ANNUAL REPORT 2018

Wood Buffalo Environmental Association

WOOD BUFFALO ENVIRONMENTAL ASSOCIATION

W B E A

CONTENTS

MESSAGE FROM THE

President

One of the greatest strengths of the Wood Buffalo Environmental Association (WBEA) is being a consensus-based, multi-stakeholder organization, and this is recognized outside of our own membership. As such, alignment is critical to progress our work in a timely fashion. Over the past year, we saw an increase in active engagement from our membership, which led to timely decision-making for the strategic direction of the organization. Members were also encouraged to foster alignment within their respective organizations to ensure ongoing communication and understanding of the WBEA's processes and objectives. The WBEA has an opportunity to be a leader in environmental monitoring in the region, and there are benefits to leveraging the collective power of our membership. I look forward to continued active participation from our members as we move forward in 2019.

The past year also marked several new beginnings for the WBEA, as well as the continued growth of the monitoring network and the organization. From moving to a new building and turning a long-term vision into a reality, to welcoming Keyano College as a non-government organization member of the WBEA, the WBEA has continued to deliver on our mission of providing quality air monitoring to the region. The WBEA leadership has also continued its ongoing work in developing long-term, sustainable funding for the WBEA, which will position the organization for ongoing success. In this regard, we are also working to implement new best-practices for non-profit organizations, such that we can steward to the work we complete in a more standardized way.

The WBEA's efforts to consolidate not just WBEA operations into one facility, but to also include Alberta Environment and Parks (AEP) and Environment and Climate Change Canada (ECCC) in sharing a new facility, is truly out-of-the-box thinking. The increased interaction and communication between the WBEA and our Oil Sands Monitoring (OSM) Program partners has a huge opportunity to improve the understanding of our shared goals and improve delivery of results. The facility optimization also positively demonstrates the fiscally responsible decision-making of the WBEA. It is important that we continually look for efficiencies in how we manage the business and funds we are allocated.

I look forward to working with the WBEA to demonstrate that we are delivering on continual improvements. I thank Sanjay and the WBEA staff for putting a focus on continued excellence in this regard.

Cliff Dimm, WBEA President

MESSAGE FROM THE

Executive Director

The past year was full of many accomplishments for the Wood Buffalo Environmental Association (WBEA). 2018 marked Year 2 of the WBEA's 2017-2021 Strategic Plan, and the organization is well-positioned to achieve our four strategic goals. As we reported to our General Members at the 2019 Annual General Meeting, the WBEA is working on or has completed over 90% of the tactics included in our Strategic Plan. The WBEA's five-year Strategic Plan includes more information about our goals and tactics, and can be found on our website.

The WBEA takes pride in being a multi-stakeholder, consensus-based organization, and we are known as being a leader in state-of-the-art environmental monitoring. The data we collect and information we share enables informed decision-making for our members, our Indigenous community partners, industry, the government, and the general public. The WBEA continues to foster positive relationships with our member organizations and others impacted by the air quality in the Regional Municipality of Wood Buffalo.

We continued to work closely with the Alberta Environment and Parks (AEP) Environmental Monitoring and Science Division (EMSD) to develop the 2019-2020 Oil Sands Monitoring work plans to ensure alignment with both the WBEA's and EMSD's strategic and operational goals. The WBEA's technical program committees also continued to meet and deliver on their respective 2018-2019 work plans. The WBEA provided support for all committees and working groups, and continued to encourage active, multi-sectoral participation.

Highlights from 2018 include:

- Moving into a central facility, which consolidated staff and operations from two facilities into one. This was a major highlight, and the new facility will provide numerous opportunities to collaborate with our members, and we will also work with the provincial and federal governments to increase working relationships through the use of a shared space.
- Submitting workplans to the Oil Sands Monitoring (OSM) Program for WBEA monitoring activities. Our workplans were vetted through the WBEA's membership prior to submitting to AEP.
- Participating in OSM Program Integration Workshops, which were designed to scientifically assess the OSM programs across several areas to address current and future state, and to produce strategic and integrated recommendations required to guide the OSM Program.
- Collaborating with several other organizations related to environmental monitoring, including but not limited to, AEP, Clean Air Strategic Alliance (CASA), Keyano College, Alberta Airsheds Council, and Fort McKay Air Quality and Odour Advisory Committee.
- Collecting our first year of Community Odour Monitoring Program (COMP) app data (from September 2017 to December 2018). The app continues to gain traction with members of the community, and the annual report will be released in 2019.
- The Deposition program began a massive project to analyze data from 1998 to 2012, called the TEEM Publication Project. Publications will also be released in 2019 through a Virtual Special Issue.
- Participating at Globe 2018 in Vancouver, BC under the Alberta Pavilion and presented the WBEA's technologies and collaborative process for program design and decision-making in a multi-stakeholder context.
- Supporting the Keyano College Environmental Technician Certification Program in Fort Chipewyan. In addition to welcoming Keyano College as a non-government organization member, we are excited to continue our partnership through a formal framework and excited to see where we go together.
- Conducting a review of financial policies and procedures to ensure the WBEA is in compliance with the Alberta Government contract terms and generally accepted accounting standards.
- Successfully passing our 2017-2018 financial audit. Along with being issued a clean audit, opportunities were identified to improve some of the WBEA's internal processes.
- Receiving closure letters for the AEP Ambient Air Monitoring Network Audits and being issued a clean audit.
- Working with communications consultants to develop branding and standard communications products for the WBEA.
- The Operations Leadership Team, established in 2017 to support the Executive Director in setting the operational direction for the organization, grew in its capacity and continued to work with the WBEA's leadership.

I would like to recognize and thank the WBEA's Governance Committee and General Members Board for their guidance and support over the past year. Your collective knowledge and expertise are invaluable to the Association. We also greatly appreciate the increased engagement and participation from our membership. We look forward to accomplishing our common monitoring objectives together to maintain an efficient monitoring organization in the Regional Municipality of Wood Buffalo to deliver high-quality environmental monitoring programs.

Sanjay Prasad, WBEA Executive Director

Who is WBEA?

Vision

People are empowered to make informed decisions to ensure a safe and healthy environment.

Mission

The WBEA is a multi-stakeholder, consensus-based organization that leads in state-of-the-art environmental monitoring to enable informed decision-making.

Core Values

- We are scientifically independent.
- We recognize, respect, and use traditional knowledge.
- We are transparent and timely in communicating accurate and accessible data.
- We are dedicated to using best available practices and technology.
- We support diverse stakeholder participation to achieve consensus-based decisions.

Strategic Plan

The WBEA *2017-2021 Strategic Plan* captures, in a single document, what the WBEA is about and what it seeks to achieve over the next five years. The plan focuses on four major goals:

1. Provide state-of-the-art environmental monitoring
2. Support meaningful stakeholder engagement and strategic partnerships
3. Recognize traditional knowledge as an important source of wisdom and information
4. Establish socially and fiscally responsible business practices

All of the WBEA's 38-member organizations contributed to the planning process. The development of the plan involved reflecting on past years of operation, gathering feedback and perspectives from all participants and setting goals to successfully carry the organization into the future.

Organizational Structure

The diagram on the right depicts how the WBEA operates and shows the relationships between the General Members Board, Governance Committee, Technical Working Groups, and the WBEA staff. The General Members Board and Governance Committee provide strategic direction and oversight for the organization. The Technical Committees determine the strategic plans and direction for each of the WBEA's monitoring programs. The Executive Director provides operational direction for the WBEA staff, engaging science and technical advisors as required, to ensure stewardship to the overarching direction set by the General Members Board and Governance Committee.

LEGEND

- Direction & Oversight
- Stewardship

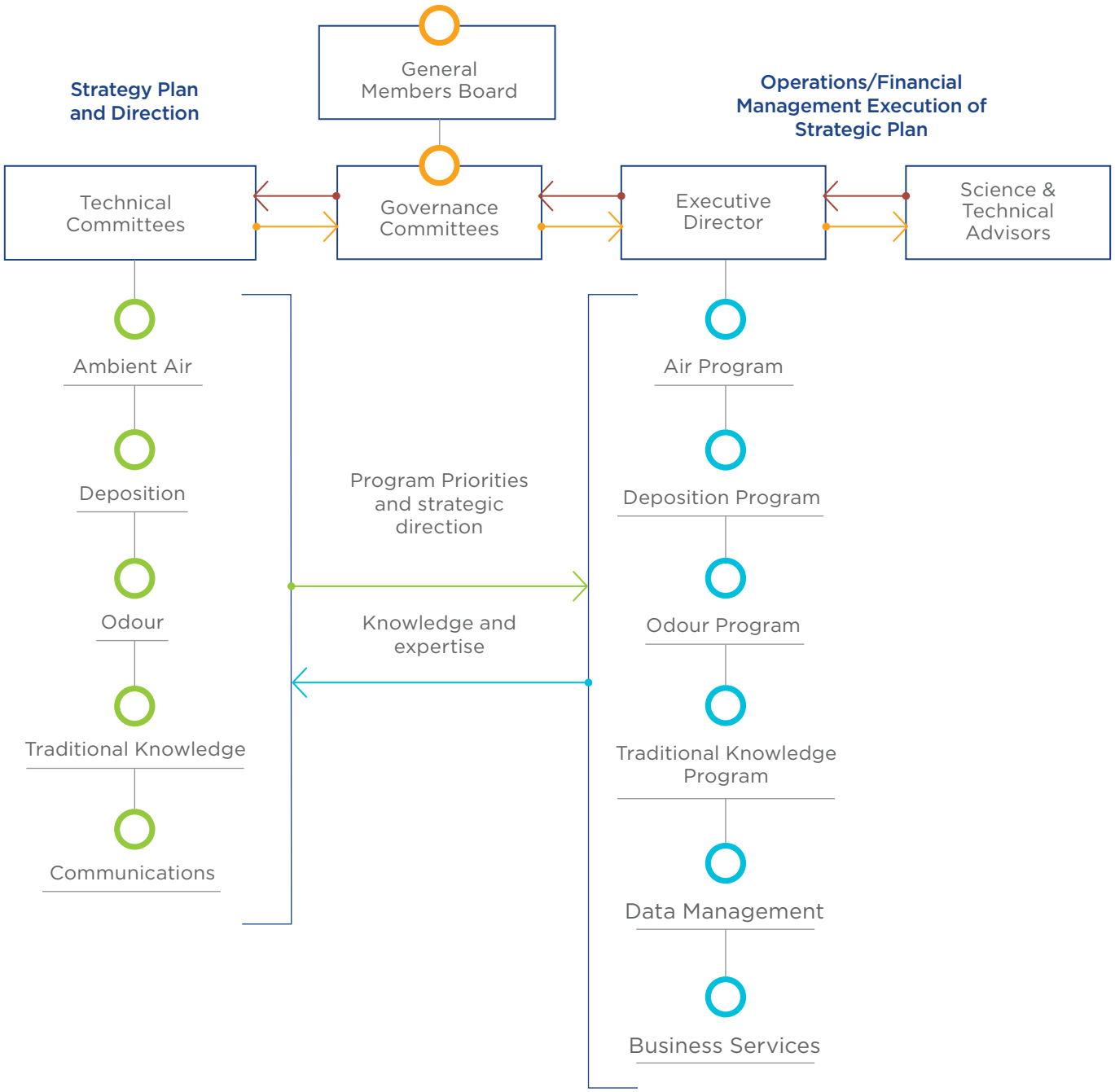



Photo credit: Cody David

Alberta Environment and Parks

Environmental Monitoring and Science Division

The Environmental Monitoring and Science Division (EMSD) of Alberta Environment and Parks (AEP) is responsible for monitoring, evaluating, and reporting on key air, water, land, and biodiversity indicators. The division's mandate is to provide open and transparent access to scientific data and information on the condition of Alberta's environment, including specific indicators as well as cumulative effects, both provincially and in specific locations. The Oil Sands Monitoring (OSM) Program is a joint federal and provincial initiative between the Government of Alberta and Environment Canada and Climate Change. The mandate of the program is to implement an ambient environmental monitoring program in the oil sands region that integrates air, water, land, and biodiversity. The OSM Program strives to improve characterization of the state of the environment and enhance understanding of the cumulative effects of oil sands development.

The WBEA has entered into a contractual agreement with the EMSD. As a working partner, the WBEA is one of the agencies helping to ensure that the OSM Program is delivered with the best expertise possible.

For more information, visit **environmentalmonitoring.alberta.ca**.

Alberta

OIL SANDS MONITORING PROGRAM

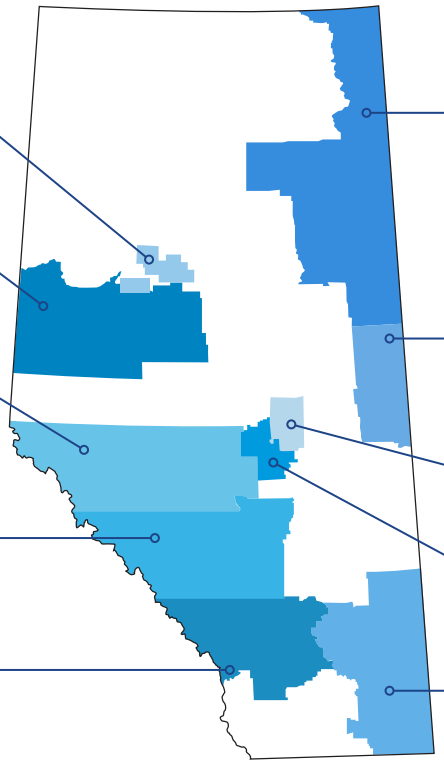
WBEA within Alberta Airsheds

Alberta's Airsheds Council

The WBEA is a member of the Alberta Airsheds Council (AAC), which is a partnership of Alberta's Airsheds and provides leadership in support of healthy air quality for Albertans and the environment.

Initiated in 2006, the AAC includes membership from all ten Airsheds in Alberta and was formed to represent the collective interests of this collaborative group.

The AAC provides a forum for Airsheds to work and learn together, to continue to advance effective and efficient air monitoring, reporting and outreach, and to address regional matters.



Peace River Area Monitoring Program Committee (PRAMP)
Peace River region

Peace Airshed Zone Associations (PAZA)
Grande Prairie and region

West Central Airshed Society (WCAS)
Jasper, Hinton, Edson, Drayton Valley and surrounding region

Parkland Airshed Management Zone (PAMZ)
Red Deer, Rocky Mountain House, Sundre, Banff and surrounding region

Calgary Region Airshed Zone (CRAZ)
Calgary and region

Wood Buffalo Environmental Association (WBEA)
Fort McMurray & Wood Buffalo region

Lakeland Industry and Community Association (LICA)
Bonnyville, Cold Lake, St. Paul and region

Fort Air Partnership (FAP)
Fort Saskatchewan region

Alberta Capital Airshed (ACA)
Edmonton region

Palliser Airshed Society (PAS)
Medicine Hat, Redcliffe and surrounding region

Ambient Air Monitoring

The WBEA operated 28 ambient air monitoring stations in 2018 throughout the RMWB. These included industrial, attribution, community, background, and meteorological stations. The WBEA collects ambient air data through continuous analyzers and time-integrated samplers to ensure residents and stakeholders have the information they need to make informed environmental decisions. All WBEA air monitoring data are fully quality-assured and then sent by the end of the following month to airdata.alberta.ca, an AEP on-line database for all of Alberta's ambient air quality data. All of the WBEA's data can also be found on our website at **wbea.org**.

AQHI

The Air Quality Health Index, or AQHI, is a provincial scale designed to help people understand what air quality means to their health. It is a tool designed to help individuals make decisions to protect their health by limiting short-term exposure to air pollution and adjusting activity levels during increased levels of air pollution.

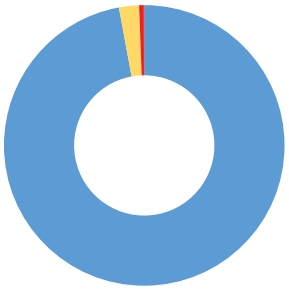
The AQHI includes concentrations of nitrogen dioxide (NO_2), fine particulate matter ($PM_{2.5}$), and ground-level ozone (O_3), which are three compounds that can cause respiratory effects. Additionally, in Alberta, hourly pollutant concentrations are compared against Alberta's Ambient Air Quality Objectives (AAAQOs). If an AAAQO is exceeded, the AQHI value is overridden with a HIGH or VERY HIGH risk value. However, odour causing compounds measured in the WBEA network are not considered in the AQHI. Therefore, this index gives an idea of air quality based on some pollutants, but it does not describe the potential for odour events.

The WBEA reports AQHI ratings from nine of its continuous monitoring stations in the Wood Buffalo region.

The Community of Fort McKay has also developed its own Fort McKay Air Quality Index (FMAQI), based on the data collected by the WBEA at its Bertha Ganter-Fort McKay air monitoring station. The FMAQI is independent of the provincial AQHI, and includes compounds that can indicate odours, such as Total Reduced Sulphur (TRS), total hydrocarbons (THC), and sulphur dioxide (SO_2). For more information on the FMAQI, visit: **wbea.org/air/fort-mckay-air-quality-index-aqi/**.

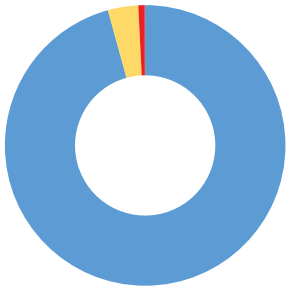
To find out more, visit: **wbea.org/air/air-quality-health-index.**

2018 Hourly AQHI by Community



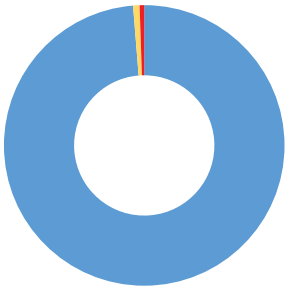
Anzac

Low Risk 97.10%
Moderate Risk 2.31%
High Risk 0.53%
Very High Risk 0.06%



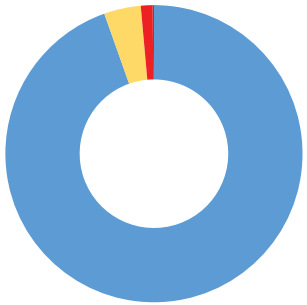
Conklin

Low Risk 95.72%
Moderate Risk 3.50%
High Risk 0.72%
Very High Risk 0.07%



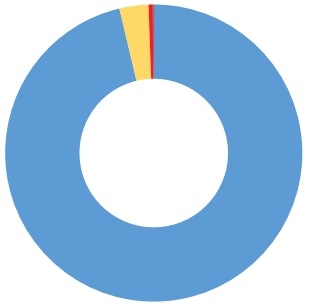
Fort Chipewyan

Low Risk 98.73%
Moderate Risk 0.75%
High Risk 0.52%
Very High Risk 0.00%



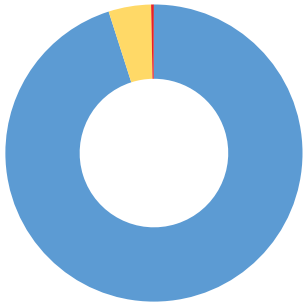
Bertha Ganter - Fort McKay

Low Risk 94.58%
Moderate Risk 4.01%
High Risk 1.27%
Very High Risk 0.14%



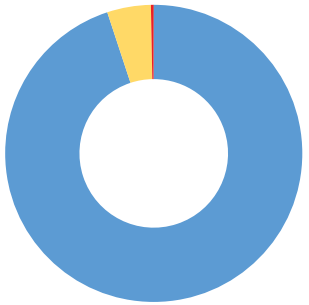
Fort McKay South

Low Risk 96.28%
Moderate Risk 3.16%
High Risk 0.45%
Very High Risk 0.11%



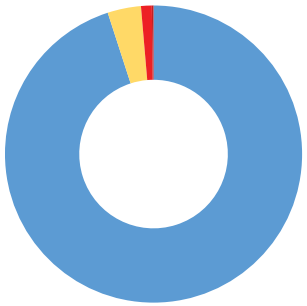
Fort McMurray (Athabasca Valley)

Low Risk 95.07%
Moderate Risk 4.63%
High Risk 0.22%
Very High Risk 0.09%



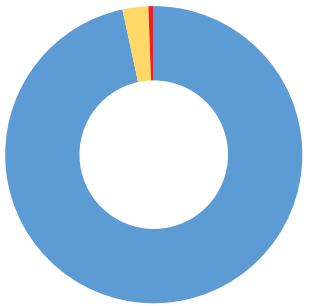
Fort McMurray (Patricia McInnes)

Low Risk 94.94%
Moderate Risk 4.76%
High Risk 0.24%
Very High Risk 0.07%



Janvier

Low Risk 95.01%
Moderate Risk 3.64%
High Risk 1.17%
Very High Risk 0.18%



Stony Mountain

Low Risk 96.62%
Moderate Risk 2.81%
High Risk 0.58%
Very High Risk 0.00%

Alberta Ambient Air Quality Objectives

Alberta's Ambient Air Quality Objectives (AAAQOs) were developed under the Alberta Environmental Protection and Enhancement Act (EPEA) to protect Alberta's air quality.

AAAQOs are generally established for 1-hour, 24-hour, and annual averaging periods, depending on the characteristics of the pollutant. The graph on page 12 presents a total count of air quality event exceedances of the AAAQOs at all WBEA ambient air monitoring stations over a five-year period, from 2014-2018. The graph on page 13 shows the exceedances for 2018 based on station locations.

When ambient concentrations of any air pollutant that the WBEA measures exceed the AAAQO, the WBEA has an Immediate Reporting Protocol that is put into action:

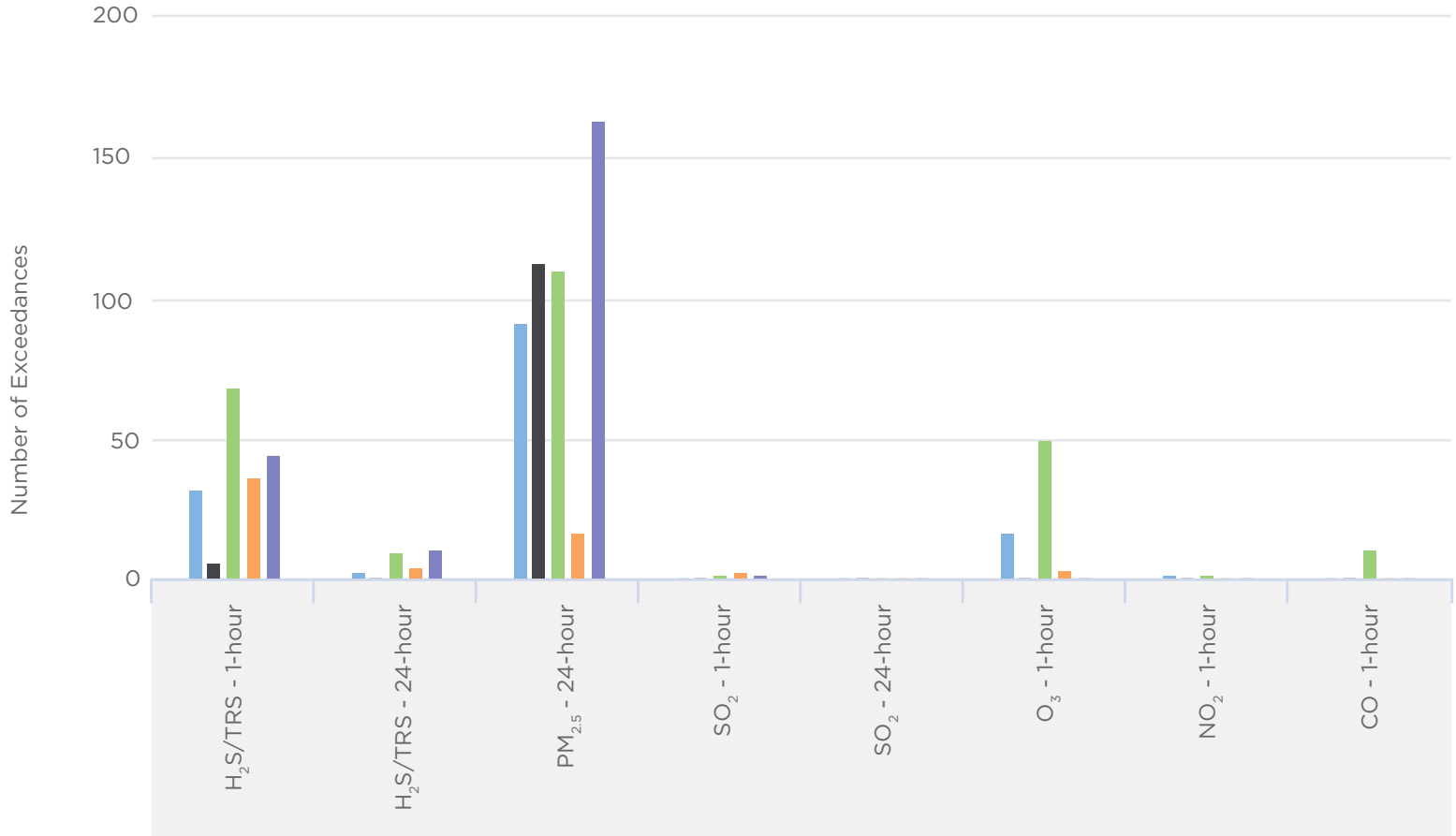
1. The data collection system automatically sends out alarm notifications to the WBEA personnel and an independent third-party alarm monitoring company.
2. The alarm company acknowledges the incoming alarm and reports the data and supporting information such as wind conditions, locations, time, etc., to AEP in real time, or as soon as becoming aware of it. AEP uses the data and information from the WBEA to follow-up as appropriate.
3. If the exceedance occurs at an industry station, the owner is informed that they have exceeded an AAAQO, and provided with the same information that was given to AEP. They are then required to follow up with AEP and/or the Alberta Energy Regulator (AER) and submit a report within seven days of the exceedance.

The table below shows the objectives for 1-hour, 24-hour, and annual averaging periods for the parameters which have established AAAQOs within the WBEA monitoring network. Where there is a dash (-) in the table below, AAAQOs do not currently exist.

Parameter	1-hour Average	8-hour Average	24-hour Average	Annual Average
Sulphur Dioxide (SO_2)	172 ppb	-	48 ppb	-
Nitrogen Dioxide (NO_2)	159 ppb	-	-	24 ppb
Ozone (O_3)	82 ppb	-	-	-
Total Reduced Sulphurs (TRS) / Hydrogen Sulphide (H_2S)*	10 ppb	-	3 ppb	-
Particulate Matter 2.5 ($PM_{2.5}$)	-	-	30 µg/m^3	-
Carbon Monoxide (CO)	13 ppm	5 ppm	-	-
Ammonia (NH_3)	2,000 ppb	-	-	-

**In the WBEA network TRS concentrations are reported using the H_2S AAAQOs.*

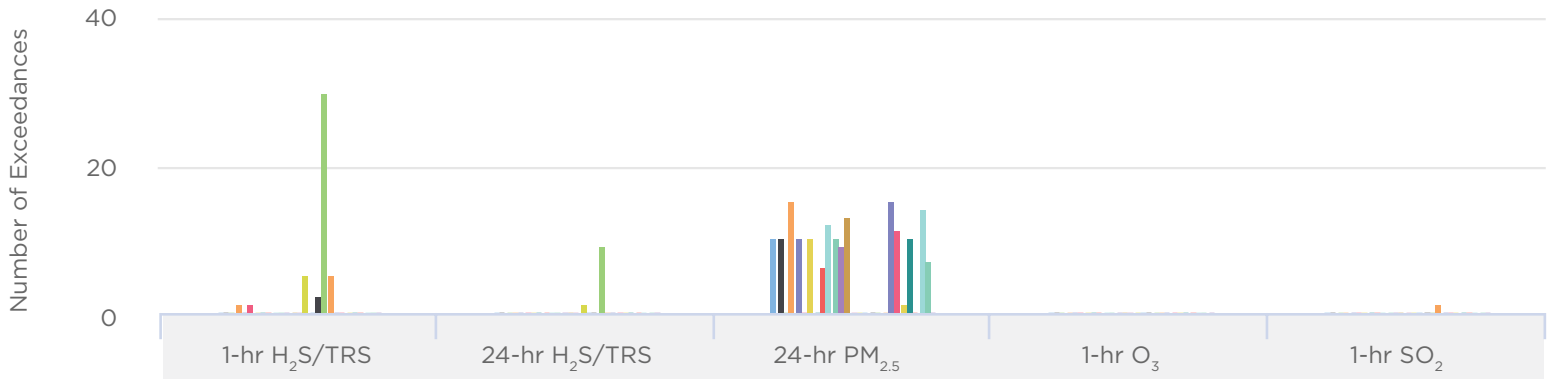
WBEA Ambient Air Monitoring Network - Total Number of AAAQO Exceedances (2014-2018)



	H_2S/TRS - 1-hour	H_2S/TRS - 24-hour	$PM_{2.5}$ - 24-hour	SO_2 - 1-hour	SO_2 - 24-hour	O_3 - 1-hour	NO_2 - 1-hour	CO - 1-hour
2014	31	2	91			16	1	
2015	5		112					
2016	68	9	109	1		49	1	10
2017	36	4	16	2		3		
2018	44	10	163	1				

Note: Forest fire season was considered to be from March 1 - November 1, 2018. Three of the $PM_{2.5}$ AAAQO exceedances were not related to forest fires in 2018.

2018 Exceedances by Station



	1-hr H_2S/TRS	24-hr H_2S/TRS	24-hr $PM_{2.5}$	1-hr O_3	1-hr SO_2
Anzac			10		
Athabasca Valley			10		
Barge Landing					
Bertha Ganter - Fort McKay	1		15		
Buffalo Viewpoint			10		
Christina Lake	1				
Conklin			10		
Firebag					
Fort Chipewyan			6		
Fort Hills			12		
Fort McKay South			10		
Horizon			9		
Janvier			13		
Leismer					
Lower Camp	5	1			
Lower Camp Met Tower					
Mackay River	2				
Mannix	30	9			
Mildred Lake	5				1
Muskeg River			15		
Patricia McInnes			11		
Sawbones Bay			1		
Stony Mountain			10		
Surmont					
Surmont 2			14		
Wapasu			7		
Waskow Ohci Pimatisiwin					

Note: Forest fire season was considered to be from March 1 - November 1, 2018. Three of the $PM_{2.5}$ AAAQO exceedances were not related to forest fires in 2018.

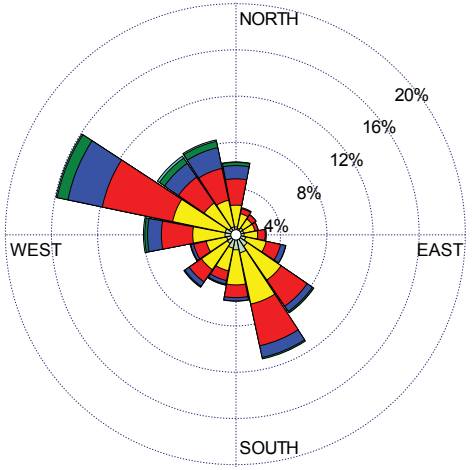
Photo by Cody David

Regional Wind Profiles

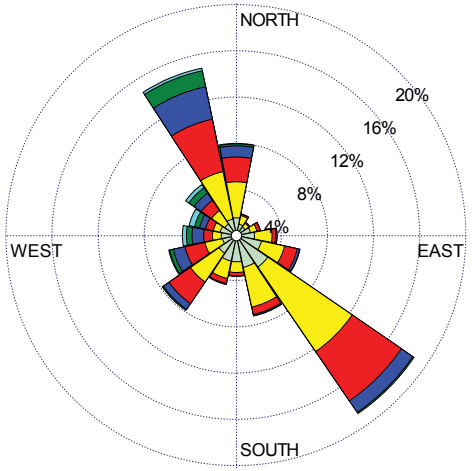
Air pollution transport, dispersion, transformation, and deposition are influenced by meteorological parameters, such as wind speed, wind direction, the vertical temperature structure of the atmosphere, humidity, atmospheric pressure, precipitation, and solar radiation.

The wind rose plots provided show the direction, speed, and frequency of winds at each community station in the network in 2018. The triangles show the direction the wind is coming from, and the legend for the wind speeds is shown below. The colours within each wind rose triangle denote the frequency of the wind speed. For example, the largest triangle in the Fort Chipewyan wind rose shows the wind came from the east 17% of the time in 2018. The green colour in this triangle shows the wind was between 8.8 and 11.1 kilometers per hour (km/h) approximately 4% of the time.

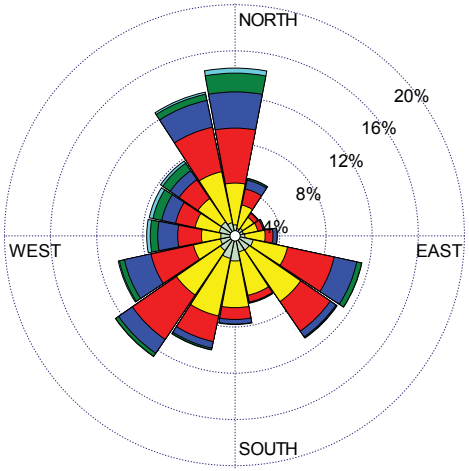
Anzac
Calms: 0.09%



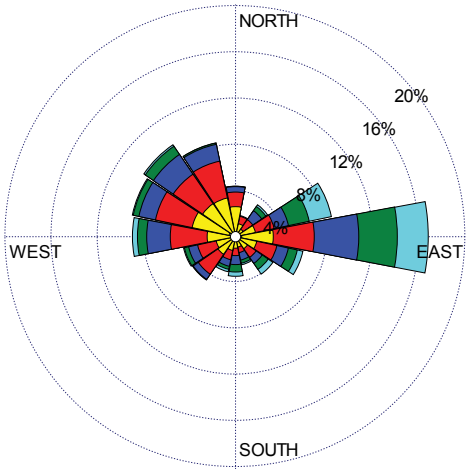
Athabasca Valley
Calms: 0.41%



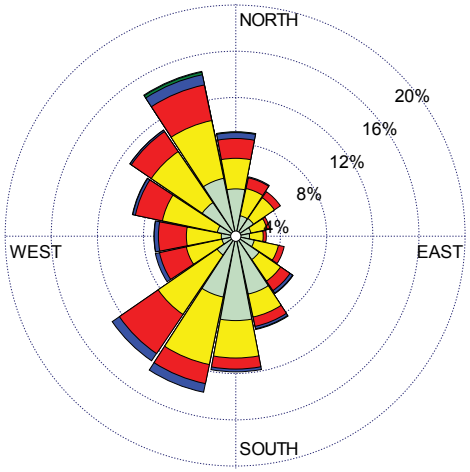
Patricia McInnes
Calms: 0.08%



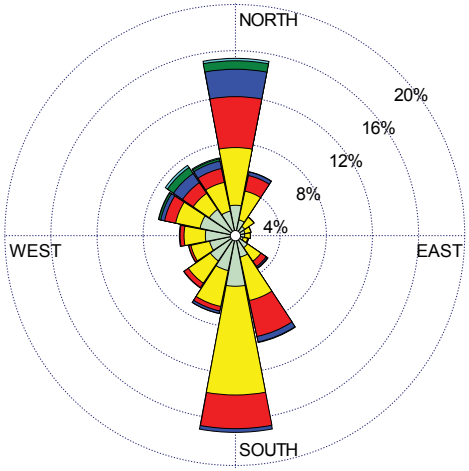
Fort Chipewyan
Calms: 0.54%



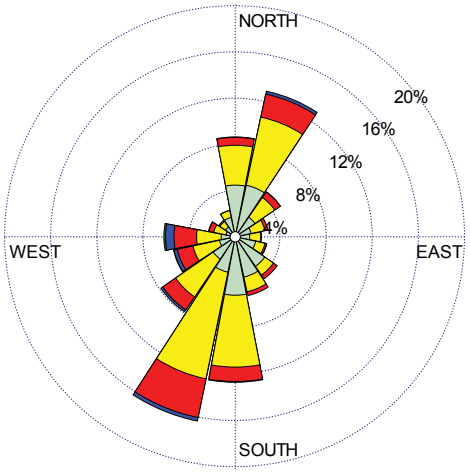
Conklin
Calms: 1.51%



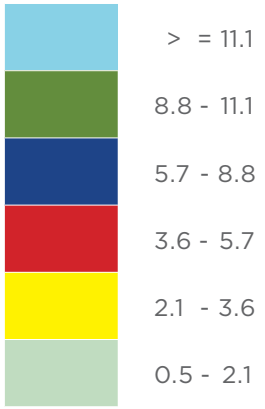
Bertha Ganter - Fort McKay
Calms: 0.24%



Janvier
Calms: 0.77%



WIND SPEED (km/h)



Parameters Monitored at WBEA Stations

The WBEA's ambient air quality monitoring program is conducted through both continuous and time-integrated (non-continuous) sampling methods. The tables below and on pages 17 and 18 provide a list of the air quality parameters measured at each station in the WBEA network.

Summary of parameters measured using integrated methods at WBEA sites.

WBEA ID	Type	Station Name	VOC	$PM_{2.5}$ Mass, Metals and Ions	$PM_{2.5}$ ECOC	MP10 Mass, Metals and Ions	PAH	Precip
1	Community	Bertha Ganter-Fort Mckay	✓	✓	✓	✓	✓	✓
4	Compliance	Buffalo Viewpoint						
6	Community	Patricia Mcinnes	✓	✓		✓	✓	✓
7	Community	Athabasca Valley	✓	✓		✓	✓	
9	Attribution	Barge Landing	✓					
11	Compliance	Lower Camp		✓				
13	Compliance/ Attribution	Fort Mckay South	✓			✓		
14	Compliance/ Community	Anzac	✓	✓		✓	✓	
15	Compliance	Horizon	✓			✓		
17	Compliance	Wapasu			✓			
18	Enhanced Deposition/ Background	Stony Mountain			✓			
22	Community	Janvier	✓					

Summary of stations and parameters measured continuously at WBEA sites.

WBEA ID	Type	Station Name	SO_2	$NO/NO_2/NO_x$	O_3	$PM_{2.5}$	TRS	H_2S	THC	Methane NMHC	CO	CO_2	NH_3
1	Community	Bertha Ganter-Fort Mckay	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓
2	Compliance	Mildred Lake	✓					✓	✓				
3	Meteorological	Lower Camp Met Tower											
4	Compliance	Buffalo Viewpoint	✓	✓	✓	✓		✓	✓	✓			
5	Compliance/ Meteorological	Mannix	✓					✓	✓				
6	Community	Patricia Mcinnes	✓	✓	✓	✓	✓		✓	✓			✓
7	Community	Athabasca Valley	✓	✓	✓	✓	✓		✓	✓	✓		
8	Community/ Compliance	Fort Chipewyan	✓	✓	✓	✓					✓	✓	
9	Attribution	Barge Landing	✓	✓		✓	✓		✓				
11	Compliance	Lower Camp	✓					✓	✓	✓			
13	Compliance/ Attribution	Fort Mckay South	✓	✓	✓	✓	✓		✓				
14	Compliance/ Community	Anzac	✓	✓	✓	✓	✓		✓	✓			
15	Compliance	Horizon	✓	✓		✓	✓		✓				
17	Compliance	Wapasu	✓	✓	✓	✓		✓	✓				
18	Enhanced Deposition/ Background	Stony Mountain	✓	✓	✓	✓	✓		✓	✓			
19	Compliance	Firebag	✓	✓				✓	✓				
20	Compliance	Mackay River	✓	✓				✓	✓				
21	Community	Conklin	✓	✓	✓	✓	✓		✓	✓			
22	Community	Janvier	✓	✓	✓	✓	✓		✓	✓			
23	Compliance	Fort Hills	✓	✓		✓	✓		✓				
25	Emergency Response	Waskow Ohci Pimatisiwin	✓					✓					
26	Compliance	Christina Lake	✓	✓				✓					
27	Compliance	Jackfish 2/3	✓	✓				✓					
29	Compliance	Surmont 2	✓	✓		✓		✓	✓				
506	Compliance	Jackfish 1	✓	✓				✓					
508	Compliance	Kirby North	✓	✓				✓	✓				

Summary of stations and meteorological parameters measured continuously at WBEA sites.

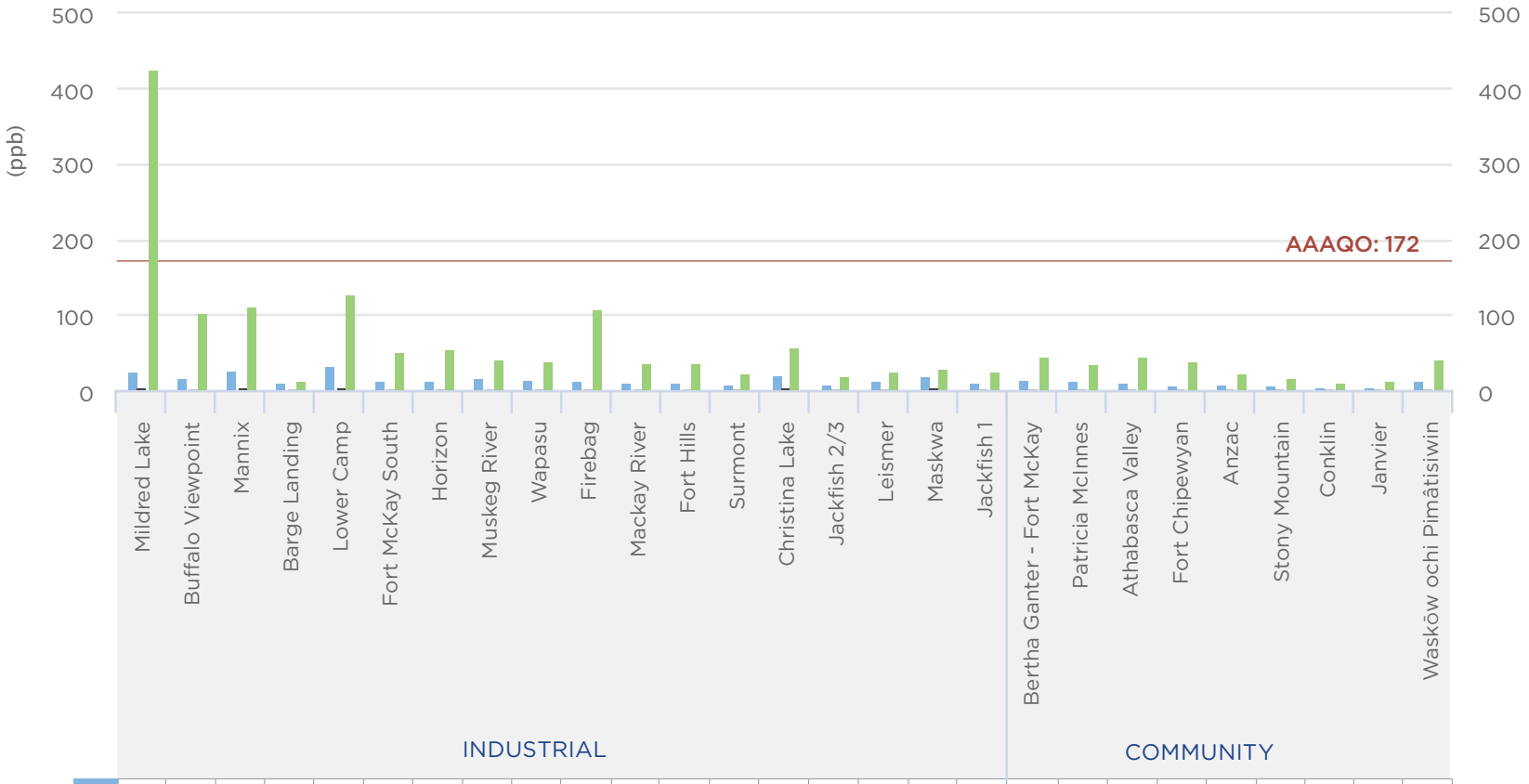
WBEA ID	Locale	Station Name	Temperature	RH	BP	Wind Speed	Wind Direction	Vertical Wind Speed	Solar Radiation	Precip	Leaf Wetness
1	Community	Bertha Ganter-Fort Mckay	✓	✓		✓	✓		✓	✓	✓
2	Compliance	Mildred Lake	✓	✓		✓	✓				
3	Meteorological	Lower Camp Met Tower	✓	✓		✓	✓	✓			
4	Compliance Meteorlogical	Buffalo Viewpoint	✓	✓		✓	✓				
5	Community	Mannix	✓	✓		✓	✓	✓			
6	Community	Patricia Mcinnes	✓	✓		✓	✓				
7	Community	Athabasca Valley	✓	✓	✓	✓	✓				
8	Community/ Compliance	Fort Chipewyan	✓	✓		✓	✓		✓	✓	✓
9	Attribution	Barge Landing	✓	✓	✓	✓	✓				
11	Compliance	Lower Camp	✓	✓		✓	✓				
13	Compliance/ Attribution	Fort Mckay South	✓	✓		✓	✓				
14	Compliance/ Community	Anzac	✓	✓		✓	✓			✓	✓
15	Compliance	Horizon	✓	✓		✓	✓		✓	✓	
17	Compliance	Wapasu	✓	✓		✓	✓			✓	
18	Enhanced Deposition/ Background	Stony Mountain	✓	✓		✓	✓		✓	✓	✓
19	Compliance	Firebag	✓	✓		✓	✓				
20	Compliance	Mackay River	✓	✓		✓	✓			✓	
21	Community	Conklin	✓	✓		✓	✓				
22	Community	Janvier	✓	✓		✓	✓				
23	Compliance	Fort Hills	✓	✓		✓	✓				
25	Emergency Response	Waskow Ohci Pimatisiwin	✓	✓		✓	✓				
26	Compliance	Christina Lake	✓	✓		✓	✓				
27	Compliance	Jackfish 2/3	✓	✓		✓	✓				
29	Compliance	Surmont 2	✓	✓		✓	✓				
506	Compliance	Jackfish 1	✓	✓		✓	✓				
508	Compliance	Kirby North									

Continuous Monitoring

Continuous ambient air monitoring uses analyzers that constantly measure the concentrations of different pollutants in the air. All stations also continuously measure temperature, relative humidity, and wind speed and direction. The WBEA's continuous sampling data is available to everyone at **wbea.org/network-and-data/historical-monitoring-data**. The data for continuous monitoring is presented in the graphs on the following pages as the annual hourly average (mean) concentrations of each parameter, along with the annual hourly 99th percentile and maximum concentrations. The annual hourly 99th percentile is used to show the high end of concentrations measured at the WBEA air monitoring stations, after removing the highest 1% of events which may be outliers.

Sulphur Dioxide (SO_2)

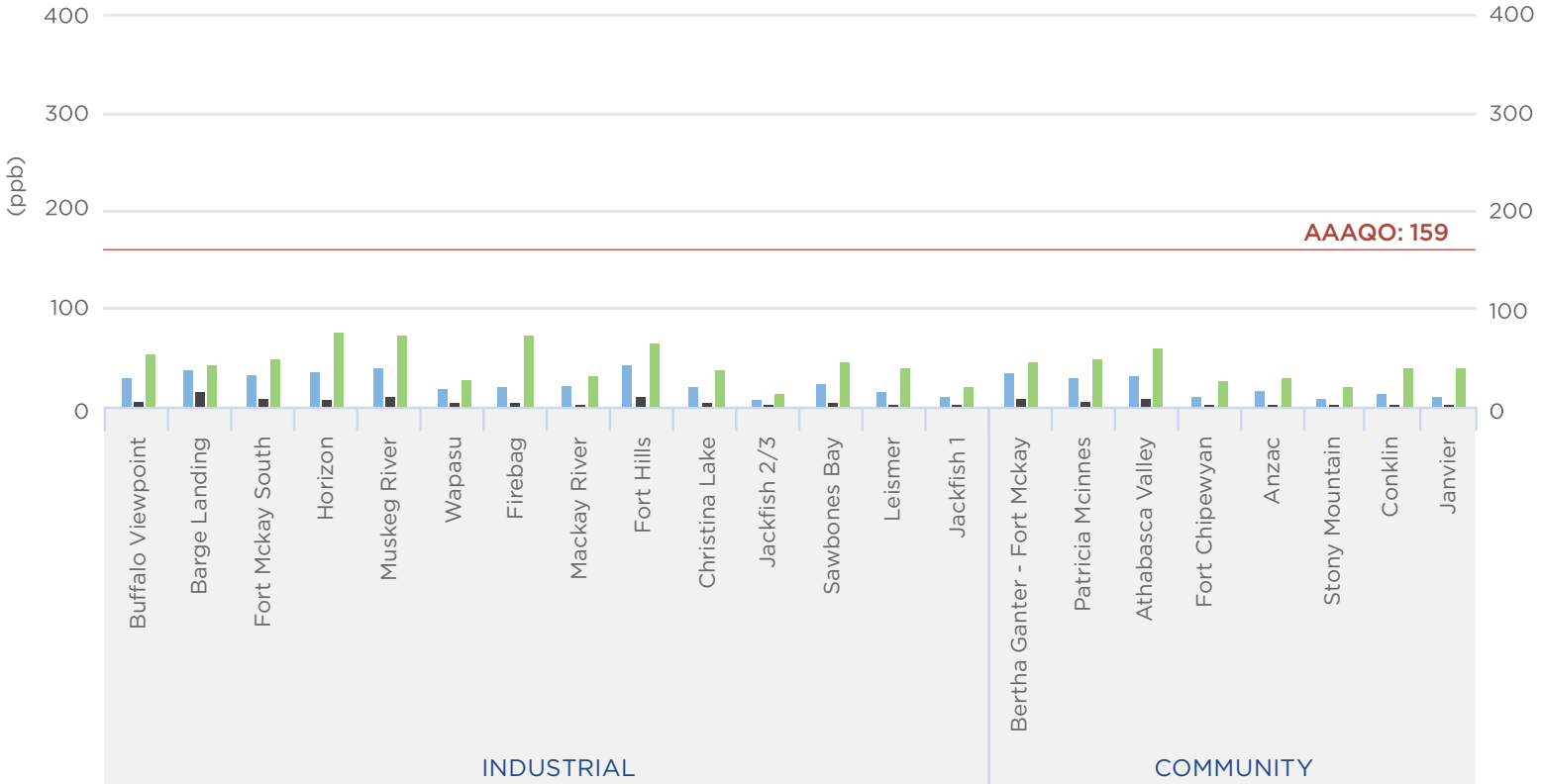
Sulphur dioxide is produced from the combustion of sulphur-containing fossil fuels. Sulphur dioxide in the air at high concentrations can make breathing difficult, particularly for children, the elderly, and people with asthma. Sulphur dioxide reacts in the atmosphere to form sulphuric acid and acidic aerosols, which contribute to acid deposition and acid rain.



	Mildred Lake	Buffalo Viewpoint	Mannix	Barge Landing	Lower Camp	Fort McKay South	Horizon	Muskeg River	Wapasu	Firebag	Mackay River	Fort Hills	Surmont	Christina Lake	Jackfish 2/3	Leismer	Maskwa	Jackfish 1	Bertha Ganter - Fort McKay	Patricia McInnes	Athabasca Valley	Fort Chipewyan	Anzac	Stony Mountain	Conklin	Janvier	Waskōw ochi Pimâtisiwin
99th Percentile	21.9	14.1	23.6	7.6	30.4	10.3	9.4	14.4	11.2	10.7	8.4	7.7	5.9	18.0	5.3	10.3	16.2	8.5	11.9	9.9	7.1	3.1	5.6	3.4	2.9	2.3	9.9
Average	1.7	0.8	1.5	0.6	2.2	0.8	0.9	0.8	1.0	1.0	0.7	0.7	0.7	1.4	0.6	0.9	1.2	0.7	0.9	0.9	0.6	0.2	0.5	0.5	0.4	0.3	0.8
Max	422.8	100.5	109.6	10.5	124.3	48.7	51.7	38.8	36.2	105.1	33.8	34.3	20.0	54.0	16.6	23.1	26.7	23.1	42.7	32.0	42.8	35.9	19.9	13.4	7.4	9.4	38.9
AAAQO 1-hour avg.	172																										

Nitrogen Dioxide (NO_2)

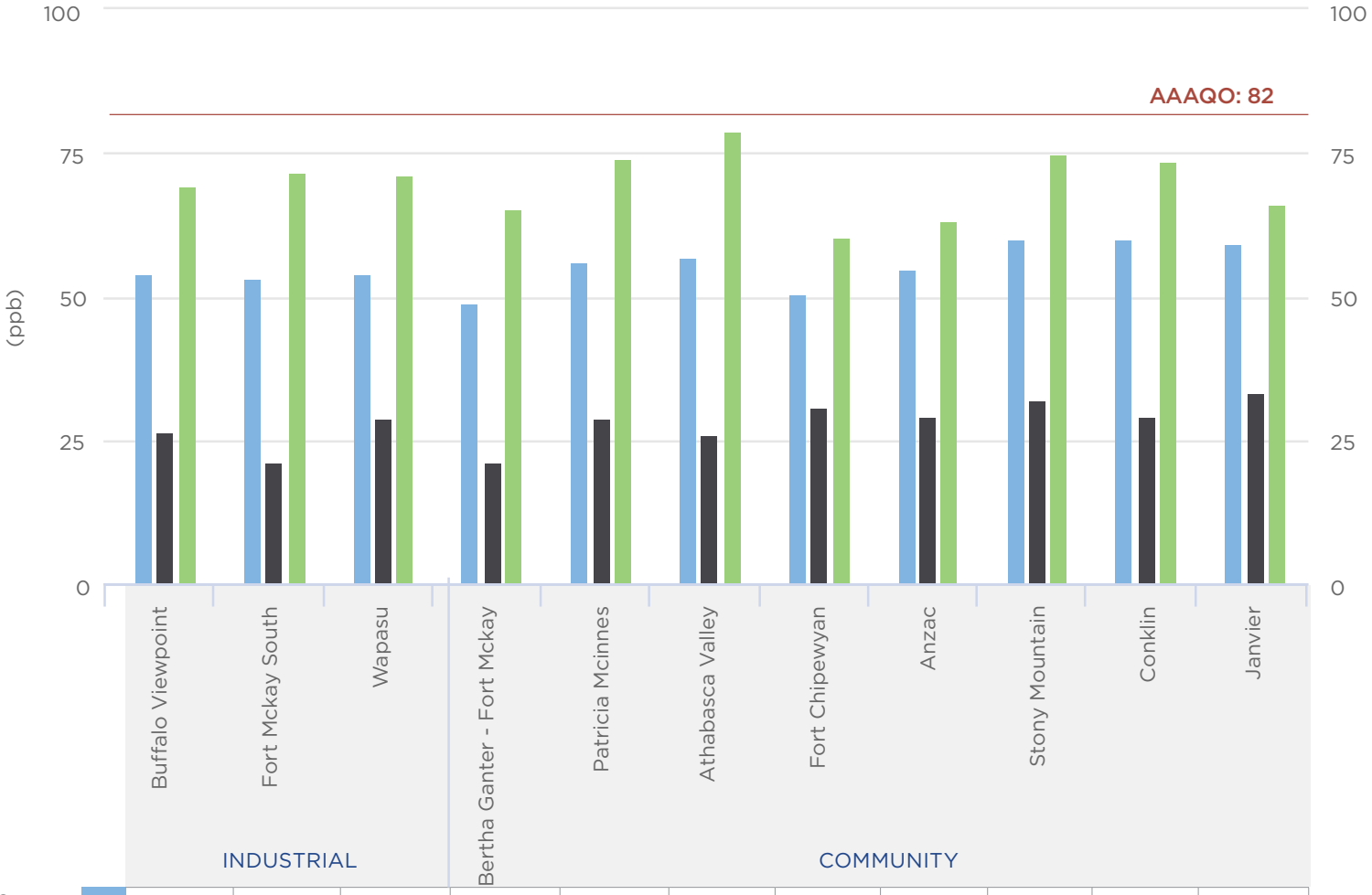
Nitrogen dioxide is a reddish-brown gas with a pungent, irritating odour that is produced by combustion of fossil fuels. It plays a major role in atmospheric photo-chemical reactions, ground-level ozone formation and destruction, and can also interact with water to form acid rain.



	Buffalo Viewpoint	Barge Landing	Fort Mckay South	Horizon	Muskeg River	Wapasu	Firebag	Mackay River	Fort Hills	Christina Lake	Jackfish 2/3	Sawbones Bay	Leismer	Jackfish 1	Bertha Ganter - Fort Mckay	Patricia Mcinnes	Athabasca Valley	Fort Chipewyan	Anzac	Stony Mountain	Conklin	Janvier
99th Percentile	29.5	37.1	32.4	36.2	38.7	17.4	19.8	20.2	42.1	18.7	7.1	22.4	14.6	10.4	33.4	28.3	30.2	10.3	15.5	8.2	13.3	10.2
Average	5.5	15.2	7.3	6.7	9.5	3.0	3.0	2.2	9.2	3.2	1.7	3.9	2.3	2.1	7.6	5.1	7.4	1.5	2.2	1.5	2.4	1.7
Max	53.4	41.7	48.8	75.5	71.9	27.7	73.3	31.2	64.8	37.8	12.7	44.6	38.1	18.6	45.8	48.1	59.8	26.1	29.4	20.1	39.5	38.1
AAAQO 1-hour avg.	159																					

Ozone (O_3)

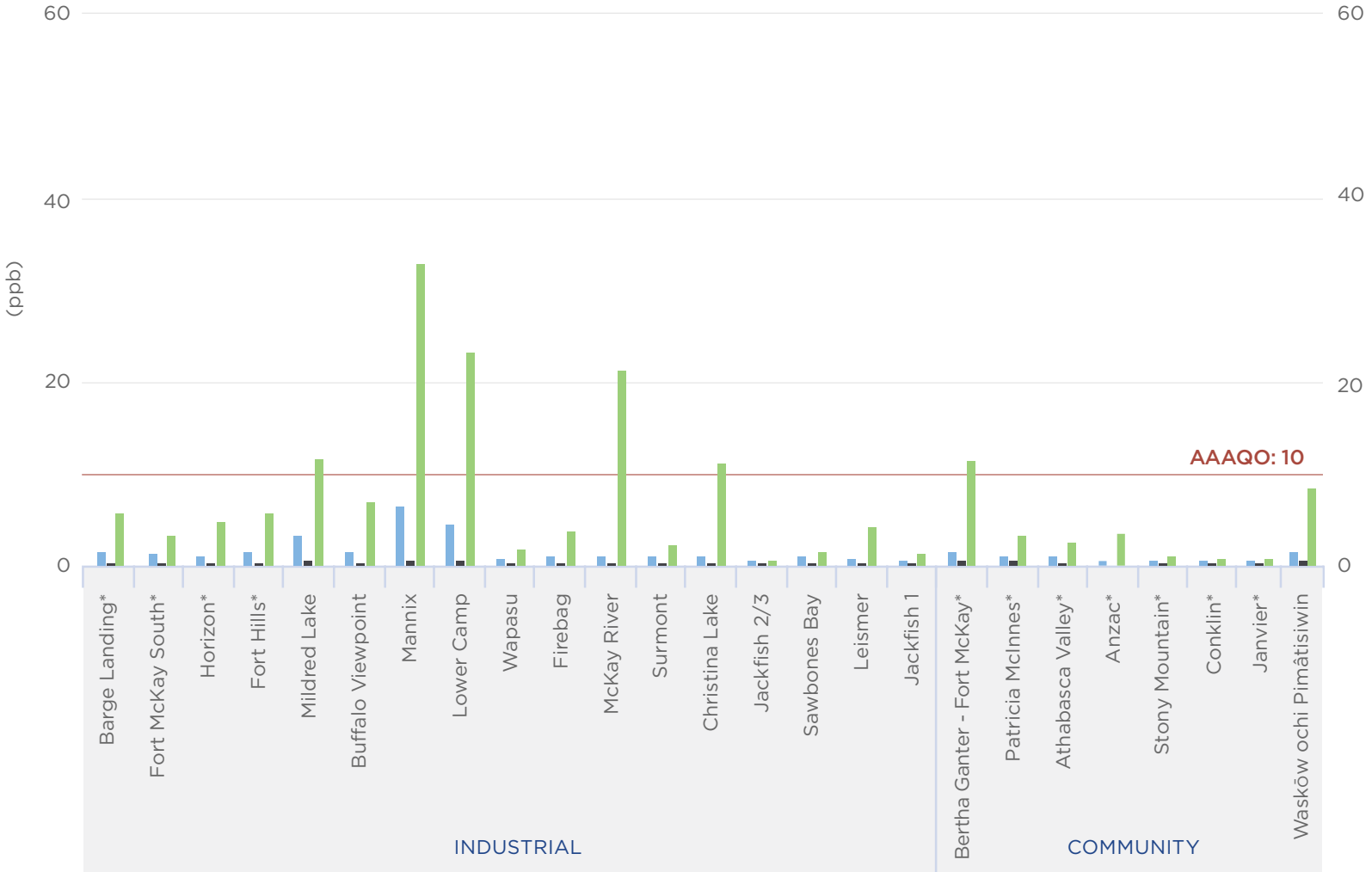
Ozone at ground-level is not emitted directly into the air but formed by chemical reactions of NO_x and volatile organic compounds (VOCs), from vehicular and industrial emissions. At high concentrations, breathing ozone can affect respiratory function, and cause coughing, throat irritation, and airway inflammation. Children, the elderly, and people with asthma are the most susceptible. Ozone can affect sensitive vegetation, by slowing plant growth and making them more susceptible to disease.



	Buffalo Viewpoint	Fort Mckay South	Wapasu	Bertha Ganter - Fort Mckay	Patricia Mcinnes	Athabasca Valley	Fort Chipewyan	Anzac	Stony Mountain	Conklin	Janvier
99th Percentile	54.2	53.3	54.2	48.9	56.1	56.8	50.3	54.7	60.0	60.2	59.3
Average	26.3	20.9	28.7	20.8	28.6	25.7	30.6	29.0	32.0	29.1	33.2
Max	69.4	71.8	71.5	65.2	74.2	79.2	60.5	63.2	75.0	73.6	66.3
AAAQO 1-hour avg.	82										

Total Reduced Sulphurs/Hydrogen Sulphide (TRS/H_2S)

Hydrogen sulphide is a colourless gas with a rotten egg odour. It is produced through industrial processes. The term "Total Reduced Sulphurs" covers a larger group of sulphur-containing compounds, including H_2S, carbonyl sulphide, mercaptans, etc. These substances have the potential to cause odours in the region. In the WBEA airshed most industrial TRS and H_2S emissions are from upgraders and tailings ponds, though there is a natural background ambient air concentration of the reduced sulphur compound carbonyl sulphide of approximately 0.5 ppb.



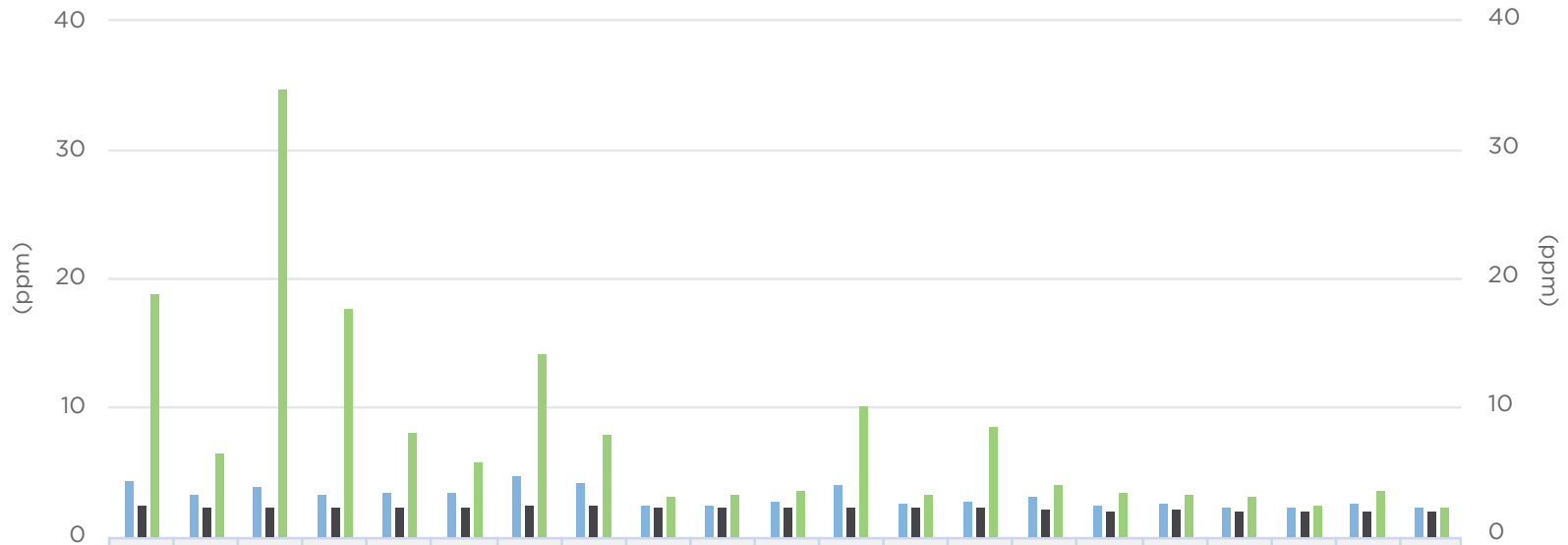
	Barge Landing*	Fort McKay South*	Horizon*	Fort Hills*	Mildred Lake	Buffalo Viewpoint	Mannix	Lower Camp	Wapasu	Firebag	McKay River	Surmont	Christina Lake	Jackfish 2/3	Sawbones Bay	Leismer	Jackfish 1	Bertha Ganter - Fort McKay*	Patricia McInnes*	Athabasca Valley*	Anzac*	Stony Mountain*	Conklin*	Janvier*	Waskōw ochi Pimâtisiwin
99th Percentile	1.5	1.3	1.0	1.5	3.3	1.6	6.5	4.4	0.7	0.9	1.1	0.9	0.9	0.5	0.9	0.7	0.6	1.6	1.0	1.0	0.4	0.5	0.5	0.4	1.5
Average	0.3	0.3	0.2	0.3	0.5	0.3	0.6	0.6	0.2	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.3	0.5	0.4	0.3	0.1	0.3	0.3	0.2	0.4
Max	5.7	3.3	4.6	5.6	11.5	6.8	32.8	23.2	1.7	3.6	21.2	2.2	11.2	0.6	1.6	4.1	1.2	11.3	3.3	2.5	3.5	0.9	0.8	0.8	8.4
AAAQO 1-hour avg.	10																								

*denotes TRS analyzer

Total Hydrocarbons (THC)

Methane (CH_4) is the most abundant hydrocarbon on earth, while reactive non-methane hydrocarbons (NMHCs) can react with other compounds in atmosphere to form ozone. Total hydrocarbons (THC) are the combined concentrations on both methane and non-methane hydrocarbons. Some stations in the WBEA network only measure THCs, while certain stations measure CH_4, NMHC, and THC. Many hydrocarbons are emitted from natural sources, while others can come from industrial and vehicular emissions. The natural background level of THC, composed mainly of CH_4, is generally around 1.8 ppm.

Note: THC does not currently have an AAAQO.

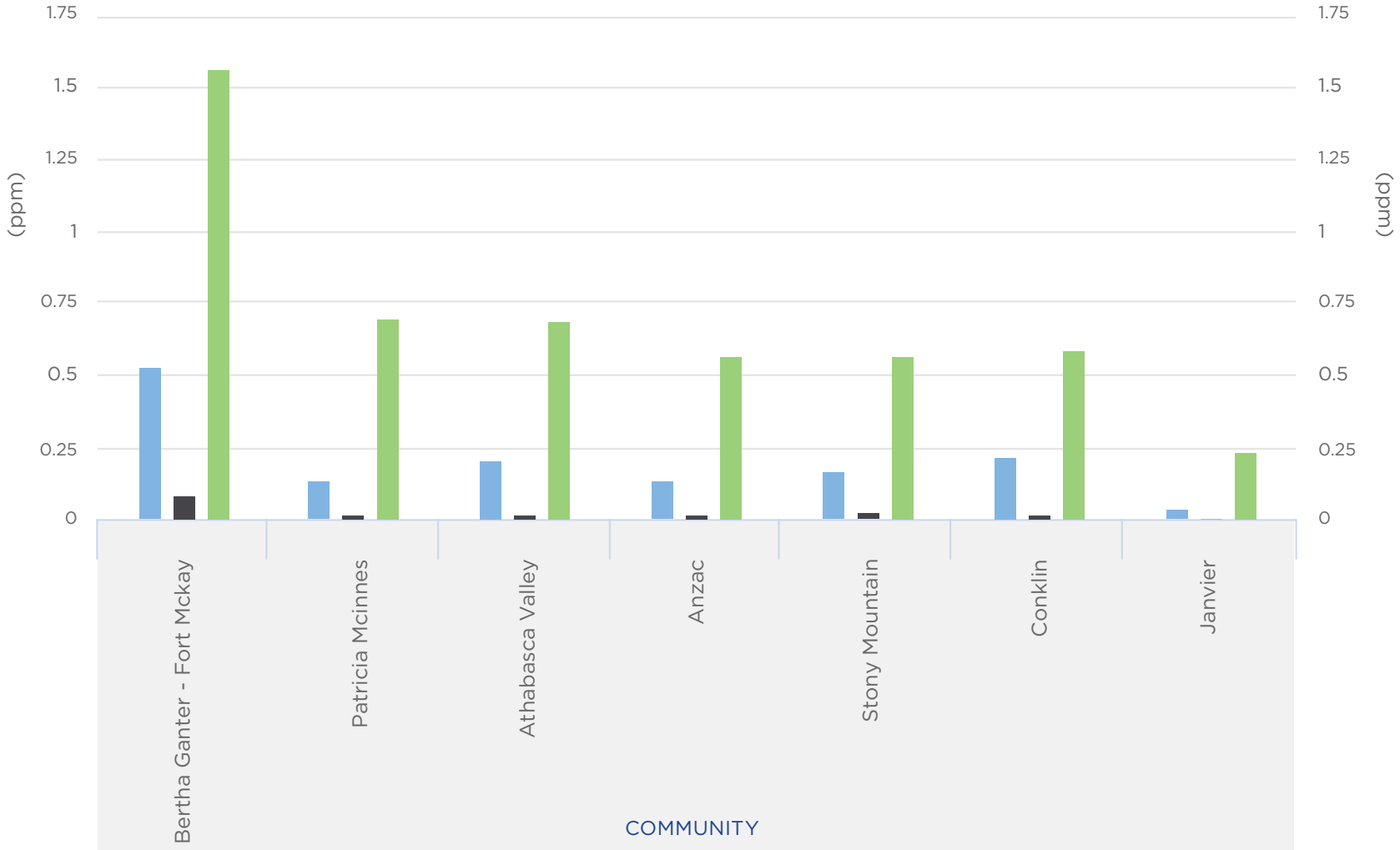


	Mildred Lake	Buffalo Viewpoint	Mannix	Barge Landing	Lower Camp	Fort McKay South	Horizon	Muskeg River	Wapasu	Firebag	MacKay River	Fort Hills	Surmont	Sawbones Bay	Bertha Ganter - Fort Mckay	Patricia Mcinnes	Athabasca Valley	Anzac	Stony Mountain	Conklin	Janvier
99th Percentile	4.3	3.3	3.9	3.3	3.4	3.4	4.7	4.2	2.5	2.5	2.7	4.0	2.6	2.8	3.1	2.4	2.6	2.3	2.2	2.6	2.2
Average	2.4	2.3	2.3	2.2	2.3	2.3	2.4	2.4	2.2	2.2	2.2	2.2	2.2	2.2	2.1	2.0	2.1	2.0	2.0	2.0	1.9
Max	18.8	6.5	34.9	17.7	8.1	5.8	14.2	7.9	3.0	3.2	3.5	10.2	3.3	8.6	4.1	3.4	3.3	3.1	2.5	3.5	2.3

Non-Methane Hydrocarbons (NMHC)

Methane (CH_4) is the most abundant hydrocarbon on earth, while reactive non-methane hydrocarbons (NMHCs) can react with other compounds in atmosphere to form ozone. Total hydrocarbons (THC) are the combined concentrations on both methane and non-methane hydrocarbons. Some stations in the WBEA network only measure THCs, while certain stations measure CH_4, NMHC, and THC. Many hydrocarbons are emitted from natural sources, while others can come from industrial and vehicular emissions. The natural background level of THC, composed mainly of CH_4, is generally around 1.8 ppm.

Note: NMHC does not currently have an AAAQO.

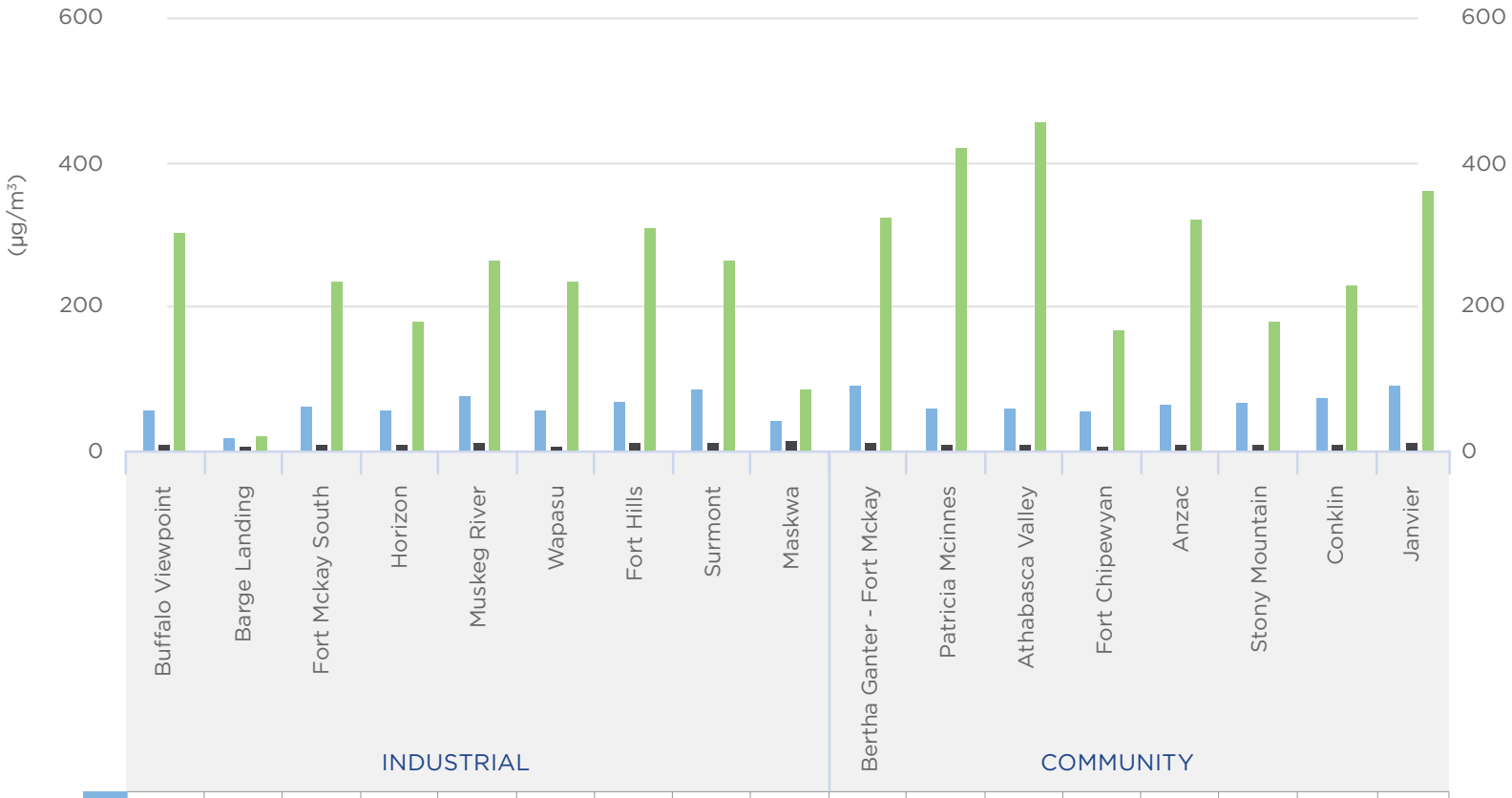


	Bertha Ganter - Fort Mckay	Patricia Mcinnes	Athabasca Valley	Anzac	Stony Mountain	Conklin	Janvier
99th Percentile	0.5	0.1	0.2	0.1	0.2	0.2	0.0
Average	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Max	1.6	0.7	0.7	0.6	0.6	0.6	0.2

Fine Particulate Matter ($PM_{2.5}$)

Particulate matter consists of a mixture of solid particles and liquid droplets found in the air. Fine particulate matter is 2.5 µm in diameter or less, and is produced mainly by combustion processes, including forest fires. In 2018, most exceedances of the $PM_{2.5}$ AAAQO in the WBEA network were a result of forest fires. Fine particles are composed primarily of sulphate, nitrate, ammonium, inorganic and organic carbon compounds, and heavy metals. Fine particulate matter poses a health risk as the particles can be inhaled deep into the lungs.

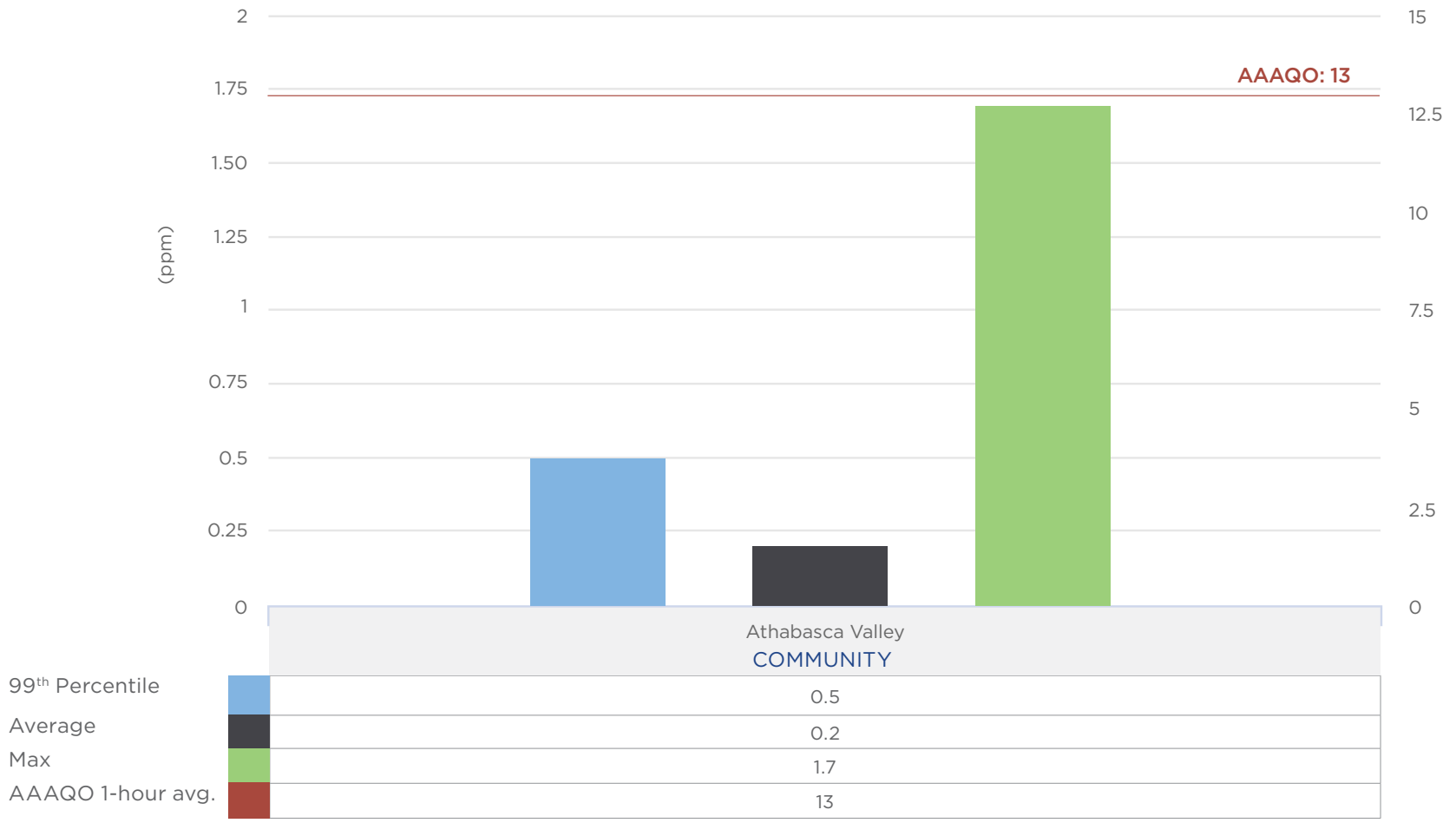
Note: The data in the graph is presented using 1-hour concentration averages. Fine Particulate Matter ($PM_{2.5}$) does not currently have a 1-hour average AAAQO.



	Buffalo Viewpoint	Barge Landing	Fort Mckay South	Horizon	Muskeg River	Wapasu	Fort Hills	Surmont	Maskwa	Bertha Ganter - Fort Mckay	Patricia Mcinnes	Athabasca Valley	Fort Chipewyan	Anzac	Stony Mountain	Conklin	Janvier
99th Percentile	55.9	17.2	59.8	56.2	74.4	55.1	68.9	84.6	42.0	88.5	57.7	57.5	52.1	64.0	65.9	72.6	88.5
Average	6.7	6.0	7.3	7.1	10.1	5.4	9.1	10.5	12.1	9.8	7.7	7.5	4.9	6.1	6.2	7.5	8.8
Max	303.2	18.5	235.1	178.7	263.3	235.2	309.2	264.3	85.0	325.0	422.0	456.8	166.2	321.4	179.6	229.2	360.7

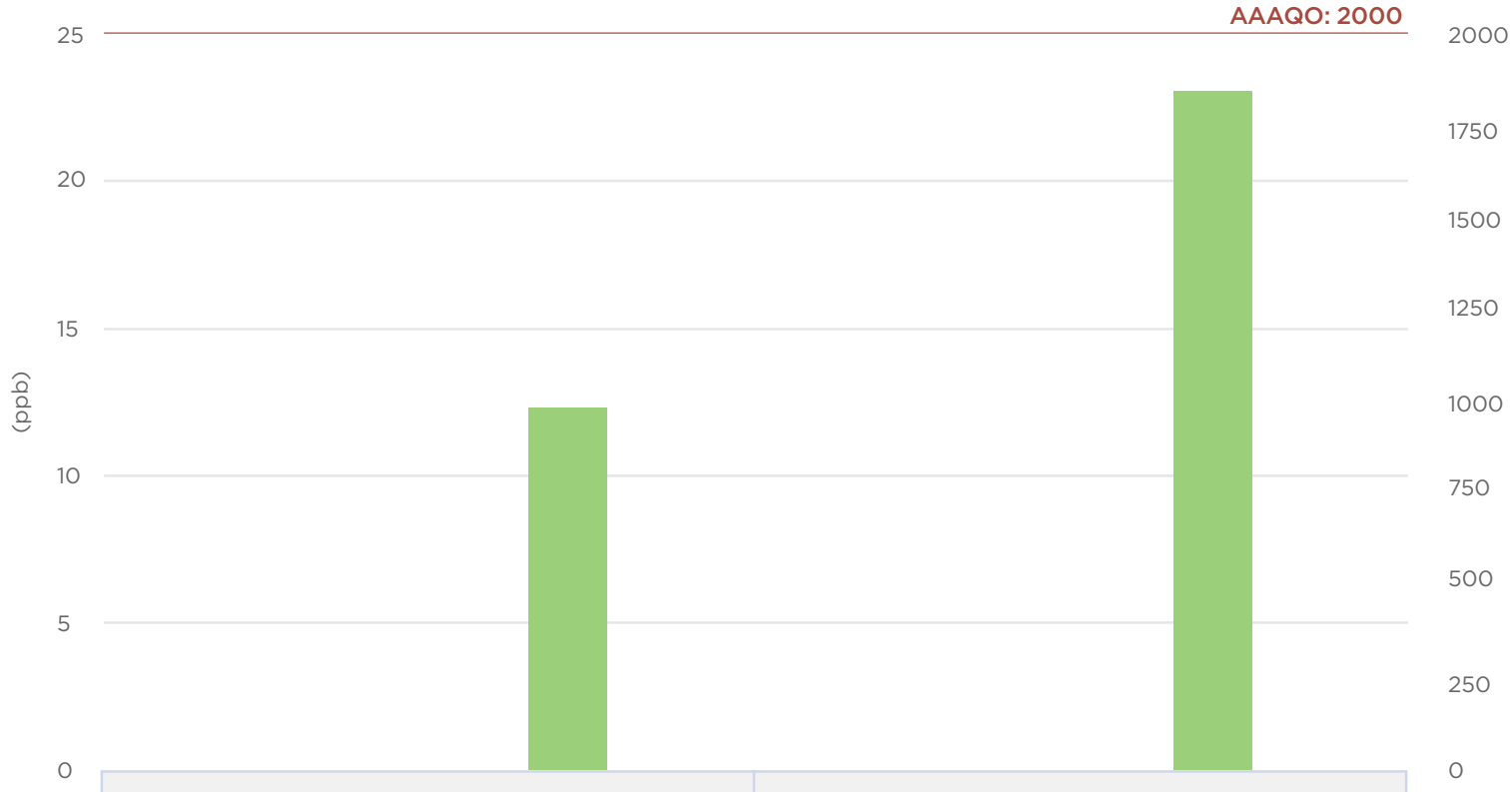
Carbon Monoxide (CO)

Carbon monoxide is formed from the incomplete combustion of carbon in fossil fuels. Transportation and vehicle emissions are the major source of carbon monoxide with elevated concentrations during the morning and evening rush hours. Breathing carbon monoxide decreases the amount of oxygen carried by the blood stream. In 2018, carbon monoxide was only monitored at the Athabasca Valley air monitoring station, in downtown Fort McMurray.



Ammonia (NH_3)

Ammonia is a natural compound found in the environment as part of the nitrogen cycle and can also come from human activity. Ammonia is monitored by the WBEA because it is used by one industry member to help reduce SO_2 emissions. Exposure to elevated concentrations of ammonia can cause irritation of the nose, throat, and respiratory tract. Ammonia is currently monitored at the Bertha Ganter - Fort McKay and Patricia McInnes air monitoring stations.



	Bertha Ganter - Fort McKay	Patricia Mcinnes
99th Percentile	0.0	0.0
Average	0.0	0.0
Max	12.3	23.1
AAAQO 1-hour avg.	2000	

Time-Integrated Monitoring

Time-integrated sampling provides more detailed analysis of species present in ambient air, and supplements continuous monitoring which reports a total concentration in real-time. Time-integrated monitoring methods consist of exposing sample media to the atmosphere for a period of time, and then the media is sent to a laboratory for analysis.

The WBEA's time-integrated sampling data is available to everyone at **wbea.org/network-and-data/integrated-data**. The data for time-integrated monitoring methods is presented in the graphs on the following pages as the annual average (mean) of 24-hour sample concentrations, along with the 95th percentile to show readings on the high-end of the data collected, after removing the highest 5% which may be outliers. There are numerous species collected, however, the graphs show the 10 parameters with the highest concentrations in 2018.

Note: to view exact data points, visit ***wbea.org/2018-annual-report***

Particulate matter ($PM_{2.5}$ PM_{10})

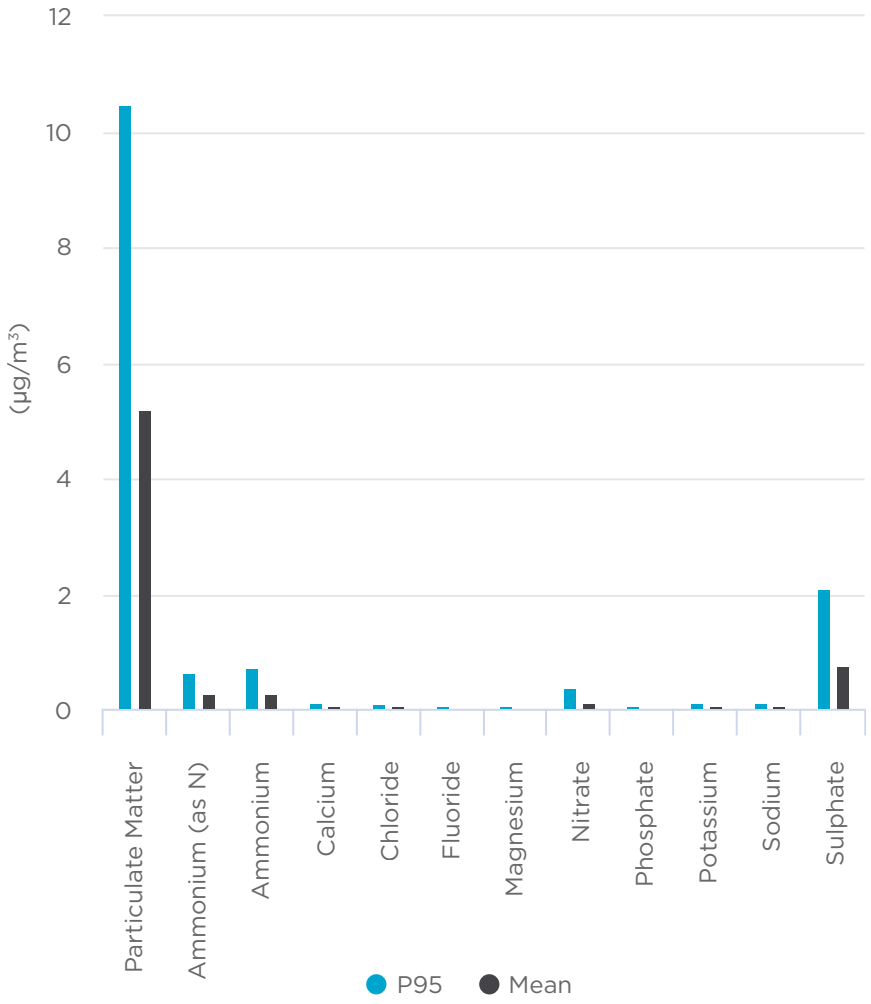
Particulate matter consists of a mixture of solid particles and liquid droplets found in the air. Fine particulate matter ($PM_{2.5}$) is 2.5 µm in diameter or less, while coarse particulate matter (PM_{10}) is 10 µm in diameter or less.

In the time-integrated sampling program, particulate matter (both $PM_{2.5}$ & PM_{10}) is collected on filter for a 24-hour period, every six days. $PM_{2.5}$ samples were collected at four community stations (Bertha Ganter - Fort McKay, Patricia McInnes, Athabasca Valley, and Anzac). PM_{10} samples were taken at the same four community stations and three industrial stations (Fort McKay South, Horizon, and Muskeg River). These filters are then sent to the lab for sample analysis to learn the chemical compositions including ionic and metal species. Ions are electrically-charged, water-soluble particles, while metals are neutral species.

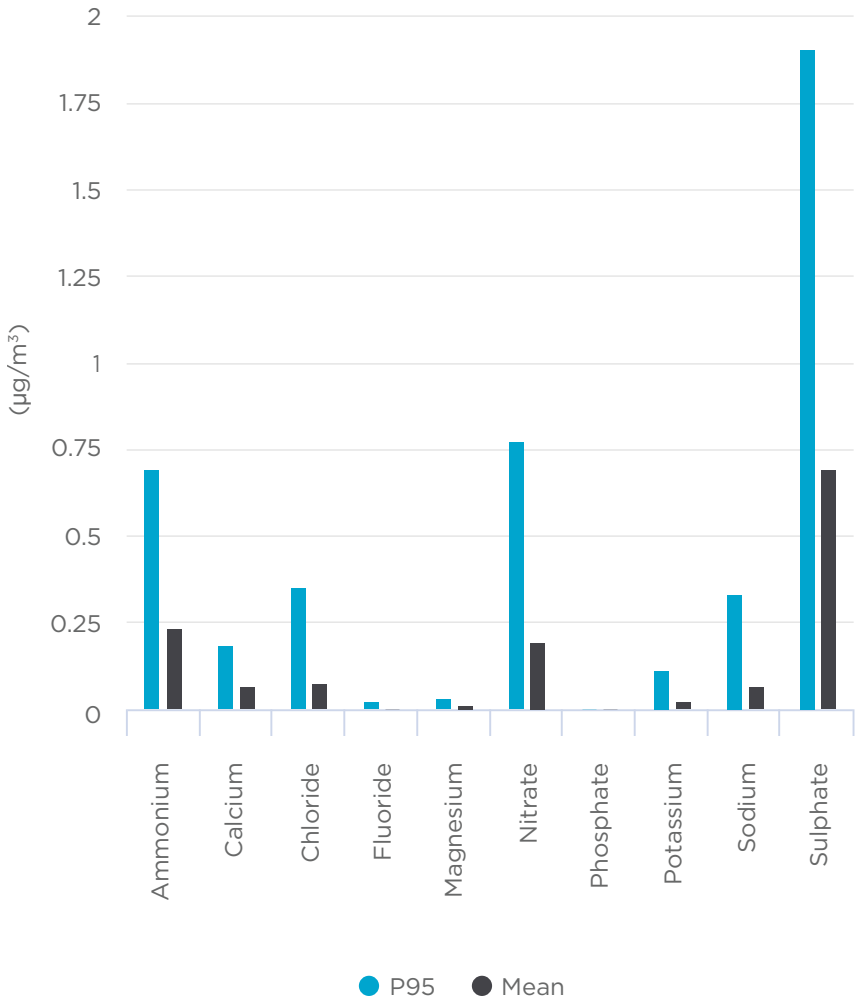
The continuous analyzer can tell us the concentration of particulate matter in the air at any given time, while a sample can tell us what is making up the particulate matter in the air.

Particulate Matter 2.5 ($PM_{2.5}$) Ions

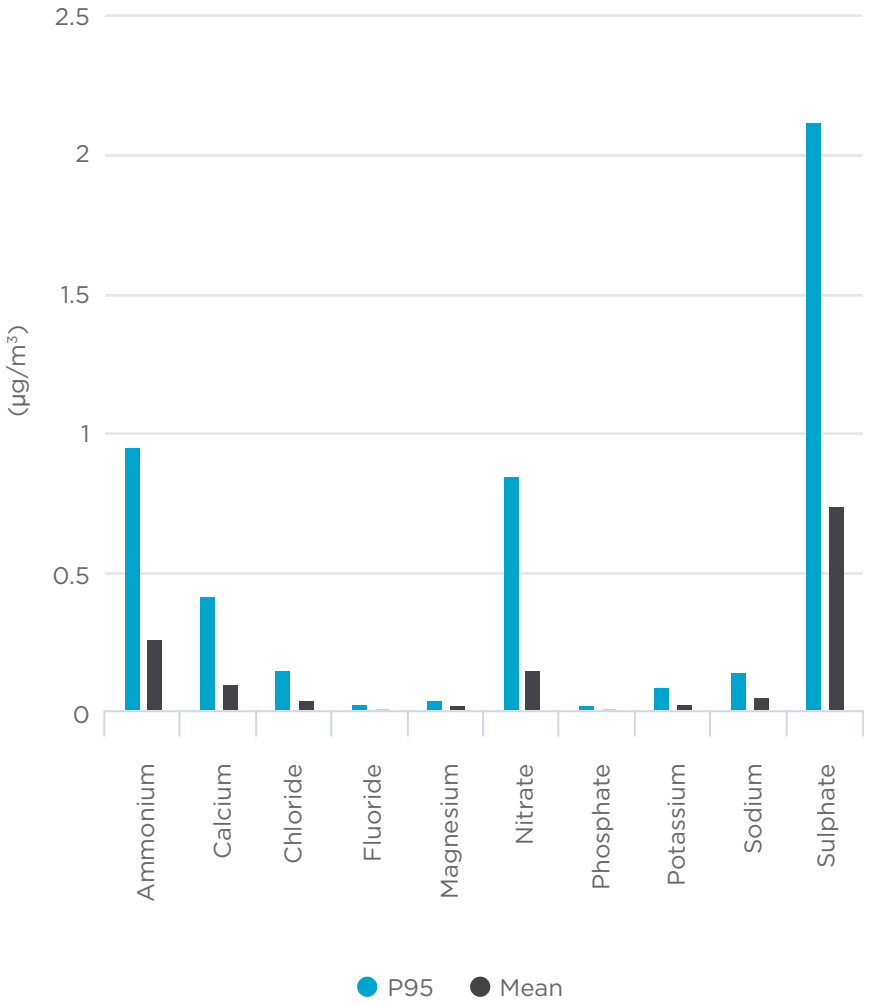
Anzac



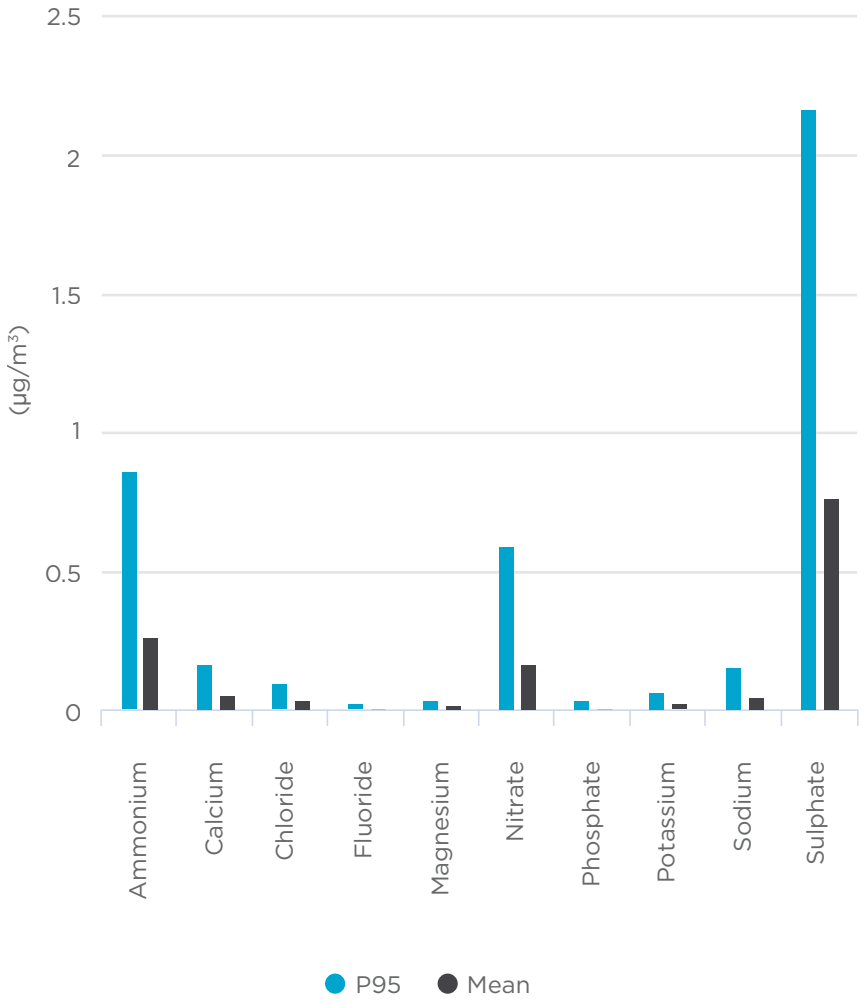
Athabasca Valley



Bertha Ganter - Fort McKay

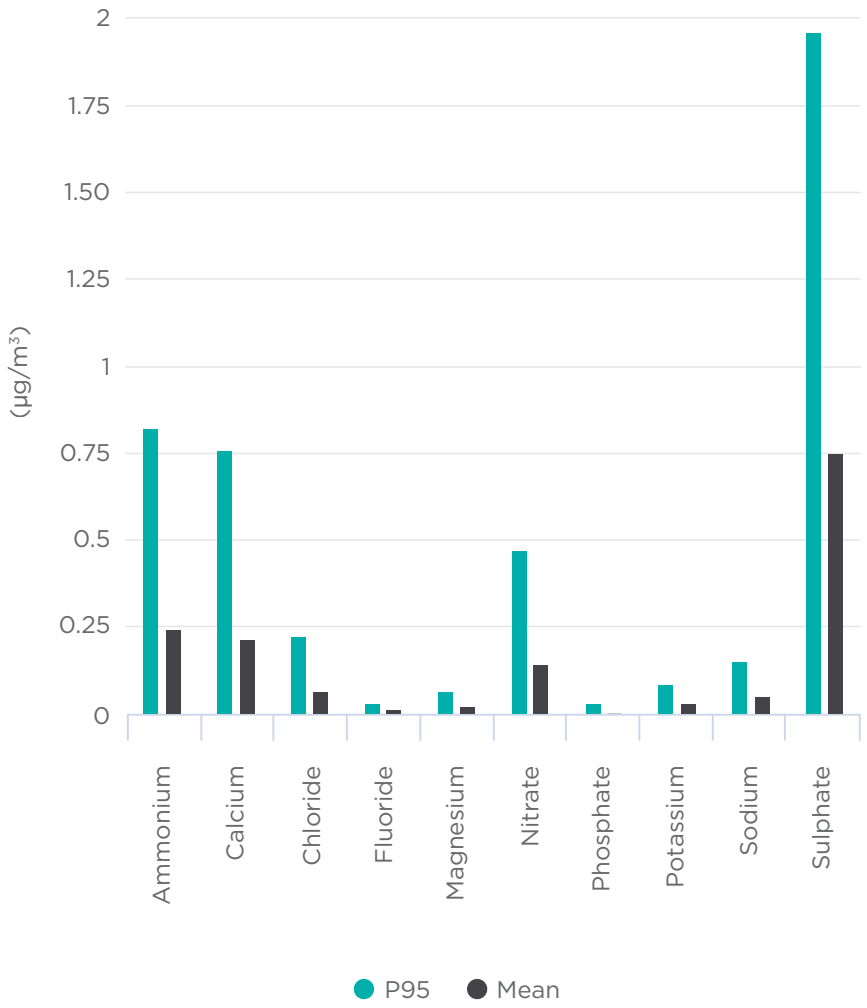


Patricia McInnes

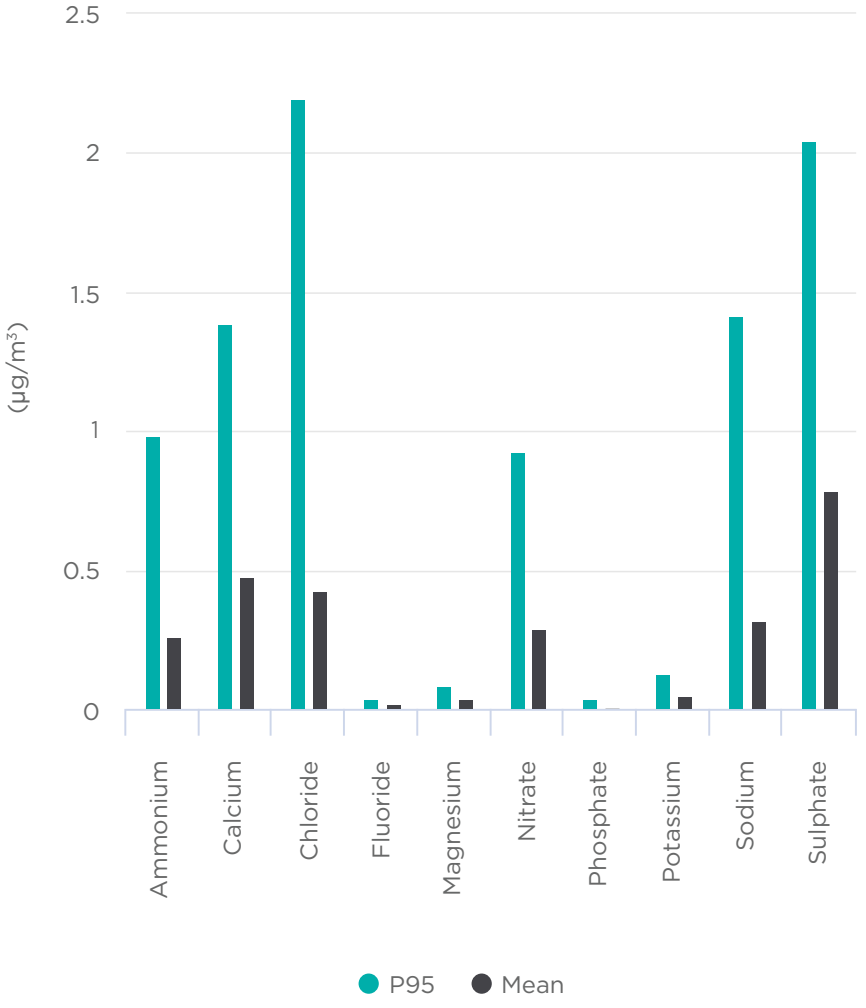


Particulate Matter 10 (PM_{10}) Ions

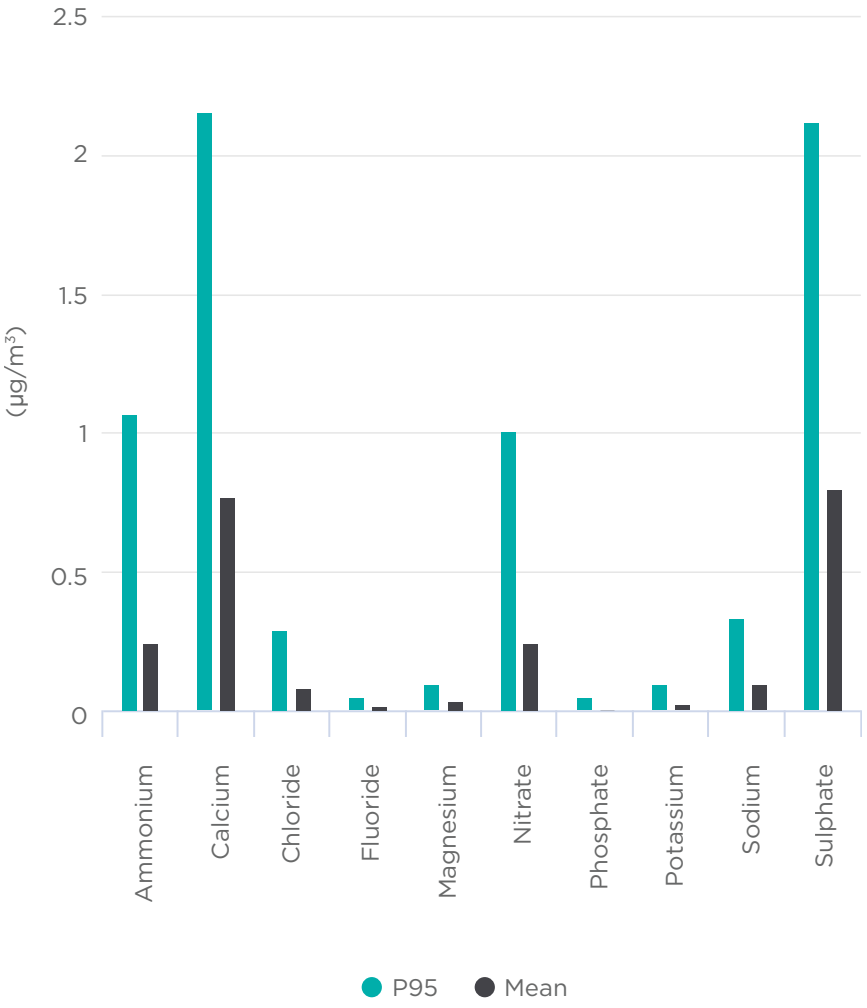
Anzac



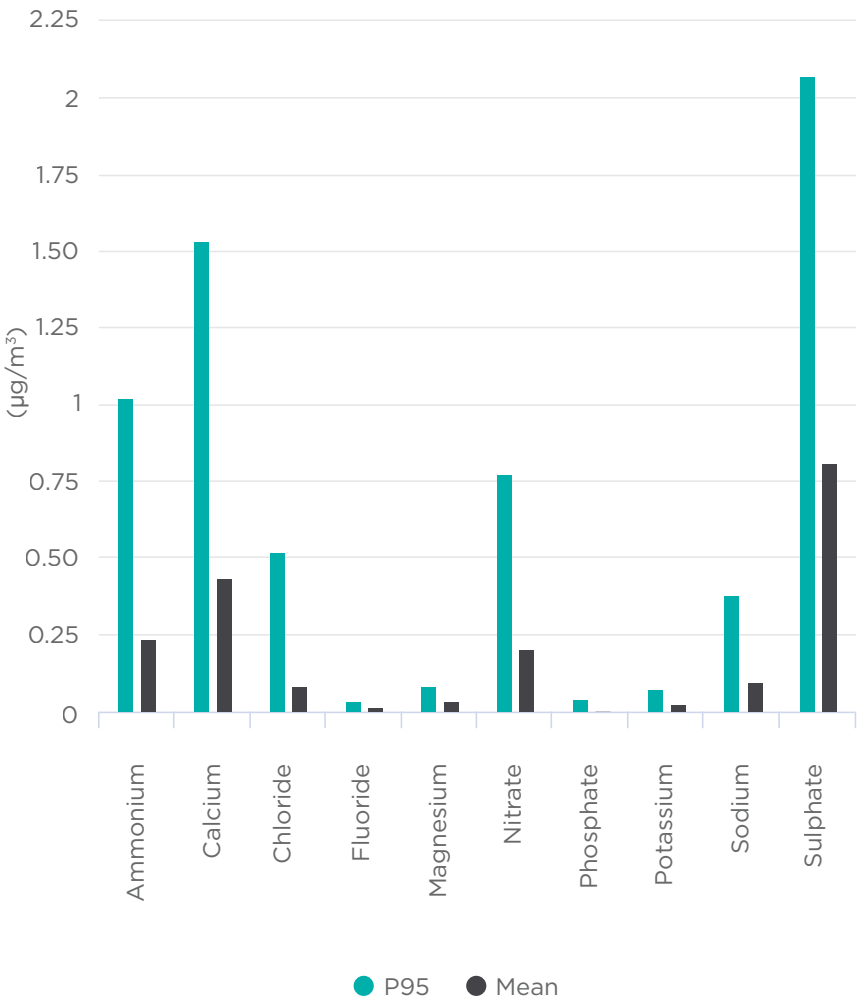
Athabasca Valley



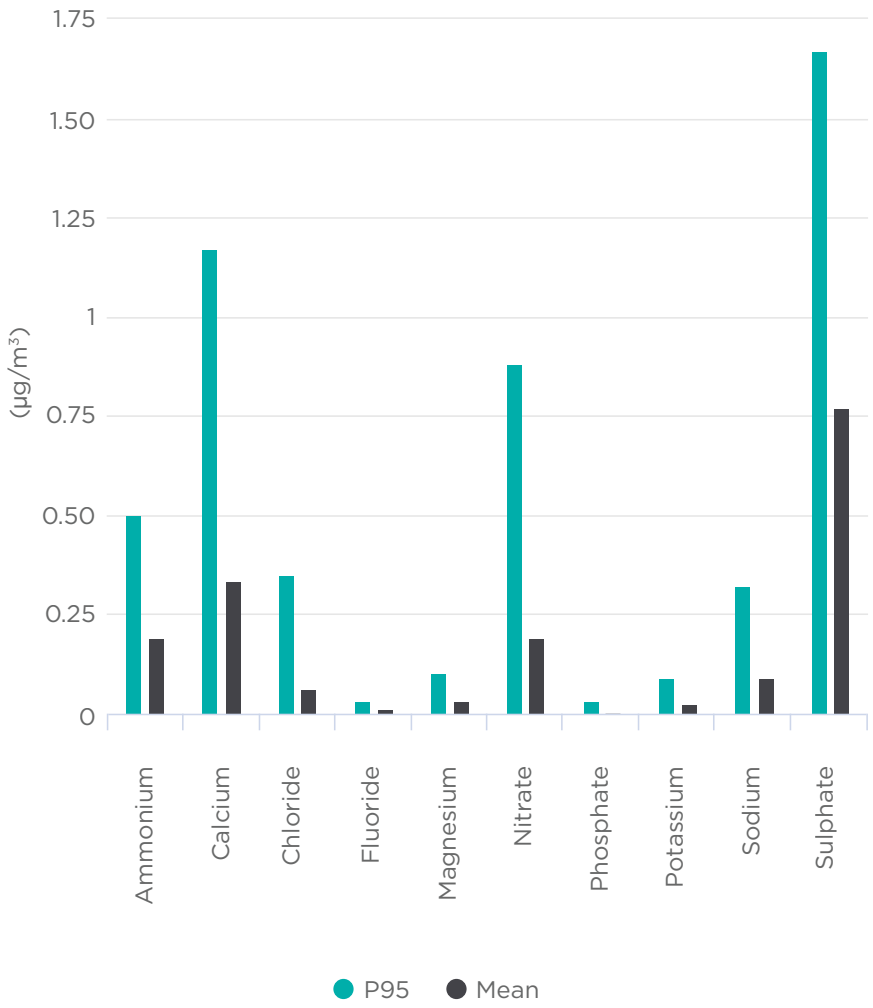
Bertha Ganter - Fort McKay



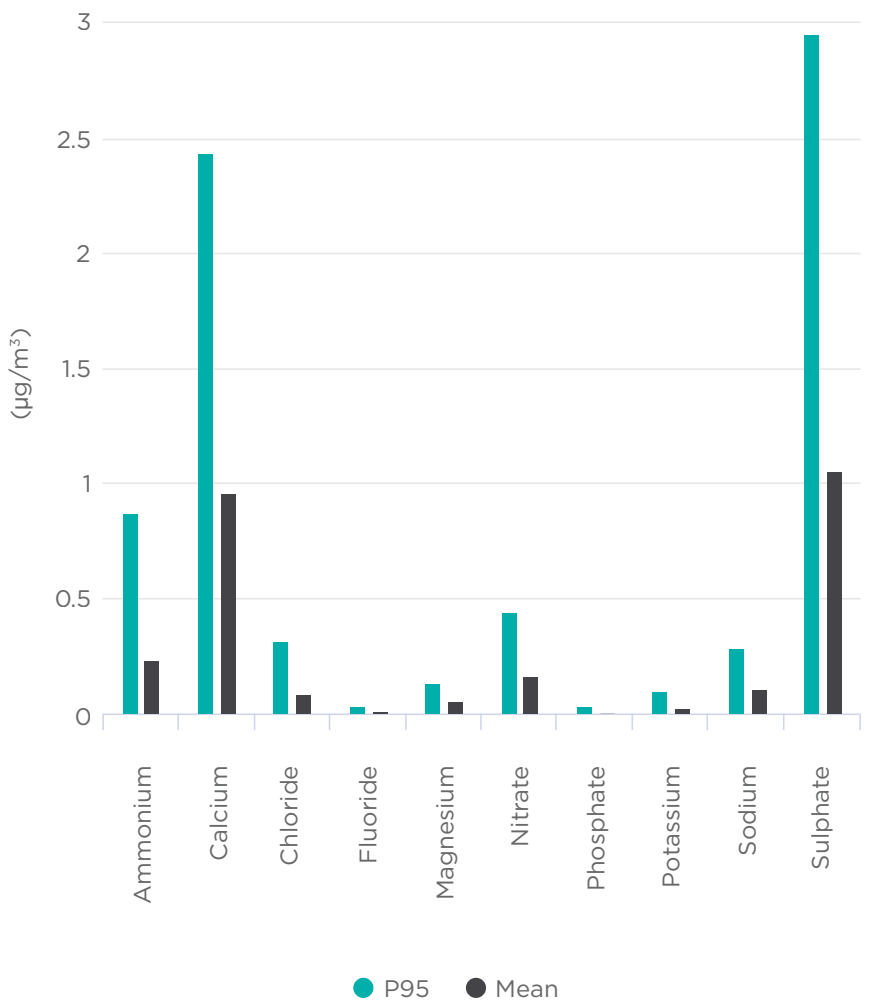
Fort McKay South



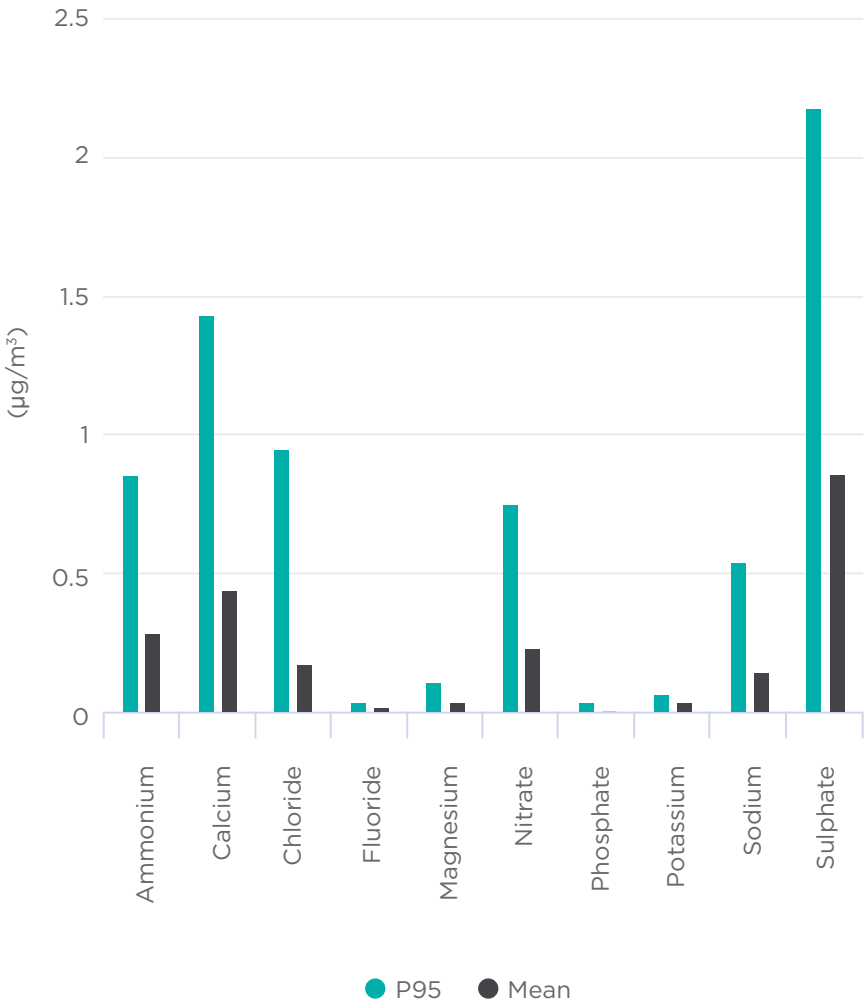
Horizon



Muskeg River

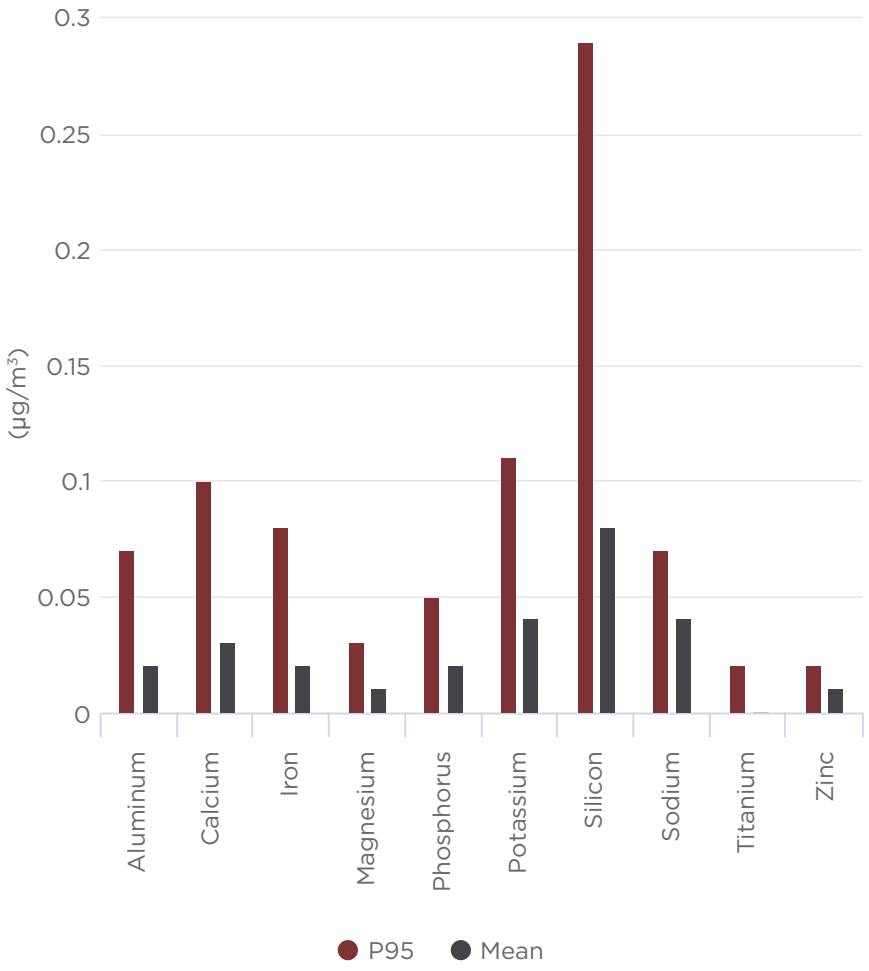


Patricia McInnes

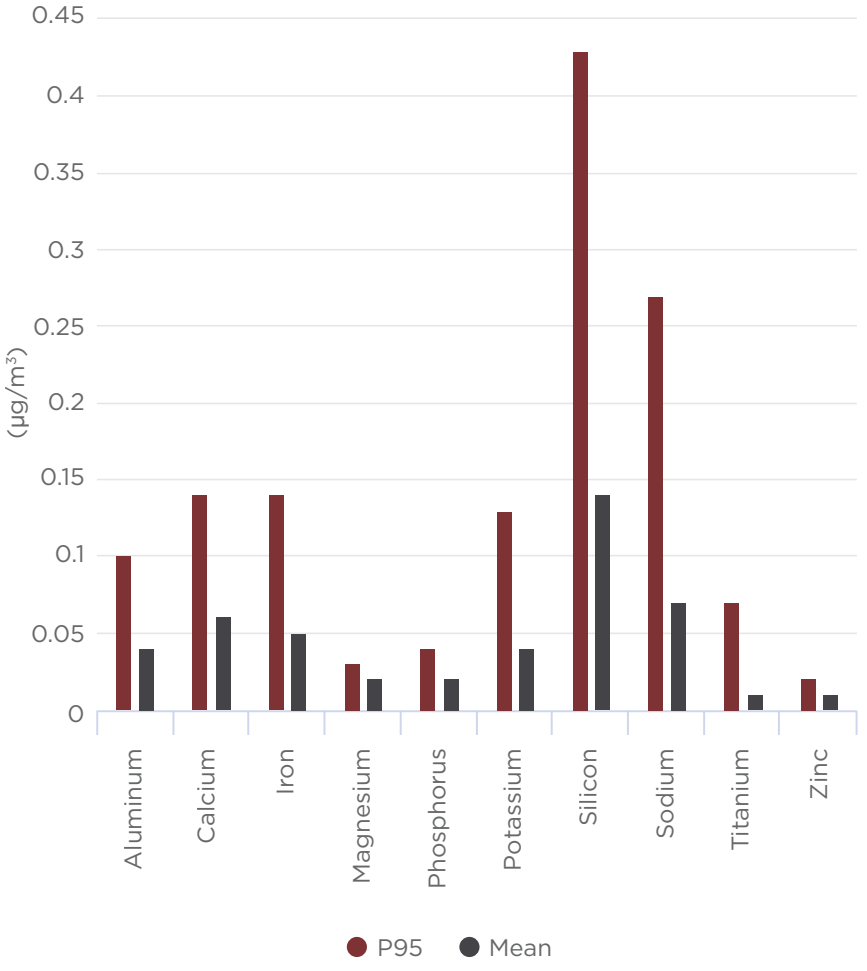


Particulate Matter 2.5 ($PM_{2.5}$) Metals

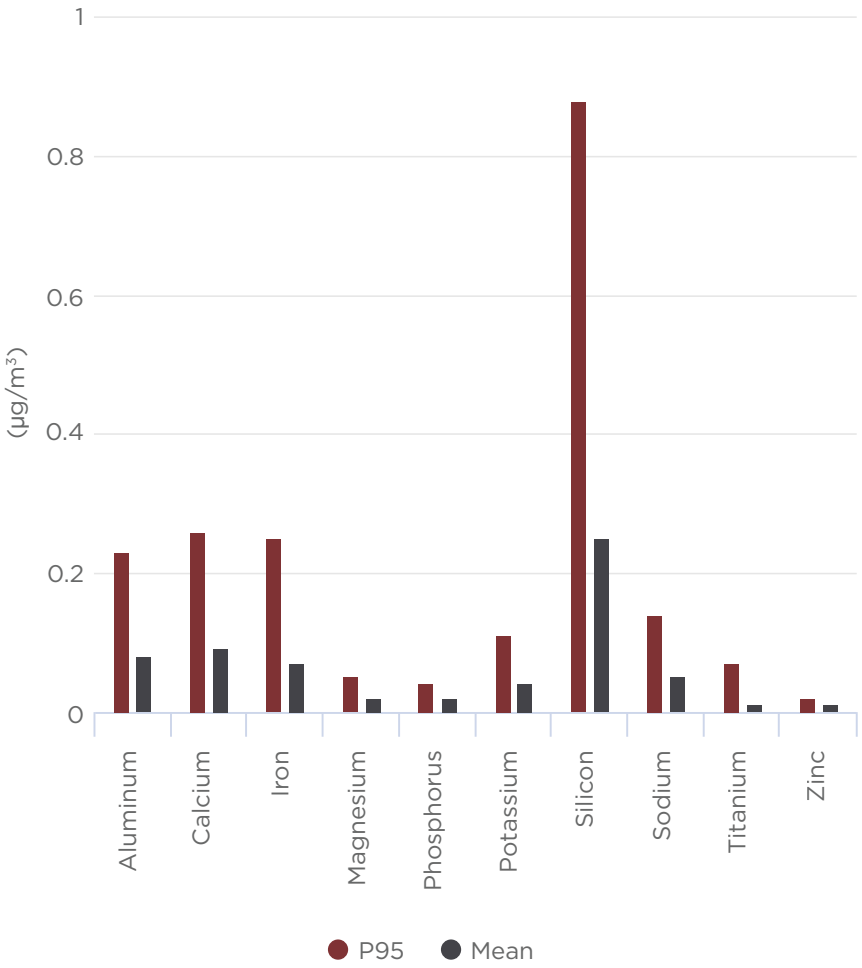
Anzac



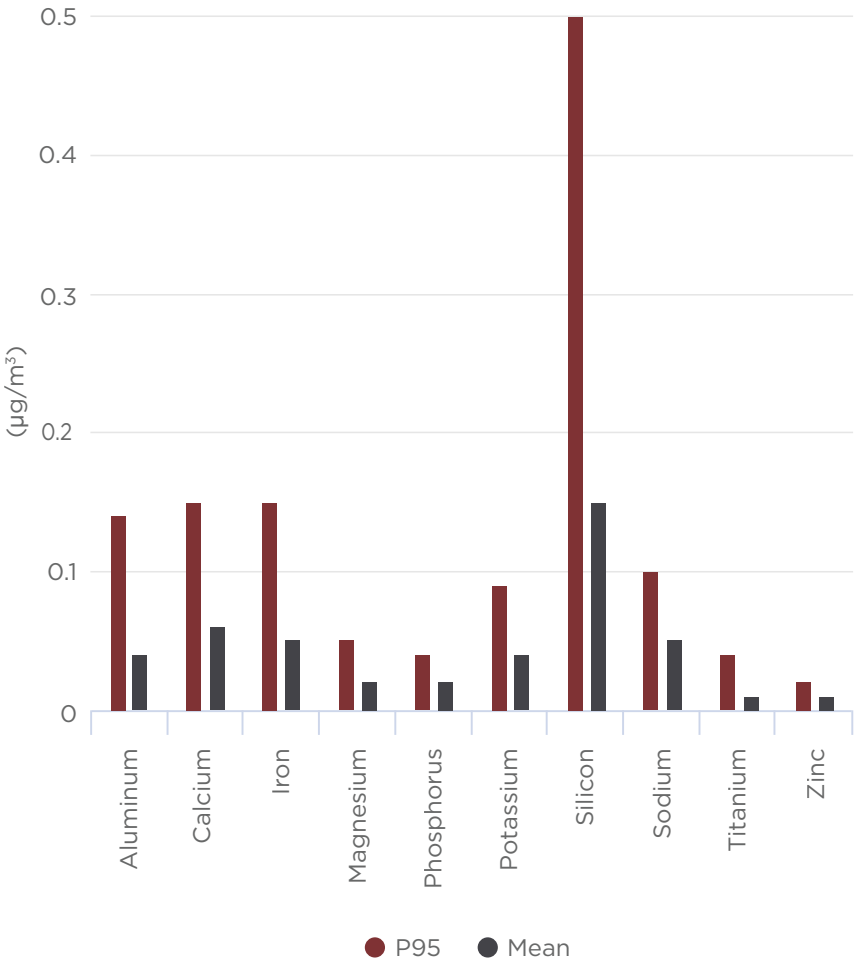
Athabasca Valley



Bertha Ganter - Fort McKay

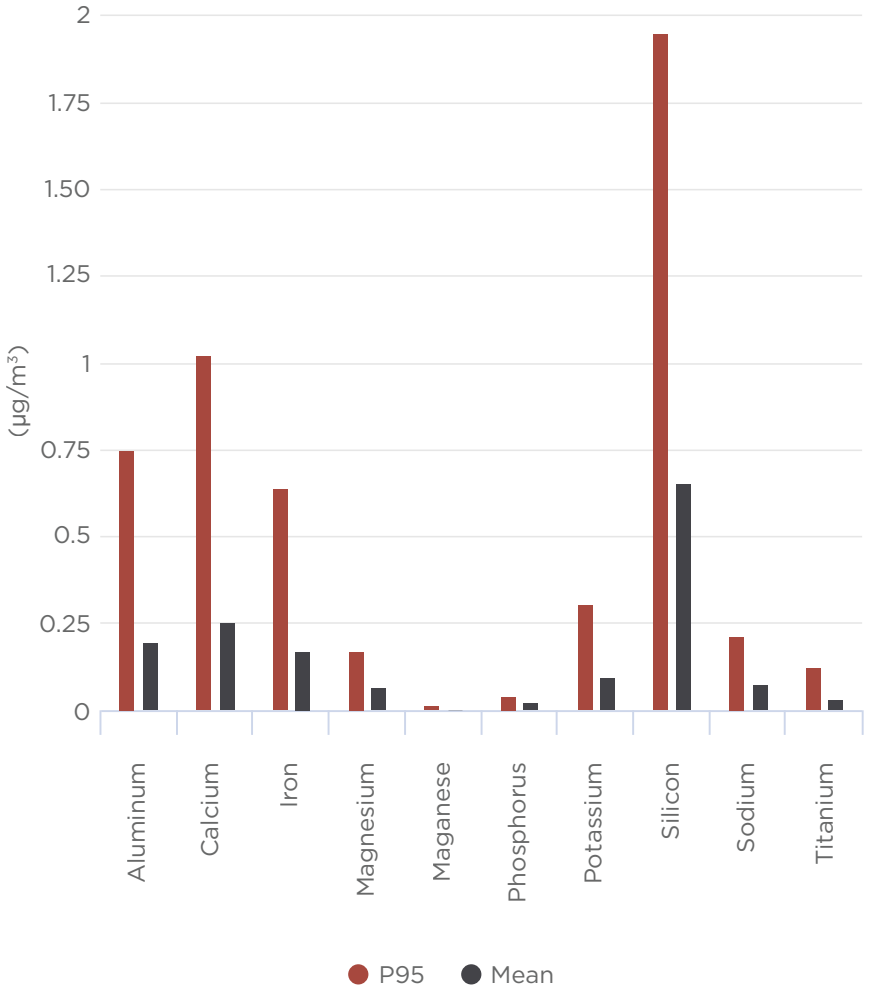


Patricia McInnes

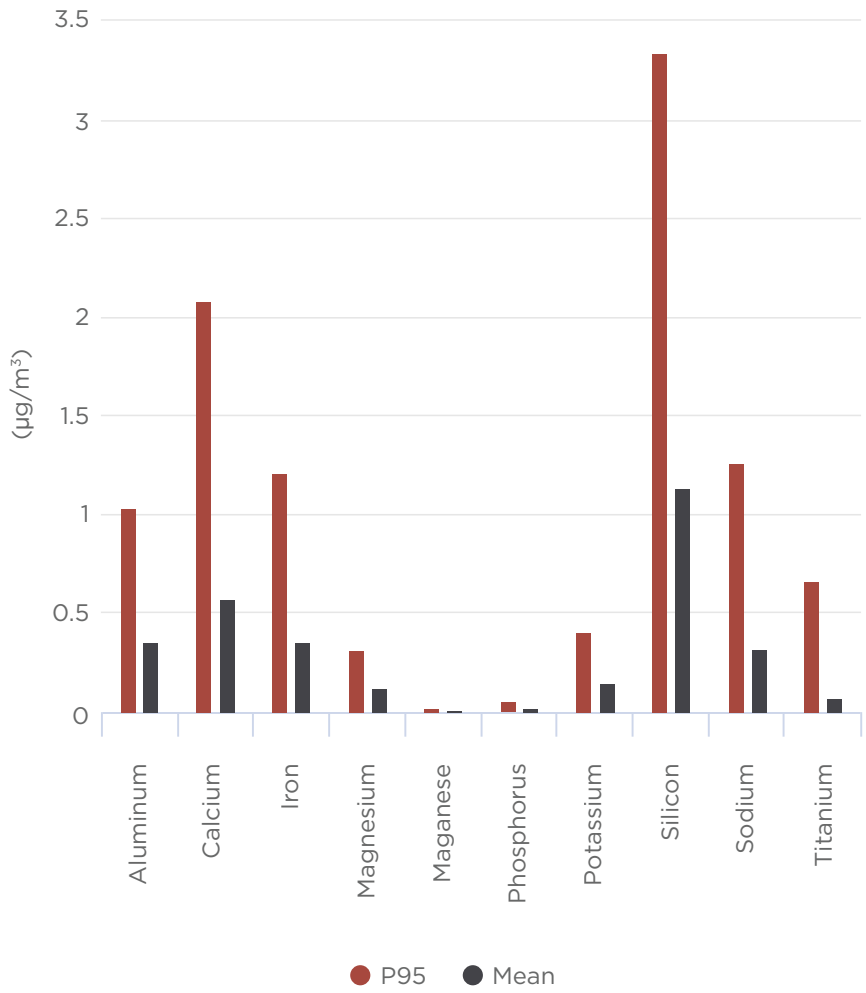


Particulate Matter 10 (PM_{10}) Metals

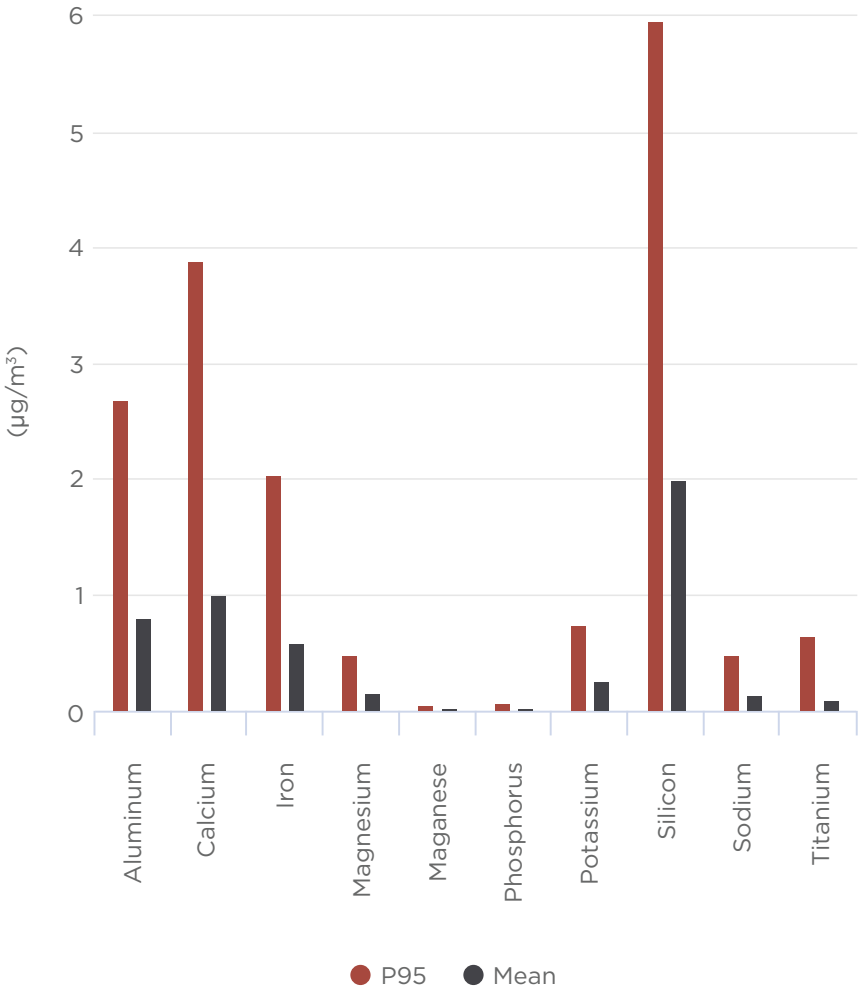
Anzac



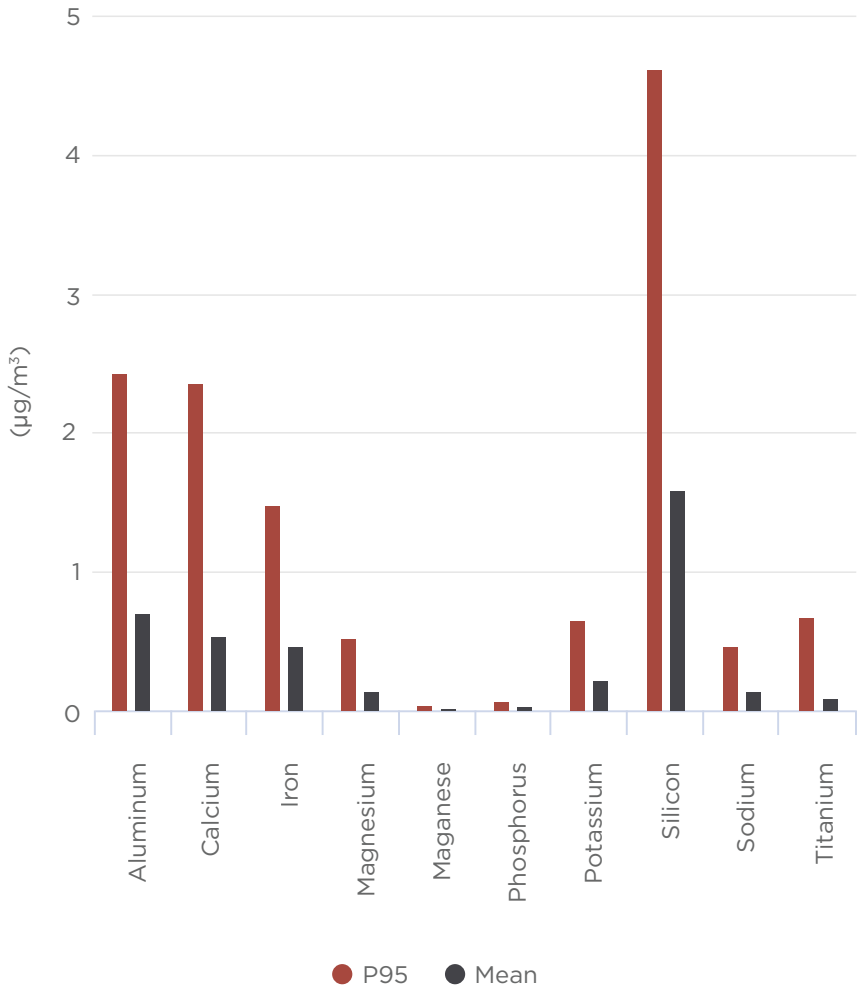
Athabasca Valley



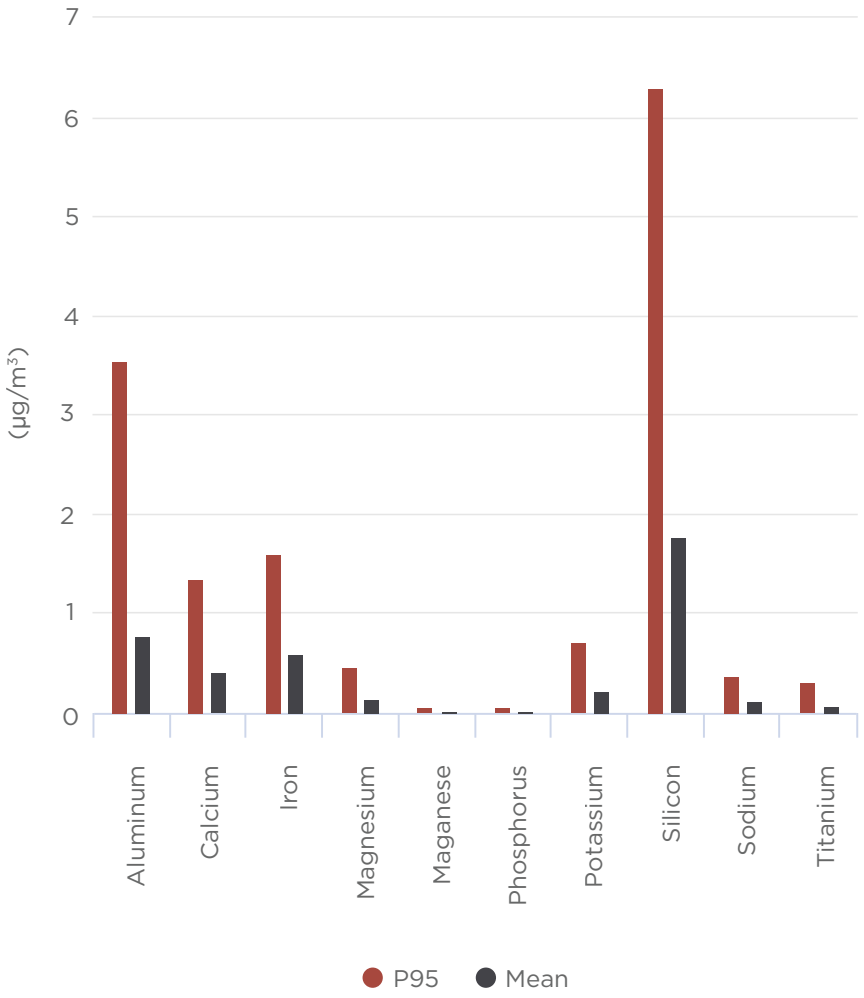
Bertha Ganter - Fort McKay



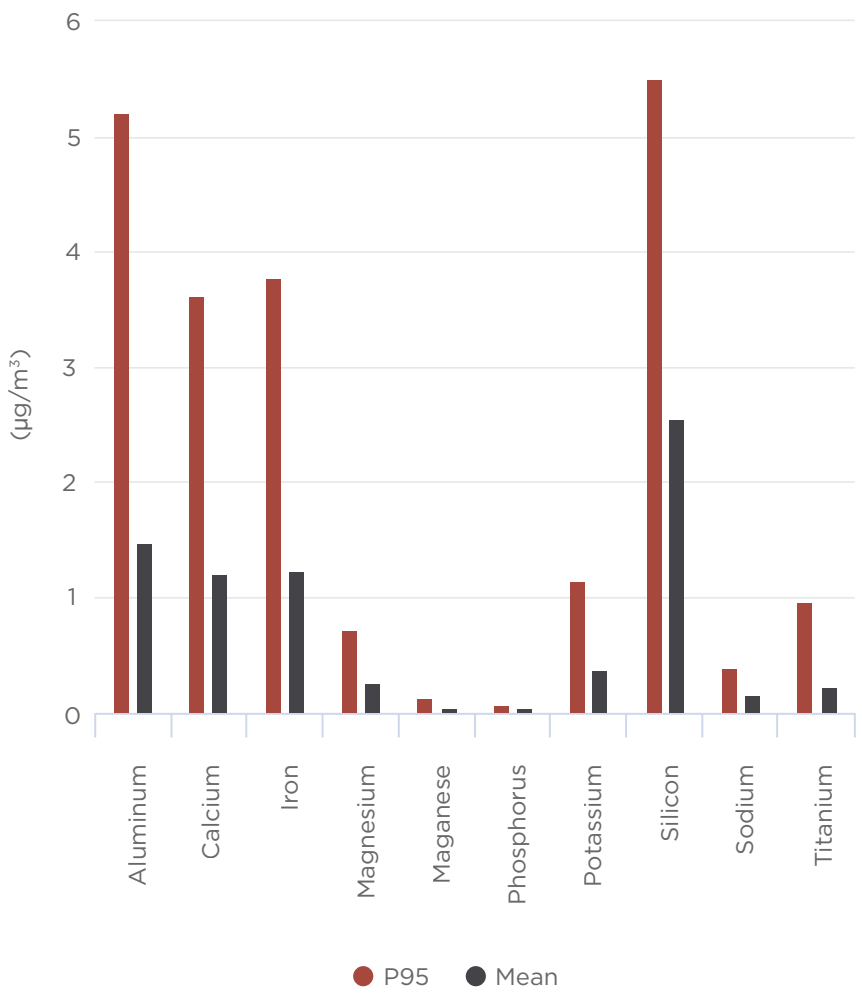
Fort McKay South



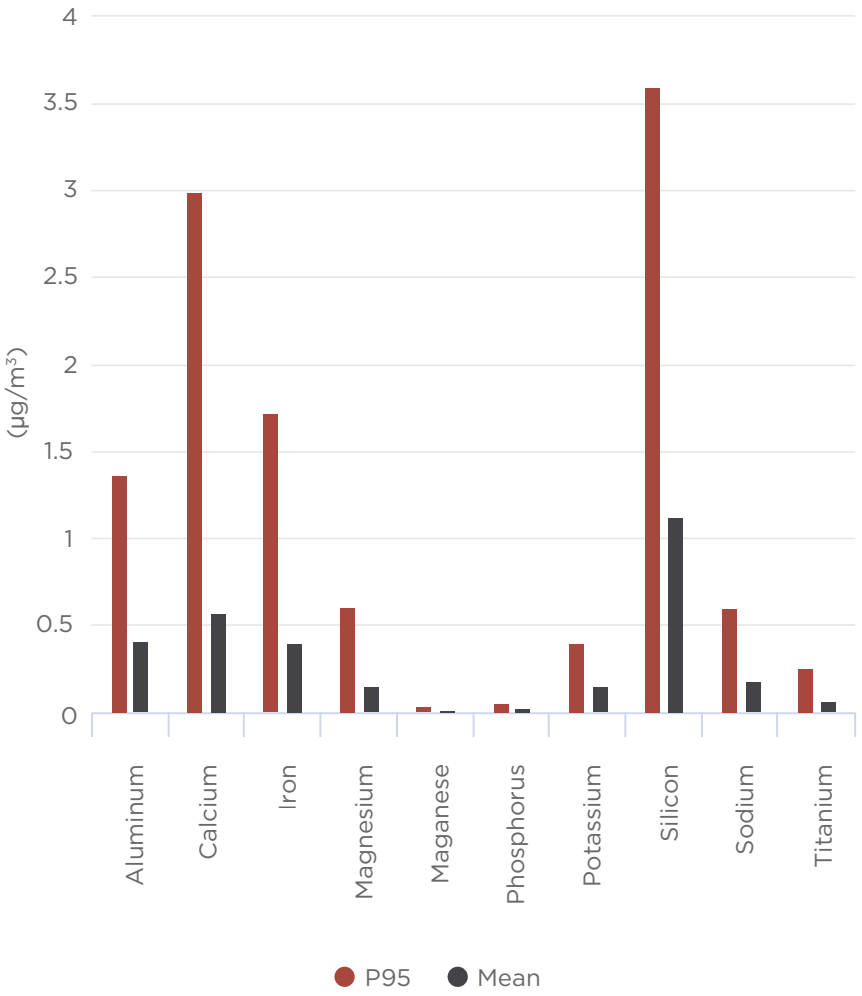
Horizon



Muskeg River



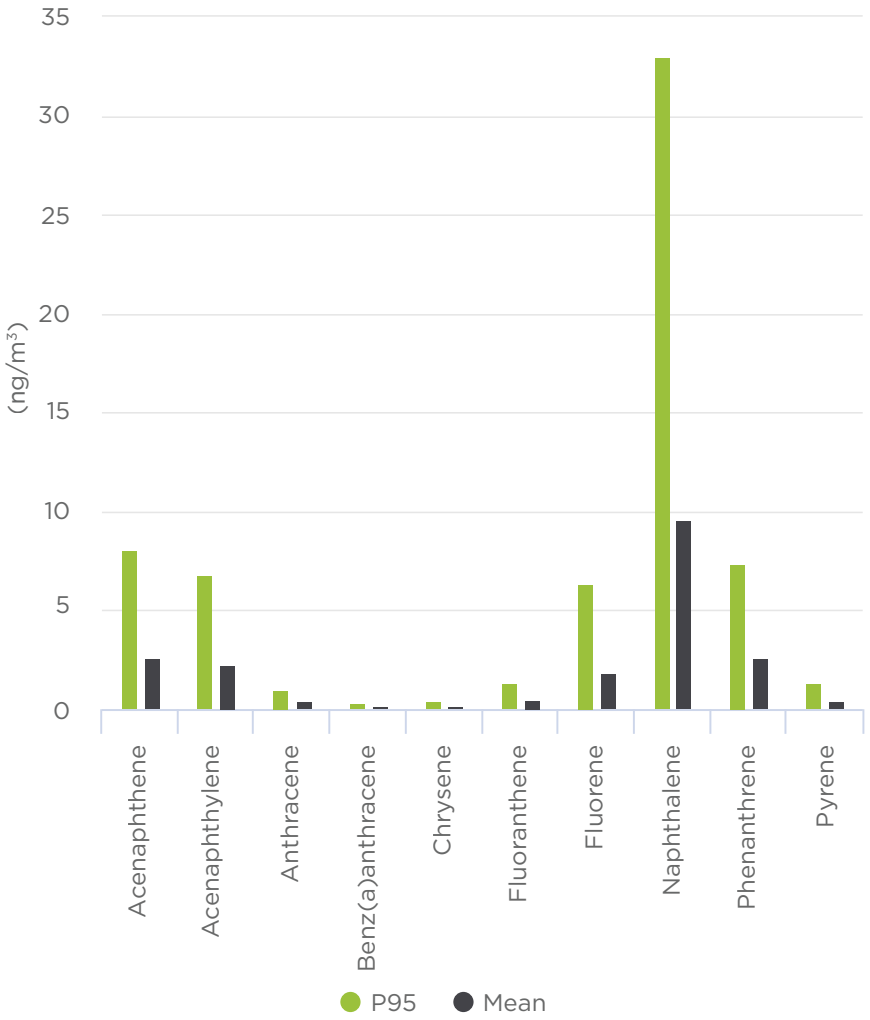
Patricia McInnes



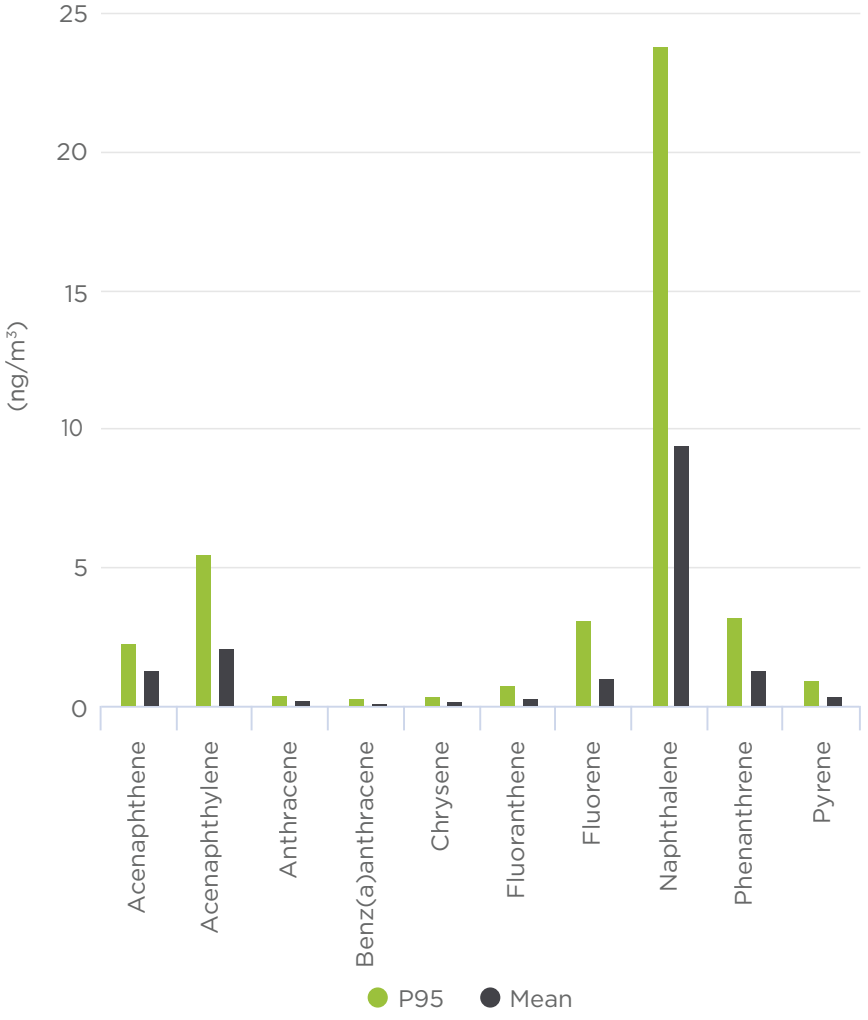
Polycyclic Aromatic Hydracarbons (PAHS)

Polycyclic aromatic hydrocarbons (PAHs) are a type of hydrocarbon – an organic compound containing carbon and hydrogen – that are produced from natural sources, such as the incomplete combustion of organic matter, and can be found in oil sand deposits. There are more than 100 different PAHs – some of which can be detrimental to human health and the environment. In the WBEA's time-integrated sampling program, PAHs are collected on a filter for a 24-hour period, every six days. These samples are collected and sent to the lab where they are analyzed to determine what PAHs were present in the air.

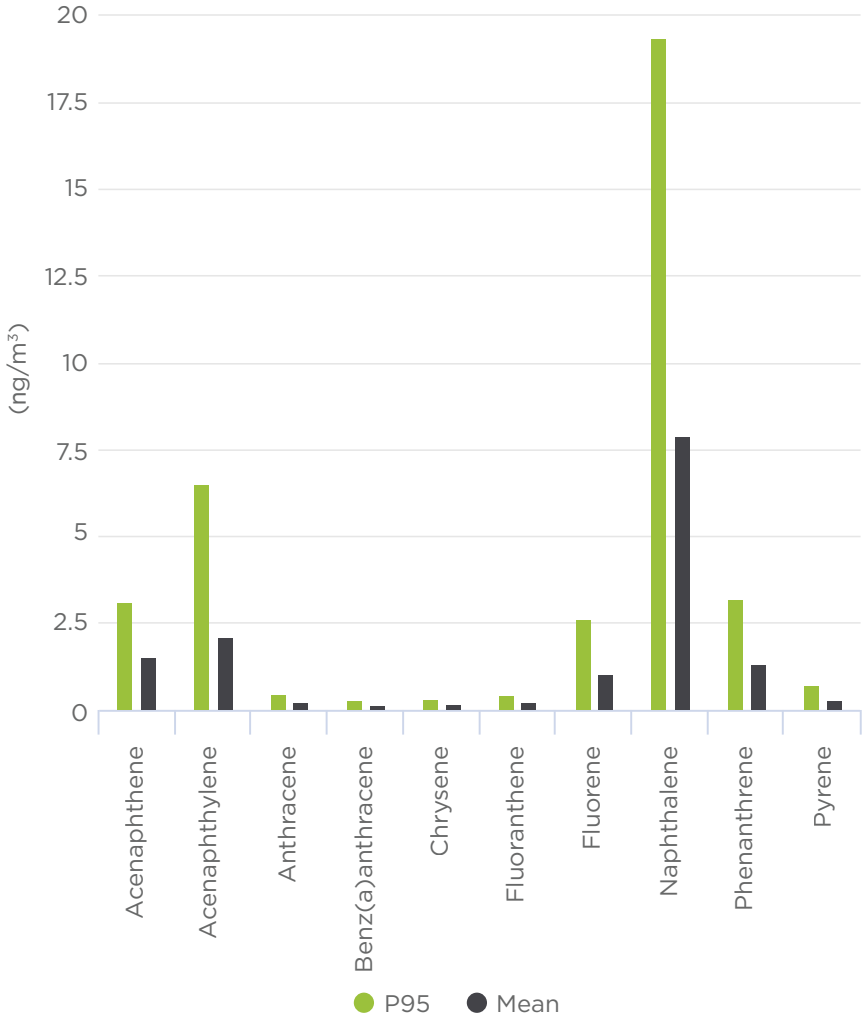
Anzac



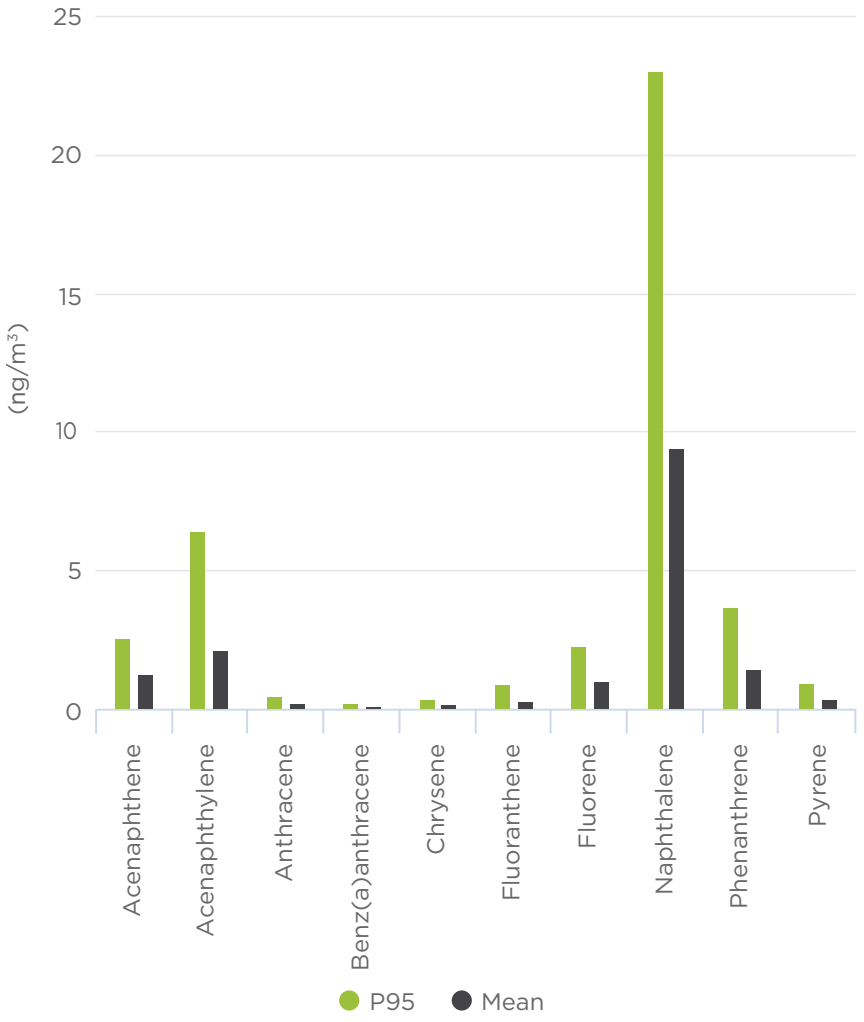
Athabasca Valley



Bertha Ganter - Fort McKay



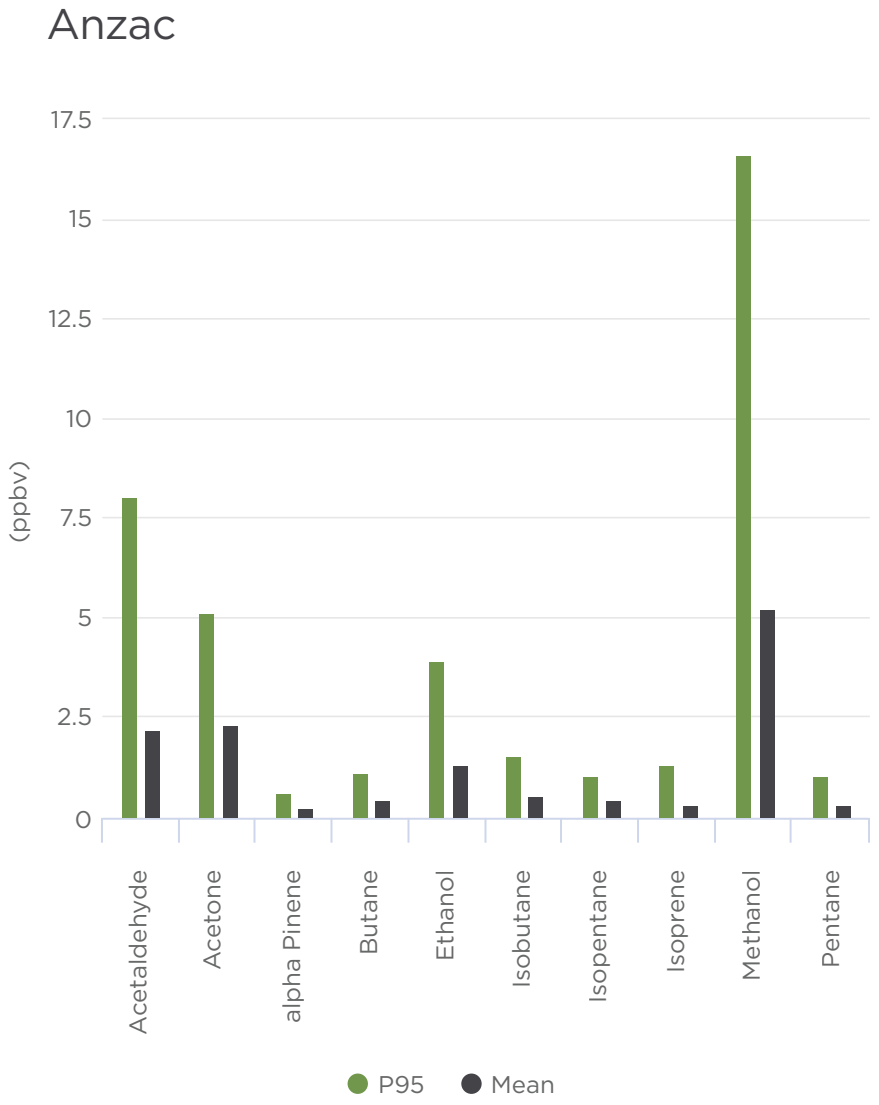
Patricia McInnes



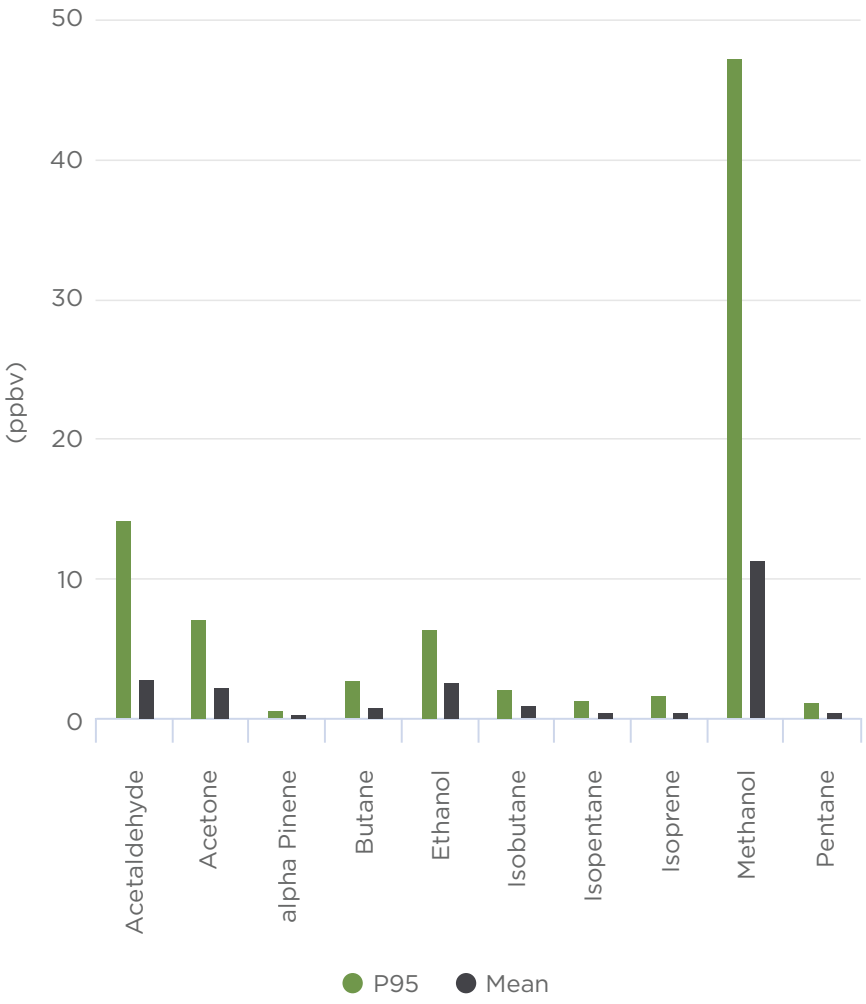
Volatite Organic Compounds (VOCs)

Volatile organic compounds (VOCs) are a group of chemical species that contain carbon, and react easily to become a gas. They may contain additional elements such as hydrogen, oxygen, fluorine, chlorine, bromine, sulphur, or nitrogen. VOCs are numerous, and come from both natural and human sources, and certain VOCs may contribute to ozone formation, odours, and long term health-effects.

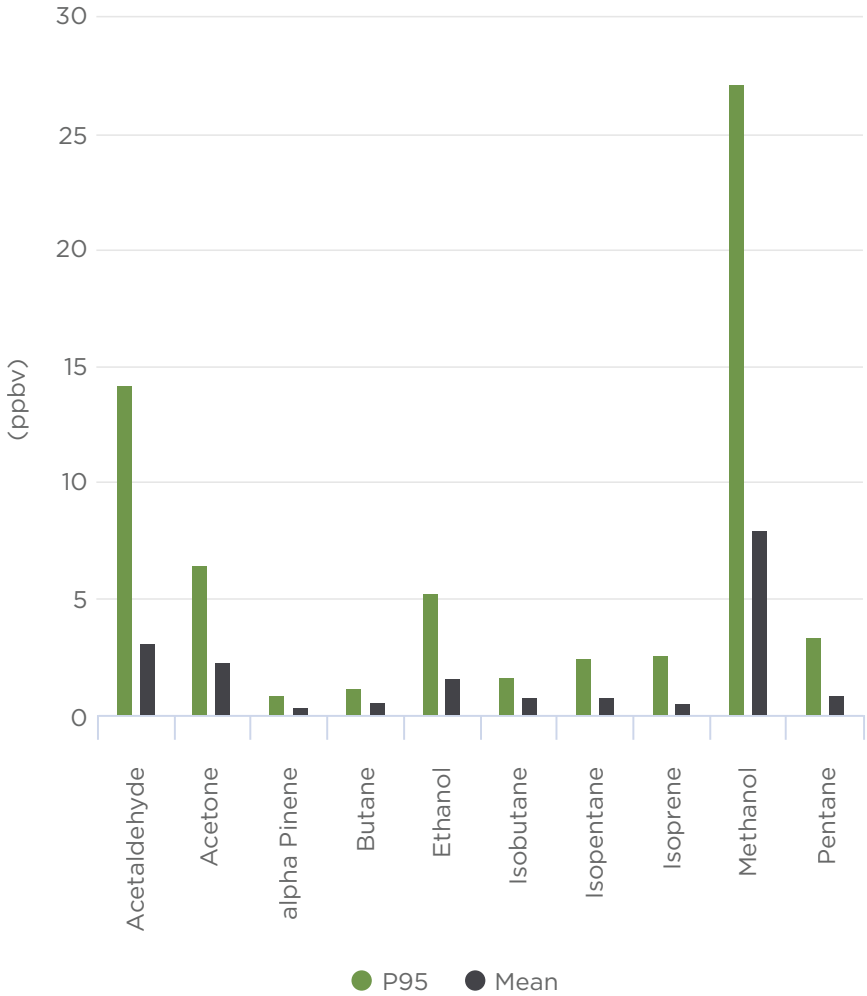
In the WBEA's time-integrated sampling program, an air sample is collected in a stainless-steel canister for a 24-hour period, every six days. These samples are then sent to the lab where they are analyzed to determine what VOCs were present in the air.



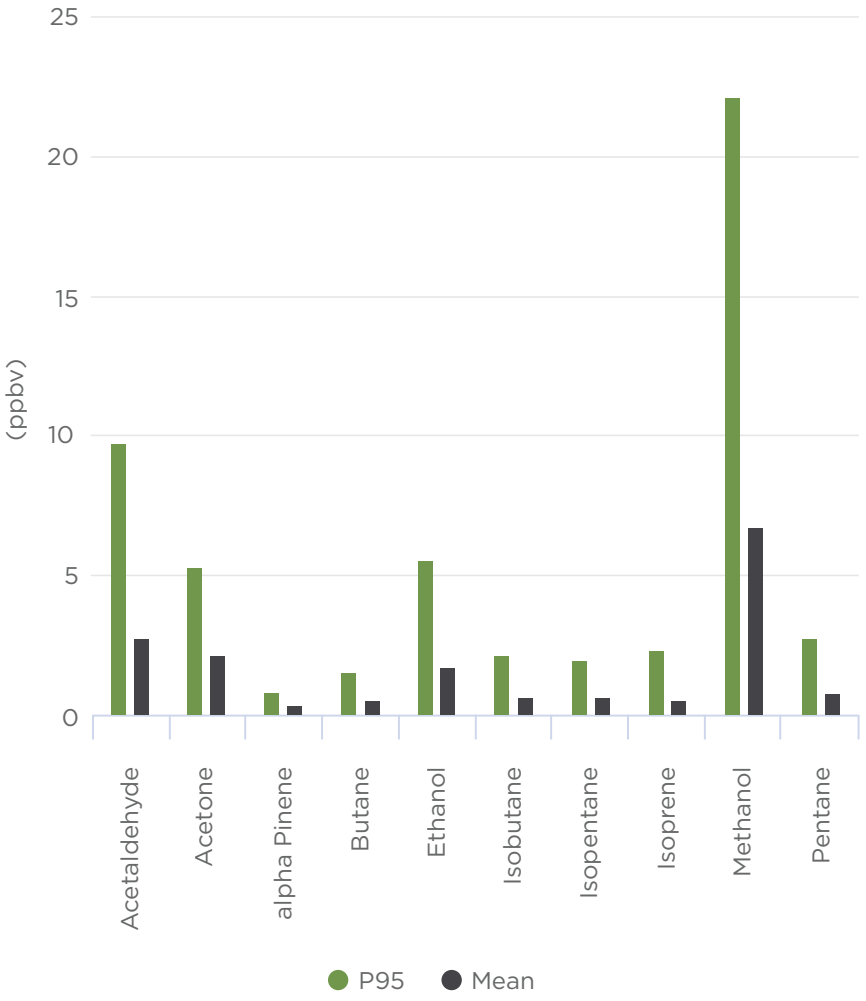
Athabasca Valley



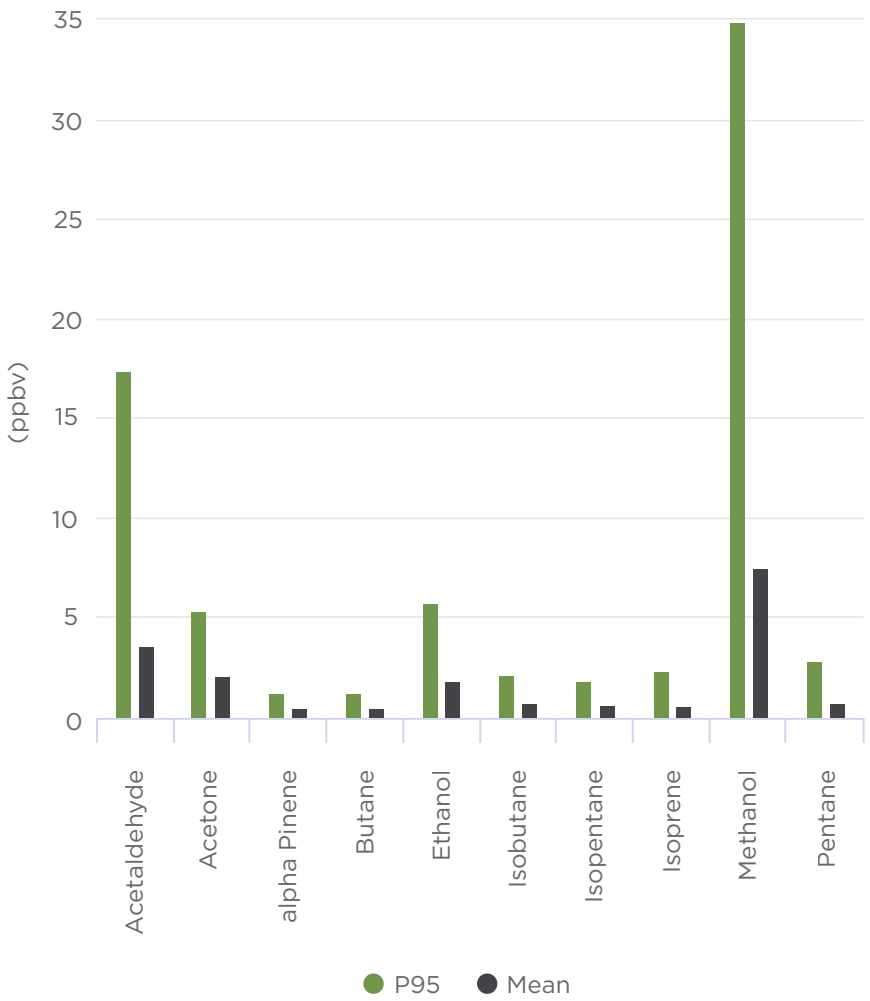
Barge Landing



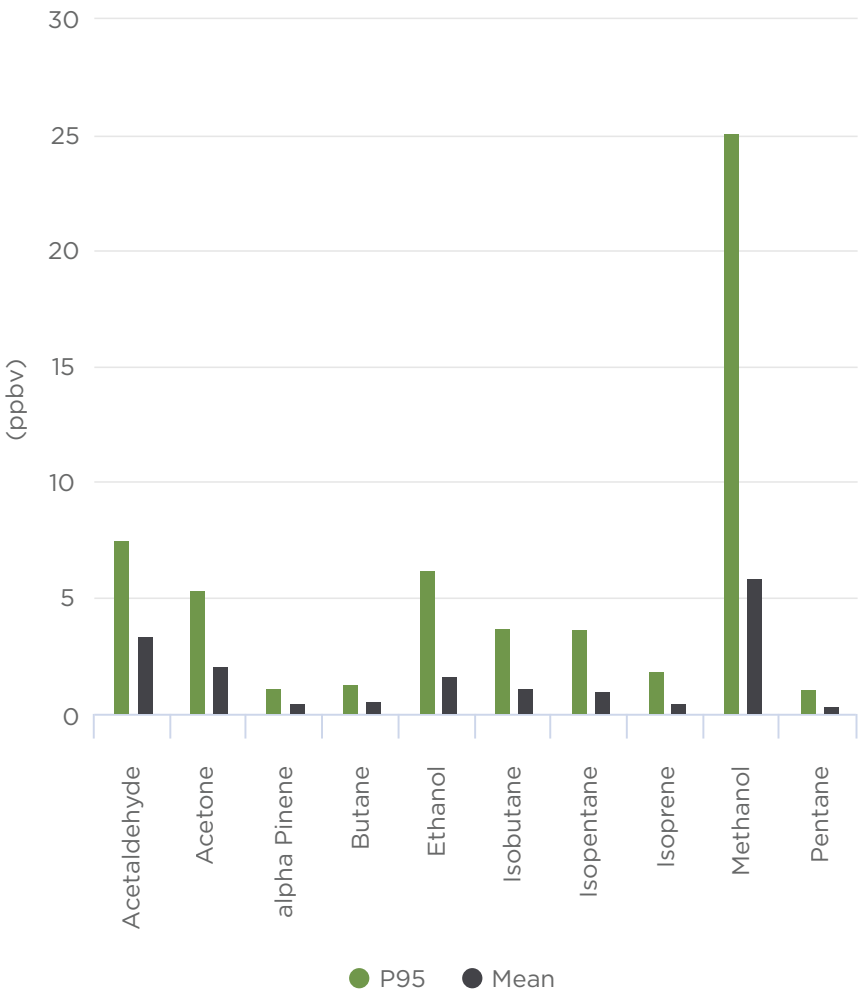
Bertha Ganter - Fort McKay



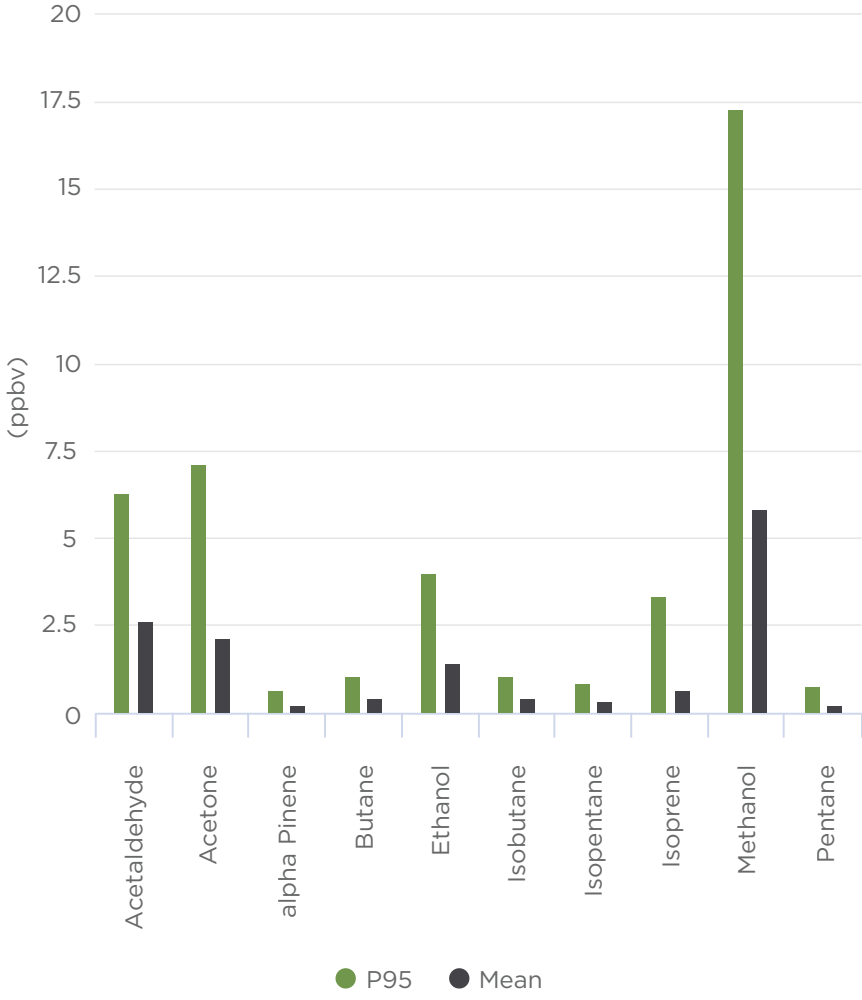
Fort McKay South



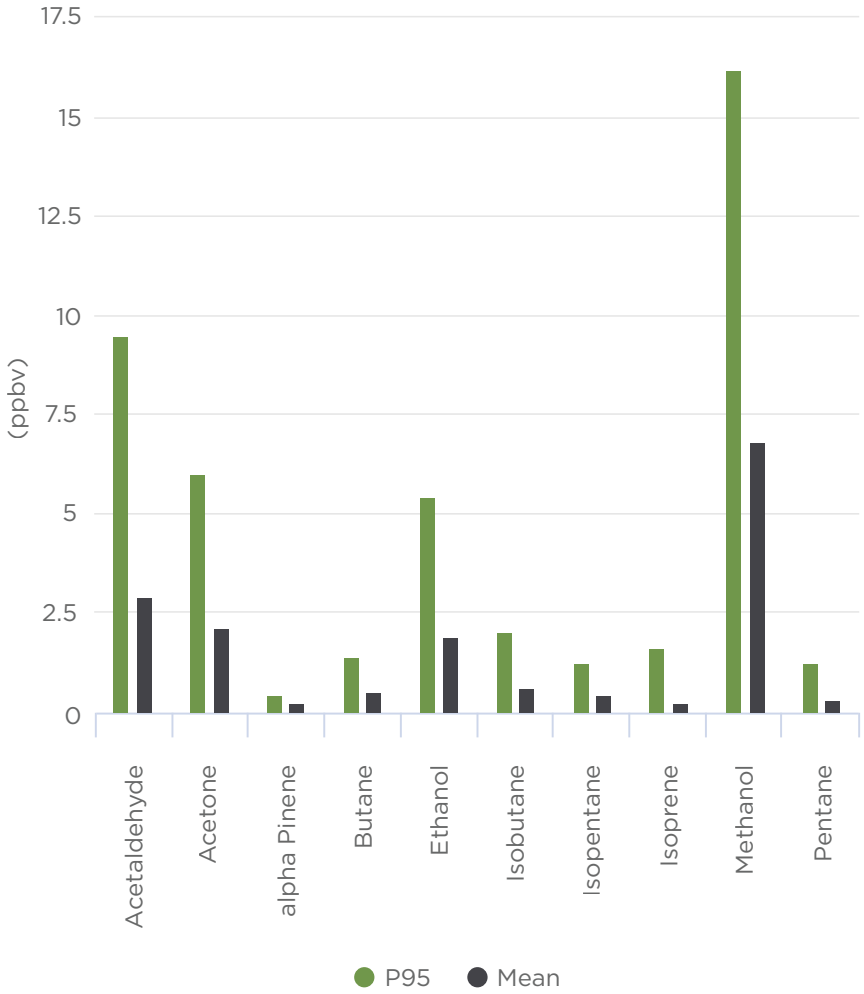
Horizon



Janvier



Patricis McInnes



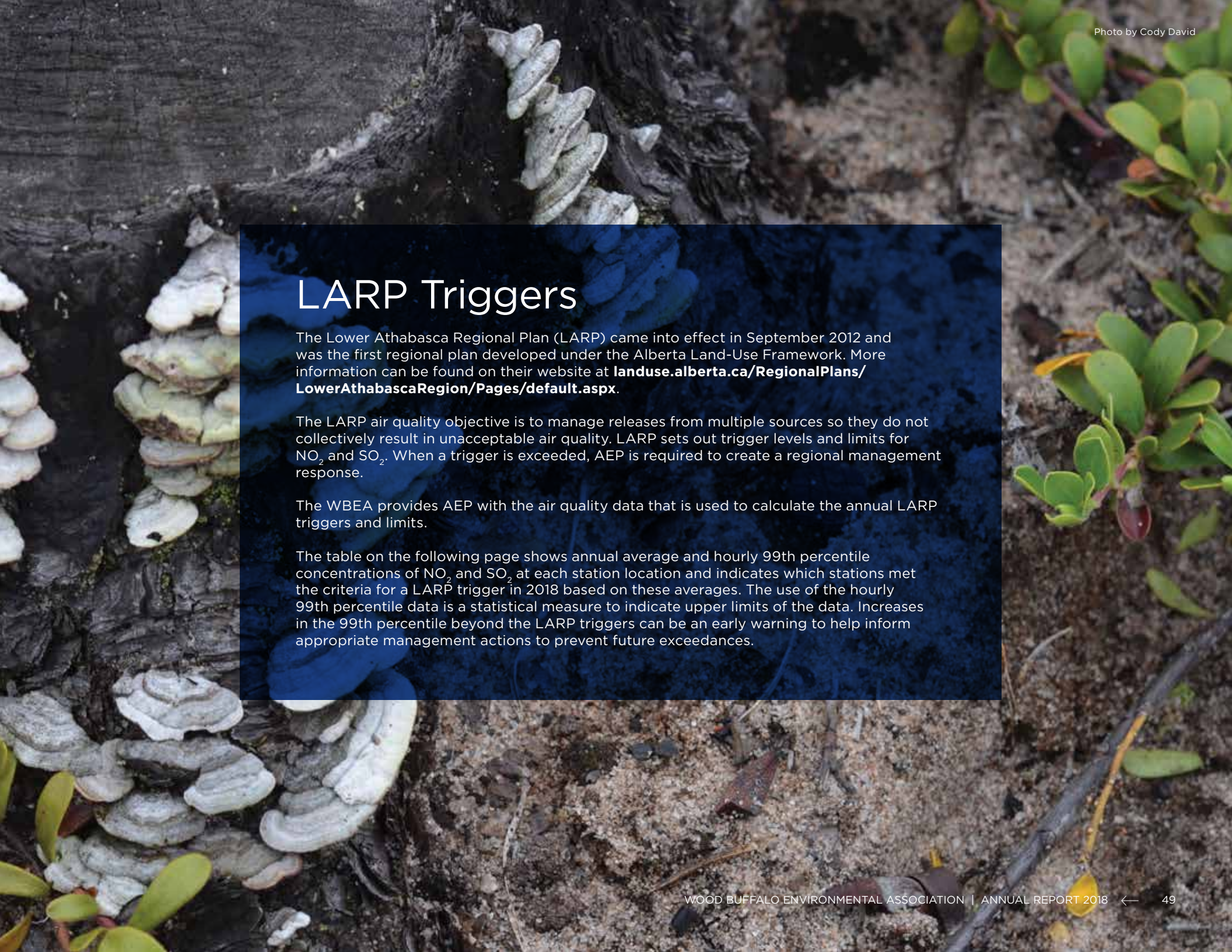


Photo by Cody David

LARP Triggers

The Lower Athabasca Regional Plan (LARP) came into effect in September 2012 and was the first regional plan developed under the Alberta Land-Use Framework. More information can be found on their website at **landuse.alberta.ca/RegionalPlans/LowerAthabascaRegion/Pages/default.aspx**.

The LARP air quality objective is to manage releases from multiple sources so they do not collectively result in unacceptable air quality. LARP sets out trigger levels and limits for NO_2 and SO_2. When a trigger is exceeded, AEP is required to create a regional management response.

The WBEA provides AEP with the air quality data that is used to calculate the annual LARP triggers and limits.

The table on the following page shows annual average and hourly 99th percentile concentrations of NO_2 and SO_2 at each station location and indicates which stations met the criteria for a LARP trigger in 2018 based on these averages. The use of the hourly 99th percentile data is a statistical measure to indicate upper limits of the data. Increases in the 99th percentile beyond the LARP triggers can be an early warning to help inform appropriate management actions to prevent future exceedances.

LARP Air Quality Management Framework Limits & Triggers

NO_2

Annual Average	ppb
Limit*	24
Level 3 Trigger	16
Level 2 Trigger	8
Below Trigger	

Annual 99th Percentile	
Level 4 Trigger	92
Level 3 Trigger	62
Level 2 Trigger	30
Below Trigger	

SO_2

Annual Average	ppb
Limit*	8
Level 3 Trigger	5
Level 2 Trigger	3
Below Trigger	

Annual 99th Percentile	
Level 4 Trigger	36
Level 3 Trigger	24
Level 2 Trigger	12
Below Trigger	

Parameter not measured at station

**The limit is the same as the Alberta Ambient Air Quality Objective*

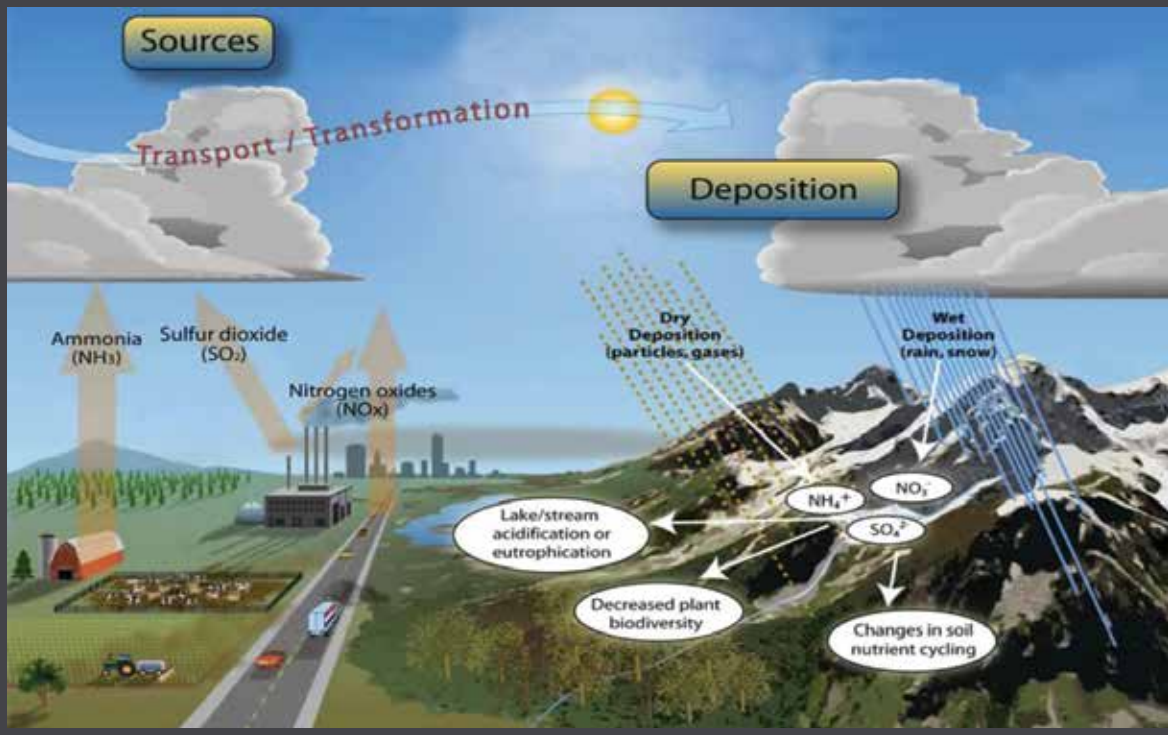
	NO_2		SO_2	
Station	Annual Average (ppb)	Annual 99th Percentile (ppb)	Annual Average (ppb)	Annual 99th Percentile (ppb)
Bertha Ganter-Fort McKay	8	33	1	12
Mildred Lake			2	22
Buffalo Viewpoint	5	30	1	14
Mannix			2	24
Patricia McInnes	5	28	1	10
Athabasca Valley	7	30	1	7
Fort Chipewyan	1	10	0	3
Barge Landing	15	36	1	7
Lower Camp			2	30
Fort McKay South	7	32	1	10
Anzac	2	15	1	6
Horizon	7	36	1	9
Muskeg River	9	39	1	14
Wapasu	3	17	1	11
Stony Mountain	1	8	0	3
Firebag	3	20	1	11
MacKay River	2	20	1	8
Conklin	2	13	0	3
Janvier	2	10	0	2
Fort Hills	9	42	1	8
Surmont	2	13	1	6
Waskow ohci Pimatisiwin			1	10
Christina Lake	2	10	1	20
Jackfish 2/3	2	7	1	5

Deposition Monitoring

The Deposition Monitoring program, also referred to as the Terrestrial Environmental Effects Monitoring (TEEM) program, was established to address community, industry, and government concerns about impacts to regional forests resulting from industrial development.

To meet this objective the WBEA operates both a long-term Forest Health Monitoring Program and an Atmospheric Pollutant Deposition Monitoring Program to monitor stressors (acidification/eutrophication) along the pathway (atmospheric transport) from source (industrial emissions) to the receiving environment (jack pine forests) - as depicted in the image to the right.

In 2018, the WBEA analyzed the historical data collected by both programs, in combination with data collected by the Ambient Air Monitoring program, and using these data, prepared nine manuscripts for open access publication in a Virtual Special Issue entitled "Relationships Between Air Pollutants and Forest Ecosystem Health in the Oil Sands Region, AB, Canada" within the journal *Science of the Total Environment*.



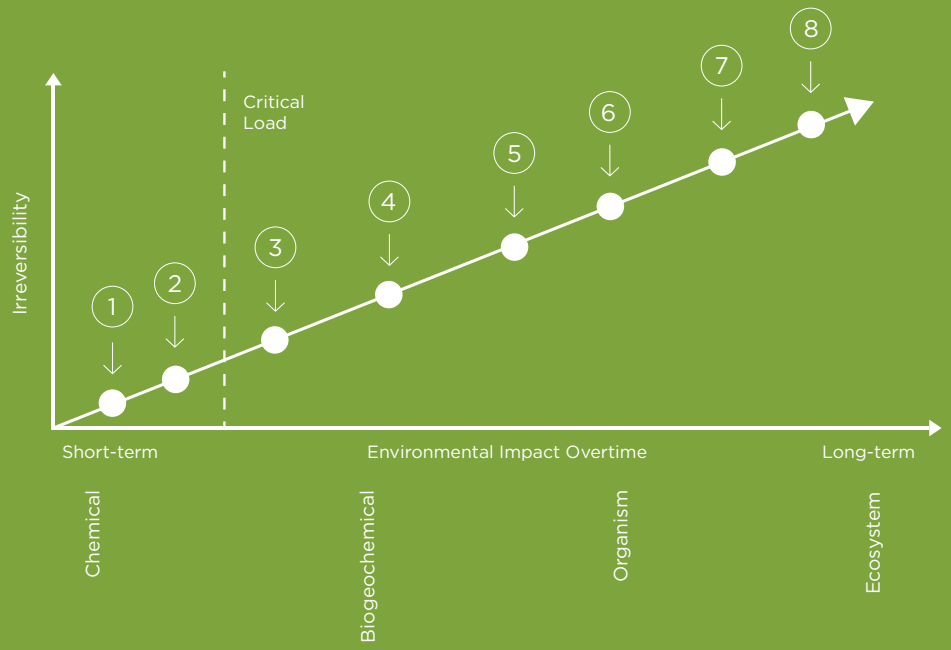
The biogeochemical cycle monitored in the Depositon Program

Photo credit: Cody David

Forest Health Monitoring

The Forest Health Monitoring program monitors jack pine forest sites to assess whether there are changes to biological, physical, and chemical indicators through a sampling campaign of soils and vegetation every 6-years, as well as lichen sampling at varying intervals. During initial program development, the upland jack pine *(Pinus banksiana)* ecosystem was identified as the most sensitive receptor to acidification due to their characteristically dry, nutrient poor soils with limited buffering capacity. In these ecosystems, the effects of acid deposition are expected to be observed in a cascading manner from soils to vegetation, first impacting individual organisms, then the stand, and onward to landscape level impacts. This concept is depicted in the graph below.

In 2018, the WBEA conducted the fourth intensive forest health sampling campaign which included soil and needle sample collection, tree core collection, and documentation of various jack pine and forest stand characteristics. In 2019, this data will be integrated with the historical dataset that was reviewed in 2018 in a separate report that will supplement the previous findings and broaden the understanding of impacts to regional forests resulting from industrial development.



1. Emissions (stack,fleet)
2. Deposition (wet, dry) below CL & no effect
3. Altered jack pine soil chemestry (BC:Al, BS% C:N, nutrients)
4. Altered jack pine growth
5. Altered jack pine understory community composition
6. Altered aspen soil chemistry (BC:Al, BS% C:N, nutrients)
7. Altered aspen growth
8. Altered aspen understory community composition

Atmospheric Pollutant Deposition Monitoring

To better understand the nature and quantity of the compounds deposited on the regional landscape, and to inform the Forest Health Monitoring program, the WBEA operates a network of air quality monitoring (using passive and active air quality samplers) and deposition monitoring sites (using ion exchange resins) in remote locations across the RMWB for evaluation of a broad set of compounds (particulate matter, organic compounds, metals).

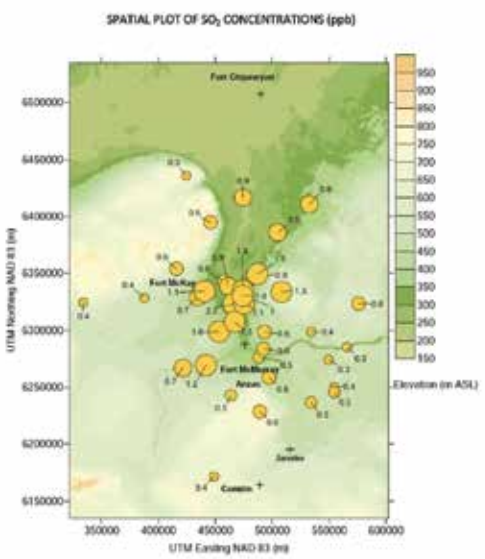
Passive Air Sampling

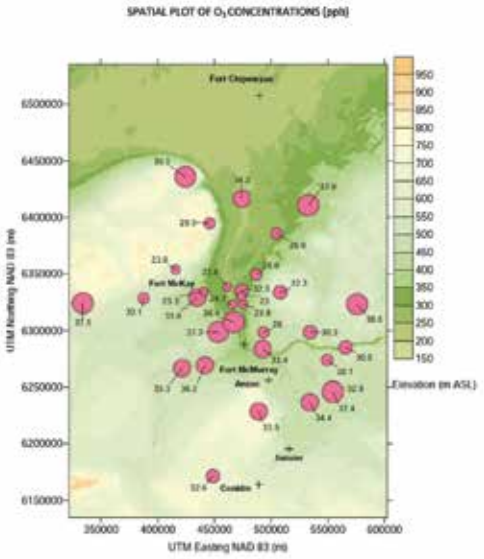
Passive air sampling uses a diffusive membrane to allow for the physical uptake of gas or vapour sample at a known rate. Data obtained from passive air sampling is used to model deposition trends across the region. Data collected in 2018 from passive air sampling for sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and ozone (O_3) is presented on the concentration maps on the following page; the bigger the circle the larger the concentration. The list of parameters measured at deposition monitoring sites using passive air sampling is included in the tables below.

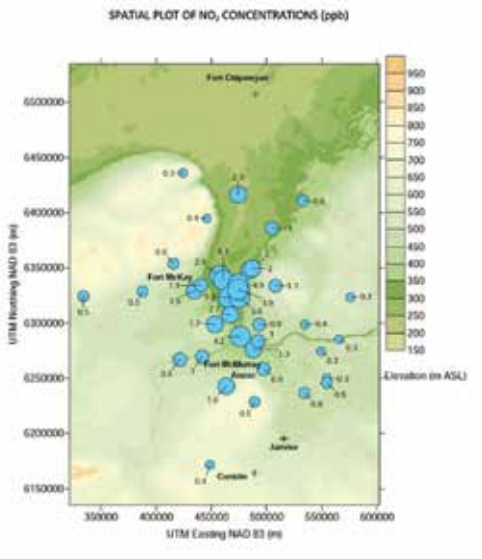
Passive Air Sampling Passive Sampler

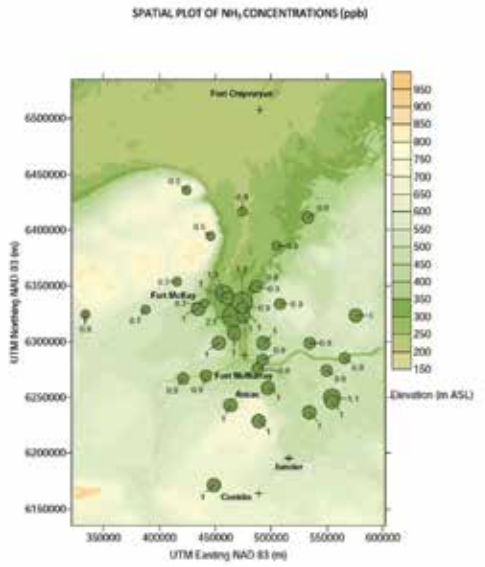
Site Name	HNO_3	NH_3	NO_2	SO_2	O_3
1001	✓	✓	✓	✓	✓
1002	✓	✓	✓	✓	✓
1004	✓	✓	✓	✓	✓
1007	✓	✓	✓	✓	✓
1008	✓	✓	✓	✓	✓
1023	✓	✓	✓	✓	✓
1027	✓	✓	✓	✓	✓
1947	✓	✓	✓	✓	✓
1991	✓	✓	✓	✓	✓
1992	✓	✓	✓	✓	✓
1993	✓	✓	✓	✓	✓
1994	✓	✓	✓	✓	✓
1995	✓	✓	✓	✓	✓
1996	✓	✓	✓	✓	✓
1997	✓	✓	✓	✓	✓
1998	✓	✓	✓	✓	✓
2001	✓	✓	✓	✓	✓
2005	✓	✓	✓	✓	✓
2010	✓	✓	✓	✓	✓
2013	✓	✓	✓	✓	✓

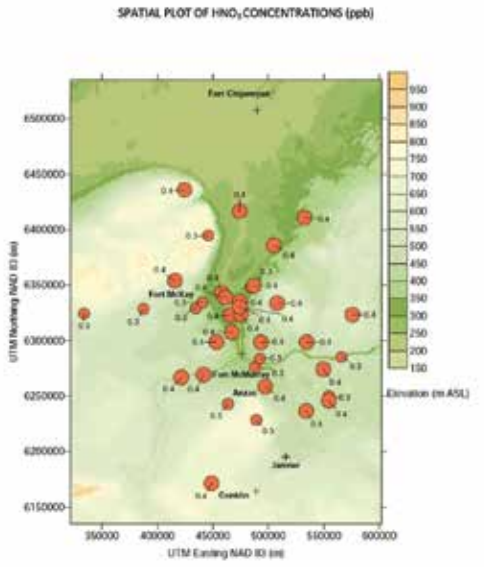
Site Name	HNO_3	NH_3	NO_2	SO_2	O_3
2054	✓	✓	✓	✓	✓
3009	✓	✓	✓	✓	✓
3011	✓	✓	✓	✓	✓
3016	✓	✓	✓	✓	✓
3083	✓	✓	✓	✓	✓
3086	✓	✓	✓	✓	✓
3088	✓	✓	✓	✓	✓
3092	✓	✓	✓	✓	✓
3096	✓	✓	✓	✓	✓
3212	✓	✓	✓	✓	✓
4000	✓	✓	✓	✓	
4001	✓	✓	✓	✓	
4002	✓	✓	✓	✓	
4003	✓	✓	✓	✓	
4004	✓	✓	✓	✓	
4014	✓	✓	✓	✓	
ATHV			✓		
BGFM	✓	✓	✓	✓	✓
MILD	✓	✓	✓	✓	✓


SPATIAL PLOT OF SO_2 CONCENTRATIONS (ppb)
Fort Chipewyan
Fort McKay
Fort McMurray
Anzac
Janvier
Conklin
UTM Northing NAD 83 (m)
UTM Easting NAD 83 (m)
Elevation (m ASL)


SPATIAL PLOT OF O_3 CONCENTRATIONS (ppb)
Fort Chipewyan
Fort McKay
Fort McMurray
Anzac
Janvier
Conklin
UTM Northing NAD 83 (m)
UTM Easting NAD 83 (m)
Elevation (m ASL)


SPATIAL PLOT OF NO_2 CONCENTRATIONS (ppb)
Fort Chipewyan
Fort McKay
Fort McMurray
Anzac
Janvier
Conklin
UTM Northing NAD 83 (m)
UTM Easting NAD 83 (m)
Elevation (m ASL)


SPATIAL PLOT OF NH_3 CONCENTRATIONS (ppb)
Fort Chipewyan
Fort McKay
Fort McMurray
Anzac
Janvier
Conklin
UTM Northing NAD 83 (m)
UTM Easting NAD 83 (m)
Elevation (m ASL)


SPATIAL PLOT OF HNO_3 CONCENTRATIONS (ppb)
Fort Chipewyan
Fort McKay
Fort McMurray
Anzac
Janvier
Conklin
UTM Northing NAD 83 (m)
UTM Easting NAD 83 (m)
Elevation (m ASL)

Active Air Sampling

Active air sampling uses a pump to provide a known volume of air to a continuous analyzer or sample media. In remote areas, absent from grid-supplied power, active sampling is achieved using solar powered systems. Ammonia (NH_3), nitric acid (HNO_3), and particulate matter ($PM_{2.5}$) are monitored year-round by active sampling combined with filter media using a denuder system. Ground-level ozone (O_3) is monitored April through October by active sampling with continuous analyzers. The list of parameters measured at deposition monitoring sites using active air sampling is included in the table below.

Active Air Sampling

	Low-Power Denuder							Portable Ozone Monitor
Site Name	HNO_3	NH_3	$PM_{2.5}$	Trace Elements	NH_4^+	NO_3^-	SO_4^{2-}	O_3
1004	✓	✓	✓	✓	✓	✓	✓	
1007	✓	✓	✓	✓	✓	✓	✓	
2001	✓	✓	✓	✓	✓	✓	✓	
2013	✓	✓	✓	✓	✓	✓	✓	
3502								✓
3501								✓
3513								✓

Passive Deposition Sampling

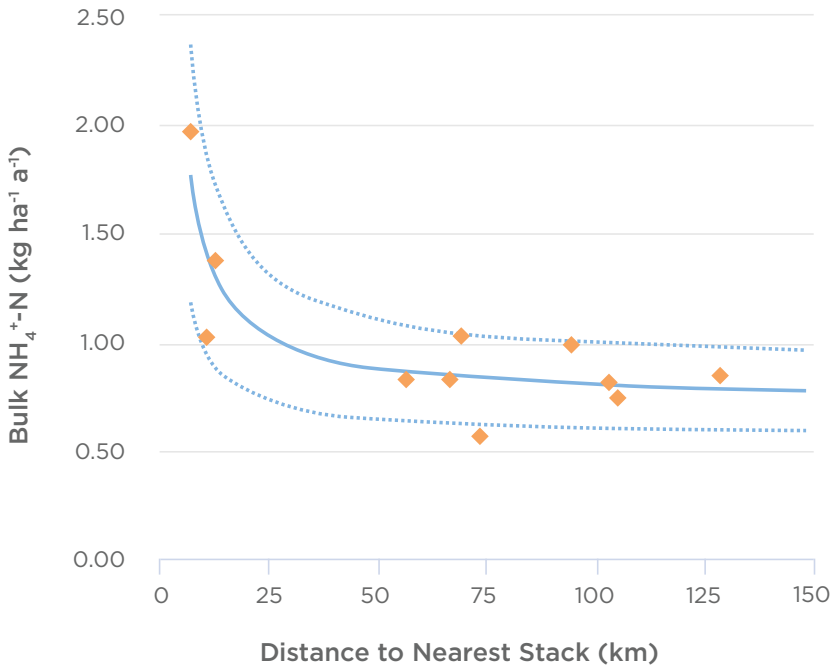
Passive deposition sampling is achieved through ion exchange resin technology (IER). A column of resin beads is affixed to precipitation collectors to capture charged chemical species (ions) in precipitation water. The graphs below depict the deposition of ammonium (NH_{4+}), nitrate (NO_3^-), sulphate (SO_4^{2-}), and calcium (Ca^+) in relation to distance from the nearest emission source (stack) and indicates that deposition is higher close to emission sources. The list of parameters at deposition monitoring sites using IER's is included in the table below.

Deposition Sampling (IER)

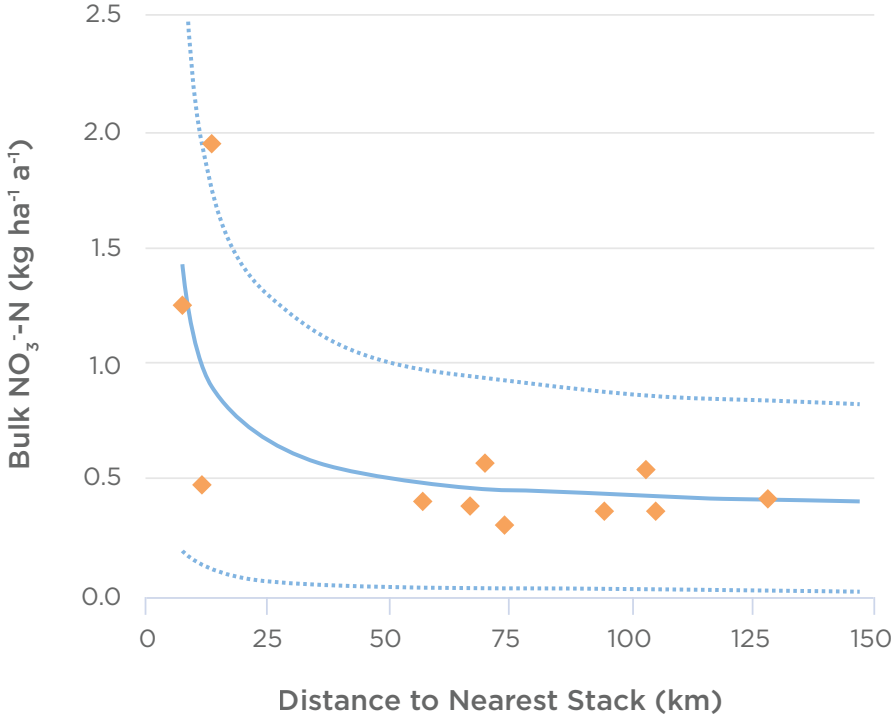
Site Name	NH_4	NO_3	PO_4	SO_4	Base Cation
1001	✓	✓	✓	✓	
1004	✓	✓	✓	✓	✓
1006	✓	✓	✓	✓	
2001	✓	✓	✓	✓	✓
2010	✓	✓	✓	✓	✓
2012	✓	✓	✓	✓	
2013	✓	✓	✓	✓	✓
2050	✓	✓	✓	✓	
2054	✓	✓	✓	✓	✓
2513	✓	✓	✓	✓	✓
2554	✓	✓	✓	✓	✓
3003	✓	✓	✓	✓	
3008	✓	✓	✓	✓	✓
3009	✓	✓	✓	✓	
3011	✓	✓	✓	✓	
3052	✓	✓	✓	✓	
3072	✓	✓	✓	✓	✓
3083	✓	✓	✓	✓	
3092	✓	✓	✓	✓	
3098	✓	✓	✓	✓	✓
3102	✓	✓	✓	✓	✓
3107	✓	✓	✓	✓	✓
3111	✓	✓	✓	✓	

Site Name	NH_4	NO_3	PO_4	SO_4	Base Cation
3116	✓	✓	✓	✓	
3153	✓	✓	✓	✓	✓
3172	✓	✓	✓	✓	✓
3202	✓	✓	✓	✓	✓
3207	✓	✓	✓	✓	✓
3210	✓	✓	✓	✓	✓
3211	✓	✓	✓	✓	✓
3212	✓	✓	✓	✓	
3253	✓	✓	✓	✓	✓
3308	✓	✓	✓	✓	✓
3309	✓	✓	✓	✓	
3311	✓	✓	✓	✓	
3398	✓	✓	✓	✓	✓
3550	✓	✓	✓	✓	
4000	✓	✓	✓	✓	✓
4001	✓	✓	✓	✓	✓
4002	✓	✓	✓	✓	✓
4003	✓	✓	✓	✓	✓
4004	✓	✓	✓	✓	✓
4014	✓	✓	✓	✓	✓
ANZC	✓	✓	✓	✓	
BGFM	✓	✓	✓	✓	

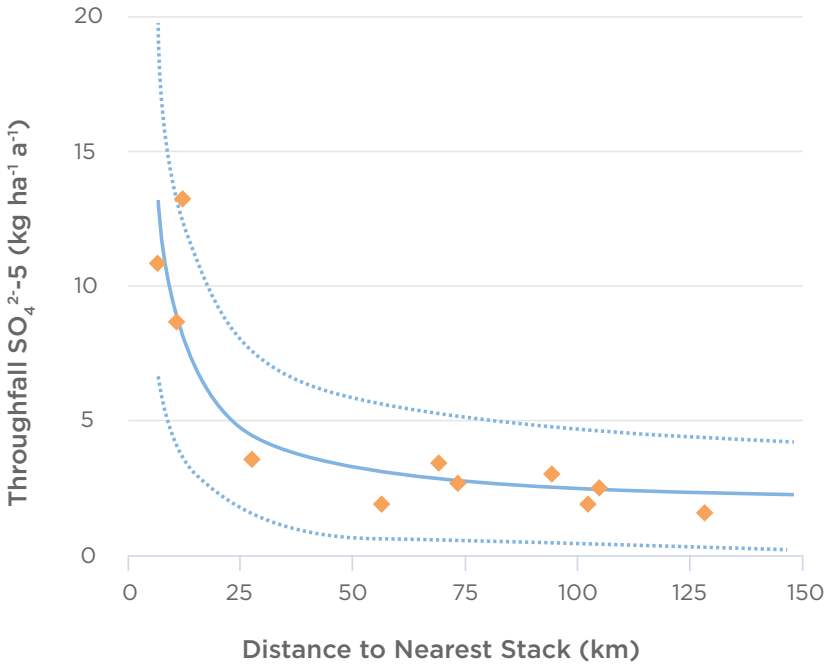
Bulk ammonium, as nitrogen



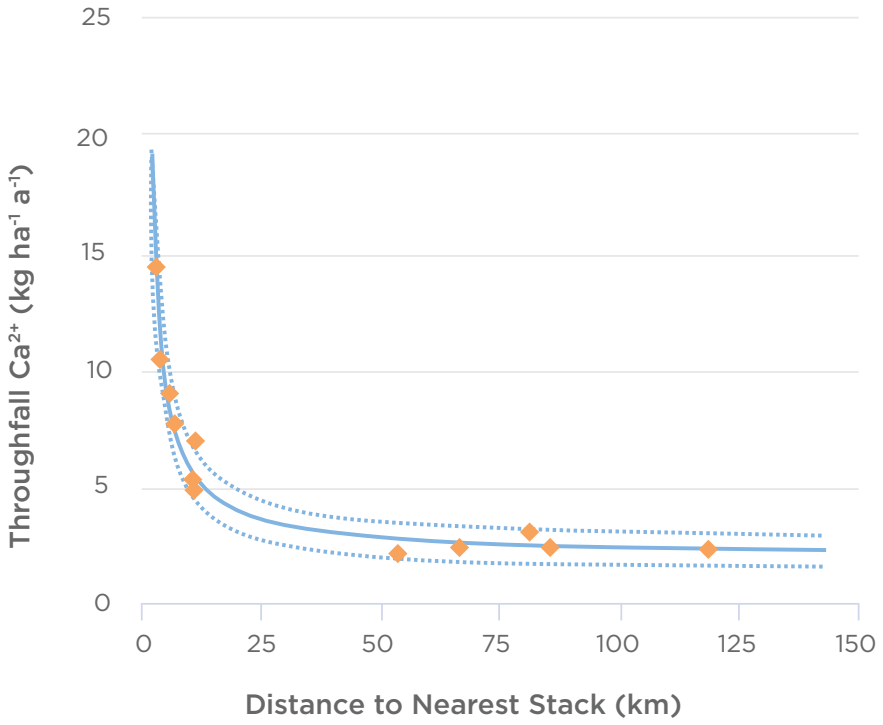
Bulk nitrate, as nitrogen



Throughfall sulphate, as sulphur

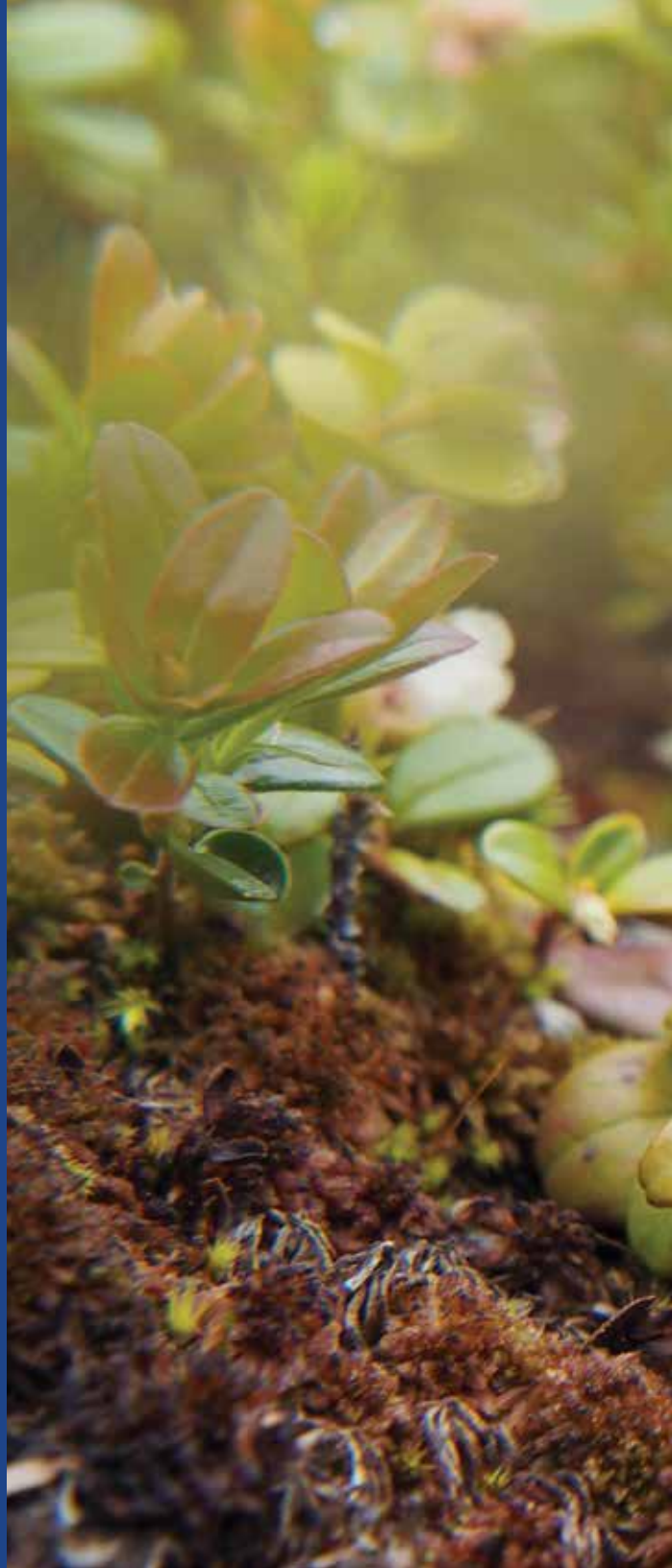


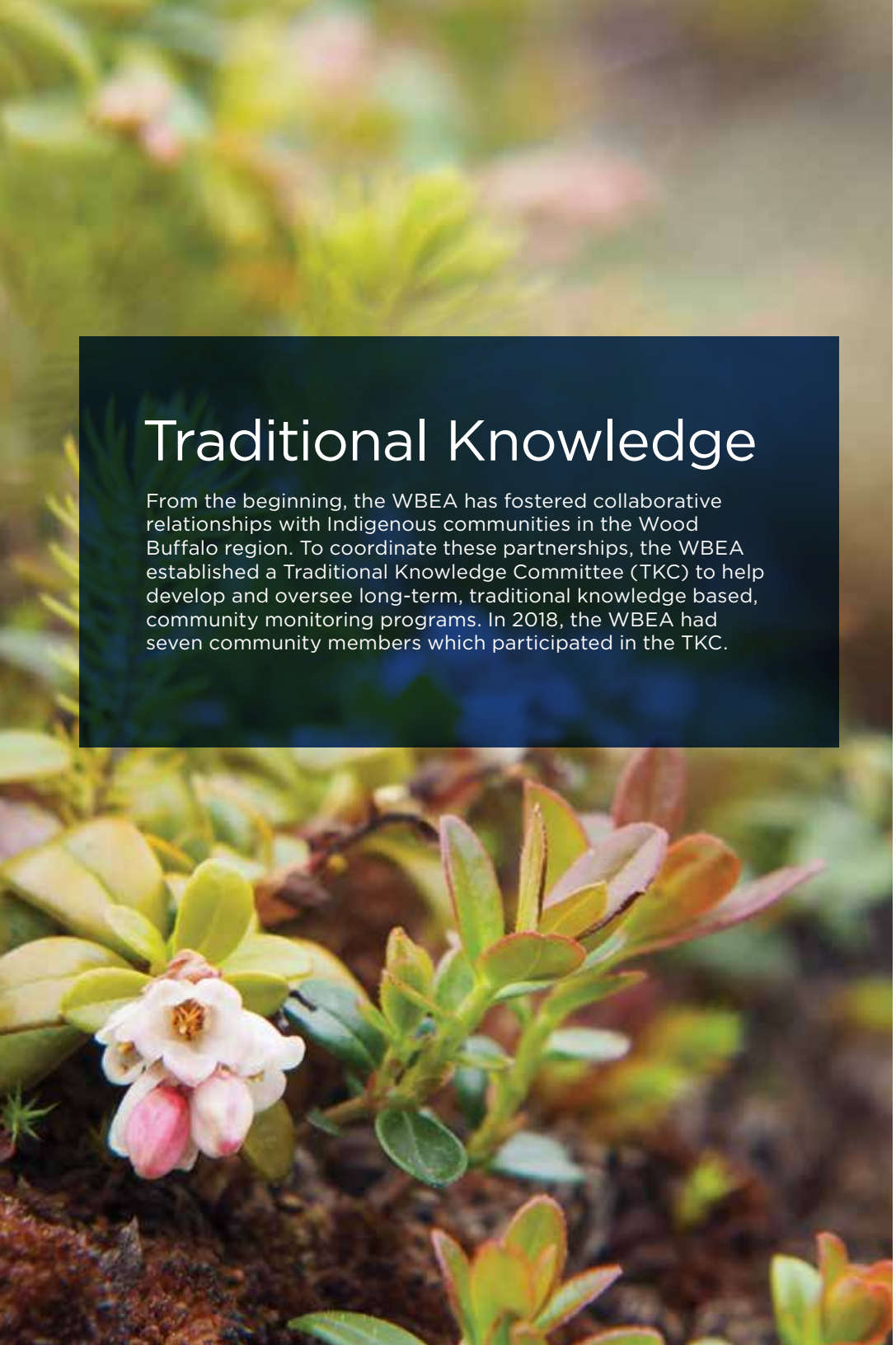
Throughfall calcium



Instrumented Regional Meteorological Network

The WBEA's regional meteorological network provides key data for calculating deposition rates and evaluating ecological data. The network is comprised of six paired sites: six 30-meter tall instrumented towers ("met towers") and six instrumented tripods ("met tripods") that provide continuous, hourly data on climatic conditions throughout the Wood Buffalo region. Each met tower is co-located with a Forest Health Monitoring (FHM) site and monitors air temperature, relative humidity, wind speed, wind direction, and solar radiation at four levels within and above the jack pine canopy, as well as temperature and volumetric water content within forest soil. Each met tripod is positioned in natural peatland clearing adjacent to a FHM site and monitors air temperature, relative humidity, wind speed, wind direction, and solar radiation. Data for all six 30-meter meterological towers can be found at **wbea.org/network-and-data/historical-monitoring-data**.





Traditional Knowledge

From the beginning, the WBEA has fostered collaborative relationships with Indigenous communities in the Wood Buffalo region. To coordinate these partnerships, the WBEA established a Traditional Knowledge Committee (TKC) to help develop and oversee long-term, traditional knowledge based, community monitoring programs. In 2018, the WBEA had seven community members which participated in the TKC.

Community Led Berry Contamination Study

In 2010, the WBEA was approached by members of the Fort McKay First Nation with concerns about observed changes in the quantity and quality of blueberries and cranberries growing on their traditional lands. In late 2010, the joint WBEA-Fort McKay Berry Focus Group was established to design a program that is directed by traditional knowledge and lived experience. It incorporates qualitative observations and western science-based tools in the monitoring and analysis of harvest locations and berries.

In 2018, Chipewyan Prairie Dene First Nation, Conklin, Fort McKay Métis, Fort McMurray Métis, and Fort McMurray First Nation 468 developed and implemented their community-specific berry contamination studies. While the WBEA provides support to these programs, the WBEA does not share the data on the communities' behalf.

Odour Monitoring

Community Odour Monitoring Program

During 2017, the WBEA worked on developing a method of collecting odour data from citizens of the RMWB to compare with ambient air monitoring being done at continuous air monitoring stations in the region. The Community Odour Monitoring Program (COMP) app was launched in September 2017 and allows members of the RMWB to submit information about the odours they experience in the region. The app is currently active and dependent on users to provide information that can be compared to the data collected at WBEA ambient air monitoring stations.

The 2018 COMP Annual Report, as well as links to download the app on iOS and Android devices can be found at **comp.wbea.org**.

New Technologies

Odours can be caused by many different and diverse compounds. The current technology used in ambient air monitoring stations can only give the concentrations of large groups of these compounds, not for individual species. Therefore, the decision was made for the WBEA to purchase semi-continuous gas chromatographs for both Reduced Sulphur Compounds (RSCs) and Volatile Organic Compounds (VOCs). This equipment is laboratory-grade and is not usually deployed in field settings. The aim of this project is to identify specific RSC and VOC compounds that may be causing odours in the region. In 2018, the equipment was acquired, and initial training was completed. The WBEA expects to have the equipment fully operational at a field site in late 2019.

Tell us what you smell

Have you ever experienced odours in our region? The WBEA wants to know more about them, and we need your help.

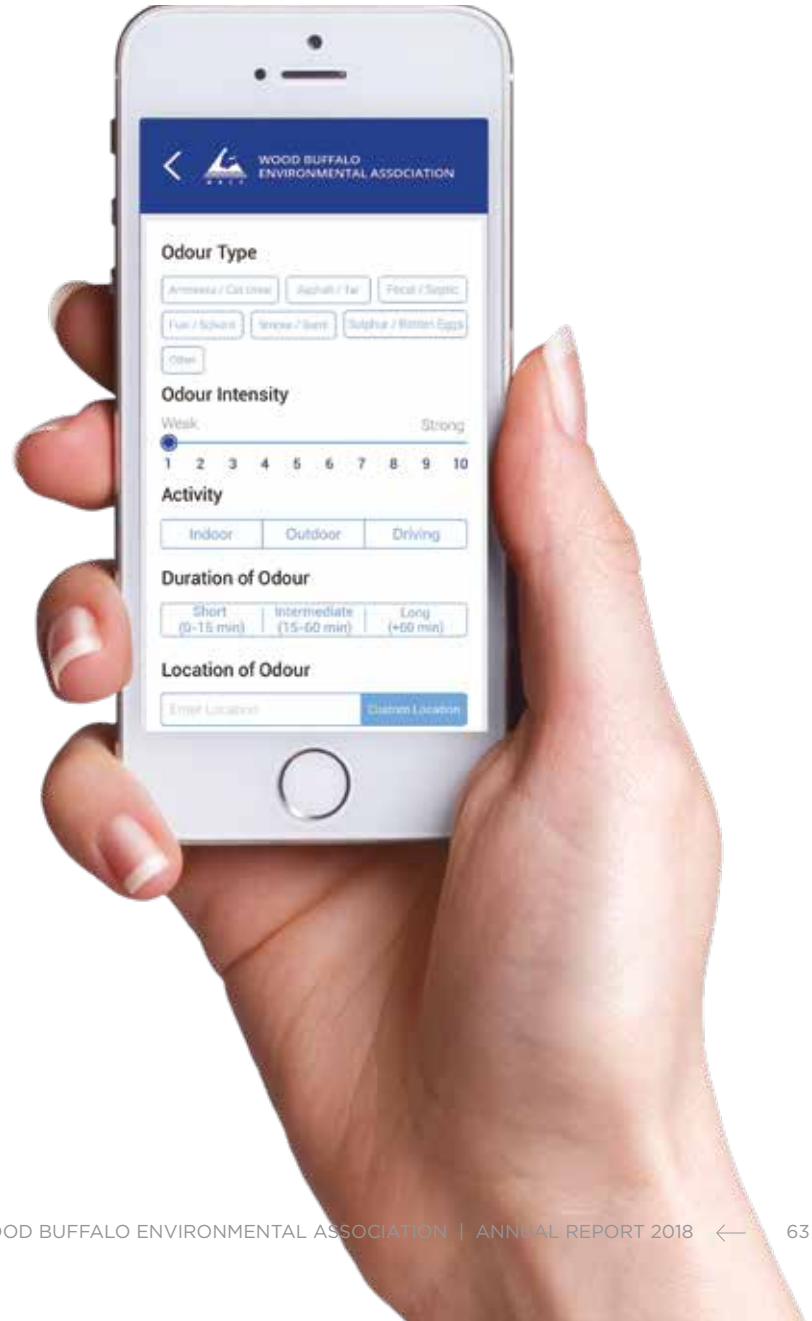
The WBEA is researching how odours in the region relate to ambient air data and needs help from all RMWB residents. It's easy to get involved:

1 DOWNLOAD OUR COMP APP AT COMP.WBEA.ORG

2 WHEN YOU SMELL AN ODOUR IN THE AIR, SUBMIT YOUR OBSERVATION THROUGH THE APP

The information collected is anonymous and will be used for research purposes only.

Learn more at **wbea.org**



WBEA 2018 Membership

INDIGENOUS MEMBERS

Chipewyan Prairie Dene First Nation
Christina River Dene Nation Council
Conklin Resource Development Advisory Council
Fort McKay First Nation
Fort McKay Métis
Fort McMurray First Nation 468
McMurray Métis

NON-GOVERNMENT ORGANIZATION MEMBERS

Keyano College
Pembina Institute for Appropriate Development

GOVERNMENT MEMBERS

Alberta Energy Regulator
Alberta Environment and Parks
Alberta Health Services
Alberta Health
Environment and Climate Change Canada
Health Canada
Parks Canada
Regional Municipality of Wood Buffalo

INDUSTRY MEMBERS

Athabasca Oil Corporation
Canadian Natural
Cenovus Energy Inc.
CNOOC International
Connacher Oil and Gas Ltd.
ConocoPhillips Canada
Devon Canada Corporation
Hammerstone Corporation
Husky Oil Operations Ltd.
Imperial Oil Limited
Inter Pipeline Limited
MEG Energy Corp.
PetroChina Canada Ltd.
Suncor Energy Inc.
Sunshine Oilsands Ltd.
Surmont Energy
Syncrude Canada Ltd.
Teck Resources Ltd.
Titan Tire Reclamation Corporation
Total E&P Canada Ltd.

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