for SO_2 emissions decrease 60 per cent between 2012 and 2017. This work is underway and based on current understanding, the probability of trigger exceedances is expected to decrease, satisfying the management intent for Level 3.

Recommended Management Actions

Action – Sulphur Emissions Reduction

Lead – AER/Environment and Parks

Environment and Parks will work with the Alberta Energy Regulator (AER) to monitor the progress of the Syncrude Sulphur Emissions Reduction Project and the impact of the emissions reductions. We will report annually on the effectiveness of this project to reduce SO_2 concentrations up to and following when this technology is at full capacity (scheduled for 2017).

The action identified for Level 3 stations will also likely affect the Level 2 stations with SO_2 triggers, as the SO_2 emissions reduction project is anticipated to reduce ambient concentrations of SO_2 in the oil sands area.

5.2 Level 2 Stations – Sulphur Dioxide (Upper Range) and Nitrogen Dioxide (Annual Average and Upper Range)

Management Level	Management Intent
Level 4	Improve ambient air quality to below Limit/Level 4 trigger
Level 3	Proactively maintain air quality below Limit/Level 4 trigger
Level 2	Improve knowledge, understanding, and plan
Level 1	Apply standard regulatory and non-regulatory tools

At Level 2, ambient levels are well below air quality limits and management actions are focussed on surveillance to improve our knowledge and understanding of ambient air quality. Based on our understanding of sources and conditions that have contributed to Level 2 trigger exceedances, Environment and Parks has selected management actions related to understanding trends, assessing the monitoring network and improving our understanding of emissions sources.

Recommended Management Actions

Action – Develop improved trend assessment methodology

Lead – Environment and Parks

This trend assessment methodology will be used at regular intervals to assess regional trends in NO_2 and SO_2 in future management responses. The trend analysis used in the current investigation is part of the State of the Environment reporting completed by Environment and Parks which has some limitations (Liu *et al.* 2015) for application in the context of the Lower Athabasca Region Air Quality Management

Framework. A new methodology would yield information on more recent changes to ambient air quality in order to identify emerging issues and track the effectiveness of air quality management in the area.

Action – Assess and improve monitoring network

Lead – Environment and Parks

Monitoring objectives for the Air Quality Management Framework will be incorporated in the Oil Sands Monitoring (OSM) network assessment, which will provide recommendations on adjustments to the monitoring network to improve characterization and understanding of ambient air quality in the region. This network assessment is part of the enhanced monitoring activities undertaken in OSM's 2014-15 and 2015-16 work plans. It will inform the evaluation and management of air quality in the Lower Athabasca Region and provide a broader understanding of emitted pollutants, their transport, transformation and deposition.

Action – Compile information on non-point source emissions

Lead – Environment and Parks

Information from recent studies on non-point source NO_2 emissions in the Lower Athabasca Region will be compiled to better understand emissions sources and identify potential gaps. This will also be used to inform any future modelling work related to air quality in the region.

6.0
Next Steps

Following the identification of management actions, the next step in the management response is oversight and delivery of these actions. Environment and Parks will also continue the investigation into the 2014 trigger exceedances to determine whether additional action is required.

Environment and Parks will continue to lead the development and implementation of recommended management actions, working with other government organizations (e.g. Alberta Energy Regulator (AER)) and external parties as required.

A report updating the status of the management response will be made publicly available within one year.

7.0 References

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Status of Surface Water Quality Management Response

Figures

Tables

1.0 Introduction

Under the Lower Athabasca Regional Plan, a management response must follow a trigger or limit exceedance when determined by the Minister of Environment and Parks (EP). Part of the management response is determining the need for management action(s).

The Minister's Determinations confirmed that Level 2 surface water quality triggers were exceeded again in 2013 and 2014. Exceedances occurred at the Athabasca River at Old Fort monitoring station (AEMERA 2016; Environment and Parks 2016).

The two triggers from 2012, total nitrogen and dissolved uranium, had exceedances again in 2013 (Table 1). Dissolved uranium triggered again in 2014. Three new indicators were identified in both 2013 (total lithium, dissolved iron and dissolved aluminum) and in 2014 (dissolved cobalt, sulphate, potassium). With the exception of dissolved uranium, these new exceedances are different from those in 2012. Dissolved uranium has consistently exceeded triggers since 2012. Management responses are currently underway based on 2012 and 2013 trigger exceedances and updates to these responses are provided in Section 2.0.

In summary, the number of trigger exceedances in 2012, 2013, and 2014 were three, five, and four, respectively. Total nitrogen exceeded triggers in 2012 and 2013, while dissolved uranium exceeded triggers in all three years.

Table 1. Surface water quality indicator Level 2 trigger exceedances at the Athabasca River at Old Fort monitoring station. The management intent of Level 2 exceedances is to proactively maintain water quality below limits and to improve knowledge and understanding of trends.

	Trigger exceedances			
Indicator	**2012**	**2013**	**2014**	**Current status of management response**
Aluminum (D)		Peak		Ongoing preliminary assessment
Cobalt (D)			Peak	Ongoing preliminary assessment
Iron (D)		Mean		Ongoing preliminary assessment
Lithium (D)	Peak			Ended after preliminary assessment
Lithium (T)		Peak		Ended after preliminary assessment
Nitrogen (T)	Mean	Mean		Under investigation
Potassium			Mean	Ongoing preliminary assessment
Sulphate			Mean	Ongoing preliminary assessment
Uranium (D)	Mean/Peak	Mean/Peak	Peak	Under investigation

(D) Dissolved; (T) Total

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

There are six steps in the management response:

- Verification
- Preliminary assessment
- Investigation
- Management actions
- Evaluation
- Communication

This report provides:
1) an update on the management response to 2012 trigger exceedances; and
2) the initial status of the management response to 2013 and 2014 trigger exceedances.

2.0
2012 Management Response

This section of the report summarizes progress made on the 2012 management response since the release of the *Lower Athabasca Region Status of Management Response for Environmental Management Frameworks* (as of March 2014). A technical supporting document (McKenzie et. al. 2015) describes in detail the analyses conducted to support the results presented in this section.

2.1 Verification

Environment and Parks has verified the 2012 surface water quality data and calculated the water quality metrics used to assess ambient water quality conditions against triggers and limits. This work was completed in the preparation of the 2012 Ambient Conditions Report (Environment and Parks, 2014).

2.2 Preliminary Assessment

Preliminary assessment for the 2012 management response is complete and two of the three indicators have been moved into the investigation phase of the management response (Table 2).

Table 2 - Results of preliminary assessment for the 2012 management response.

Level 2 Trigger Exceedance	Moved into Investigation Phase?
Total Nitrogen	Yes
Dissolved Uranium	Yes
Dissolved Lithium	No

The technical assessment that supports these decisions includes:

- examining 2012 flow conditions
- establishing the relationship between the water quality indicator and flow
- examining seasonality
- testing for temporal trends in flow and in water quality for each indicator.

Because flow is an important factor affecting water quality concentrations, trends were examined for both flow-adjusted (FA) and non-flow-adjusted (NFA) concentrations. By considering changes in flow in the calculations (flow-adjusted), water quality concentrations in high low times can be compared with those from low flow times allowing for trends to be observed that could not be seen by using

non-flow-adjusted data. When increasing concentration trends were observed at Old Fort monitoring station, the trends were also examined at the upstream of Fort McMurray monitoring station to look for differences or similarities between stations. The upstream Fort McMurray station is approximately 200 km upstream of the Old Fort station (Figure 1). A summary of this assessment for each indicator is given in the following sections and further details are provided in Appendix A.

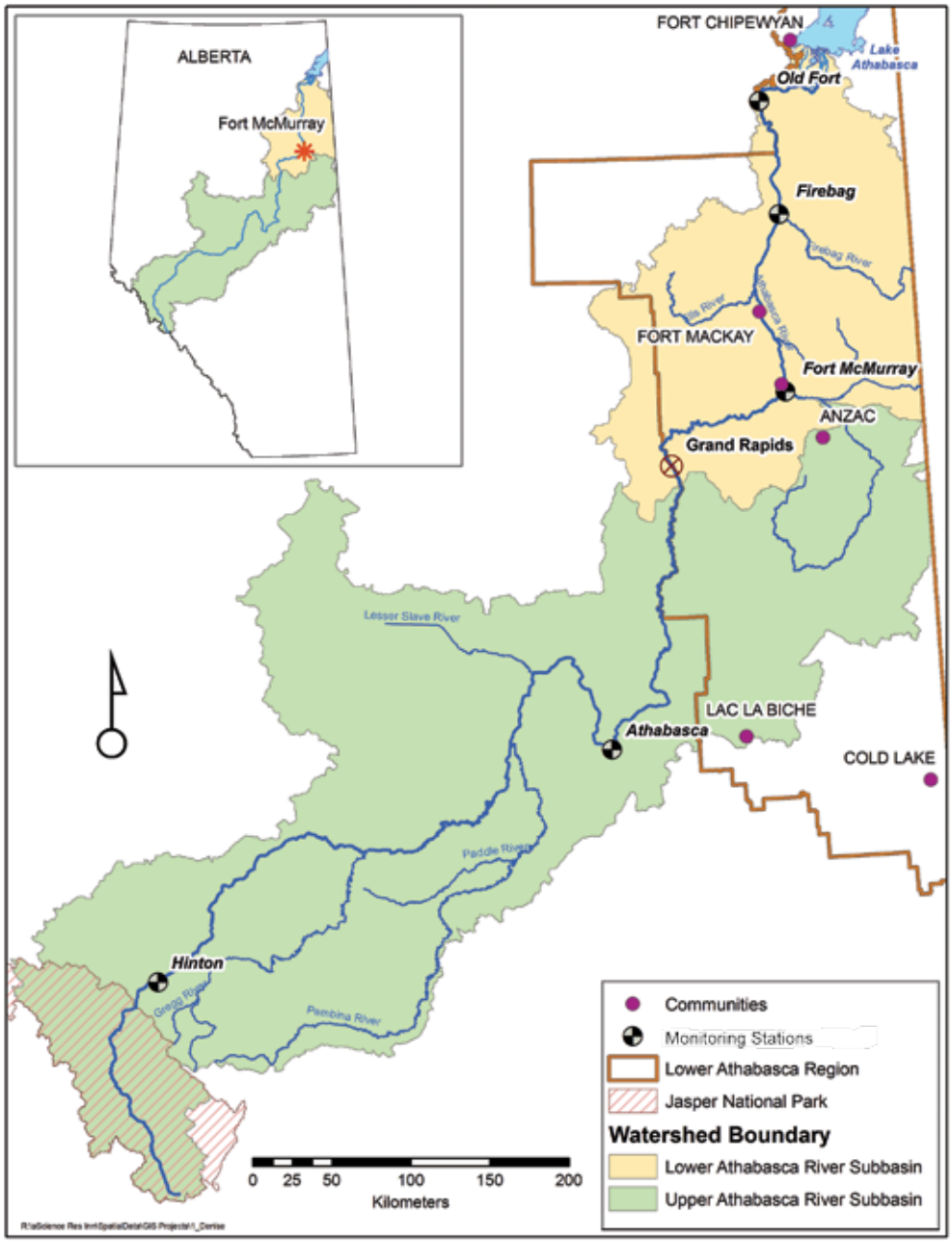

Figure 1
Select Environment and Parks Surface Water Quality Monitoring Stations in the Athabasca River Basin. Triggers apply at the Old Fort monitoring station. Data from the upstream of Fort McMurray station are also analyzed for comparison.

2.2.1 Total Nitrogen

Environment and Parks has moved total nitrogen from preliminary assessment into investigation. Trend assessment revealed statistically significant increasing trends in NFA and FA total nitrogen concentrations at the Old Fort station from 1988-2012 (McKenzie et al. 2015). Although the magnitude of the trend is small, total nitrogen again exceeded the mean trigger at Old Fort station in 2013. The potential effects of increasing total nitrogen concentrations in the lower Athabasca River are primarily related to nutrient enrichment. Nutrient enrichment is an ongoing concern within the lower Athabasca River as other studies have found increasing trends in nutrients at Old Fort (Hebben, 2009) and in the Athabasca River downstream of the Old Fort station (Glozier et al. 2009).

To investigate whether this was a trend only observed at the Old Fort station, the same calculations were completed for the Athabasca River upstream of Fort McMurray (Upstream of Fort McMurray station) and the Old Fort monitoring stations for two time periods (1989-2012 and 2002- 2012). The results showed significant seasonal trends exist at both the Upstream of Fort McMurray station and Old Fort station over the last decade. Because of the results, Environment and Parks will continue to investigate total nitrogen concentrations within the lower Athabasca River until we are confident in our understanding of the key factors influencing these trends.

2.2.2 Dissolved Uranium

Environment and Parks has moved dissolved uranium from preliminary assessment into investigation. The trend assessment at the Old Fort station did not reveal significant increasing trends in dissolved uranium concentrations from 2003-2012. The NFA results, however, were close to being statistically significant (McKenzie et al. 2015). Because it was nearly significant and because dissolved uranium triggered again in 2013, a trend assessment for the same time period was completed at the Upstream of Fort McMurray station. The results of the trend assessment found no significant differences in NFA or FA concentrations from 2003 - 2012.

These additional analyses were not initiated out of concern for existing concentrations of dissolved uranium in the lower Athabasca River. Current levels at Old Fort are lower than at upstream stations on the Athabasca River (Environment and Parks, unpublished data) and 10 times lower than the most stringent water quality guideline. The intent of the additional testing is to better understand temporal and spatial patterns in dissolved uranium in the lower Athabasca River.

2.2.3 Dissolved Lithium

Environment and Parks has completed the management response for dissolved lithium and concluded that no further action is required. This is because dissolved lithium has a strong inverse relationship with flow and the 2012 winter flows were unusually low. A trend assessment did not reveal any statistically significant trends in either the NFA or FA dissolved lithium concentrations at the Old Fort station from 1999-2012 (McKenzie et al. 2015). In addition, the timing of the 2012 dissolved lithium peak exceedances (January, February and April) corresponded well with unusual flow conditions within the lower Athabasca River.

3.0
2013 Management Response

This section of the report presents progress on the status of the management response to monitoring data reported in the 2013 Ambient Conditions Report (Environment and Parks, 2016) and some preliminary findings. For indicators that exceeded triggers in 2012 and 2013 (i.e., total nitrogen and dissolved uranium), the management response in 2013 is informed by and is a continuation of the work initiated in response to the 2012 exceedances.

3.1 Verification

Environment and Parks has verified the 2013 surface water quality data. This includes calculating the water quality metrics used to assess ambient water quality conditions against triggers and limits. This work was completed in the preparation of the 2013 Ambient Conditions Report. Environment and Parks has also verified that the Obed Mountain Mine Release did not affect the November and December 2013 ambient water quality results for the Old Fort or Upstream of Fort McMurray monitoring stations (see Appendix B).

3.2 Preliminary Assessment

The first step of the preliminary assessment was completed and is described in the 2013 Ambient Conditions Report. The Minister's Determination confirmed that Level 2 surface water quality triggers were exceeded for five indicators at the Old Fort station (total nitrogen, dissolved uranium, dissolved iron, dissolved aluminum, and total lithium). The next step is to determine if an investigation is required for these indicators.

Initial steps taken to evaluate the need for an investigation include:

1) Comparing the 2013 data to the historical dataset to put the 2013 trigger exceedances in context.
2) Examining the monitoring data from the Upstream of Fort McMurray station (Figure 1) to determine if similar patterns in the indicators are evident.

A summary of the preliminary assessment to date is provided below. A full description is provided in Appendix B.

3.2.1 Mean Annual Trigger Exceedances (Level 2)

Table 3 summarizes the results of the preliminary assessment to date, for the mean trigger exceedances.

Table 3
Comparison of 2013 annual means with historical annual means for the Athabasca River Upstream of Fort McMurray station and the Athabasca River at Old Fort station.

Indicator[1]	Units	Monitoring Station	2013 Mean	Historical Mean[2]	Data set for Historical Mean	Direction of Change	Per Cent Change
Nitrogen (T)	mg/L	Fort McMurray	0.704	0.567	1998-2009	Increase	24%
		Old Fort	0.794	0.597	1998-2009	Increase	33%
Uranium (D)	µg/L	Fort McMurray	0.564	0.456	2002-2009	Increase	24%
		Old Fort	0.363	0.313	2003-2009	Increase	16%
Iron (D)	µg/L	Fort McMurray	102	109	2002-2009	Decrease	6%
		Old Fort	266	185	2003-2009	Increase	44%

[1] (D) Dissolved; (T) Total

[2] For the Athabasca River at Old Fort monitoring station, the historical mean is also the mean trigger.

In 2013, three mean annual triggers were exceeded at the Old Fort station: total nitrogen, dissolved uranium and dissolved iron (Table 3). Total nitrogen and dissolved uranium annual means were also higher than their historical values at the Upstream Fort McMurray station.

In contrast, the concentration of dissolved iron was higher than the historical value at the Old Fort station, but lower at the Upstream of Fort McMurray station.

Examination of the historical dataset for both total nitrogen and dissolved uranium at the Old Fort station revealed that the 2013 annual mean was higher than all other annual means in the dataset, including the 2012 annual mean. The 2013 annual mean for dissolved iron was the third highest in the historical dataset.

The pattern in total nitrogen concentrations between the two stations has been variable over time. From 1988-1999 the annual means were higher 58 per cent of the time at the Upstream of Fort McMurray station; however, since 2000, the annual total nitrogen means have been consistently higher at Old Fort station. For dissolved uranium concentrations, the annual means are consistently higher at the Upstream of Fort McMurray station than at the Old Fort station. In contrast, the annual means for dissolved iron have been higher at the Old Fort station than at the Upstream of Fort McMurray station, with the exception of 1999.

3.2.2 Peak Trigger Exceedances (Level 2)

Table 4 summarizes the results of the preliminary assessment to date, for the peak trigger exceedances.

In 2013, peak triggers were exceeded at the Old Fort station for dissolved uranium, total lithium and dissolved aluminum. In each case, three out of 12 samples were above the historical 95th percentile. Five, one and zero out of 12 samples were above the historical 95th percentile for these indicators at the Upstream of Fort McMurray station in 2013, respectively.

The highest concentration of dissolved uranium and total lithium observed at the Old Fort station in 2013 did not exceed the previous maximum concentrations; however, dissolved uranium concentrations were among the highest when compared to the historical dataset used to establish triggers (2003-2009). The highest concentration of dissolved aluminum observed at the Athabasca River at Old Fort station in 2013 exceeded the previous maximum concentration by 13 per cent.

Table 4
Number of samples in 2013 above the historical 95th percentile for the Athabasca River Upstream of Fort McMurray station and the Athabasca River at Old Fort station.

Indicator[1]	Units	Monitoring Station	Historical 95th Percentile[2]	Data set for Historical 95th Percentile	# of 2013 Samples Above Historical 95th Percentile[3]
Uranium (D)	µg/L	Fort McMurray	0.615	2002-2009	5
		Old Fort	0.381	2003-2009	3
Lithium (T)	µg/L	Fort McMurray	16	2002-2009	1
		Old Fort	12	1999-2009	3
Aluminum (D)	µg/L	Fort McMurray	90	2002-2009	0
		Old Fort	49	2003-2009	3

[1] (D) Dissolved; (T) Total

[2] For the Athabasca River at Old Fort monitoring station, the historical 95th percentile is also the peak trigger.

[3] Binomial tests indicate that with 12 samples, 3 samples above the 95th percentile yields a significant result (ie. trigger exceedance at Old Fort monitoring station).

4.0
2014 Management Response

This section of the report presents progress on the status of the management response to monitoring data reported in the 2014 Ambient Conditions Report, and some preliminary findings. Progress was made on the first two steps: verification and preliminary assessment. For indicators that exceeded triggers in 2012, 2013, and 2014 (i.e., total nitrogen and dissolved uranium),the management response in 2014 is informed by and is a continuation of the work initiated in response to the 2012 and 2013 exceedances.

4.1 Verification

In this step, the 2014 surface water quality data were verified and the water quality metrics used to assess ambient water quality conditions against triggers and limits were calculated (AEMERA 2016). This work was completed in the preparation of the 2014 Ambient Conditions Report.

4.2 Preliminary Assessment

The Minister's Determination confirmed that Level 2 surface water quality triggers were exceeded for four indicators at the Old Fort station: sulphate, potassium, dissolved uranium, and dissolved cobalt. The next step is to determine if an investigation is required for each indicator.

The required steps to evaluate the need for an investigation include:

1. Comparing the 2014 data to the historical dataset to put the 2014 trigger exceedances into context.
2. Examining the monitoring data from the Upstream of Fort McMurray station to determine if similar patterns in the indicators are evident.

4.2.1 Mean Annual Trigger Exceedances (Level 2)

Table 5 summarizes the results of the preliminary assessment to date, for the mean trigger exceedances.

In 2014, two mean annual triggers were exceeded at the Old Fort station: sulphate and potassium (Table 5). The 2014 annual means at Old Fort were higher than, the historical means for both indicators (within one standard deviation). From a historical perspective, the annual means for both indicators routinely exceed the historical mean.

Sulphate and potassium mean annual concentrations (2014) were also slightly higher than their respective historical values at the station upstream of Fort McMurray. However, due to unsafe ice conditions at the Upstream Fort McMurray station, samples were not collected in March or April 2014. Therefore the calculated annual mean excludes samples from late winter and early spring. The comparisons of the historic mean and annual mean may contain temporal bias as a result of missing samples. Regardless, the 2014 annual means remained within one standard deviation from the historical mean and maximum 2014 values are below the historic 95th percentile for both indicators at the upstream Fort McMurray site.

Table 5.
Comparison of 2014 annual means with historical annual means for the Athabasca River Upstream of Fort McMurray station and the Athabasca River at Old Fort station.

Indicator	Units	Monitoring Station	2014 Mean	Historical Mean[1]	Data set for Historical Mean	Direction of Change	Per Cent Change
Sulphate	mg/L	Fort McMurray	39.5	38.029	1988-2009	Increase	4%
		Old Fort	31.25	26.747	1988-2009	Increase	17%
Potassium	mg/L	Fort McMurray	1.717	1.626	1988-2009	Increase	4%
		Old Fort	1.568	1.373	1988-2009	Increase	6%

[1] For the Athabasca River at Old Fort monitoring station, the historical mean is also the mean trigger.

4.2.2 Peak Trigger Exceedances (Level 2)

Table 6 summarizes the results of the preliminary assessment to date, for the peak trigger exceedances.

In 2014 peak triggers were exceeded at the Old Fort station for dissolved uranium and dissolved cobalt. In the case of dissolved uranium, four out of 12 samples were above the historical 95th percentile. These four samples were higher than all but one measurement in the historical dataset.

With respect to dissolved uranium data collected at the upstream of Fort McMurray station, only one observation within the historical dataset exceeded the 95th percentile between 2003 and 2009. This maximum historic value was surpassed in two samples collected on November 18th and December 9th, 2014. These high concentrations at the Upstream of Fort McMurray station and had roughly coincident timing with peak exceedances measured downstream at Old Fort.

Both stations experienced episodic increases in dissolved uranium that differed from historical conditions. Yet despite coincident peaks in concentration, the differences in results at the two stations suggest that dilutive processes exerted significant influence as water travelled downstream to Old Fort. Higher spatial resolution sampling could aid the investigation of dissolved uranium.

With respect to dissolved cobalt, three out of 12 samples were higher than the historical 95th percentile for the Old Fort station. These values were also higher than the maximum values within the historical dataset. These relatively high concentrations at Old Fort coincided temporally with high concentrations at the Upstream of Fort McMurray station; however, none of the nine samples collected at the upstream of Fort McMurray station exceeded the historic 95th percentile. While the historical mean is lower at Old Fort than at the upstream Fort McMurray station, the variance in the historical dataset at Old Fort has also been considerably lower.

Table 6.
Number of samples in 2014 above the historical 95th percentile for the Athabasca River Upstream of Fort McMurray station and the Athabasca River at Old Fort station.

Indicator[1]	Units	Monitoring Station	Historical 95th Percentile[2]	Data set for Historical 95th Percentile	# of 2014 Samples Above Historical 95th Percentile[3]
Uranium (D)	µg/L	Fort McMurray	0.615	2002-2009	2
		Old Fort	0.381	2002-2009	4
Cobalt (D)	µg/L	Fort McMurray	0.243	2003-2009	0
		Old Fort	0.105	2003-2009	3

[1] (D) Dissolved; (T) Total

[2] For the Athabasca River at Old Fort monitoring station, the historical 95th percentile is also the peak trigger.

[3] Binomial tests indicate that with 12 samples, 3 samples above the 95th percentile yields a significant result (ie. trigger exceedance at Old Fort monitoring station).

5.0
Next Steps

The next steps in the Management Response are to continue with the investigation phase for dissolved uranium and total nitrogen. To assist with this, in the winter of 2014/15, Environment and Parks conducted a synoptic water quality survey of the Athabasca River from the headwaters to the mouth. A synoptic survey consists of sampling the river at timed intervals along the river to understand where the changes in water composition occur and by how much. It helps us to understand what may be influencing the water chemistry along its path and provide insight about the potential sources of contaminants to the river. Once validation is completed and analysis occurs, it should assist us in further developing the management response, including the design of more specific studies to narrow down causes. While a low flow synoptic survey (i.e. winter) can provide insight into issues such as point-sources and and groundwater/surface water interactions, an additional survey under high flow conditions may be necessary to better understand issues such as non-point sources.

In addition to the synoptic survey, ambient monitoring data collected historically through the Regional Aquatics Monitoring Program and the Oil Sands Monitoring Program will also be investigated for potential emerging trends.

Environment and Parks will also complete the preliminary assessment for the indicators that exceeded triggers in 2013 or 2014. This will include conducting flow- and non-flow-adjusted analyses and completing a trend assessment. Comparison will be made with the upstream of Fort McMurray station as appropriate. These analyses will assist in understanding how the natural conditions for 2013 and 2014 may or may not have contributed to triggering exceedances and will determine for which indicators an investigation is required.

A report updating the status of the management response will also be made publicly available within one year.

6.0 References

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7.0 Appendices

Appendix A

Results of Trend Assessment in 2012 Management Response

The 2012 management response included an assessment of temporal trends in flow and in water quality for each of the three indicators for which there were trigger exceedances, namely, total nitrogen, dissolved uranium and dissolved lithium.

Because flow is an important factor affecting water quality concentrations, trends were examined for both flow-adjusted and non-flow-adjusted concentrations. When increasing trends were found for either the non-flow-adjusted or flow-adjusted concentrations, trends were examined at the Upstream of Fort McMurray monitoring station (approximately 200 km upstream of the Old Fort station; Figure 1) to better understand the trend.

Total Nitrogen

Environment and Parks has moved total nitrogen from preliminary assessment into investigation. Trend assessment revealed statistically significant increasing trends in non-flow-adjusted (NFA) and flow-adjusted (FA) total nitrogen concentrations at the Athabasca River at Old Fort monitoring station from 1988-2012 (Table A1). Although the magnitude of the trend is small, total nitrogen again exceeded the mean trigger at Old Fort station in 2013. The potential effects of increasing total nitrogen concentrations in the lower Athabasca River are primarily related to nutrient enrichment. Nutrient enrichment is an ongoing concern within the lower Athabasca River as other trend assessment studies have found increases in nutrients, at Old Fort (Hebben 2009) and in the Athabasca River downstream of Old Fort (Glozier *et. al.* 2009). Environment and Parks needs a better understanding of these increasing trends to support management and planning activities.

Table A1
Results of Trend Assessment on Total Nitrogen Concentrations at the Athabasca River at Old Fort Monitoring Station (1988-2012).
NFA=non-flow-adjusted, FA=flow-adjusted

	NFA Total Nitrogen	FA Total Nitrogen
Direction of annual trend and level of significance	Seasonal Mann-Kendall test revealed a highly significant increasing trend (p-value<0.001)	Seasonal Mann-Kendall test revealed a highly significant increasing trend (p-value<0.001)
Magnitude of trend - slope and 95 per cent confidence interval	0.0049 mg/L/year (0.002-0.007 mg/L/year)	0.006 mg/L/year (0.003-0.009 mg/L/year)
Direction of seasonal trends and level of significance	Significant increasing trends in May (p-value=0.03) and September (p-value=0.04), and marginally significant increasing trend in December (p-value=0.09)	Significant increasing trends in May (p-value=0.01) and September (p-value=0.02), and marginally significant increasing trend in August (p-value=0.1) and December (p-value=0.09)

To investigate the origin and spatial extent of the increasing trend in total nitrogen at Old Fort, additional trend analyses were conducted at both the Athabasca River upstream of Fort McMurray and the Athabasca River at Old Fort monitoring stations for two time periods (1989-2012 and 2002-2012). The results indicate that for the longer time period examined (1989-2012), the annual NFA and FA total nitrogen trends were statistically significant at Old Fort, but not at the upstream station (Table A2). For the more recent time period (2002-2012), significant increasing annual trends were apparent at both stations for the NFA total nitrogen concentrations, although when adjusted for variability in flow, these annual trends were no longer statistically significant. However, statistically significant seasonal trends are evident in the flow- adjusted concentrations at both stations. (Table A3).

Consequently, Environment and Parks will continue to investigate total nitrogen concentrations in the lower Athabasca River until we are confident our understanding of the key factors influencing these trends is complete.

Table A2
Results of Trend Assessment on Total Nitrogen Concentrations at the Athabasca River at Old Fort Monitoring Station and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station (1989-2012). The analyses were conducted on quarterly data.
NFA=non-flow-adjusted,FA=flow-adjusted

u/s Fort McMurray	Old Fort
NFA concentrations: • Seasonal Mann-Kendall test non-significant (p-value=0.92)	NFA concentrations: • Seasonal Mann-Kendall test revealed a significantly increasing trend (p-value=0.03) • Significant increasing trend in May (p-value=0.02) and marginally significant increasing trend in October (p=0.059)
FA concentrations: • Seasonal Mann-Kendall test non-significant (p-value=0.88) • Marginally significant trend in May (p-value=0.09)	FA concentrations: • Seasonal Mann-Kendall test revealed a highly significantly increasing trend (p-value=0.004) • Highly significant trend in May (p-value=0.006) and significant trend in October (p-value=0.04)

Table A3
Results of Trend Assessment on Total Nitrogen Concentrations at the Athabasca River at Old Fort Monitoring Station and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station (2002-2012). The analyses were conducted on monthly data.
NFA=non-flow-adjusted, FA=flow-adjusted

u/s Fort McMurray	Old Fort
NFA concentration: • Seasonal Mann-Kendall test revealed a significantly increasing trend (p-value=0.01) • Significant trend in August (p-value=0.02) and December (p-value=0.03)	NFA concentration: • Seasonal Mann-Kendall test revealed a significantly increasing trend (p-value=0.04) • Significant trend in September (p-value=0.01)
FA concentration: • Seasonal Mann-Kendall trend test marginally significant (p-value=0.08) • Significant trends in August (p-value=0.04) and December (p-value=0.05)	FA concentration: • Seasonal Mann-Kendall trend test non-significant (p-value=0.17) • Highly significant increasing trend in September (p-value=0.008)

Dissolved Uranium

Environment and Parks has moved dissolved uranium from preliminary assessment into investigation. Although trend assessment did not reveal statistically significant increasing trends in NFA and FA dissolved uranium concentrations at the Athabasca River at Old Fort monitoring station from 2003-2012, the NFA results were close to being statistically significant (Table A4). Given the proximity of this result to statistical significance and because dissolved uranium triggered again in 2013 (both mean and peak triggers) Environment and Parks decided to run a trend assessment for the same time period at the Athabasca River upstream of Fort McMurray monitoring station. These additional analyses were not initiated out of concern for existing concentrations of dissolved uranium in the lower Athabasca River. Current levels at Old Fort are lower than at upstream stations on the Athabasca River (Environment and Parks unpublished data), and an order of magnitude lower than the most stringent water quality guideline. Rather, the intent of the additional testing is to better understand temporal patterns in dissolved uranium in the lower Athabasca River.

Table A4
Results of Trend Assessment on Dissolved Uranium Concentrations at the Athabasca River at Old Fort Monitoring Station (2003-2012). NFA=non-flow-adjusted, FA=flow-adjusted

NFA Dissolved Uranium	FA Dissolved Uranium
• Mann-Kendall test marginally significant (p-value=0.053) • Slope with 95 per cent confidence interval = 0.006 µg/L/year (0.000-0.011 µg/L/year)	• Mann-Kendall test non-significant (p-value=0.17)

Results of the trend assessment on dissolved uranium conducted at Athabasca River upstream of Fort McMurray monitoring station found no significant differences in NFA or FA concentrations at that station from 2003-2012 (Table A5). Consequently, future analyses will focus on the lower Athabasca River and its tributaries downstream of Fort McMurray. The next steps in this investigation are outlined in section 5.0 of this report.

Table A5
Results of Trend Assessment on Dissolved Uranium Concentrations at the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station (2003-2012).
NFA=non-flow-adjusted,FA=flow-adjusted

NFA Dissolved Uranium	FA Dissolved Uranium
• Seasonal Mann-Kendall test non-significant (p-value=0.069)	• Mann-Kendall test non-significant (p-value=0.89)

Dissolved Lithium

Environment and Parks has completed the management response for dissolved lithium and concluded that no further action is required. Trend assessment did not reveal any statistically significant trends in either the NFA or FA dissolved lithium concentrations at the Athabasca River at Old Fort monitoring station from 1999-2012 (Table A6). In addition, the timing of the 2012 dissolved lithium peak exceedances (January, February and April) corresponded well with unusual flow conditions within the lower Athabasca River. Dissolved lithium has a strong inverse relationship with flow and 2012 winter flows were unusually low.

Table A6
Results of Trend Assessment on Dissolved Lithium Concentrations at the Athabasca River at Old Fort Monitoring Station (1999-2012). NFA=non-flow-adjusted,FA=flow-adjusted

NFA Dissolved Lithium	FA Dissolved Lithium
• Seasonal Mann-Kendall test non-significant (p-value=0.090)	• Mann-Kendall test non-significant (p-value=0.83)

Appendix B

The Obed Mountain Mine Release

The Obed Mountain Mine is a coal mine located near the town of Hinton in the Upper Athabasca Region. On October 31, 2013 a failure of the Red-Green Pit released ~670,000 m^3 of coal wash water and sediment into the Athabasca River. Over the next six weeks, a plume of noticeably turbid water made its way down the Athabasca River.

To better understand the potential impacts of this release and to track the location of the process water plume, Environment and Parks monitoring staff deployed near real-time water quality data sondes in the Athabasca River. These sondes provided basic measures of water quality (pH, turbidity, water temperature, and conductivity) at 15-minute intervals. The results from the data sondes clearly show how turbidity (due to the large amount of suspended sediment within the plume) increased then decreased as the process water plume flowed past each sonde (Figure A1). For example, at the water quality monitoring station upstream of Fort McMurray, turbidity within the Athabasca River first began to increase on November 23 and peaked on November 26. As the plume continued to flow downstream, turbidity at that location within the Athabasca River returned to normal (i.e., pre-plume) levels.

To avoid any potential influence from the plume on long-term ambient surface water quality monitoring data, monthly water quality samples were collected on November 13 and December 18 from the Upstream of Fort McMurray monitoring station. At the Old Fort station, water quality samples were collected on November 12 and December 10, again to avoid any possible influence of the plume on the data. Figure A1 shows that the November and December sampling events occurred either prior to the arrival, or after the departure, of the process water plume at these locations within the Athabasca River.

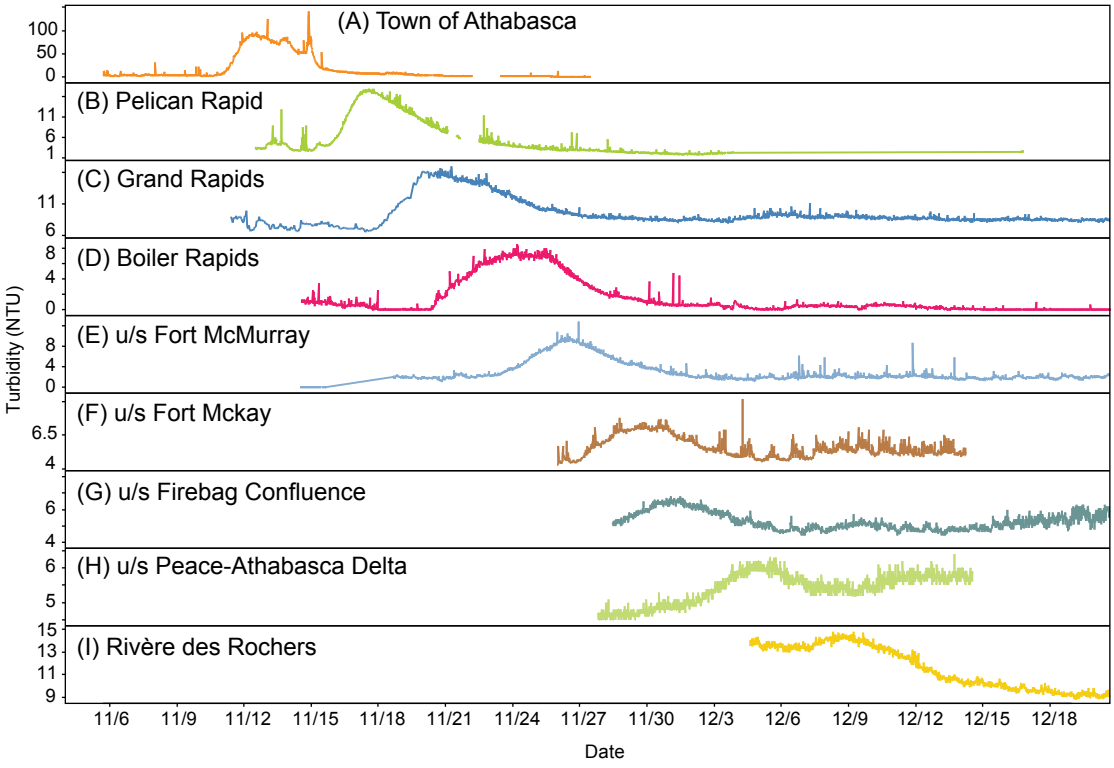

Figure B1
Profiles of Turbidity at Various Locations within the Athabasca River between November 6 and December 18, 2013.

Note: Turbidity within the river increased as the Obed Mine process water plume travelled downstream, but returned to normal levels as the plume flowed past a given location.

Appendix C

Results of the Preliminary Assessment of 2013 Data to Date

Total Nitrogen – Mean Trigger Exceedance (Level 2)

A statistically significant increase in the annual mean (compared to the historical mean) was found for total nitrogen at the Athabasca River at Old Fort monitoring station in 2013. Mean total nitrogen concentration in 2013 was 0.794 mg/L, which is 33 per cent higher than the mean trigger (i.e., the historical mean; 0.597 mg/L). A 24 per cent increase was observed at the Athabasca River upstream of Fort McMurray monitoring station during the same time period (Table C1 and Figure C1).

Examination of the historical dataset for total nitrogen at the Athabasca River at Old Fort station revealed that the 2013 annual mean was higher than all other annual means in the dataset, including the 2012 annual mean. The 2013 total nitrogen annual mean was two percent higher than the previous historical annual maximum of 0.778 mg/L measured in 1997. At the Athabasca River upstream of Fort McMurray station, the 2013 annual mean was higher than most other means in the dataset; however, the 2013 annual mean (0.704 mg/L) was lower than the 2012 annual mean (0.713 mg/L).

The pattern in total nitrogen concentrations between the two stations has been variable over time (Figure C2). From 1988–1999 the annual means were higher 58 per cent of the time at the Athabasca River upstream of Fort McMurray station. However, since 2000, the annual total nitrogen means have been consistently higher at the Athabasca River at Old Fort station.

Table C1
Comparison of Total Nitrogen at the Athabasca River at Old Fort Monitoring Station in 2013 Relative to the Historical Mean and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station.

Indicator	Upstream of Fort McMurray				Old Fort			
	2013 Mean	Historical Mean (1998-2009)	Direction of Change	Per Cent Change	2013 Mean	Historical Mean* (1998-2009)	Direction of Change	Per Cent Change
Total Nitrogen (mg/L)	0.704	0.567	increase	24	0.794	0.597	increase	33

* For the Athabasca River at Old Fort station, the historical mean is also the mean trigger.

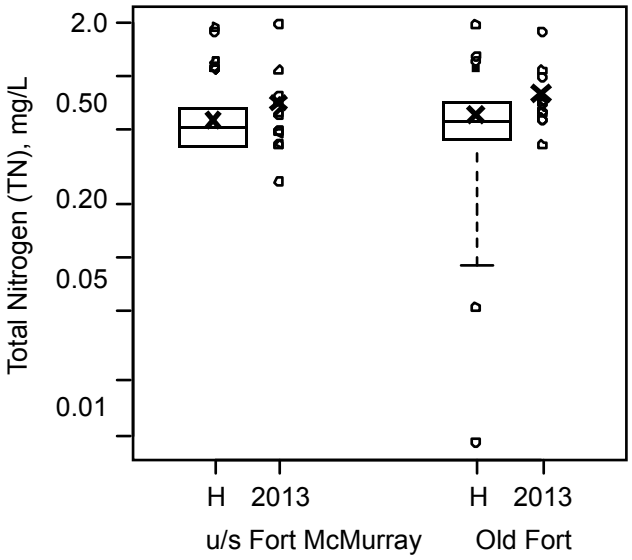

Figure C1
Graphical Presentation of Total Nitrogen Data at the Athabasca River at Old Fort Monitoring Station in 2013 Relative to the Historical Mean and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station.

Note: Historical data (H) are summarized with box plots while all the 2013 data are shown. Crosses are means of the historical and 2013 data, respectively while solid boxes are the 95th percentile of the historical data.

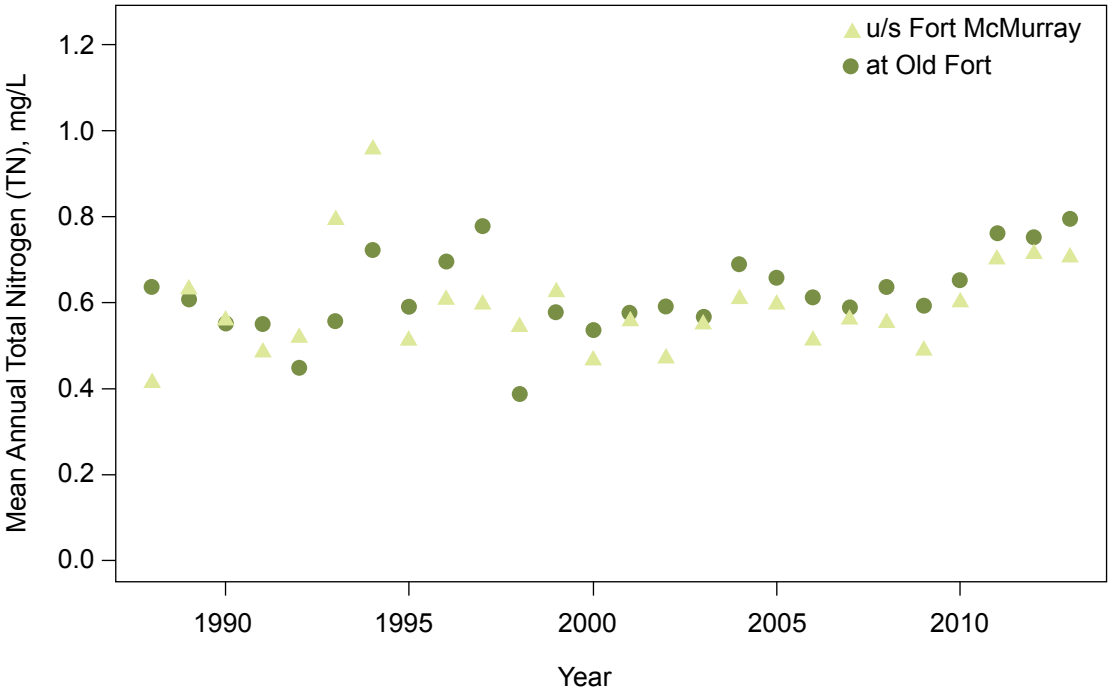

Figure C2
Plot of the Annual Total Nitrogen Means at the Athabasca River at Old Fort Monitoring Station and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station.

Dissolved Uranium – Mean Trigger Exceedance (Level 2)

A statistically significant increase in the annual mean (compared to the historical mean) was found for dissolved uranium at the Athabasca River at Old Fort monitoring station in 2013. Mean dissolved uranium concentration in 2013 was 0.363 µg /L, which is 16 per cent higher than the mean trigger (i.e., the historical mean; 0.313 µg/L). Similarly a 24 per cent increase in the 2013 annual mean (compared to the historical mean) was found for dissolved uranium at the Athabasca River upstream of Fort McMurray monitoring station (Table C2 and Figure C3).

Examination of the historical dataset for dissolved uranium at the Athabasca River at Old Fort station revealed that the 2013 annual mean was higher than all other annual means in the dataset, including the 2012 annual mean. This indicates that the 2013 annual mean was quite unusual; however, the historical dataset for this indicator is relatively short (2003-2009). Analysis of the historical dataset at the Athabasca River upstream of Fort McMurray station showed that the 2013 annual mean (0.564 µg /L) was also higher than all other annual means in the historical dataset.

The pattern in dissolved uranium concentrations between the two stations has been consistent over time (Figure C4). Without exception, the annual means for dissolved uranium have been higher at the Athabasca River upstream of Fort McMurray station than at the Athabasca River at Old Fort station.

Table C2
Comparison of Dissolved Uranium at the Athabasca River at Old Fort Monitoring Station in 2013 Relative to the Historical Mean and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station.

Indicator	Upstream of Fort McMurray				Old Fort			
	2013 Mean	Historical Mean (2002-2009)	Direction of Change	Per Cent Change	2013 Mean	Historical Mean* (2003-2009)	Direction of Change	Per Cent Change
Dissolved Uranium (g/L)	0.564	0.456	increase	24	0.363	0.313	increase	16

* For the Athabasca River at Old Fort station, the historical mean is also the mean trigger.

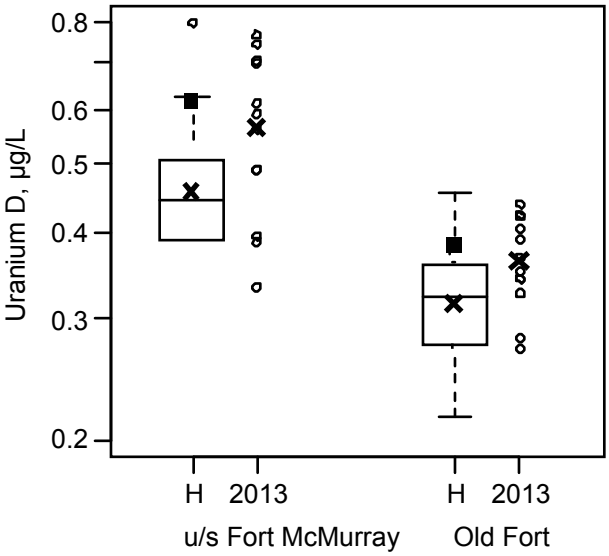

Figure C3
Graphical Presentation of Dissolved Uranium Data at the Athabasca River at Old Fort Monitoring Station in 2013 Relative to the Historical Mean and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station.

Note: Historical data (H) are summarized with box plots while all the 2013 data are shown. Crosses are means of the historical and 2013 data, respectively while solid boxes are the 95th percentile of the historical data. D=dissolved.

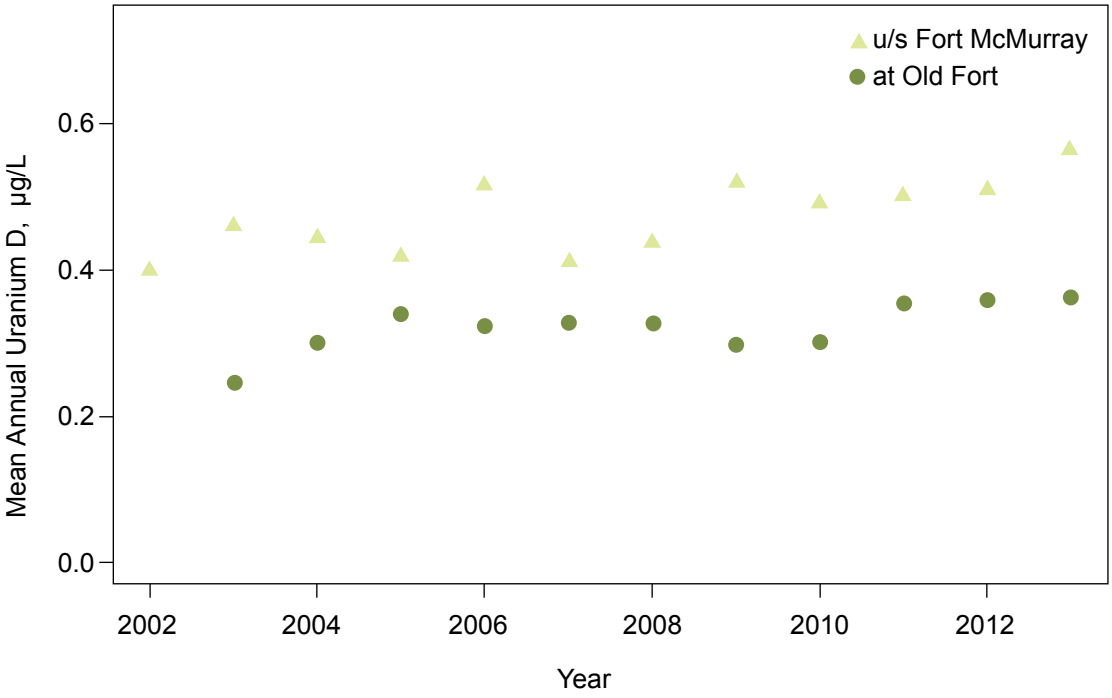

Figure C4
Plot of the Annual Dissolved Uranium Means at the Athabasca River at Old Fort Monitoring Station and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station. D=dissolved.

Dissolved Iron – Mean Trigger Exeedance (Level 2)

A statistically significant increase in the annual mean (compared to the historical mean) was found for dissolved iron at the Athabasca River at Old Fort monitoring station in 2013. Mean dissolved iron concentration in 2013 was 266 µg/L, which is 44 per cent higher than the mean trigger (i.e., the historical mean; 185 µg/L). In contrast, the 2013 mean was 6 per cent lower than the historical mean at the Athabasca River upstream of Fort McMurray monitoring station (Table C3 and Figure C5).

Examination of the historical dataset for dissolved iron at the Athabasca River at Old Fort station, which extends back to 1999, revealed that the 2013 annual mean was higher than most other annual means in the dataset with the exception of 2008 and 2009, which averaged 341 and 268 µg/L, respectively. In contrast, analysis of the historical dataset at the Athabasca River upstream of Fort McMurray station showed that the 2013 annual mean (102 µg/L) was very close to the historical mean.

The pattern in dissolved iron concentrations between the two stations has been relatively consistent over time (Figure C6). With the exception of 1999, the annual means for dissolved iron have been higher at the Athabasca River at Old Fort station than at the Athabasca River upstream of Fort McMurray station.

Table C3
Comparison of Dissolved Iron at the Athabasca River at Old Fort Monitoring Station in 2013 Relative to the Historical Mean and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station.

Indicator	Upstream of Fort McMurray				Old Fort			
	2013 Mean	Historical Mean (2002-2009)	Direction of Change	Per Cent Change	2013 Mean	Historical Mean* (2003-2009)	Direction of Change	Per Cent Change
Dissolved Iron (µg/L)	102	109	decrease	6	266	185	increase	44

* For the Athabasca River at Old Fort station, the historical mean is also the mean trigger.

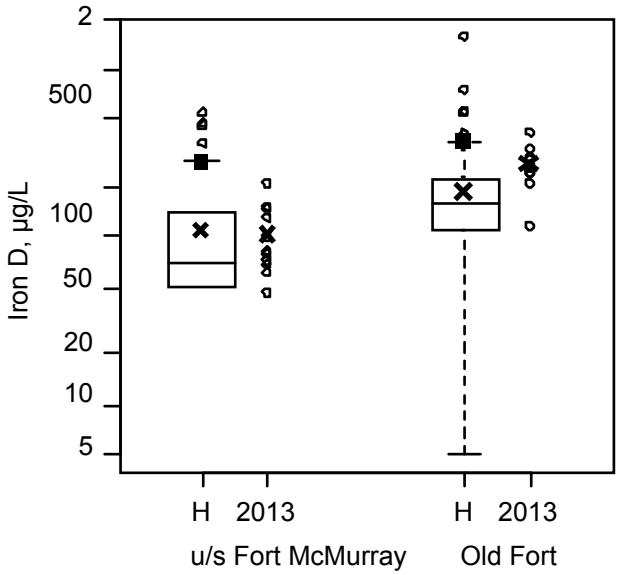

Figure C5
Graphical Presentation of Dissolved Iron Data at the Athabasca River at Old Fort Monitoring Station in 2013 Relative to the Historical Mean and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station.

Note: Historical data (H) are summarized with box plots while all the 2013 data are shown. Crosses are means of the historical and 2013 data respectively, while solid boxes are the 95th percentile of the historical data. D=dissolved.

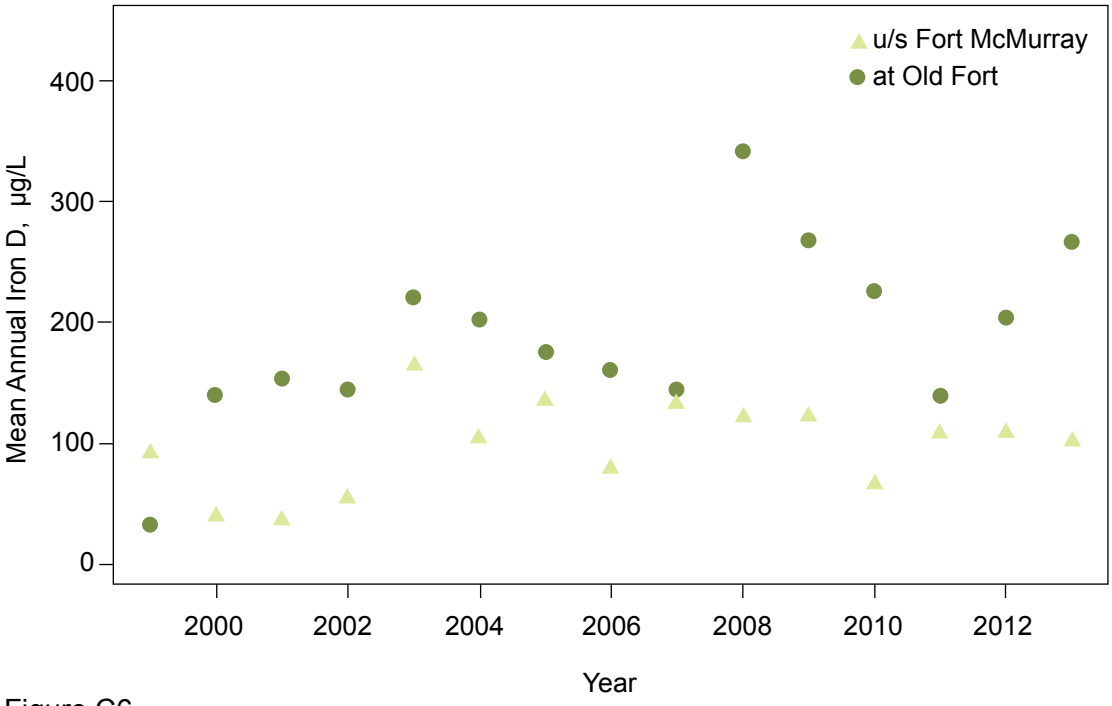

Figure C6
Plot of the Annual Dissolved Iron Means at the Athabasca River at Old Fort Monitoring Station and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station. D=dissolved

Dissolved Uranium – Peak Trigger Exceedance (Level 2)

A statistically significant peak trigger exceedance was found for dissolved uranium at the Athabasca River at Old Fort monitoring station (three out of 12 samples above the historical 95th percentile). Similarly, five out of 12 samples were above the historical 95th percentile for dissolved uranium at the Athabasca River upstream of Fort McMurray station in 2013 (Table C4 and Figure C7).

Examination of the historical dataset for dissolved uranium at the Athabasca River at Old Fort station revealed that the highest value observed in 2013 (0.438 µg/L) did not exceed the previous maximum concentration observed at this station (0.455 µg/L in 2005). The maximum value for dissolved uranium at the Athabasca River upstream of Fort McMurray station in 2013 (0.8 µg/L) was equal to the maximum historical value observed in 2003.

Table C4
Comparison of Dissolved Uranium at the Athabasca River at Old Fort Monitoring Station in 2013 Relative to the Historical 95th Percentile and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station.

Indicator	Upstream of Fort McMurray		Old Fort	
	Historical 95th Percentile (2002-2009)	# of 2013 Samples Above Historical 95th Percentile	Historical 95th Percentile* (2003-2009)	# of 2013 Samples Above Historical 95th Percentile
Dissolved Uranium (µg/L)	0.615	5	0.381	3

* For the Athabasca River at Old Fort station, the historical 95th percentile is also the peak trigger.

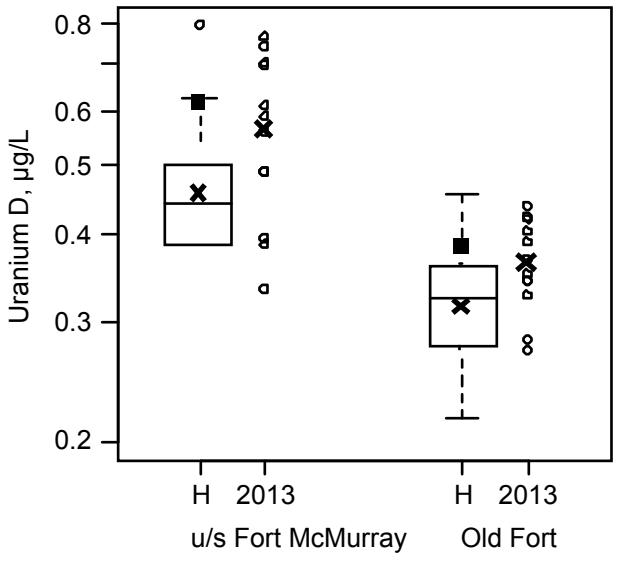

Figure C7
Graphical Presentation of the Dissolved Uranium Data at the Athabasca River at Old Fort Monitoring Station in 2013 Relative to the Historical 95th Percentile and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station.

Note: Historical data (H) are summarized with box plots, while all the 2013 data are shown. Crosses are means of the historical and 2013 data respectively, while solid boxes are the 95th percentile of the historical data. D=dissolved.

Total Lithium – Peak Trigger Exceedance (Level 2)

A significant peak trigger exceedance was found for total lithium at the Athabasca River at Old Fort monitoring station (3 out of 12 samples higher than the historical 95th percentile). In comparison, only one sample was above the historical 95th percentile at the Athabasca River upstream of Fort McMurray station (Table C5 and Figure C8).

Examination of the historical dataset for total lithium at the Athabasca River at Old Fort station revealed that none of the 2013 values exceeded the historical maximum concentration observed at this station (34 µg/L in 2007); however, it was unusual to have three sampling occasions with concentrations above the 95th percentile. In the historical dataset (1999 to 2009), only one observation, the historical maximum concentration, exceeded the 95th percentile.

Table C5
Comparison of Total Lithium at the Athabasca River Old Fort Monitoring Station in 2013 Relative to the Historical 95th Percentile and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station.

Indicator	Upstream of Fort McMurray		Old Fort	
	Historical 95th Percentile (2002-2009)	# of 2013 Samples Above Historical 95th Percentile	Historical 95th Percentile* (1999-2009)	# of 2013 Samples Above Historical 95th Percentile
Total Lithium (µg/L)	16	1	12	3

* For the Athabasca River at Old Fort station, the historical 95th percentile is also the peak trigger.

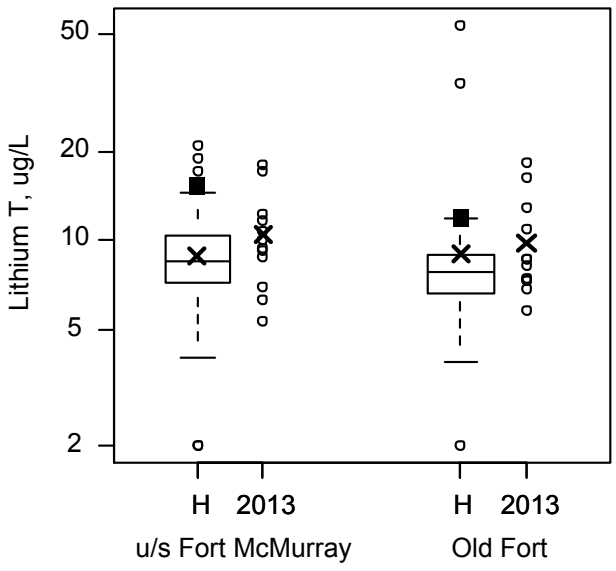

Figure C8
Graphical Presentation of the Total Lithium Data at the Athabasca River at Old Fort Monitoring Station in 2013 Relative to the Historical 95th Percentile and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station.

Note: Historical data (H) are summarized with box plots, while all the 2013 data are shown. Crosses are means of the historical and 2013 data respectively, while solid boxes are the 95th percentile of the historical data. D=dissolved.

Dissolved Aluminum – Peak Trigger Exceedance (Level 2)

A statistically significant peak trigger exceedance was found for dissolved aluminum at the Athabasca River at Old Fort monitoring station (three out of 12 samples above the historical 95th percentile). In contrast, none of the 12 samples were above the historical 95th percentile for dissolved aluminum at the Athabasca River upstream of Fort McMurray station in 2013 (Table C5 and Figure C9).

Examination of the historical dataset for dissolved aluminum at the Athabasca River at Old Fort station revealed that the June 2013 sample (110 µg/L) exceeded the previous maximum concentration observed at this station (98 µg/L in 2008) by 12 per cent. In contrast, the historical maximum value for dissolved aluminum at the Athabasca River upstream of Fort McMurray station (203 µg/L in 2011) was not exceeded by the maximum value for 2013 (80 µg/L).

Table C6
Comparison of Dissolved Aluminum at the Athabasca River at Old Fort Monitoring Station in 2013 Relative to the Historical 95th Percentile and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station.

Indicator	Upstream of Fort McMurray		Old Fort	
	Historical 95th Percentile (2002-2009)	# of 2013 Samples Above Historical 95th Percentile	Historical 95th Percentile* (2003-2009)	# of 2013 Samples Above Historical 95th Percentile
Dissolved Aluminum (µg/L)	90	0	49	3

* For the Athabasca River at Old Fort station, the historical 95th percentile is also the peak trigger.

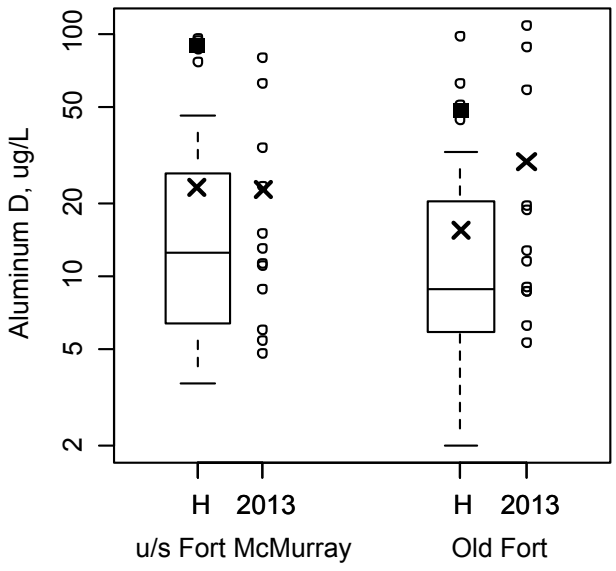

Figure C9
Graphical Presentation of the Dissolved Aluminum Data at the Athabasca River at Old Fort Monitoring Station in 2013 Relative to the Historical 95th Percentile and the Athabasca River Upstream (u/s) of Fort McMurray Monitoring Station.

Note: Historical data (H) are summarized with box plots while all the 2013 data are shown. Crosses are means of the historical and 2013 data, respectively while solid boxes are the 95th percentile of the historical data. D=dissolved.