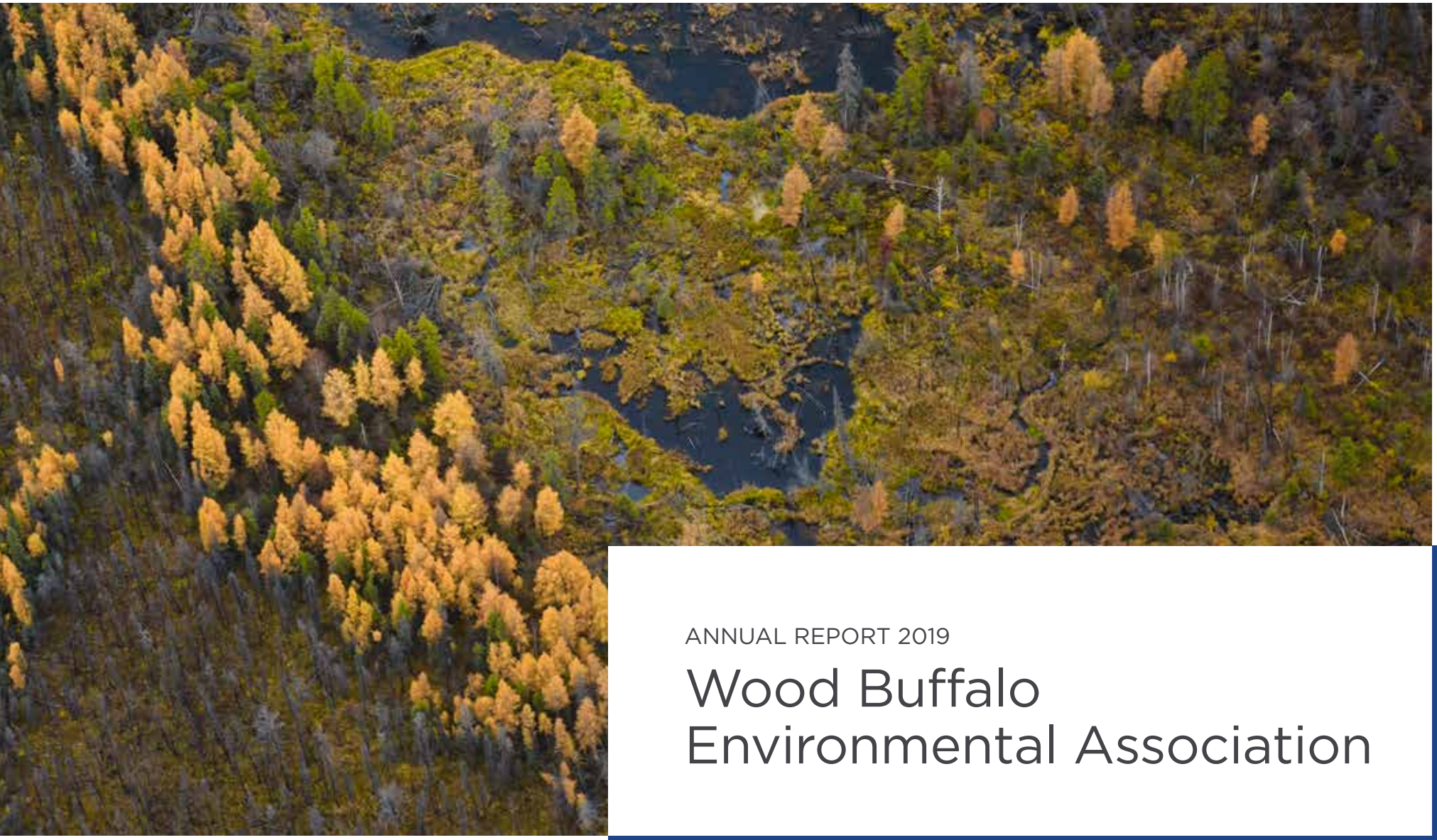
WOOD BUFFALO
ENVIRONMENTAL ASSOCIATION
W B E A



ANNUAL REPORT 2019

Wood Buffalo Environmental Association

Contents

MESSAGE FROM THE

President

As we look back over 2019, the Wood Buffalo Environmental Association (WBEA) has made several accomplishments, and the year marked several new beginnings for the WBEA. From moving to a new building; to anticipating the potential needs, wants, and requirements of a new provincial government; to dealing with funding timing that impacts the organizational capability, the WBEA has continued to deliver on its mission of providing high-quality air monitoring to the Regional Municipality of Wood Buffalo. In addition, the strength of being a consensus-based, multi-stakeholder organization is one that is recognized outside of our own membership. That strength is best realized when we have an engaged membership, whether through meeting or committee attendance and participation.

At the AGM in June 2019, for the first time in more than a year, the General Members Board was able to elect a full slate to the Governance Committee, and welcomed Simon Tatlow (Alberta Environment and Parks), Diane Scoville (Lakeland Métis Community Association), and Gillian Donald (McMurray Métis). Even for something as simple as achieving a quorum, having seven members of the Governance Committee has been a benefit, and I appreciate everyone's time and dedication. In addition to new Governance Committee members, the WBEA added several new Member organizations, including H.J. Baker Sulphur Canada ULC, Lakeland Métis Community Association, Parsons Creek Aggregates, Mikisew Cree First Nation, and Athabasca Chipewyan First Nation. It is encouraging that the WBEA continues to see increased participation from its membership, as well as interest expressed from organizations to become members of the WBEA.

In March of this year, I received a tour of the WBEA Centre to see the renovations that will make the facility functional for sustaining the WBEA's operations. During a tour of the facility in 2018, the Alberta Environment and Parks (AEP) Chief Scientist stated the WBEA Executive Director's concept for the facility was "visionary." It will be exciting to see how the use of the facility will support and strengthen relationships between the WBEA, its members, and our partners, as well as bring cost savings to the Association and its monitoring network. This endeavor is another example of the WBEA Leadership delivering on the 2017-2021 Strategic Plan goal of not just being good at the work we do but also being recognized as a leader. This is stepping outside the norm and making bold moves to get bold results.

The WBEA leadership understands there will always be a degree of uncertainty around potential changes to political, regulatory, economic, or environmental matters. Continuing to be an organization aligned on the goals we have to achieve, and how best to achieve them – while understanding associated risks to the business – will help position the organization to sustainably deliver quality results. Showcasing those results, as the WBEA has done, also puts the WBEA in a solid position to grow its scope, if that was ever an ask from any of our stakeholders and partners.

The WBEA worked through a Corporate Risk Registry, which will be reviewed quarterly by the Governance Committee. This is another step towards applying best practices in the organization. From a financial audit perspective, this year the WBEA issued a Request for Proposals to multiple companies and received several proposals. As a result, MNP LLP was retained for financial audit services for the 2019-2020 fiscal year. The WBEA's Operations Leadership Team and the Governance Committee also participated in procurement training, which was a great business literacy opportunity.

Other initiatives advanced by the WBEA this year included a facility lease agreement with AEP for sharing the WBEA Centre with Community Based Monitoring programs for the OSM Program, and a business case for providing analytical services. Some of these initiatives bring sustainable and long-term cost savings to the WBEA. The WBEA has also continued to report on the progress of the 2017-2021 Strategic Plan, which has seen accomplishments by the operations and governance teams.

I would like to again thank all Member organizations and their representatives for their participation. I would also like to thank Sanjay Prasad and the Operational Leadership Team for the time spent, both in the region and outside, to promote not just the WBEA's achievements, but also what we're capable of delivering through further collaboration.

I look forward to another great year.

Cliff Dimm, WBEA President

MESSAGE FROM THE

Executive Director

The WBEA is proud to be 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. 2019 was an eventful year for the Wood Buffalo Environmental Association (WBEA). It marked Year 3 of the WBEA's 2017-2021 Strategic Plan, and the organization continues to be 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. You can read more about the goals and tactics in the WBEA's five-year Strategic Plan, which can be found at **wbea.org/about/strategic-plan/**.

We continued to work closely with Alberta Environment and Parks (AEP) to develop our 2020-2021 Oil Sands Monitoring (OSM) work plans to ensure alignment with both the WBEA's and AEP's strategic and operational goals. The WBEA's technical program committees also continued to meet and deliver on their respective 2019-2020 work plans. The WBEA provided support for all committees and working groups, and continued to encourage active, multi-sectoral participation.

Highlights from 2019 include technical, operational, financial, and stakeholder engagement activities and initiatives. Below is a summary of those highlights.

Technical

1. The WBEA provided comments to AEP on the Draft Total Reduced Sulphur (TRS) Guideline and Alberta Ambient Air Quality Objectives/Guidelines (AAAQO/G) clarifications.
2. It was noted in 2019 that the Lower Camp Meteorological Tower required replacing, and the WBEA submitted a business case to the OSM Program to demonstrate the need and a proposed solution.
3. The WBEA participated in two partial ambient air monitoring network audits performed by AEP and received 100% compliance of the Air Monitoring Directive audit criteria.
4. The WBEA, along with its Science Advisors, published a series of research papers focused on the WBEA's deposition data from 2000-2017. The Special Virtual Issue was published through the State of the Total Environment (STOTEN) and is titled: ***Relationships Between Air Pollutants and Forest Ecosystem Health in the Oil Sands Region***.
5. The WBEA participated in the Clean Air Strategic Alliance (CASA) Air Quality TRS/H2S and NO2/SO2 subgroups for the Alberta Ambient Air Quality Objectives (AAAQO) on behalf of the Alberta Airshed Council (AAC)

Operational

1. The WBEA revised and finalized its bylaws, Financial Policies and Procedures, governance policies, and Information Technology Infrastructure roadmap.
2. Working with Human Resources and Safety contractors, the WBEA revised its Health and Safety Manual to align with the revised Occupational Health and Safety (OHS) code and Certificate of Recognition (COR) audit requirements.
3. The WBEA's safety program became more efficient and achieved increased staff engagement through the availability of safety information, forms, tracking, and training programs on an online portal and an app.
4. The WBEA completed the implementation of recommendations of the Corporate Internal Audit Services (CIAS) audit.
5. The WBEA shared its Adaptive Management Pathway paper with key personnel within the OSM Program.

Financial

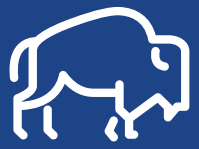
1. A letter was submitted to OSM Program decision-makers to further explain budget explanations for the 2019-2020 work plans. A second letter was also provided about the WBEA's minimum funding levels required for the next five years.
2. While waiting for approval of OSM Program work plans, the WBEA operated in cashflow management from April to October 2019.
3. The WBEA received multi-year agreements for OSM Program work plans in November 2019. The agreements are inclusive of 2019 to 2023 funding; the WBEA must submit annual work plans and cost estimates for approval.

Stakeholder Engagement

1. The WBEA received a Canada Summer Jobs Grant to provide a student employment opportunity, which focused on stakeholder engagement and communications. The successful applicant developed materials to promote the Community Odour Monitoring Program (COMP) app in the local region and improve the WBEA's presence on social media.
2. The WBEA developed an online annual report for the COMP app. More information can be found on the COMP website, comp.wbea.org.
3. The WBEA also received the Knowledge Translation Grant from AEP to support communication and outreach projects.
4. The Keyano College Environmental Program partnered with the WBEA to assist with Keyano's Air Sampling Program.
5. As a member of the AAC, the WBEA continues to work collaboratively to develop key priorities for the Airsheds to align with government priorities.

The WBEA greatly appreciates the collective knowledge and expertise of the Governance Committee and General Members Board membership. Thank you for your increased and continued engagement and participation over the past year. 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. I also want to acknowledge the dedication and support of WBEA staff and Science Advisors in working towards and delivering on our organizational goals.

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

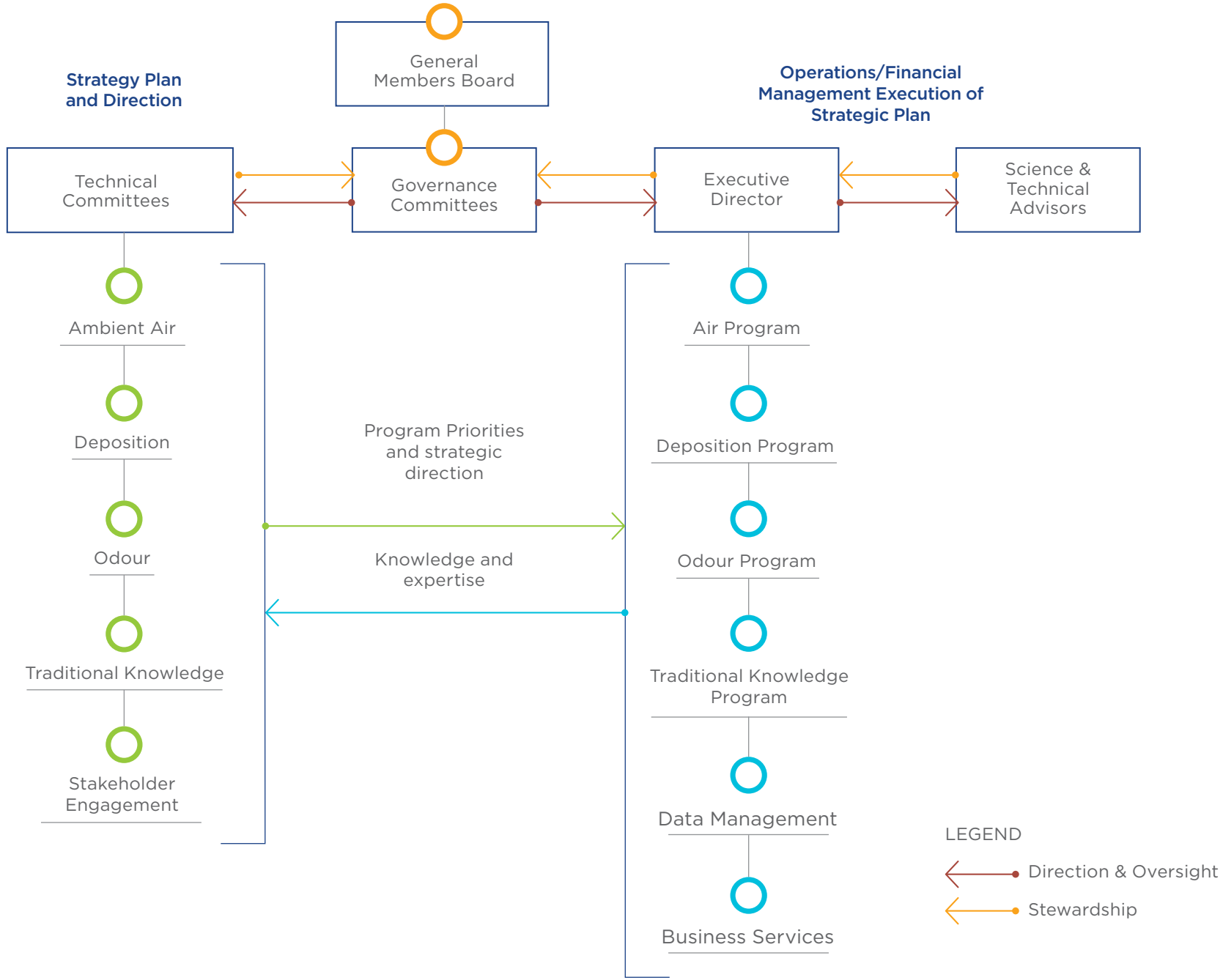
The WBEA ***2017-2021 Strategic Plan*** captures, in a single document, what the WBEA is about and what it seeks to achieve over the next five years. The plan focuses on four major goals:

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 following page 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.


General Members Board
Strategy Plan and Direction
Operations/Financial Management Execution of Strategic Plan
Technical Committees
Governance Committees
Executive Director
Science & Technical Advisors
Ambient Air
Deposition
Odour
Traditional Knowledge
Stakeholder Engagement
Program Priorities and strategic direction
Knowledge and expertise
Air Program
Deposition Program
Odour Program
Traditional Knowledge Program
Data Management
Business Services
LEGEND
Direction & Oversight
Stewardship

Alberta Environment and Parks

Oil Sands Monitoring Branch

Alberta Environment and Parks (AEP) is responsible for monitoring, evaluating, and reporting on key air, water, land, and biodiversity indicators. The mandate within the ministry 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 and Climate Change Canada. 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 AEP. 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.

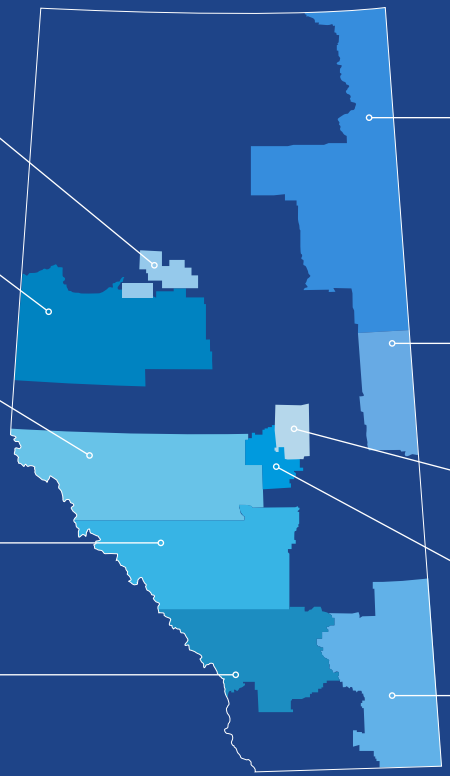
Peace River Area Monitoring Program Committee (PRAMP)
Peace River region

Peace Airshed Zone Associations (PAZA)
Grande Prairie and region

West Central Airshed Society (WCAS)
Jasper, Hinton, Edson, Lake Wabamun, Drayton Valley, Pigeon Lake 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



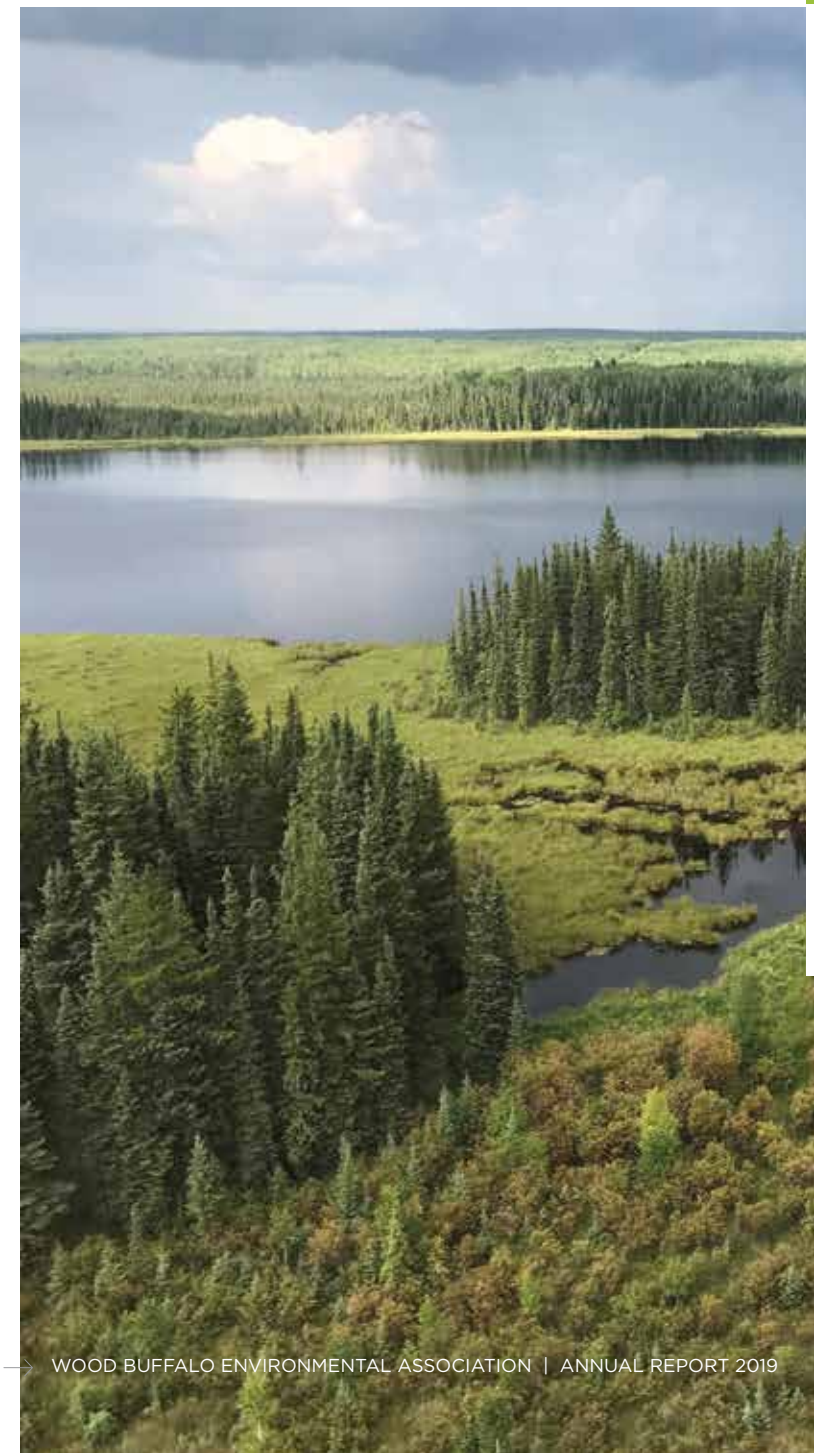
Wood Buffalo Environmental Association (WBEA)
Fort McMurray and the Wood Buffalo region

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

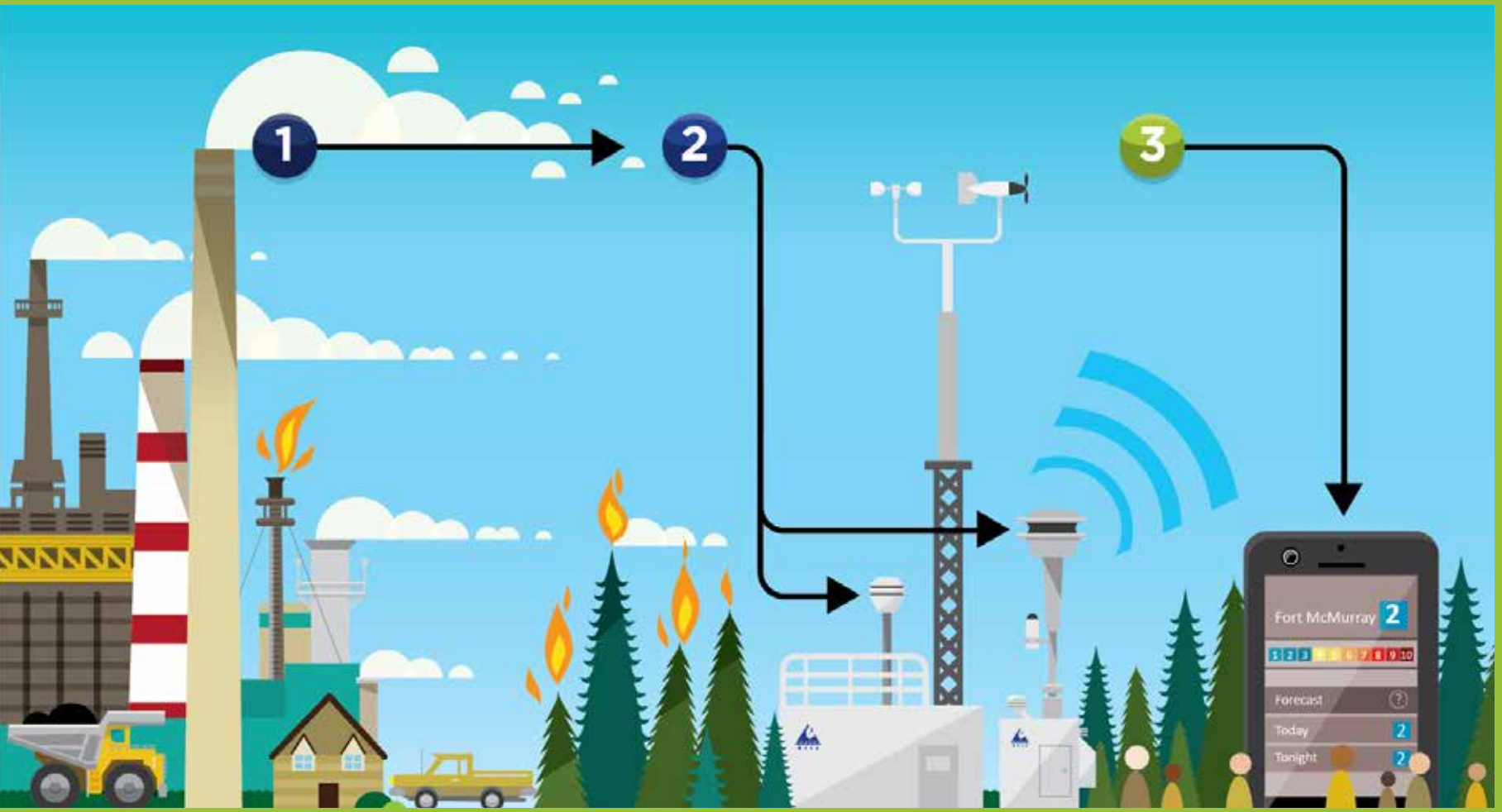


Ambient Air Monitoring

The WBEA operated 28 ambient air monitoring stations in 2019 throughout the RMWB. These included industrial, attribution, community, background, and meteorological stations. The image on the following page demonstrates how 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.

The WBEA provides all air monitoring data online via the following ways:

- 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**.
- To see various ambient air monitoring trends within the WBEA's network, visit **annualtrends.wbea.org**.



1. Source

Pollution is emitted into the air from a variety of sources

2. Measure

The WBEA ambient air monitoring stations measures the concentrations of pollutants in the air

3. Share

The information the WBEA collects is available to view on wbea.org and is used to calculate the air quality health index (AQHI)

AIR QUALITY HEALTH INDEX

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.

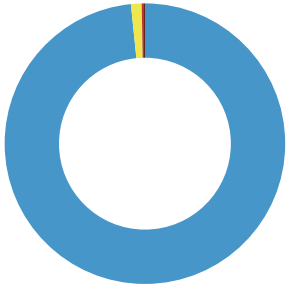
The AQHI includes concentrations of nitrogen dioxide (NO2), fine particulate matter (PM2.5), and ground-level ozone (O3), which are three compounds that can cause respiratory effects. Additionally, in Alberta, hourly pollutant concentrations are compared against Alberta's Ambient Air Quality Objectives (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 (SO2). For more information on the FMAQI, visit: **wbea.org/air/fort-mckay-air-quality-index-aqi/**.

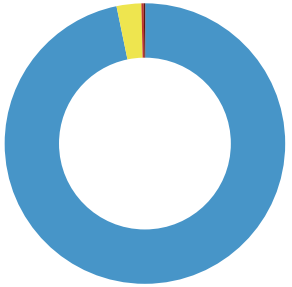
To find out more, visit: **wbea.org/air/air-quality-health-index**.

2019 Hourly AQHI by Station



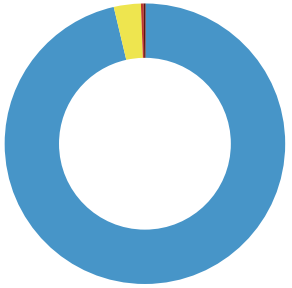
Anzac

Low Risk 98.43%
Moderate Risk 1.21%
High Risk 0.28%
Very High Risk 0.08%



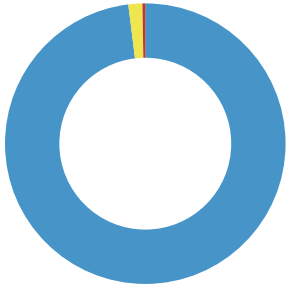
Bertha Ganter - Fort McKay

Low Risk 96.32%
Moderate Risk 3.14%
High Risk 0.49%
Very High Risk 0.06%



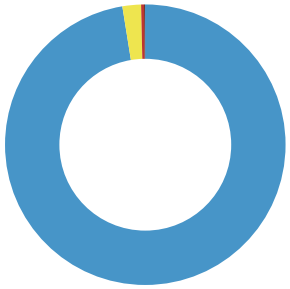
Patricia McInnes (Fort McMurray)

Low Risk 96.39%
Moderate Risk 3.08%
High Risk 0.32%
Very High Risk 0.21%



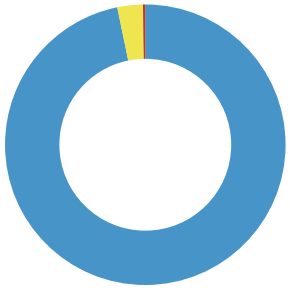
Conklin

Low Risk 98.08%
Moderate Risk 1.58%
High Risk 0.33%
Very High Risk 0.01%



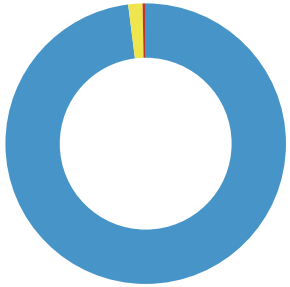
Fort McKay South

Low Risk 97.43%
Moderate Risk 2.15%
High Risk 0.35%
Very High Risk 0.07%



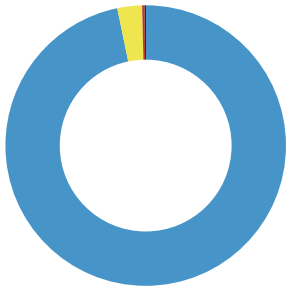
Janvier

Low Risk 96.79%
Moderate Risk 2.92%
High Risk 0.28%
Very High Risk 0.01%



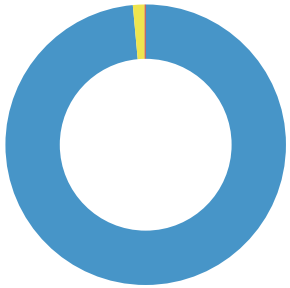
Fort Chipewyan

Low Risk 98.00%
Moderate Risk 1.63%
High Risk 0.34%
Very High Risk 0.02%



Athabasca Valley (Fort McMurray)

Low Risk 96.73%
Moderate Risk 2.84%
High Risk 0.29%
Very High Risk 0.14%



Stony Mountain

Low Risk 98.52%
Moderate Risk 1.30%
High Risk 0.18%
Very High Risk 0.00%

LOW RISK

1 2 3

MODERATE RISK

4 5 6

HIGH RISK

7 8 9 10

VERY HIGH RISK

+

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, 30-day, and annual averaging periods, depending on the characteristics of the pollutant. The graph on page 13 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 2015-2019. The graph on page 15 shows the exceedances for 2019 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:

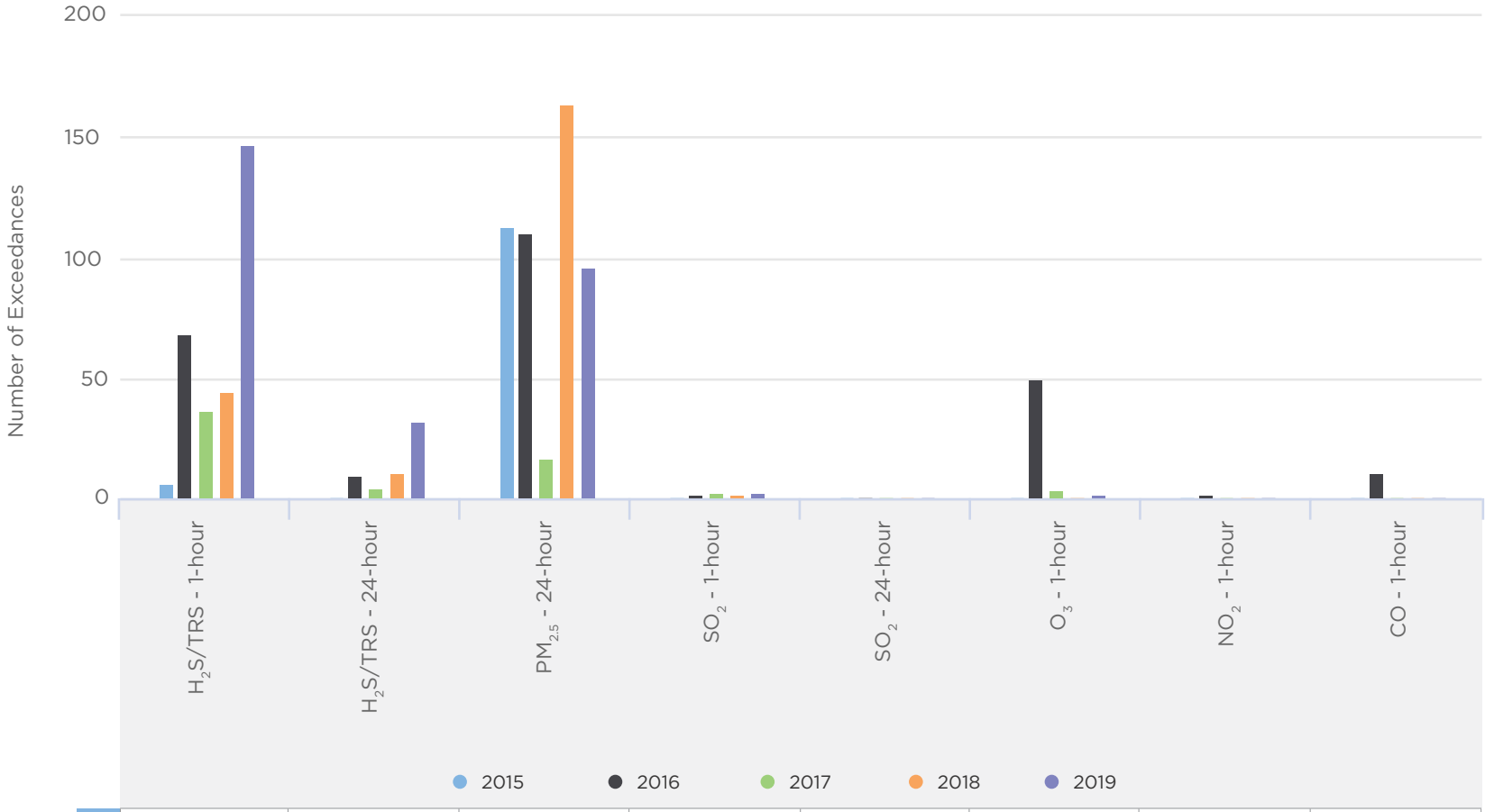
1. The data collection system automatically sends out alarm notifications to the WBEA personnel and an independent third-party alarm monitoring company.
2. The alarm company acknowledges the incoming alarm and reports the data and supporting information such as wind conditions, locations, time, etc., 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, 30-day, 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	30-day Average	Annual Average
Sulphur Dioxide (SO_2)	172 ppb	-	48 ppb	11 ppb	8 ppb
Nitrogen Dioxide (NO_2)	159 ppb	-	-	-	24 ppb
Ozone (O_3)	76 ppb	-	-	-	-
Total Reduced Sulphurs (TRS) / Hydrogen Sulphide (H_2S)*	10 ppb	-	3 ppb	-	-
Particulate Matter 2.5 ($PM_{2.5}$)	-	-	29 µg/m^3	-	-
Carbon Monoxide (CO)	13 ppm	5 ppm	-	-	-
Ammonia (NH_3)	2 ppm	-	-	-	-

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

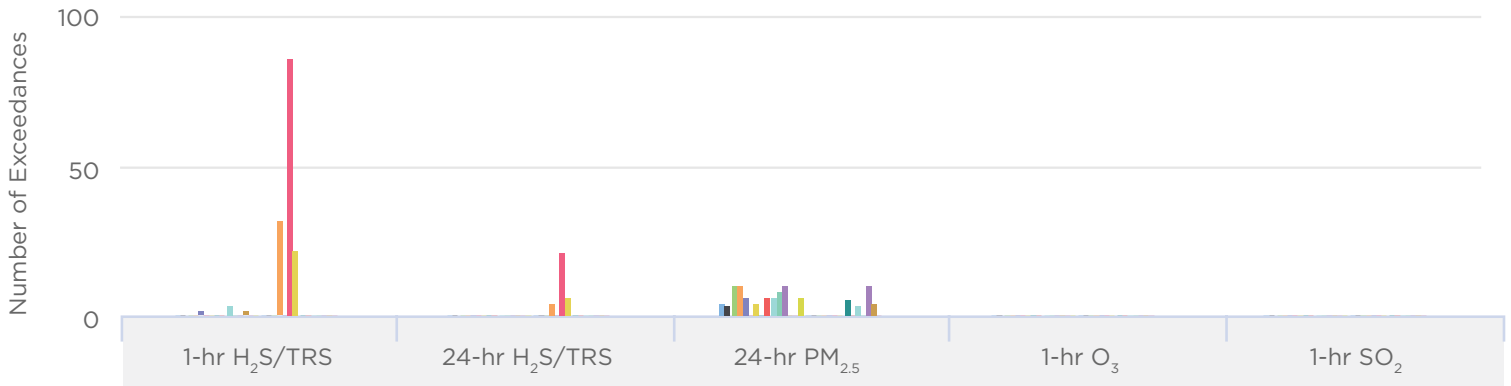
WBEA Ambient Air Monitoring Network — Total Number of AAAQO Exceedances (2015-2019)



	H2S/TRS - 1-hour	H2S/TRS - 24-hour	PM2.5 - 24-hour	SO2 - 1-hour	SO2 - 24-hour	O3 - 1-hour	NO2 - 1-hour	CO - 1-hour
2015	5	0	112	0	0	0	0	0
2016	68	9	109	1	0	49	1	10
2017	36	4	16	2	0	3	0	0
2018	44	10	163	1	0	0	0	0
2019	146	31	95	2	0	1	0	0

Forest fire season was considered to be from March 1 - November 1, 2019. All of the $PM_{2.5}$ AAAQO exceedances were related to forest fires in 2019.

2019 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			4		
Athabasca Valley			3		
Barge Landing			10		
Bertha Ganter - Fort McKay			10		
Buffalo Viewpoint	1		6		
Christina Lake					
Conklin			4		
Firebag					
Fort Chipewyan			6		
Fort Hills	3		6		
Fort McKay South			8		
Horizon			10		
Jackfish 1	1				
Jackfish 2/3					
Janvier			6		
Kirby North					
Kirby South					
Leismer					
Lower Camp	32	4			
McKay River					
Mannix	87	21			
Mildred Lake	22	6			
Patricia McInnes			5		
Sawbones Bay					
Stony Mountain			3		
Surmont					
Surmont 2			10		
Wapasu			4		
Waskow Ohci Pimatisiwin					

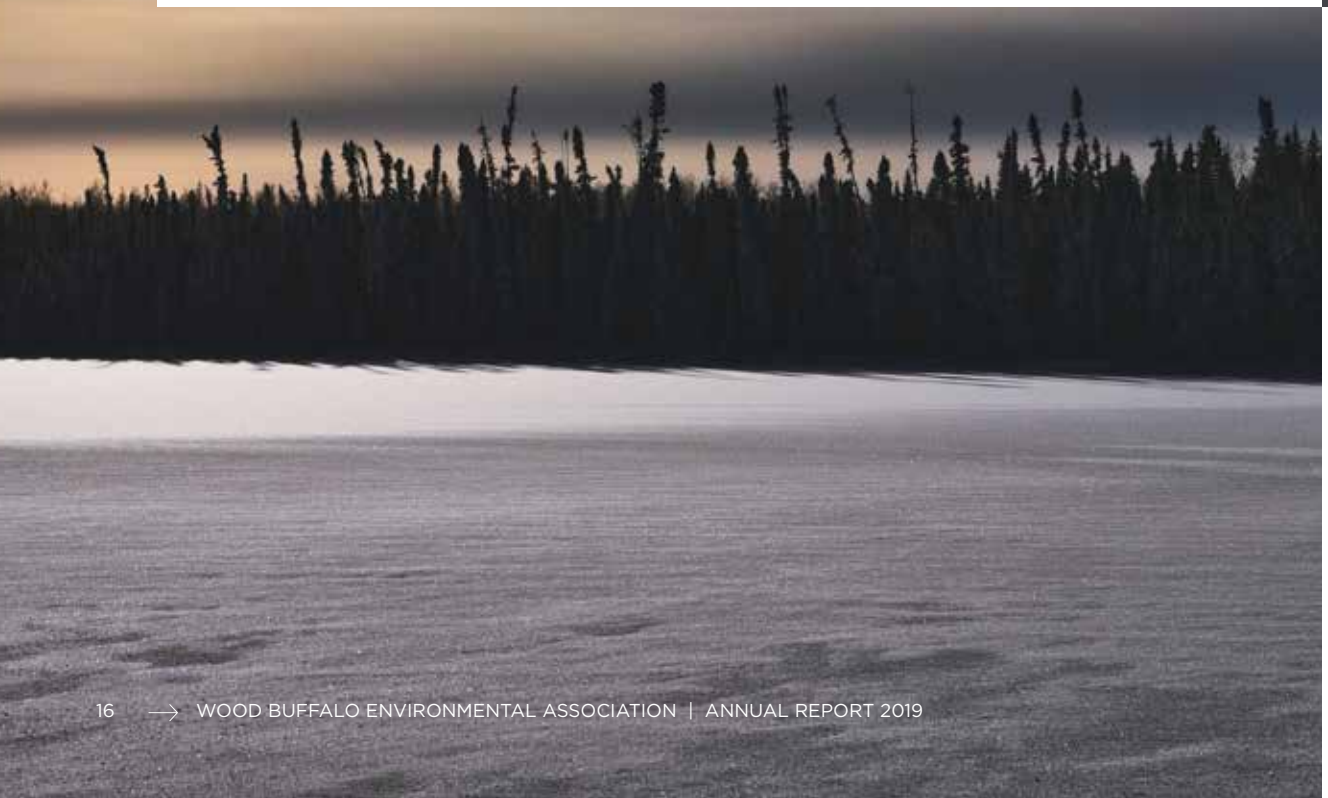
Forest fire season was considered to be from March 1 - November 1, 2019. All of the $PM_{2.5}$ AAAQO exceedances were related to forest fires in 2019.

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 2019. The triangles show the direction the wind is coming from, and the legend for the wind speeds is shown on the right. The colours within each wind rose triangle denote the frequency of the wind speed.

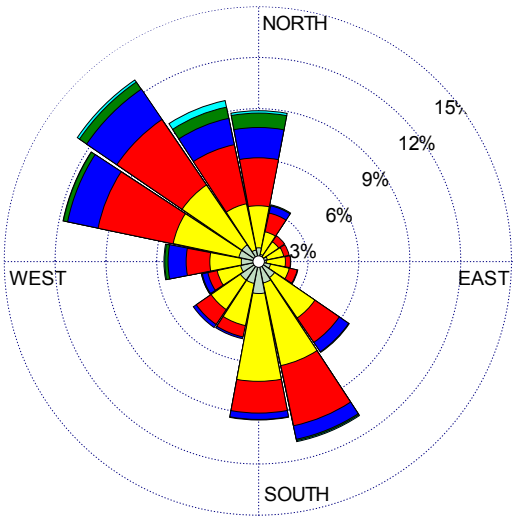
For example, the largest triangle in the Fort Chipewyan wind rose shows that the wind comes from the east, just 17% of the time in 2019. The red colour in this triangle shows the wind was between 10 and 15 kilometers per hour (km/h) 4% of the time.



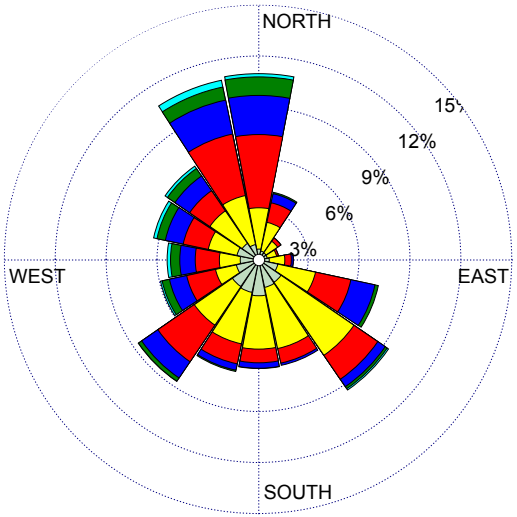
WIND SPEED (km/h)

- > = 25
- 20 - 25
- 15 - 20
- 10 - 15
- 5 - 10
- 0.5 - 5

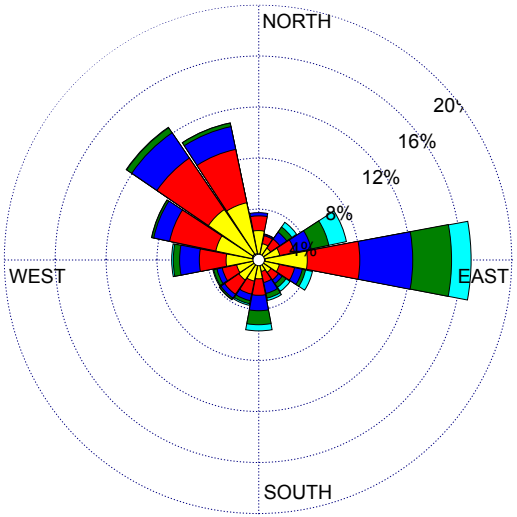
Anzac
Calms: 0.04% | Tower Height: 20m



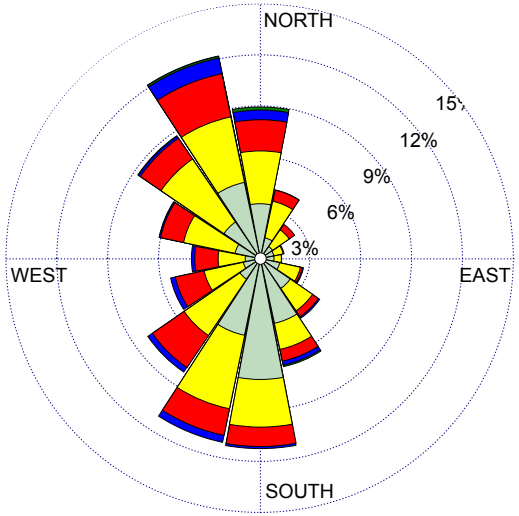
Patricia McInnes (Fort McMurray)
Calms: 0.12% | Tower Height: 10m



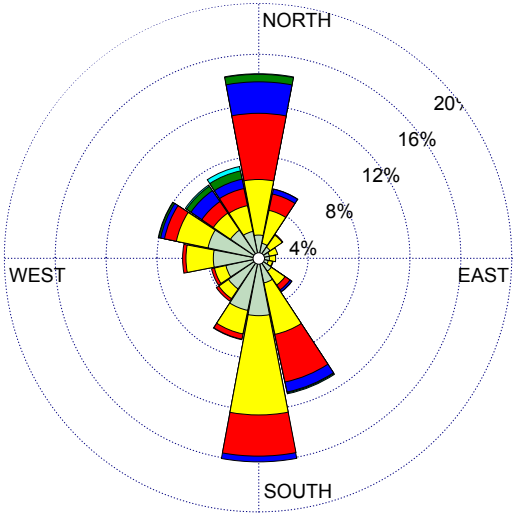
Fort Chipewyan
Calms: 0.06% | Tower Height: 10m



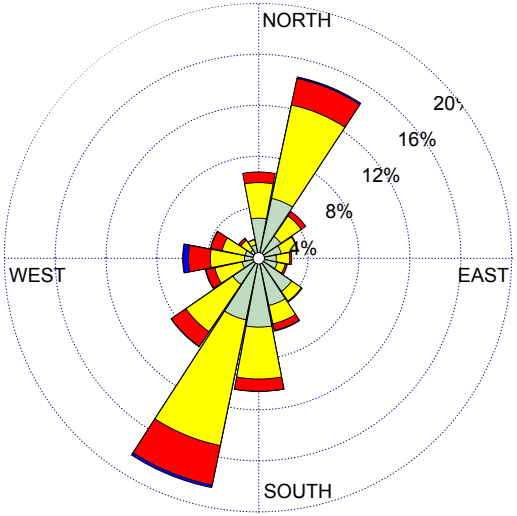
Conklin
Calms: 1.37% | Tower Height: 10m



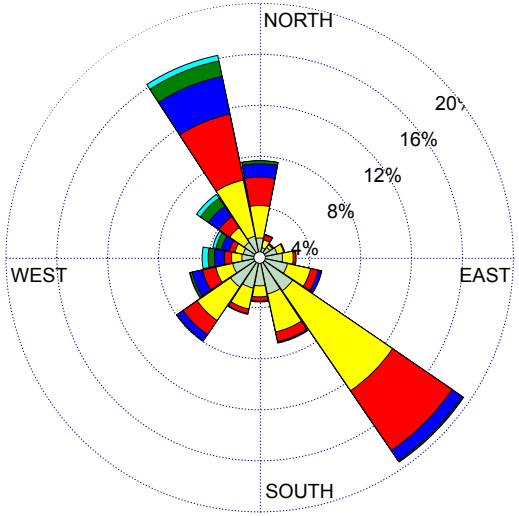
Bertha Ganter - Fort McKay
Calms: 0.36% | Tower Height: 10m



Janvier
Calms: 0.87% | Tower Height: 10m



Athabasca Valley (Fort McMurray)
Calms: 0.36% | Tower Height: 10m



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 on pages 19, 20, and 21 provide a list of air quality parameters measured at each startion. The graphs on pages 23 to 51 provide general information for each parameter measured and the corresponding collected data for 2019.

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	✓	✓		✓		✓	✓				
505	Compliance	Sawbones Bay	✓	✓				✓					
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	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	✓	✓		✓	✓				
505	Compliance	Sawbones Bay	✓	✓		✓	✓				
508	Compliance	Kirby North									

Summary of parameters measured using integrated methods at WBEA sites.

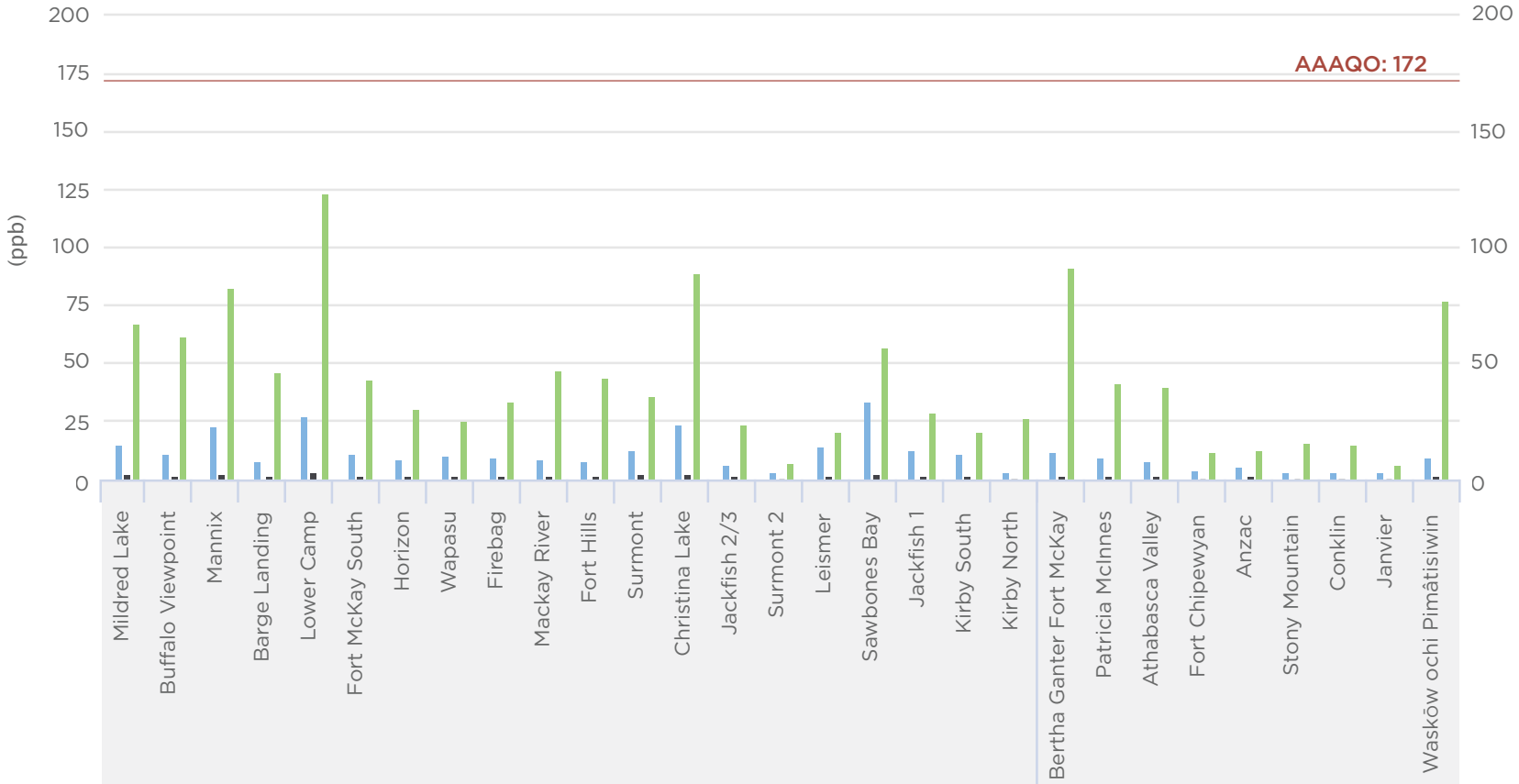
WBEA ID	Type	Station Name	VOC	$PM_{2.5}$ Mass, Metals and Ions	$PM_{2.5}$ Mass, ECOC	MP_{10} Mass, Metals and Ions	PAH	Precip
1	Community	Bertha Ganter-Fort Mckay	✓	✓	✓	✓	✓	✓
6	Community	Patricia Mcinnes	✓	✓		✓	✓	
7	Community	Athabasca Valley	✓	✓		✓	✓	
9	Attribution	Barge Landing	✓					
13	Compliance/ Attribution	Fort Mckay South	✓			✓		
14	Compliance/ Community	Anzac	✓	✓		✓	✓	
15	Compliance	Horizon	✓	✓		✓		
17	Compliance	Wapasu			✓			
18	Enhanced Deposition/ Background	Stony Mountain			✓			✓
21	Community	Conklin	✓	✓		✓	✓	
22	Community	Janvier	✓	✓			✓	

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)

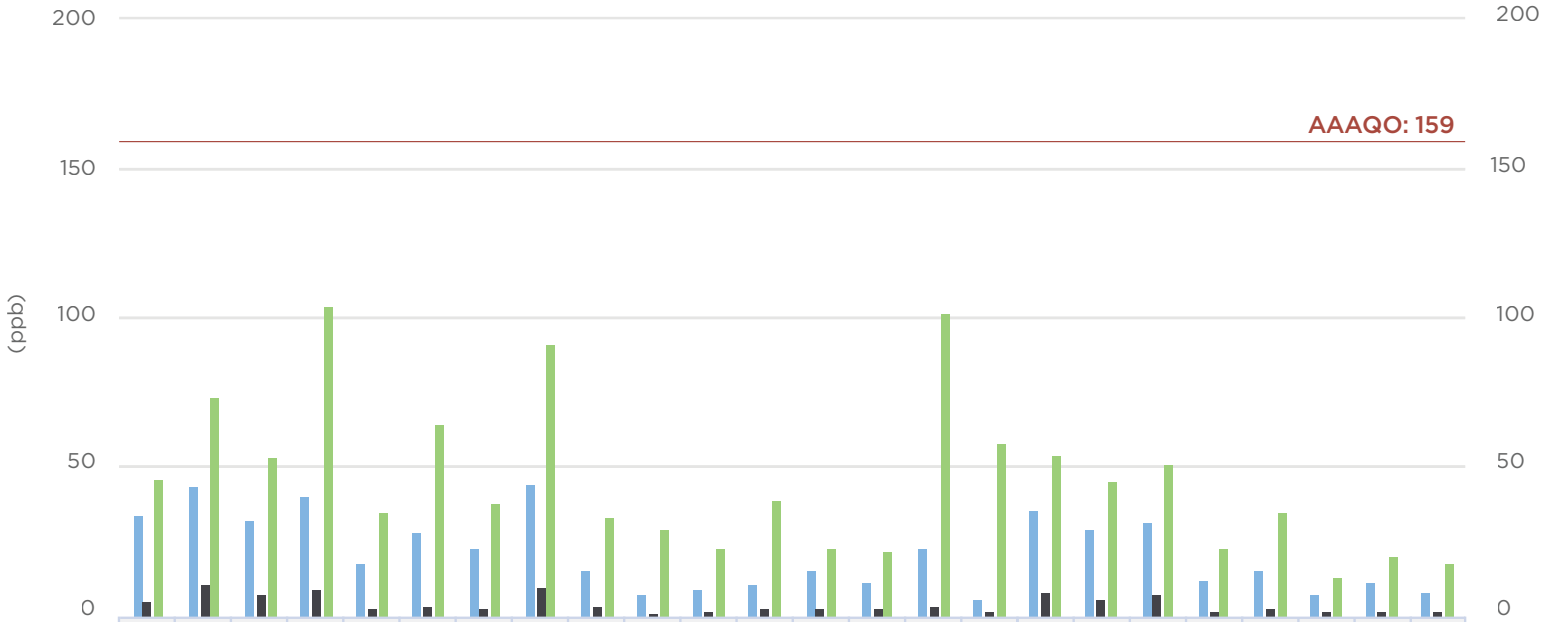
Sulphur dioxide is produced from the combustion of sulphur-containing fossil fuels. Sulphur dioxide in the air at high concentrations can make breathing difficult, particularly for children, the elderly, and people with asthma. Sulphur dioxide reacts in the atmosphere to form sulphuric acid and acidic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



	Mildred Lake	Buffalo Viewpoint	Mannix	Barge Landing	Lower Camp	Fort McKay South	Horizon	Wapasu	Firebag	Mackay River	Fort Hills	Surmont	Christina Lake	Jackfish 2/3	Surmont 2	Leismer	Sawbones Bay	Jackfish 1	Kirby South	Kirby North	Bertha Ganter Fort McKay	Patricia McInnes	Athabasca Valley	Fort Chipewyan	Anzac	Stony Mountain	Conklin	Janvier	Waskōw ochi Pimātisiwin
99th Percentile	14.6	10.5	22.7	7.4	26.5	10.1	7.7	9.4	8.5	7.9	7.4	12.0	23.7	6.0	2.6	13.7	33.1	12.5	10.1	2.4	11.0	8.9	7.5	3.0	4.5	2.8	2.3	2.2	9.0
Average	1.3	0.8	1.6	0.6	2.1	0.8	0.8	0.8	0.8	0.7	0.7	1.6	1.9	0.7	0.4	1.0	2.0	1.2	0.9	0.4	0.9	0.9	0.6	0.2	0.6	0.4	0.3	0.4	0.9
Max	66.7	60.9	81.9	45.8	123.6	42.8	30.0	25.0	33.2	46.4	43.6	35.4	88.4	23.5	6.3	20.4	56.8	28.1	20.5	25.5	91.5	41.0	39.8	11.2	12.4	15.1	14.8	5.8	76.3
AAAQO 1-hour avg.	172																												

Nitrogen Dioxide (NO_2)

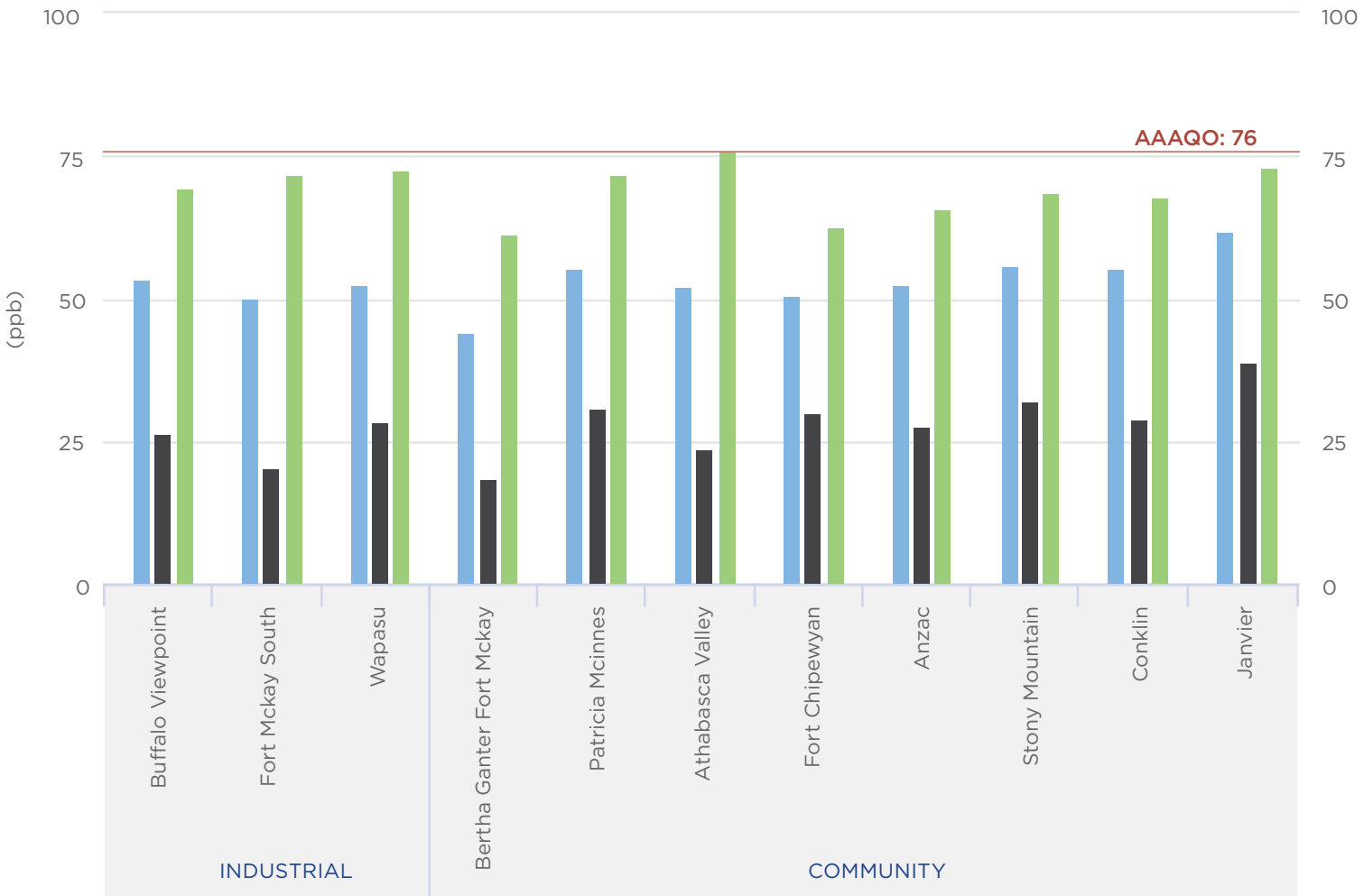
Nitrogen dioxide is a reddish-brown gas with a pungent, irritating odour that is produced by combustion of fossil fuels. It plays a major role in atmospheric photo-chemical reactions, ground-level ozone formation and destruction, and can also interact with water to form acid rain.



	Buffalo Viewpoint	Barge Landing	Fort Mckay South	Horizon	Wapasu	Firebag	Mackay River	Fort Hills	Christina Lake	Jackfish 2/3	Surmont 2	Leismer	Sawbones Bay	Jackfish 1	Kirby South	Kirby North	Bertha Ganter Fort Mckay	Patricia Mcinnes	Athabasca Valley	Fort Chipewyan	Anzac	Stony Mountain	Conklin	Janvier
99th Percentile	33.5	43.2	31.9	40.7	17.8	28.4	22.2	44.1	15.7	7.1	8.6	10.1	15.5	11.2	22.6	5.8	35.1	29.4	31.8	11.7	15.6	6.9	11.1	8.0
Average	5.1	1.02	7.3	9.2	2.6	3.5	2.3	9.7	3.1	1.2	1.3	2.2	2.5	2.1	3.6	1.4	8.3	5.4	7.6	2.0	2.2	1.3	2.0	1.4
Max	46.3	73.0	53.4	104.0	34.4	64.8	37.9	90.8	32.7	28.7	22.3	38.6	22.9	21.9	101.3	58.1	54.1	44.8	51.1	22.4	34.5	13.2	20.0	17.7
AAAQO 1-hour avg.	159																							

Ozone (O_3)

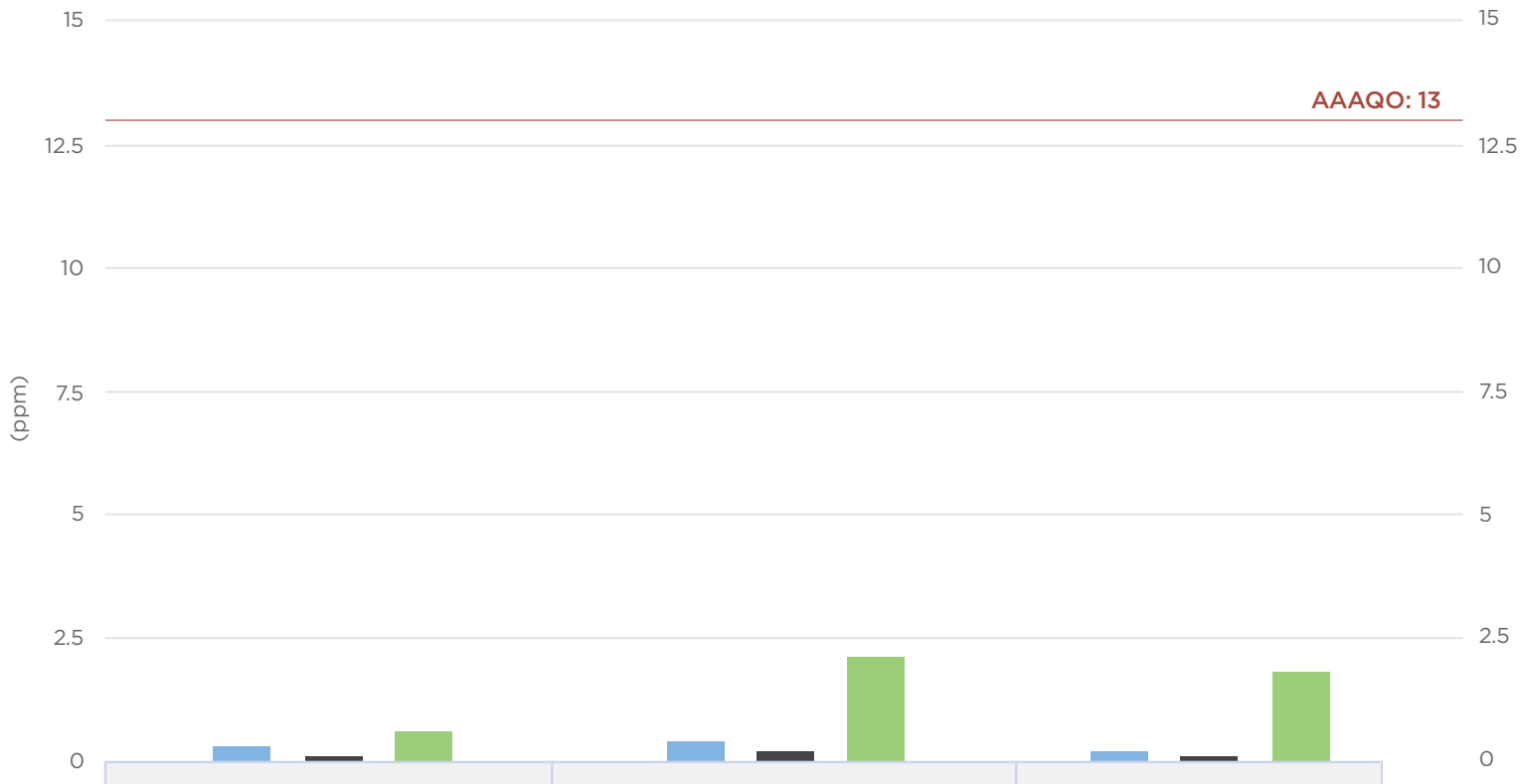
Ozone at ground-level is not emitted directly into the air but formed by chemical reactions of NO_x and volatile organic compounds (VOCs), from vehicular and industrial emissions. At high concentrations, breathing ozone can affect respiratory function, and cause coughing, throat irritation, and airway 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	53.4	50.2	52.5	43.8	55.1	52.0	50.4	52.3	55.7	55.1	61.5
Average	26.1	20.0	28.1	18.3	30.7	23.5	29.8	27.4	31.8	28.6	38.8
Max	69.4	71.7	72.4	61.4	71.8	75.9	62.7	65.8	68.4	67.8	73.0
AAAQO 1-hour avg.	76										

Carbon Monoxide (CO)

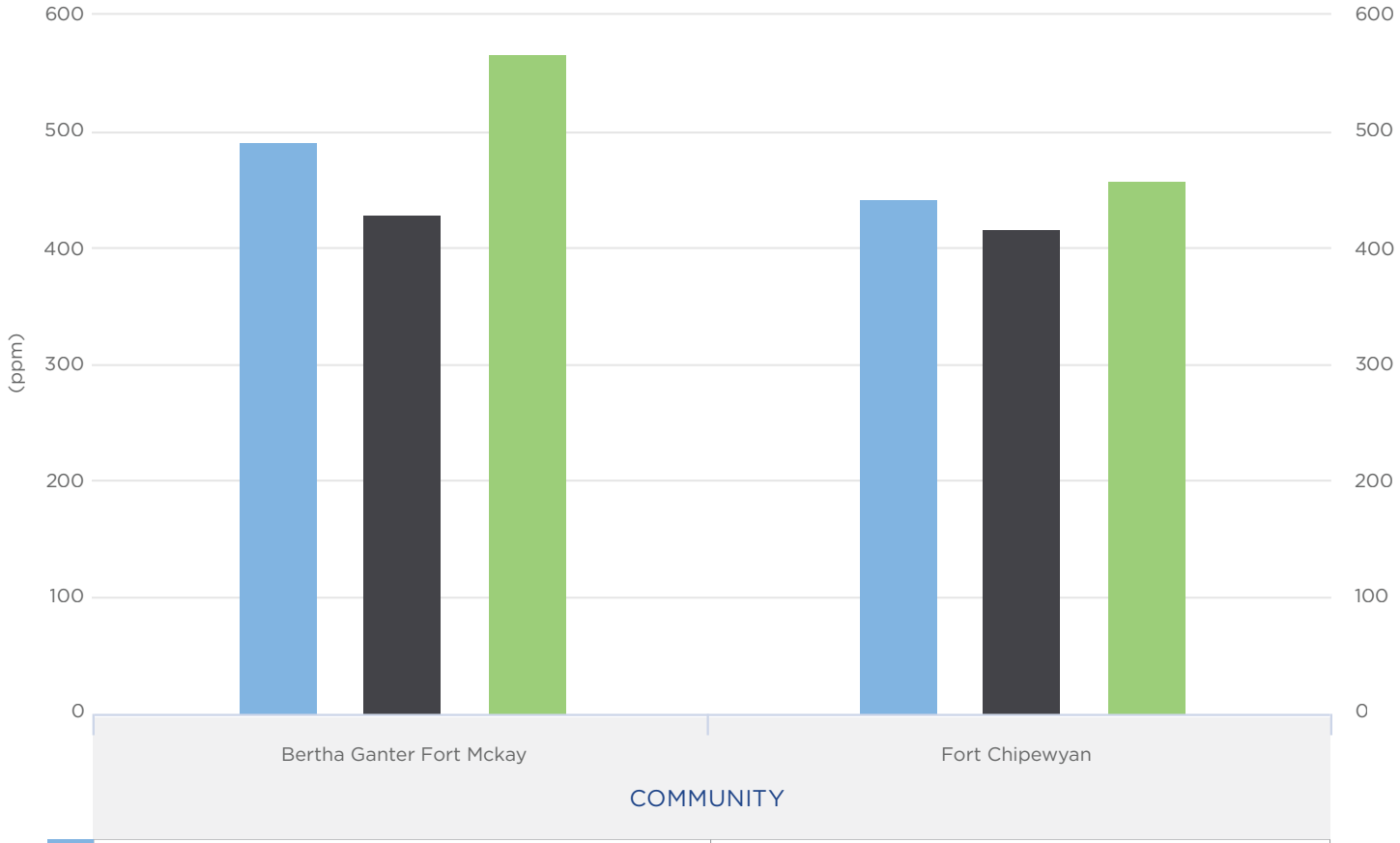
Carbon monoxide is formed from the incomplete combustion of carbon in fossil fuels. Transportation and vehicle emissions are the major source of carbon monoxide with elevated concentrations during the morning and evening rush hours. Breathing carbon monoxide decreases the amount of oxygen carried by the blood stream.



	Bertha Ganter Fort Mckay	Athabasca Valley	Fort Chipewyan
99th Percentile	0.3	0.4	0.2
Average	0.1	0.2	0.1
Max	0.6	2.1	1.8
AAAQO 1-hour avg.	13		

Carbon Dioxide (CO_2)

Carbon dioxide is a natural component of the air we breath. It is a colorless, odourless gas produced by respiration of plants and animals, and through combustion of fossil fuels. Ambient carbon dioxide is generally not a human health concern and is monitored in the network to help differentiate between origins of emissions such as forest fires and anthropogenic sources.

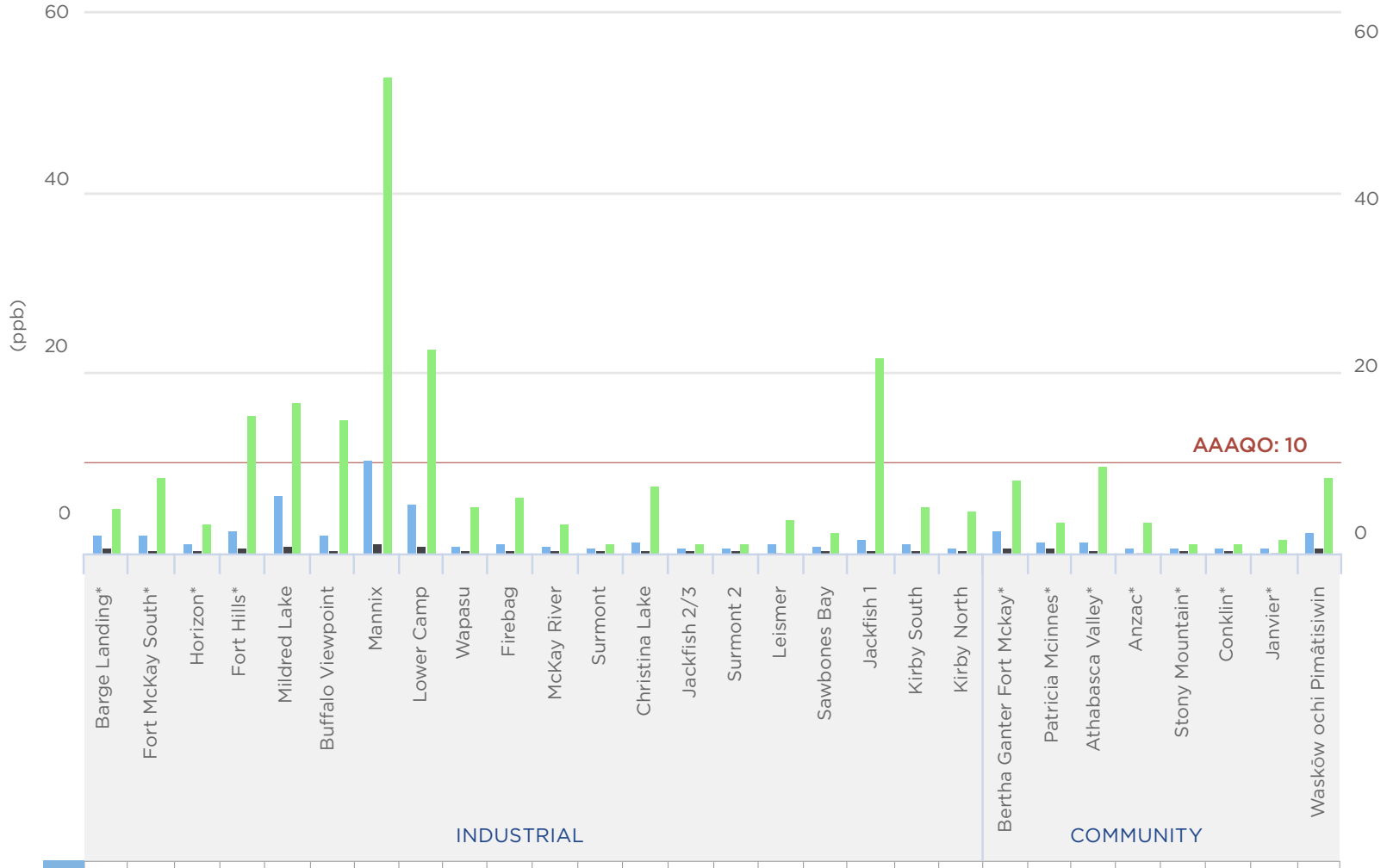


	Bertha Ganter Fort Mckay	Fort Chipewyan
99th Percentile	491.9	441.7
Average	427.7	415.7
Max	566.7	457.8

Note: CO_2 does not currently have an AAAQO.

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.

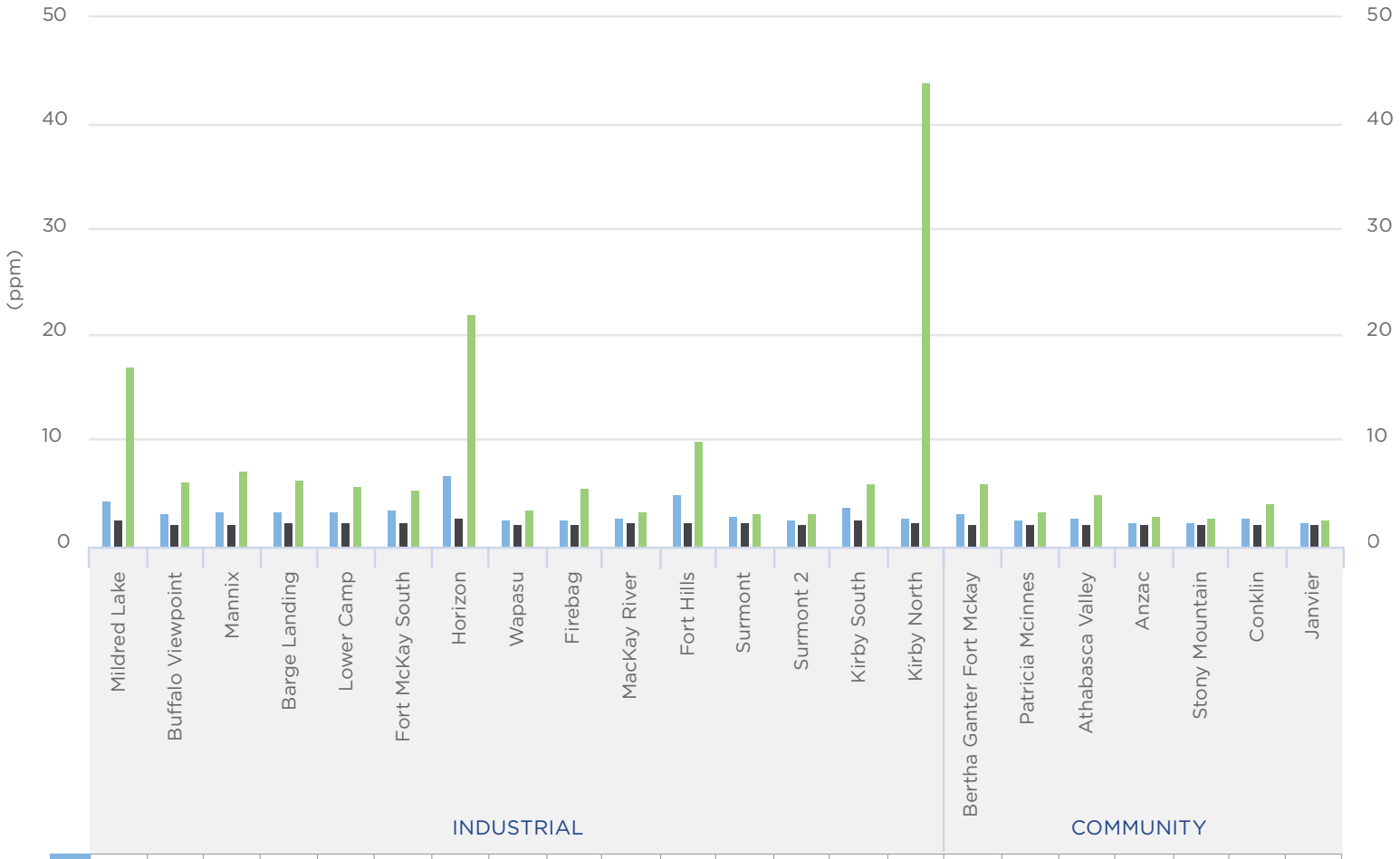


	Barge Landing*	Fort McKay South*	Horizon*	Fort Hills*	Mildred Lake	Buffalo Viewpoint	Mannix	Lower Camp	Wapasu	Firebag	McKay River	Surmont	Christina Lake	Jackfish 2/3	Surmont 2	Leismer	Sawbones Bay	Jackfish 1	Kirby South	Kirby North	Bertha Ganter Fort Mckay*	Patricia Mcinnes*	Athabasca Valley*	Anzac*	Stony Mountain*	Conklin*	Janvier*	Waskŏw ochi Pimâtisiwin
99th Percentile	1.9	1.9	1.1	2.5	6.4	2.0	10.3	5.5	0.7	1.0	0.8	0.6	1.2	0.6	0.5	1.0	0.8	1.4	0.9	0.5	2.4	1.3	1.3	0.4	0.5	0.5	0.4	2.1
Average	0.4	0.3	0.2	0.4	0.7	0.3	0.9	0.7	0.2	0.3	0.2	0.2	0.3	0.2	0.2	0.1	0.2	0.3	0.3	0.2	0.6	0.4	0.3	0.1	0.2	0.3	0.1	0.4
Max	4.9	8.3	3.2	15.3	16.8	14.7	53.2	22.6	5.2	6.1	3.2	0.9	7.5	1.1	1.0	3.6	2.2	21.7	5.2	4.7	8.2	3.4	9.6	3.5	0.9	1.1	1.5	8.3
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.

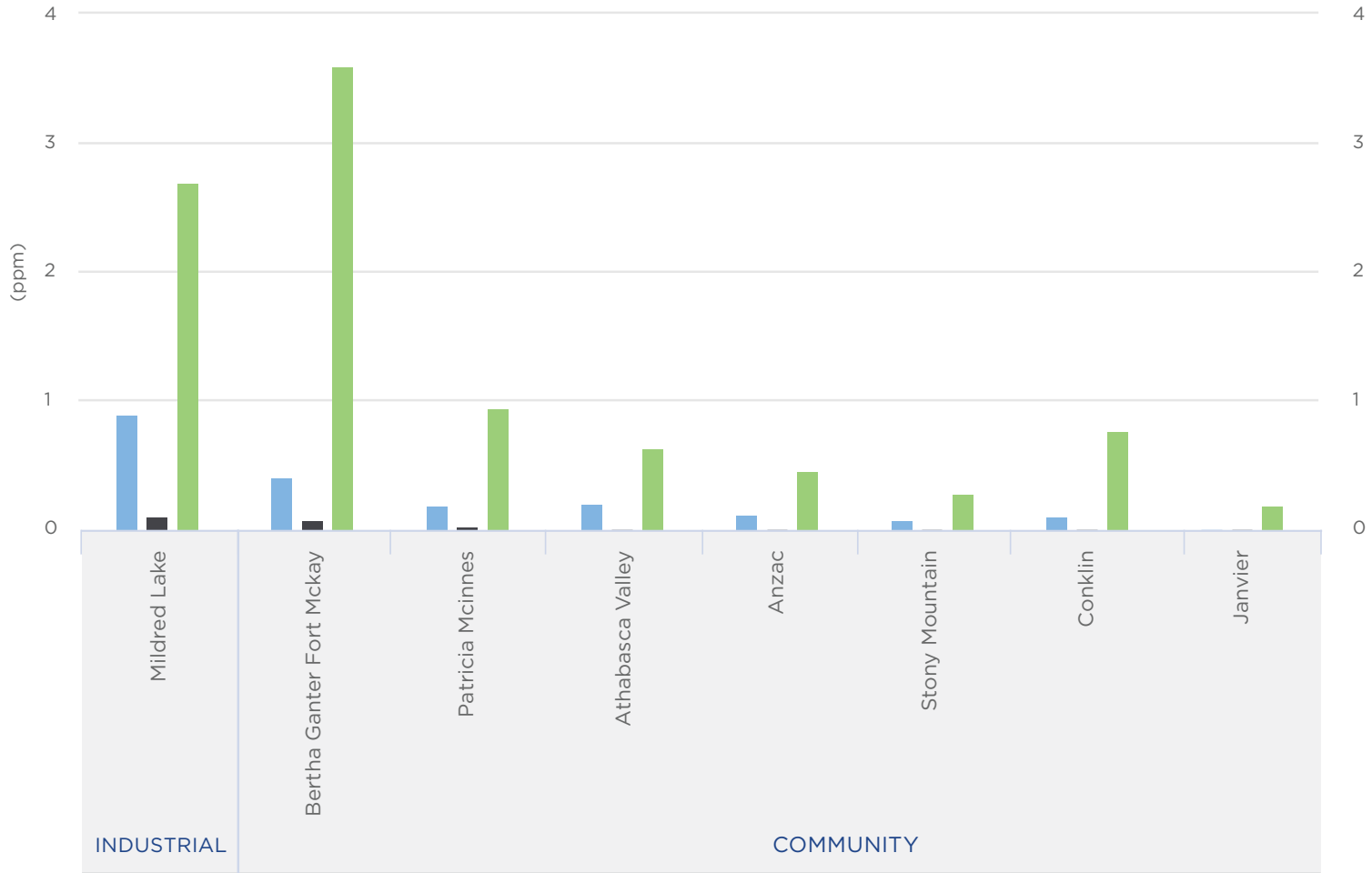


	Mildred Lake	Buffalo Viewpoint	Mannix	Barge Landing	Lower Camp	Fort McKay South	Horizon	Wapasu	Firebag	MacKay River	Fort Hills	Surmont	Surmont 2	Kirby South	Kirby North	Bertha Ganter Fort Mckay	Patricia Mcinnes	Athabasca Valley	Anzac	Stony Mountain	Conklin	Janvier
99th Percentile	4.2	3.0	3.3	3.3	3.2	3.5	6.7	2.5	2.5	2.6	4.8	2.8	2.5	3.7	2.6	3.1	2.5	2.6	2.3	2.2	2.6	2.2
Average	2.4	2.0	2.1	2.2	2.2	2.3	2.6	2.1	2.1	2.2	2.3	2.2	2.1	2.4	2.3	2.1	2.0	2.0	2.0	2.0	2.0	2.0
Max	17.0	6.1	7.0	6.2	5.7	5.3	22.0	3.4	5.5	3.3	9.8	3.1	3.0	5.8	44.0	5.9	3.2	4.8	2.9	2.6	4.1	2.5

Note: THC does not currently have an AAAQO.

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.

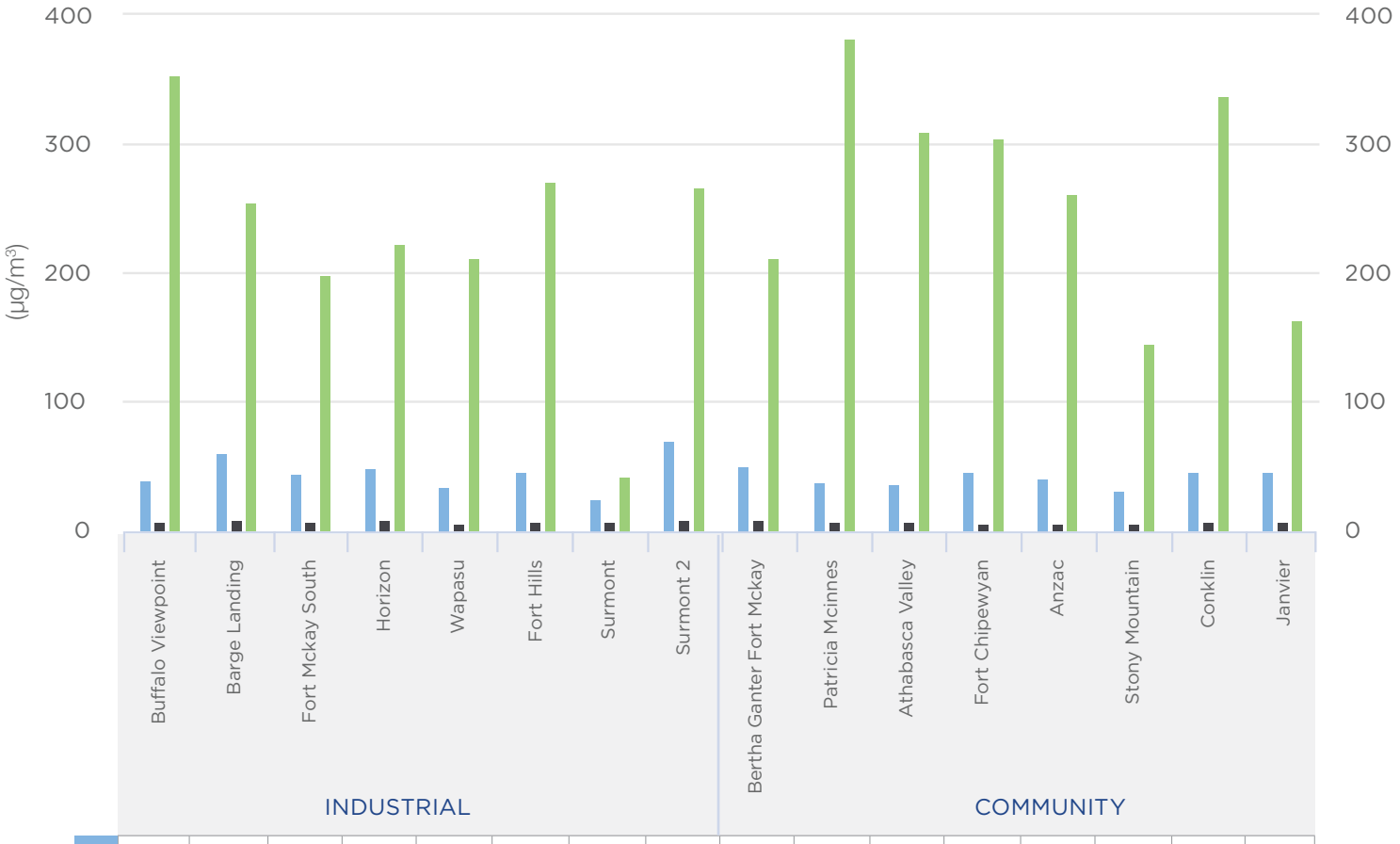


	Mildred Lake	Bertha Ganter Fort Mckay	Patricia Mcinnes	Athabasca Valley	Anzac	Stony Mountain	Conklin	Janvier
99th Percentile	0.9	0.4	0.2	0.2	0.1	0.1	0.1	0.0
Average	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Max	2.7	3.6	0.9	0.6	0.5	0.3	0.8	0.2

Note: NMHC does not currently have an AAAQO.

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 2019, all 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.

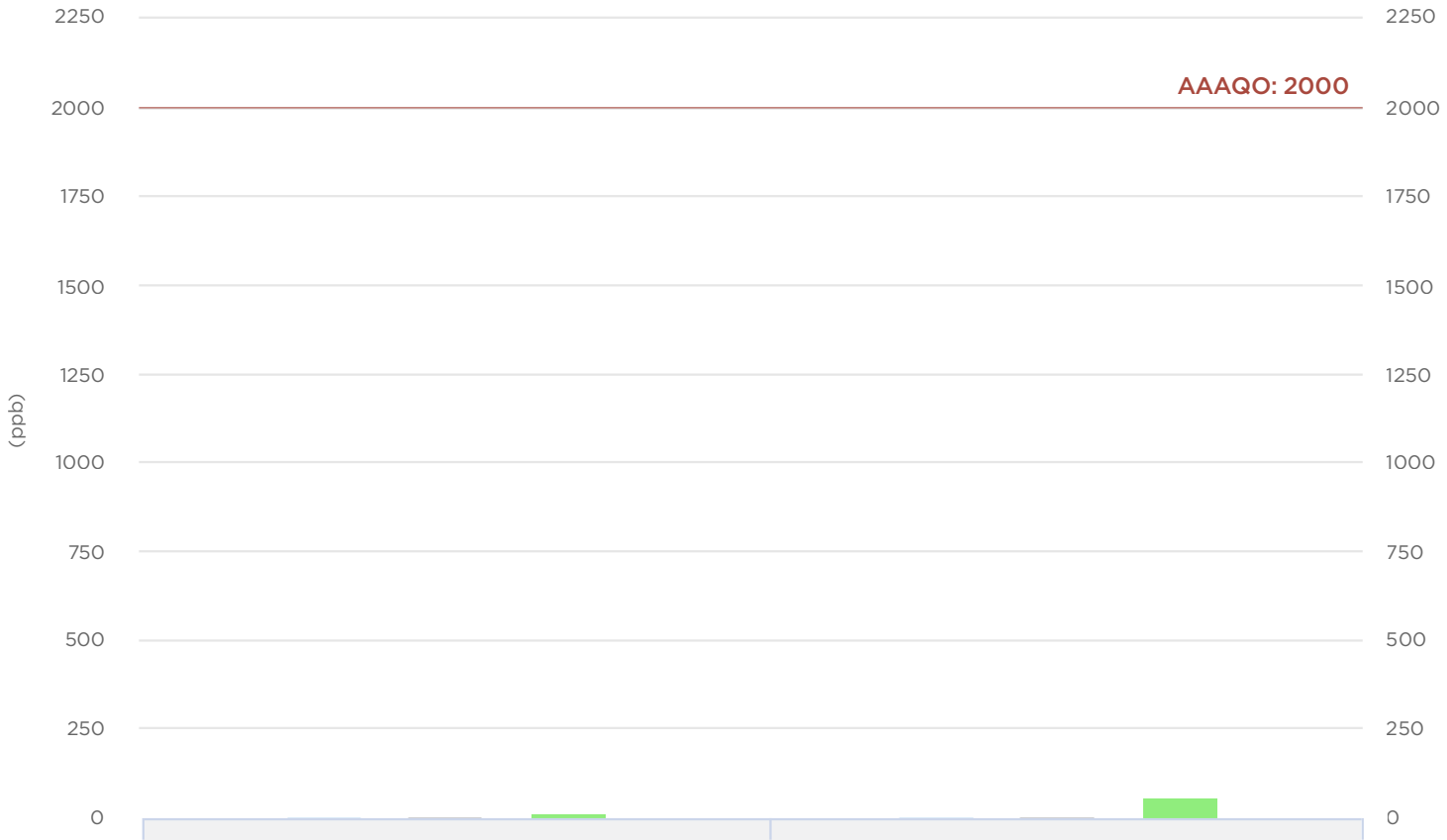


	Buffalo Viewpoint	Barge Landing	Fort Mckay South	Horizon	Wapasu	Fort Hills	Surmont	Surmont 2	Bertha Ganter Fort Mckay	Patricia Mcinnes	Athabasca Valley	Fort Chipewyan	Anzac	Stony Mountain	Conklin	Janvier
99th Percentile	39.5	59.3	42.8	47.8	33.3	45.4	23.5	69.0	50.2	37.2	35.6	45.0	40.0	30.3	44.4	44.6
Average	5.8	8.4	6.9	7.4	4.9	7.1	5.8	7.9	8.2	6.6	6.1	5.2	5.3	5.2	6.2	5.8
Max	353.2	254.6	198.1	223.1	210.8	270.8	41.5	266.4	211.9	382.7	309.5	305.5	261.1	145.1	337.7	163.1

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.

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	0.1
Max	12.2	54.3
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**, and can be searched using the tool found at **wbea.org/network-and-data/integrated-data-search**. 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 2019.

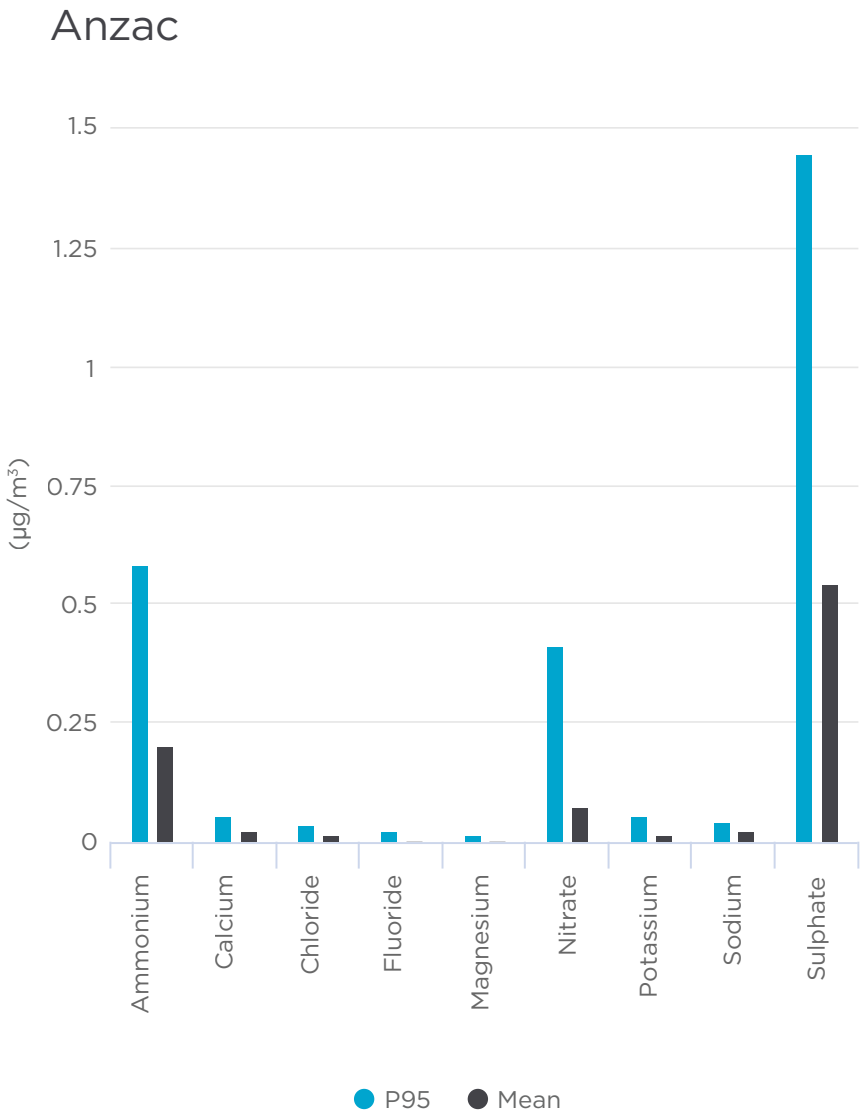
*Note: to view exact data points, visit **wbea.org/2019-annual-report***

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

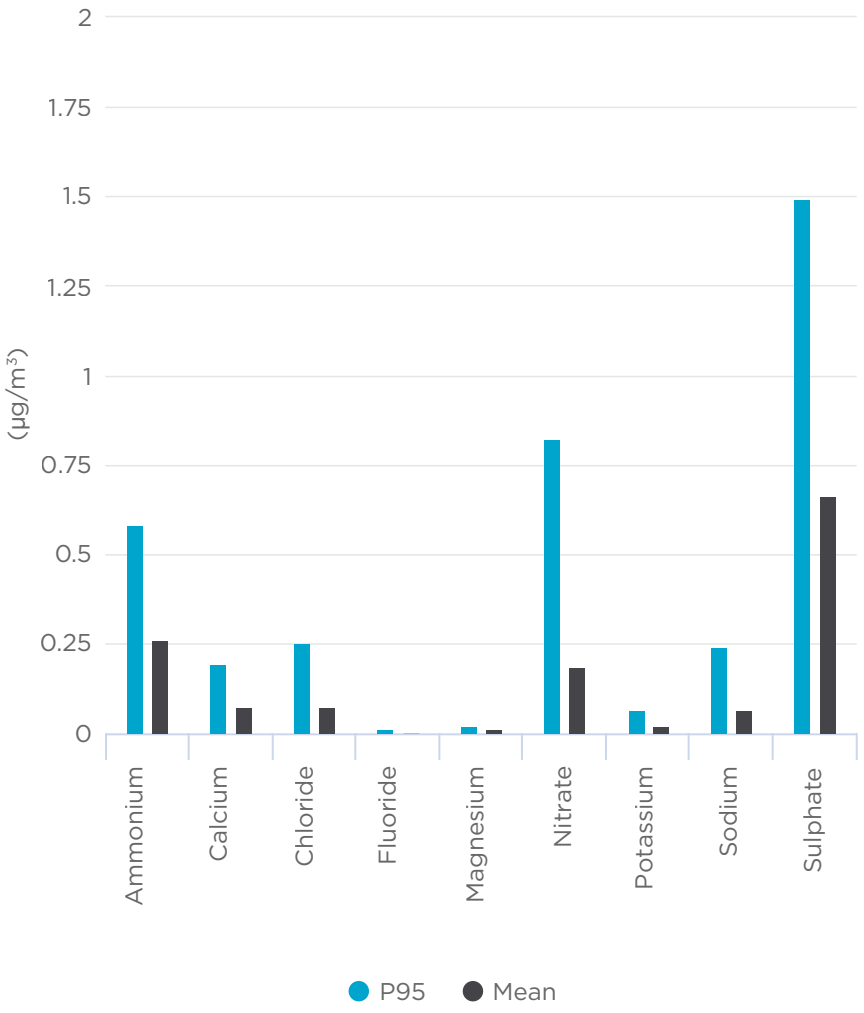
Particulate matter ($PM_{2.5}$ PM_{10}) consists of a mixture of solid particles and liquid droplets found in the air. Fine particulate matter ($PM_{2.5}$) is 2.5 µm in diameter or less, while coarse particulate matter (PM_{10}) is 10 µm in diameter or less.

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.

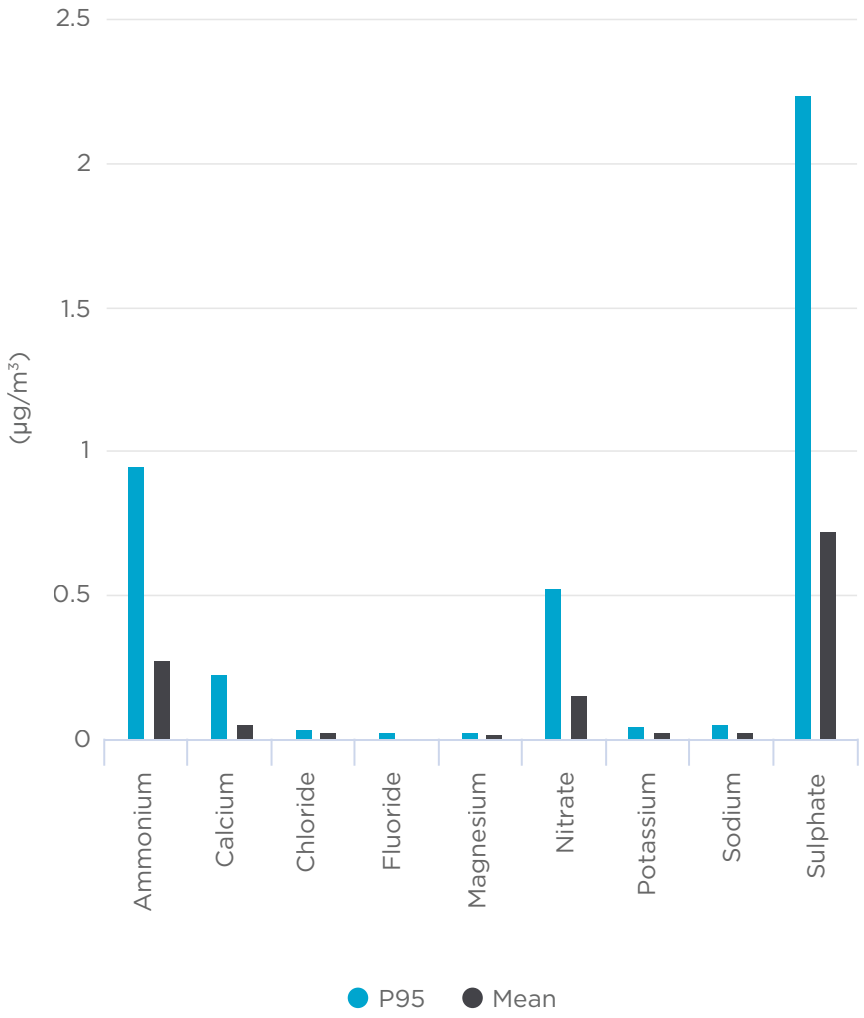
The continuous analyzer can tell us the concentration of particulate matter in the air at any given time, while a sample can tell us what is making up the particulate matter in the air.



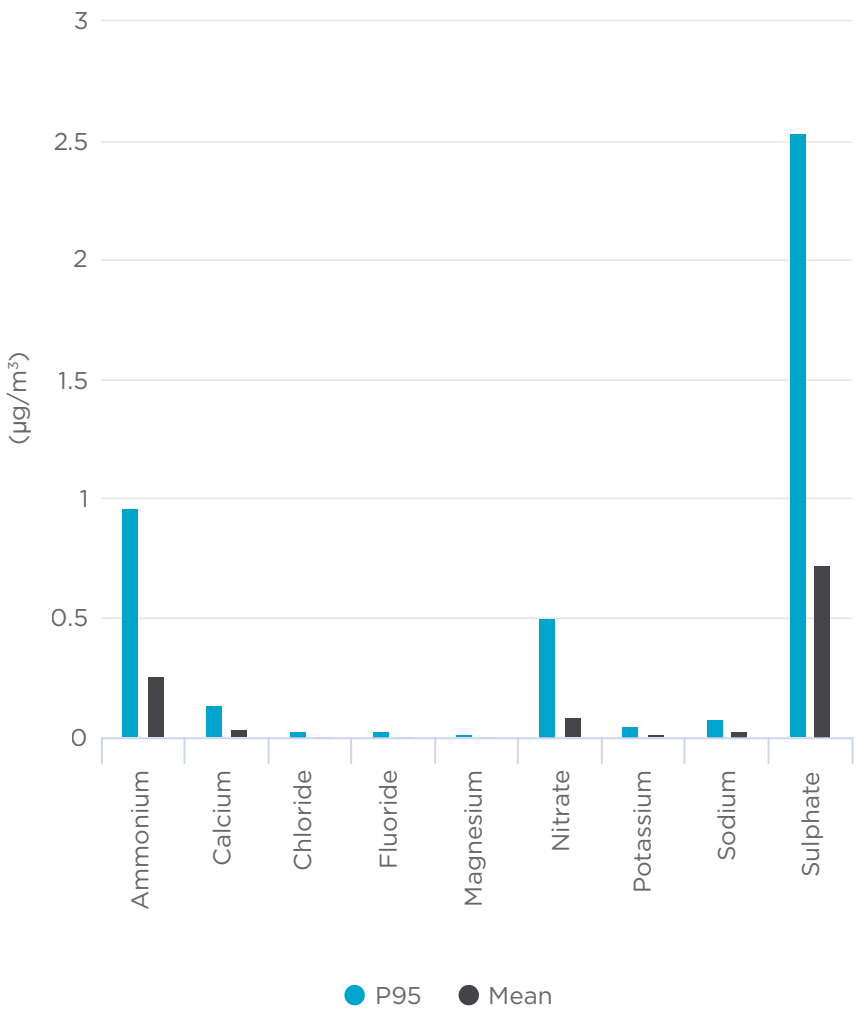
Athabasca Valley



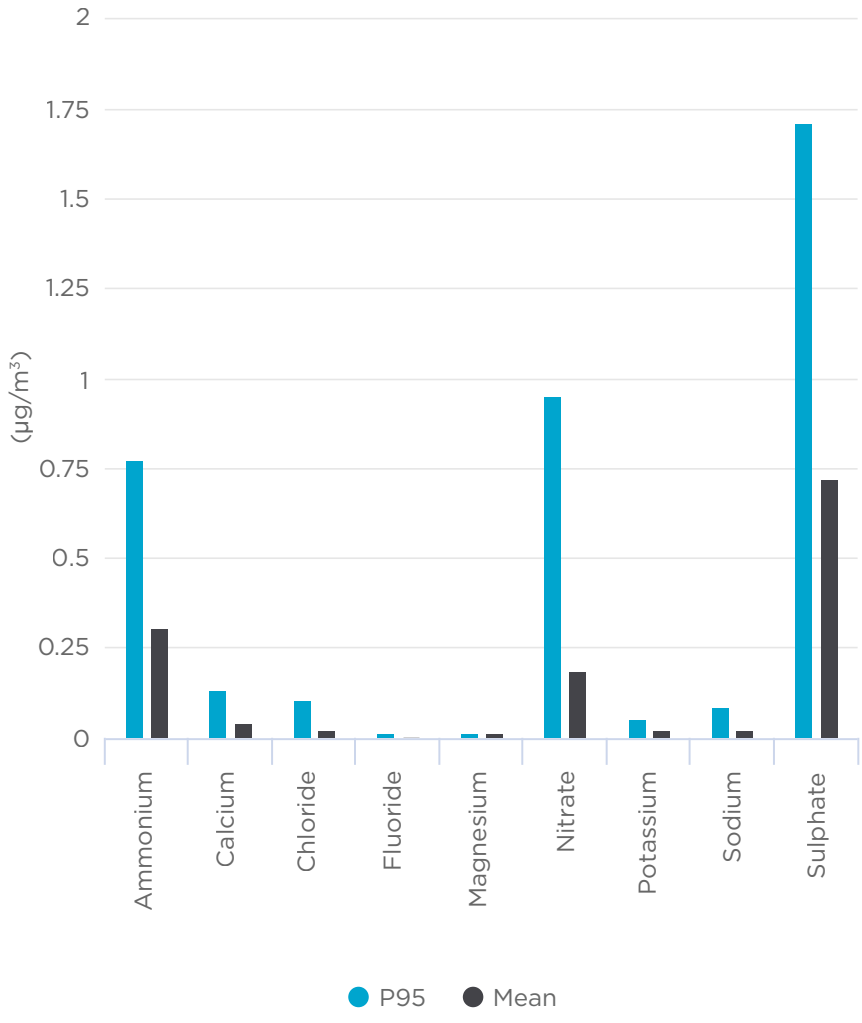
Bertha Ganter - Fort McKay



Horizon

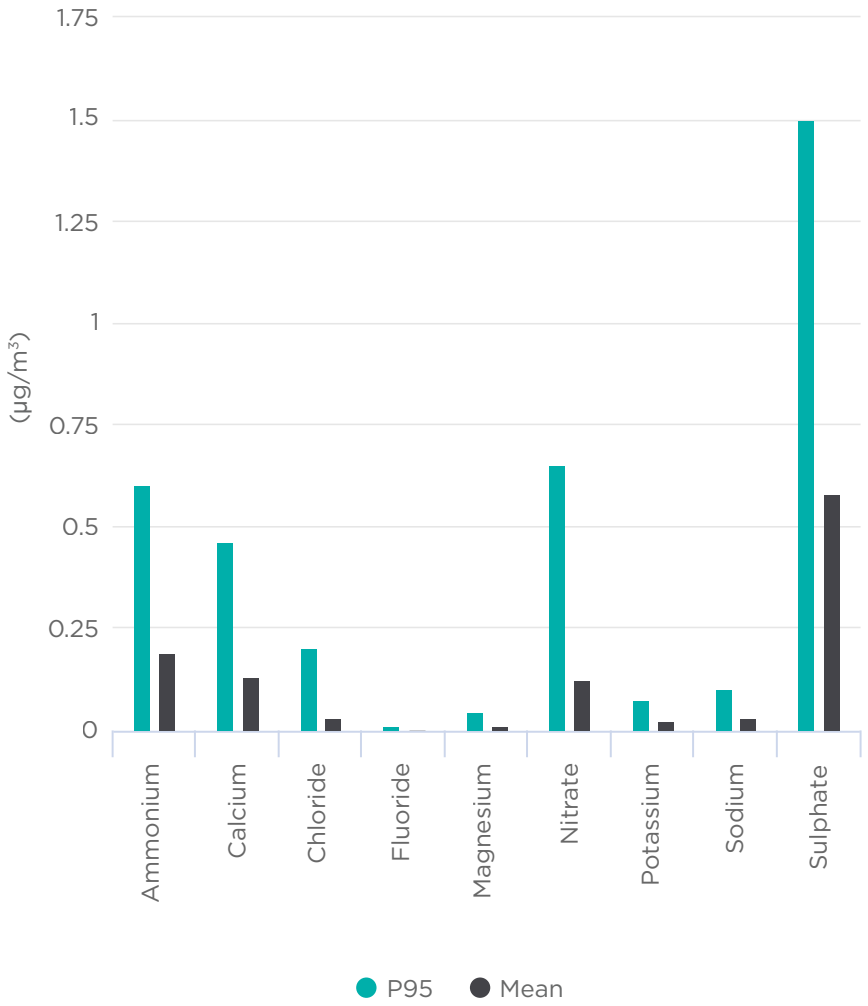


Patricia McInnes

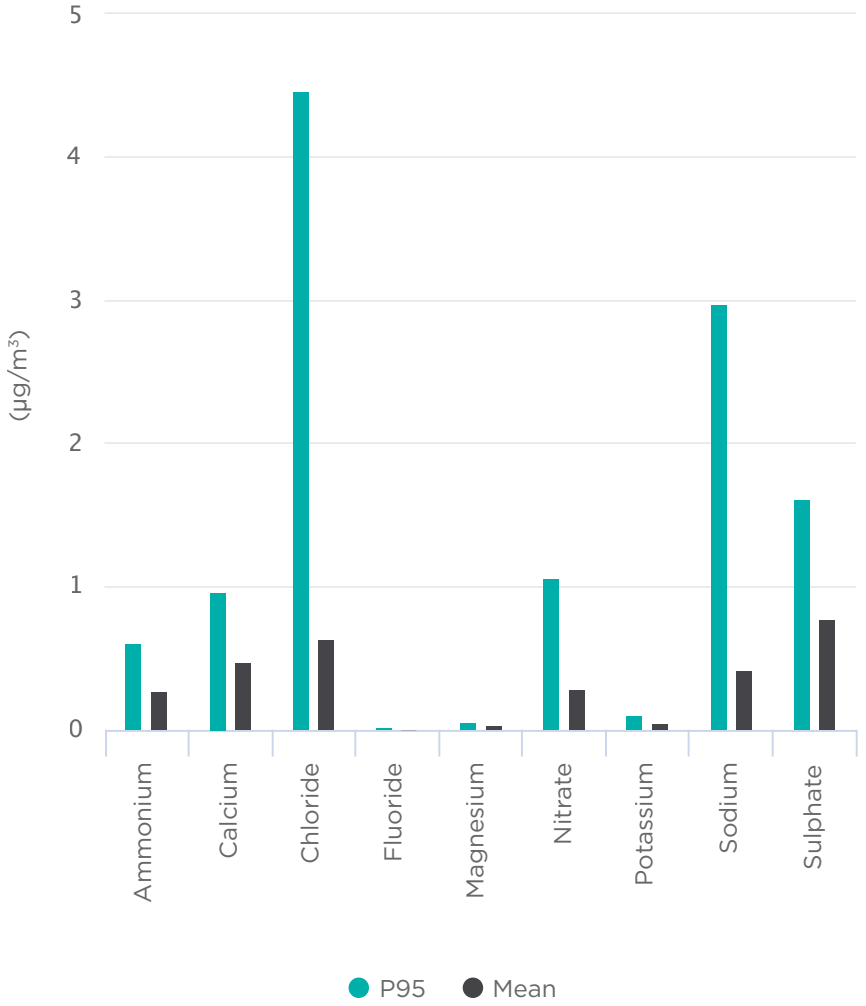


Particulate Matter 10 (PM_{10}) Ions

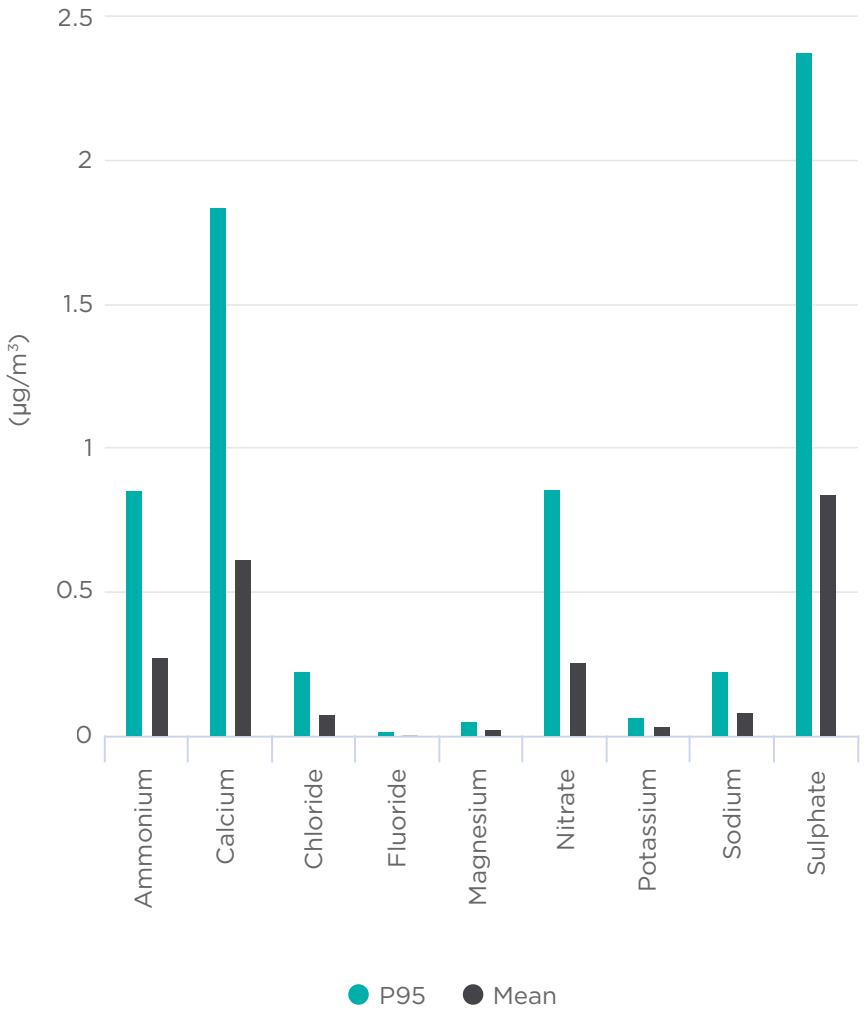
Anzac



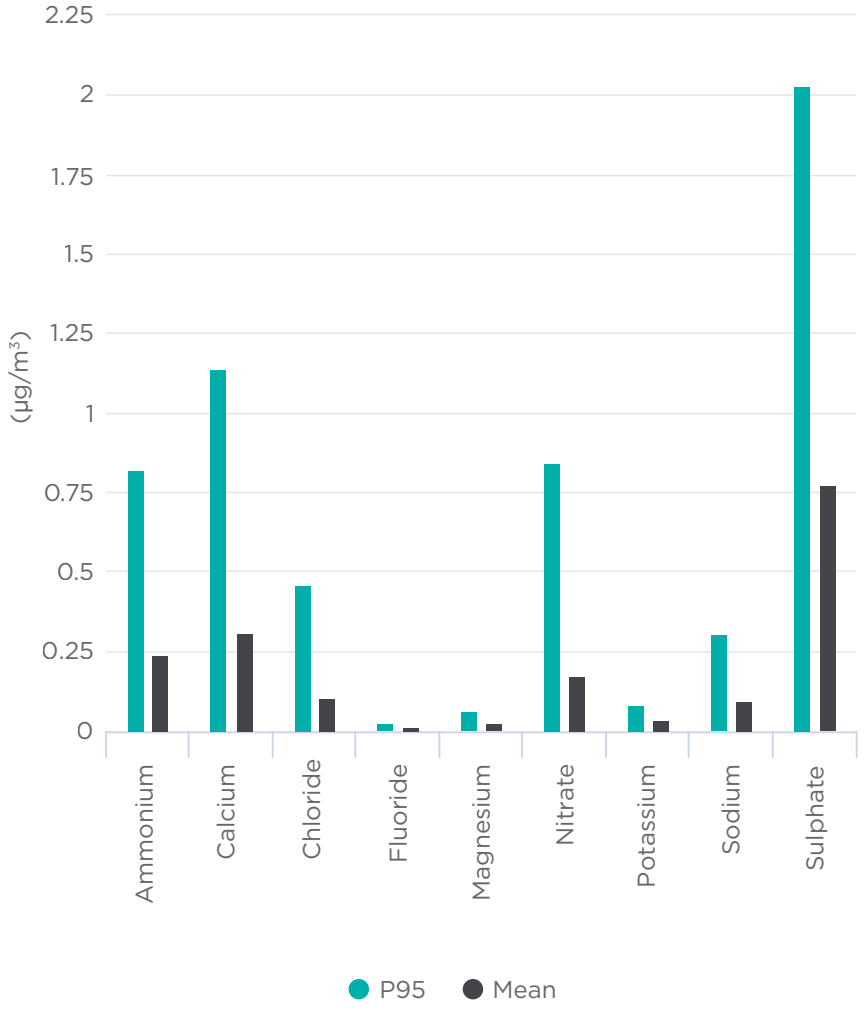
Athabasca Valley



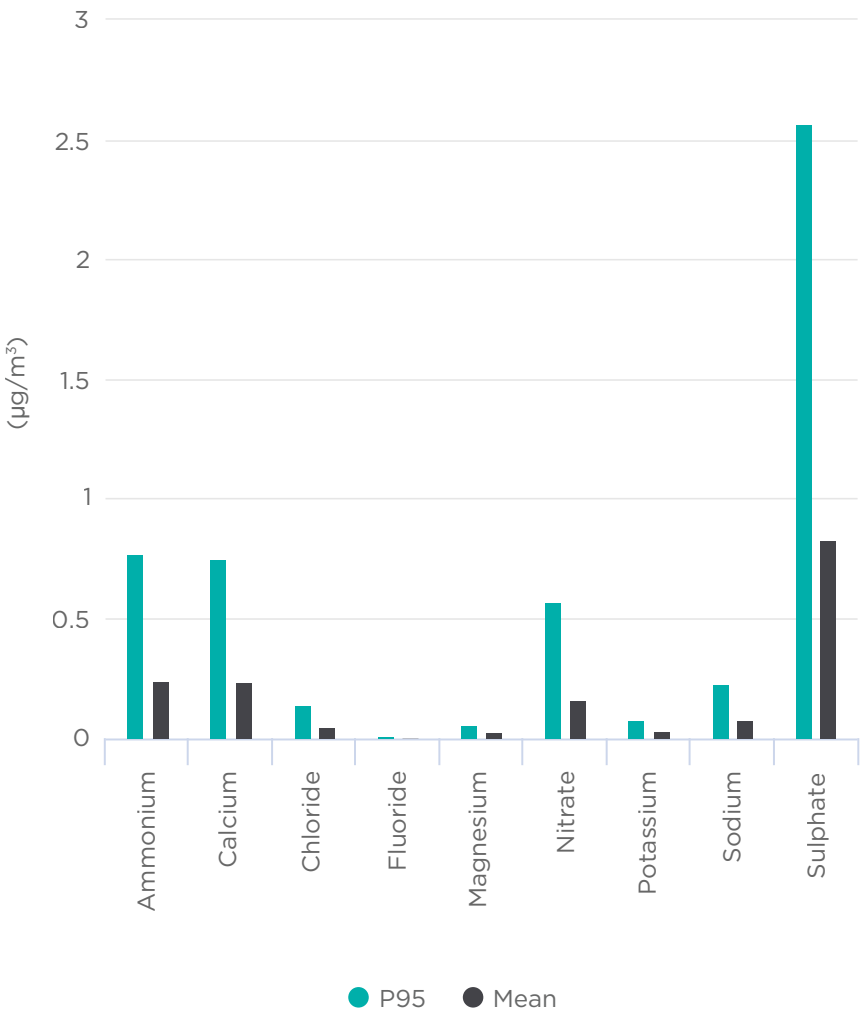
Bertha Ganter - Fort McKay



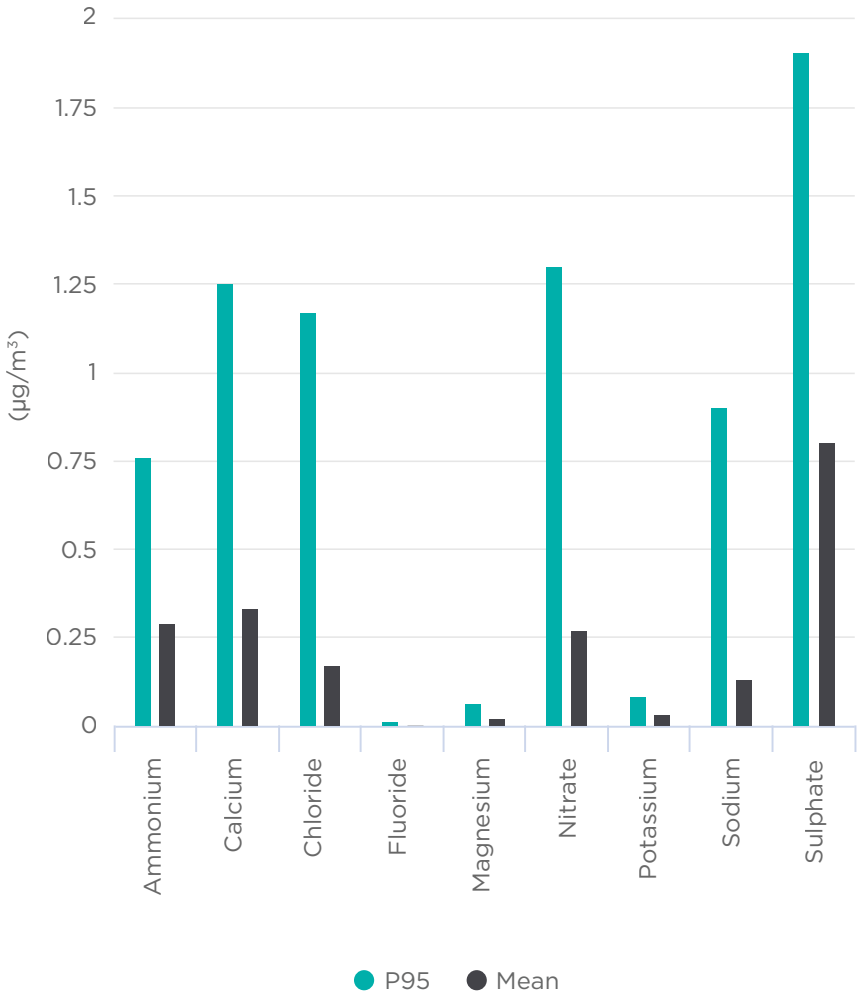
Fort McKay South



Horizon

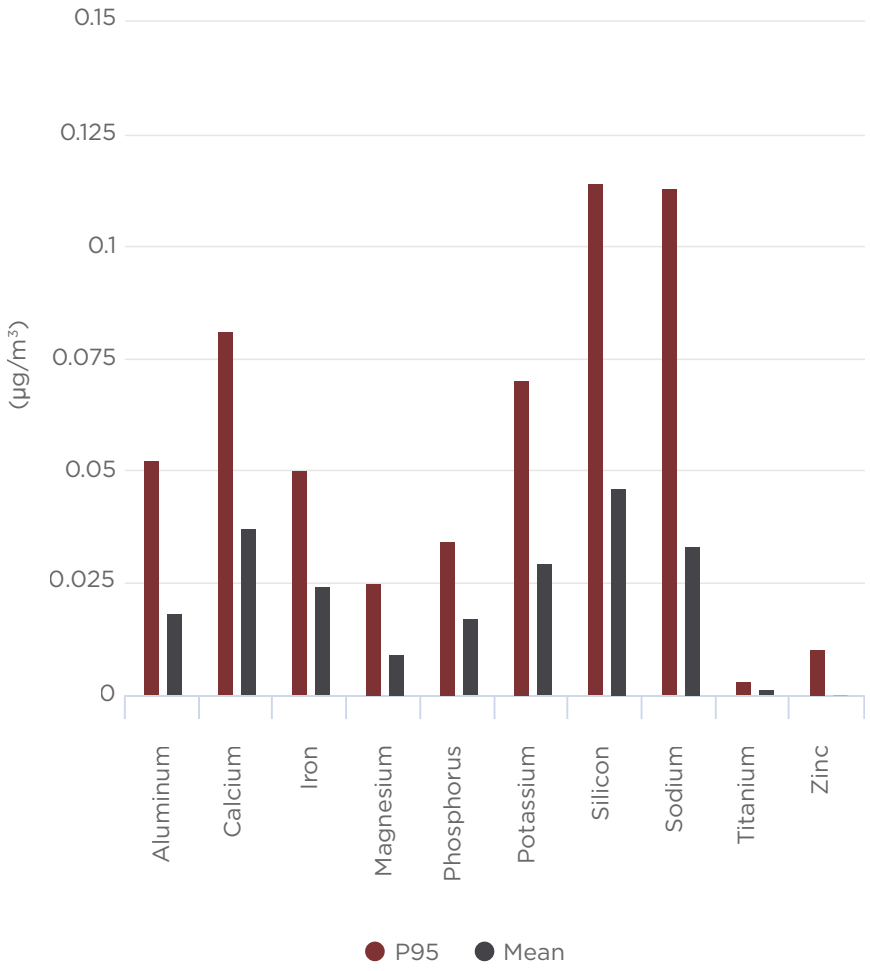


Patricia McInnes

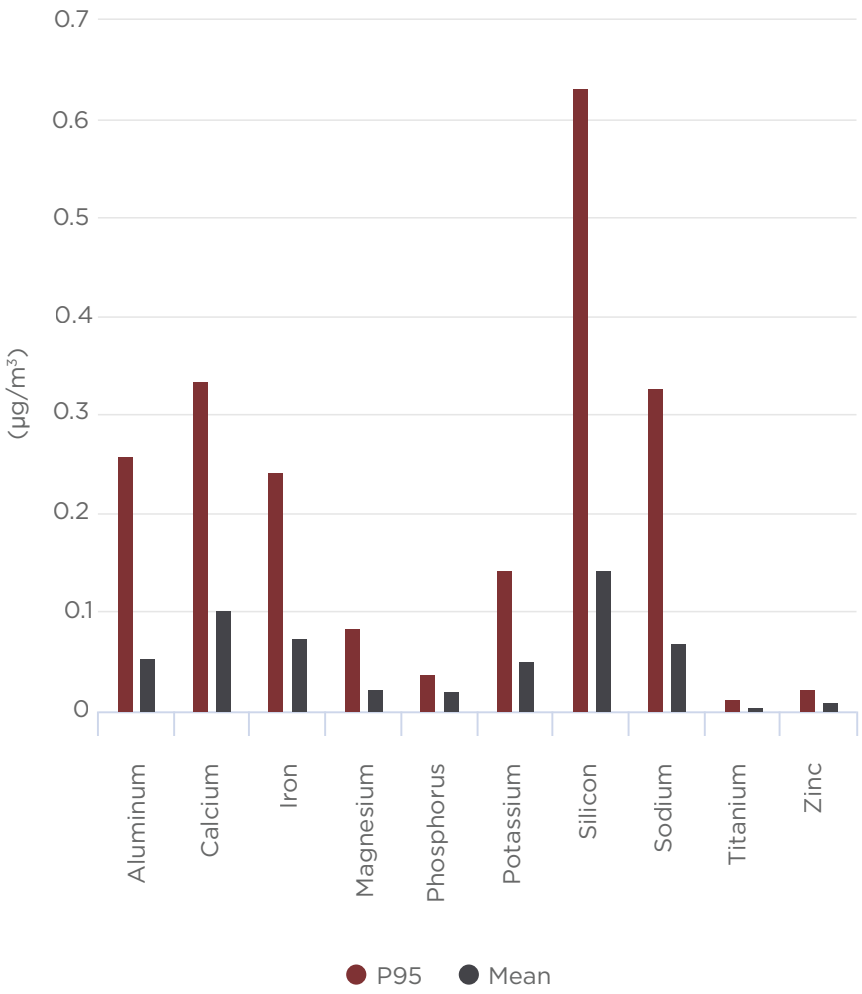


Particulate Matter 2.5 ($PM_{2.5}$) Metals

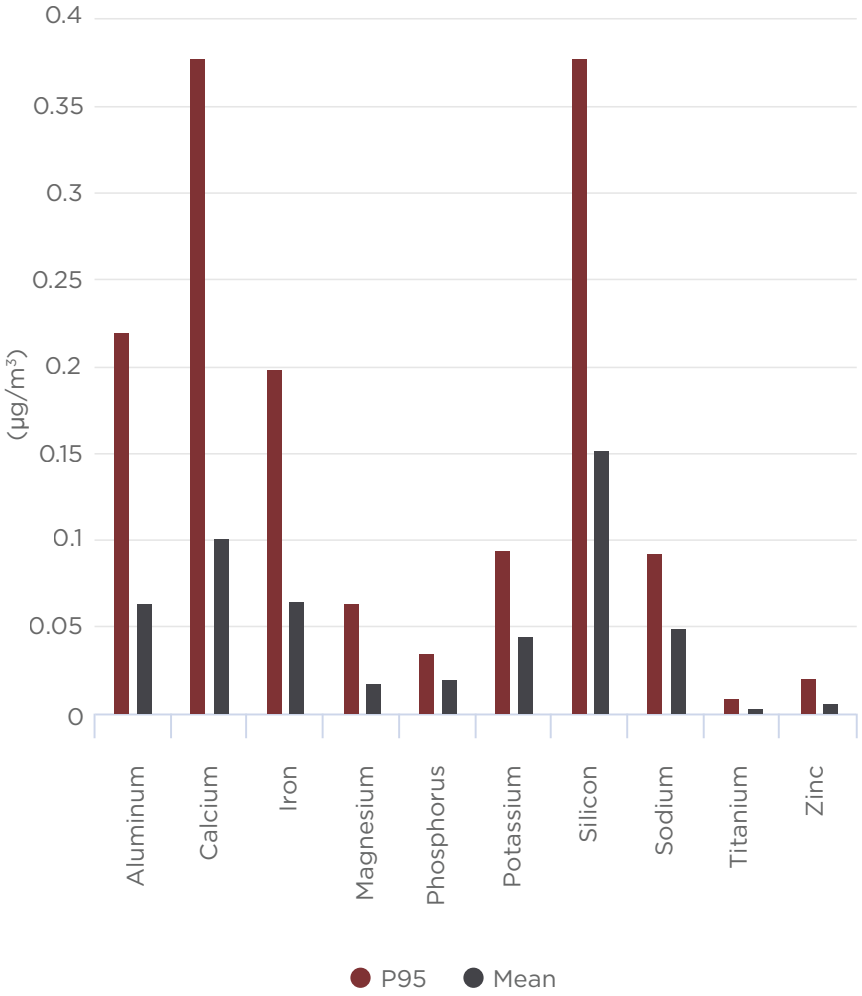
Anzac



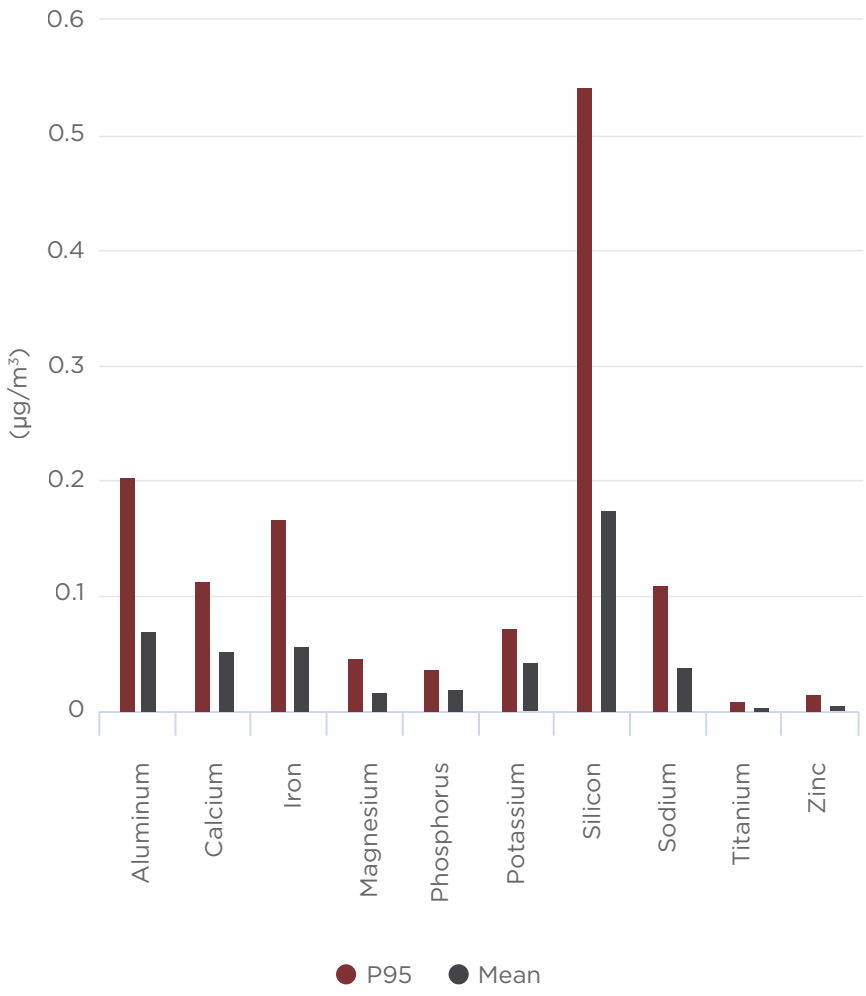
Athabasca Valley



Bertha Ganter - Fort McKay

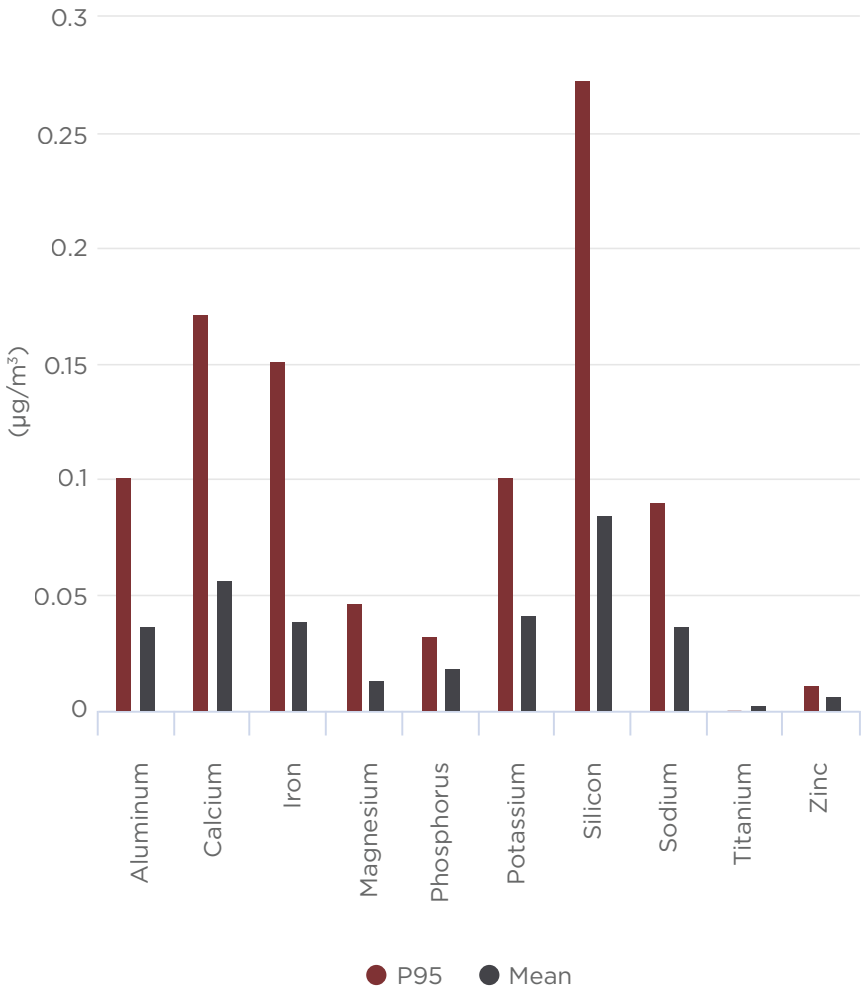


Horizon

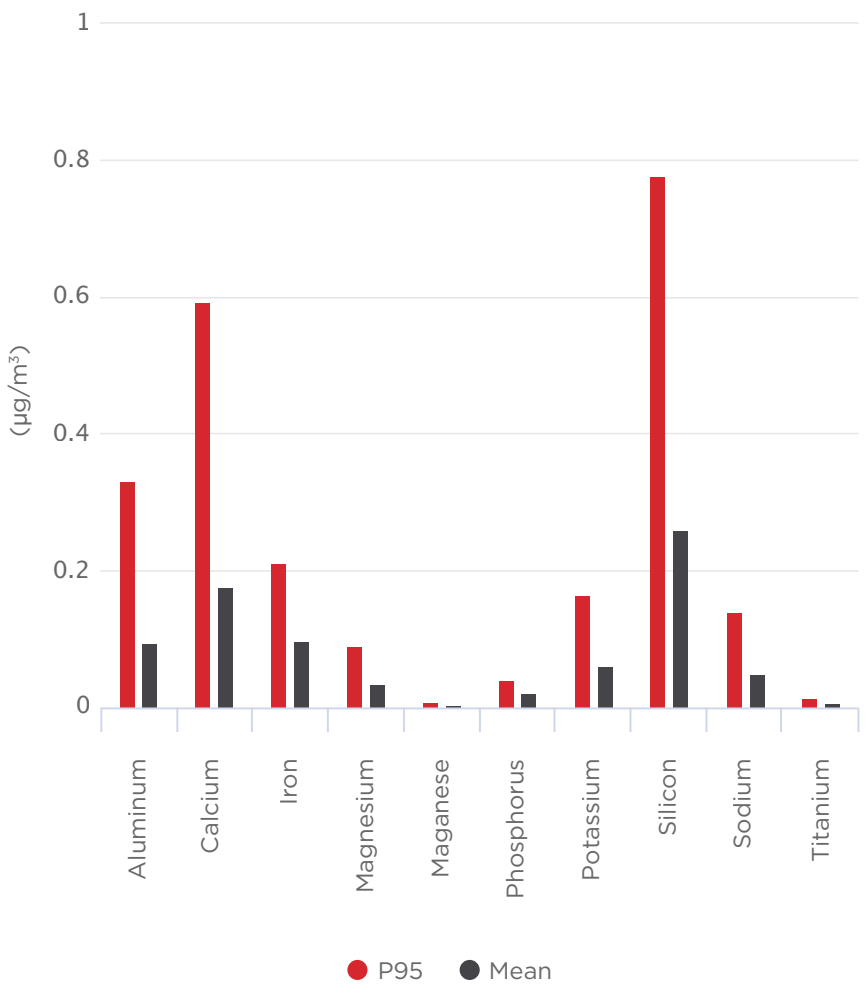


Particulate Matter 10(PM_{10}) Metals

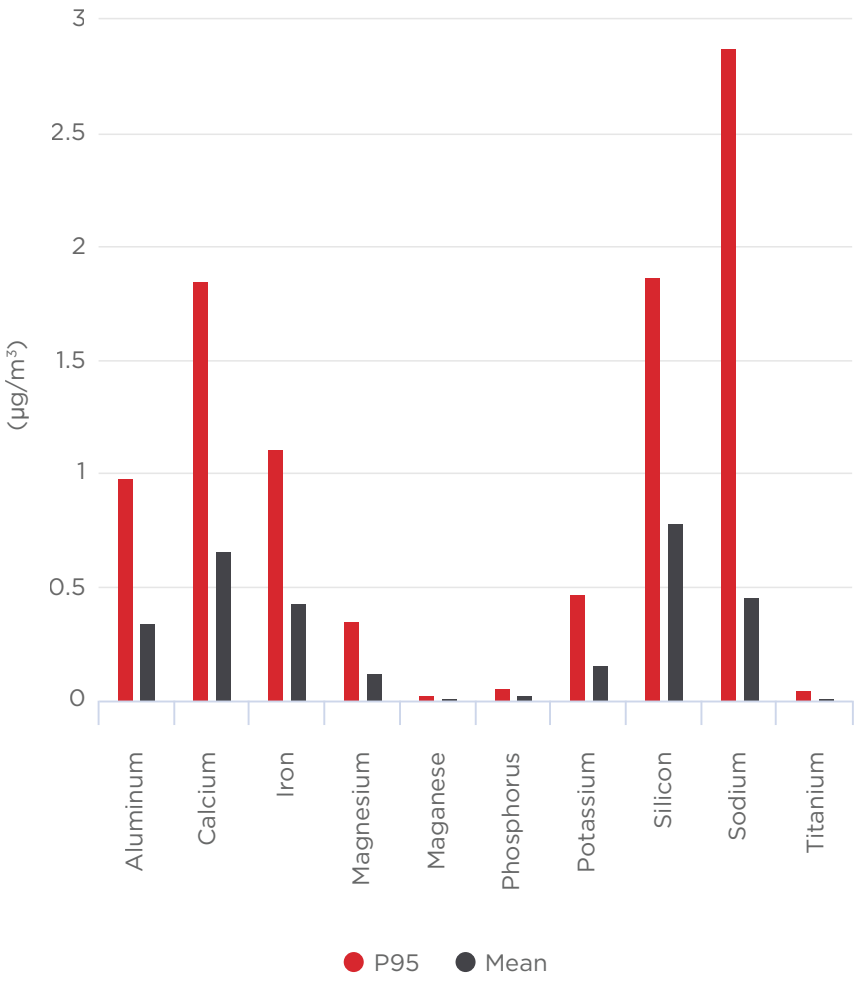
Patricia McInnes



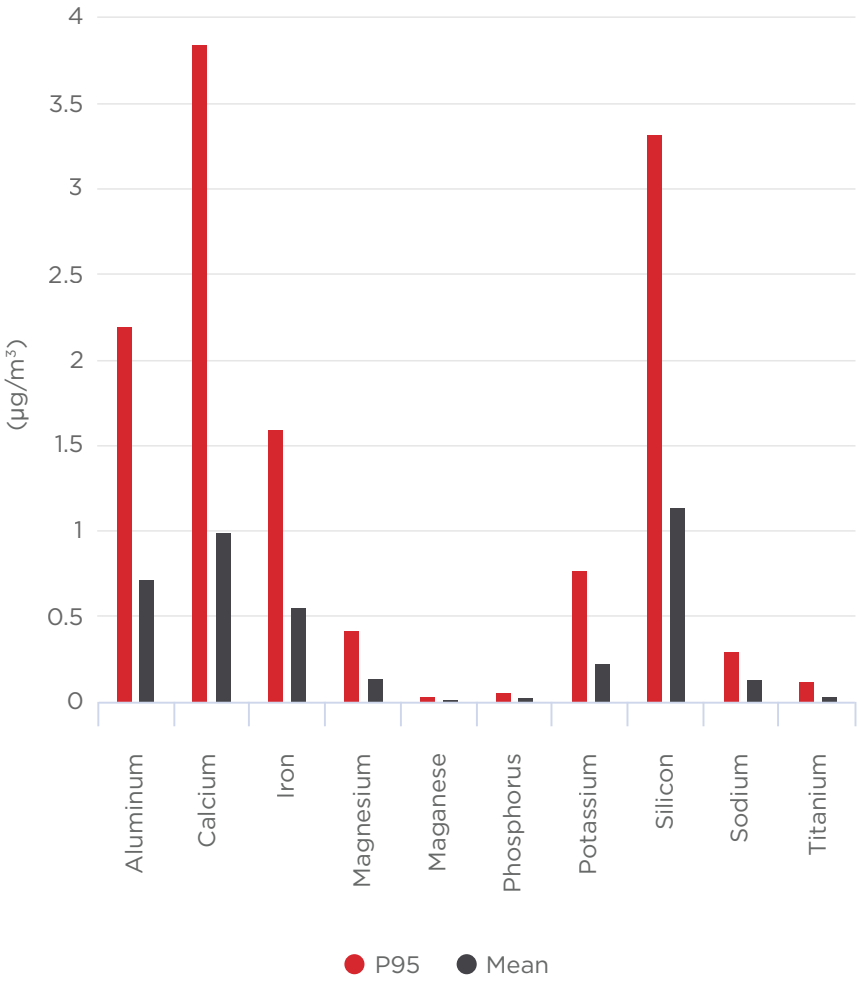
Anzac



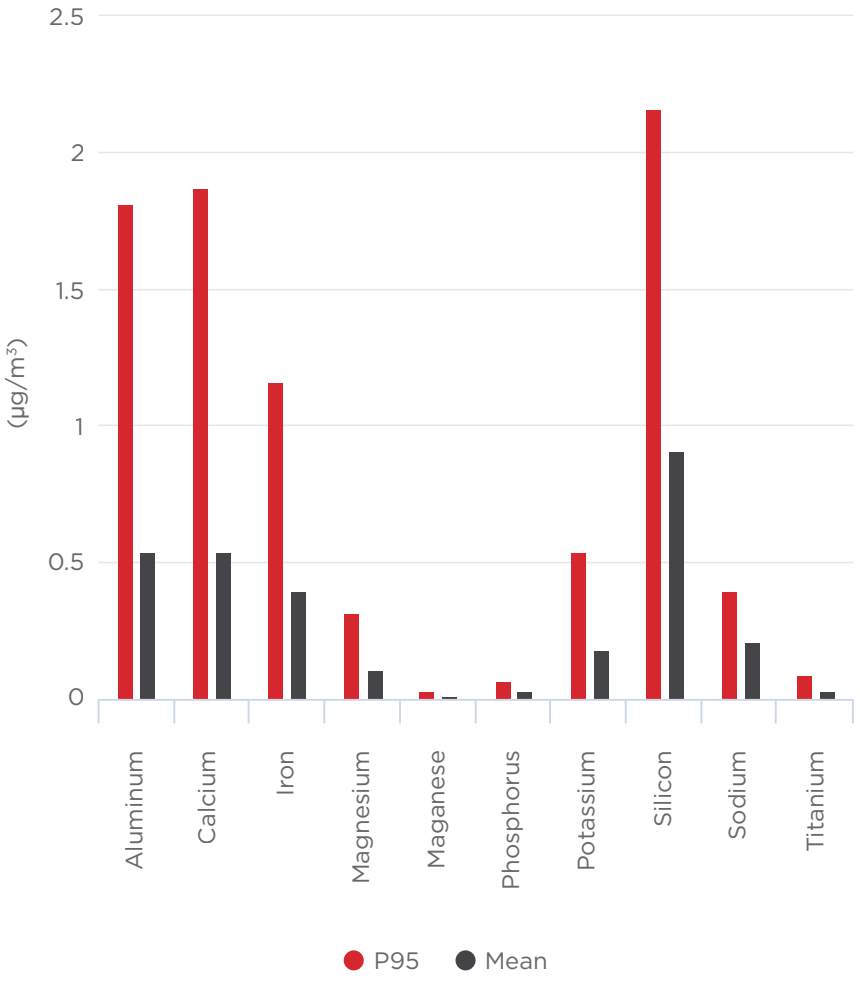
Athabasca Valley



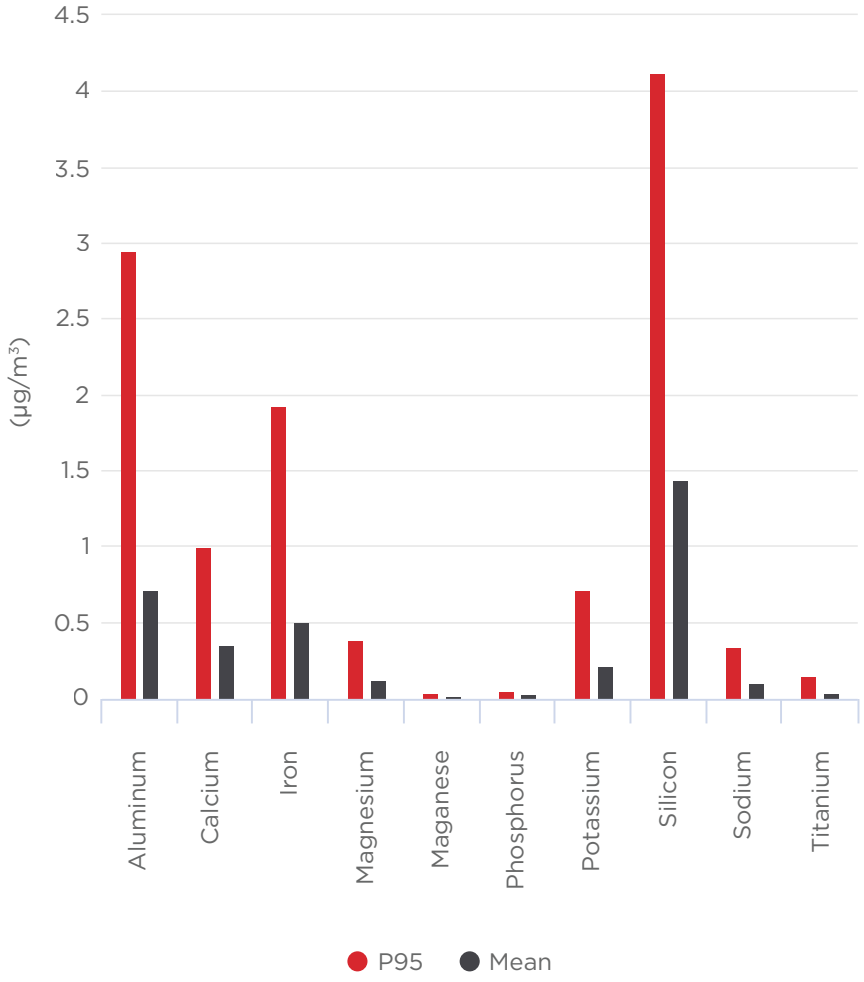
Bertha Ganter - Fort McKay



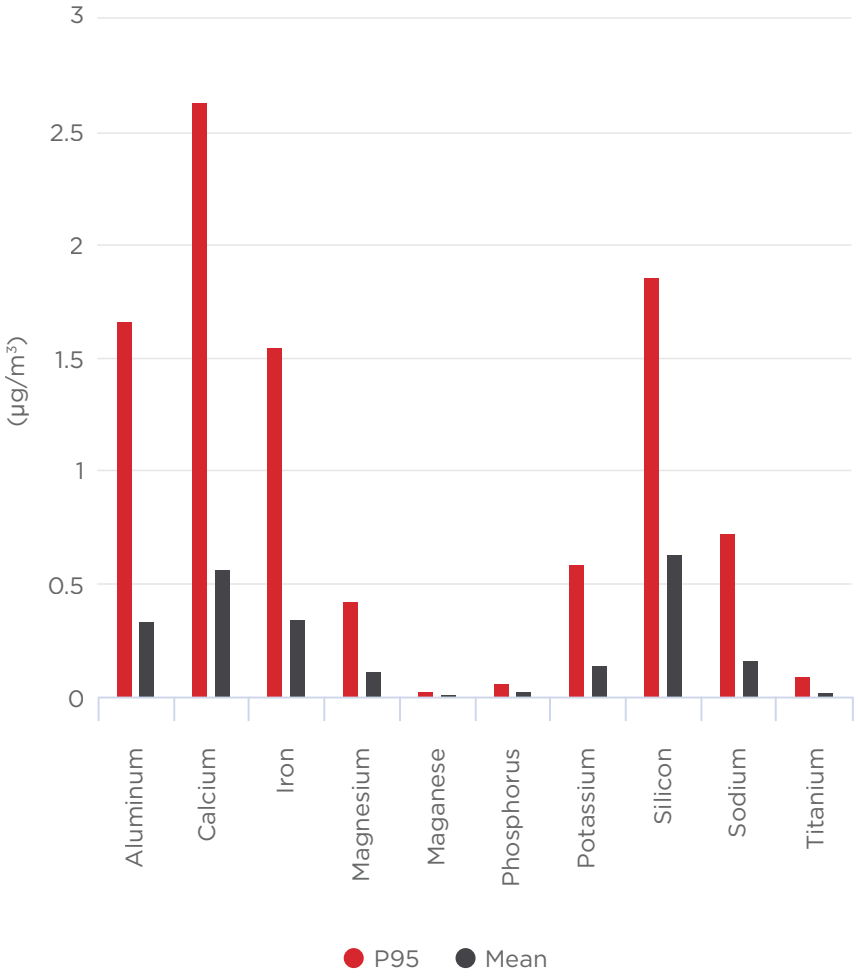
Fort McKay South



Horizon



Patricia McInnes

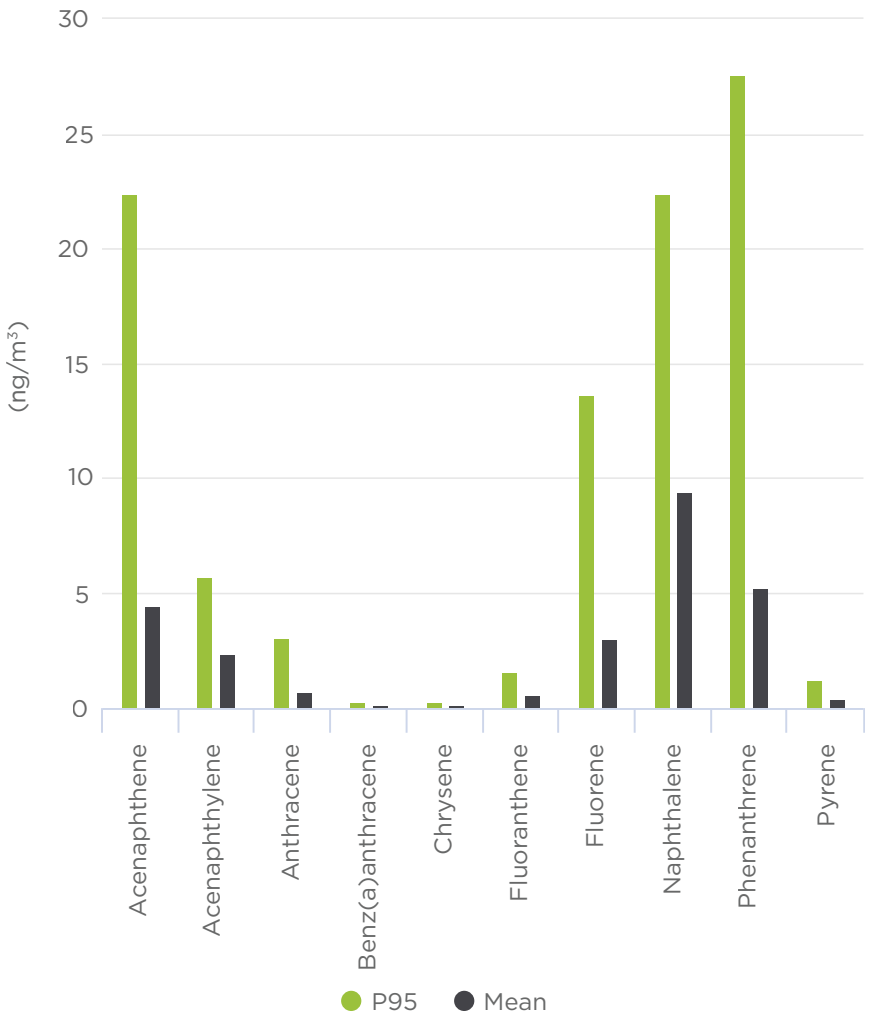


Polycyclic Aromatic Hydracarbons (PAHs)

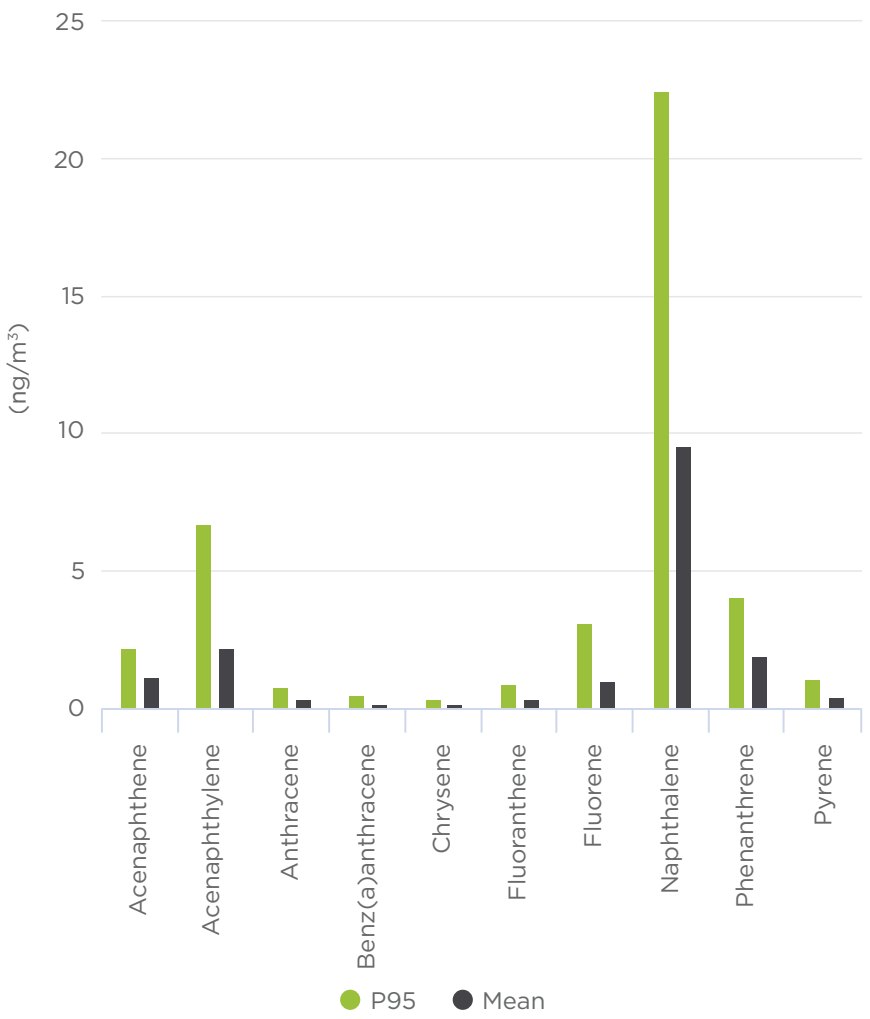
Polycyclic aromatic hydrocarbons (PAHs) are a type of hydrocarbon – an organic compound containing carbon and hydrogen – that are produced from natural sources, such as the incomplete combustion of organic matter, and can be found in oil sand deposits. There are more than 100 different PAHs – some of 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.

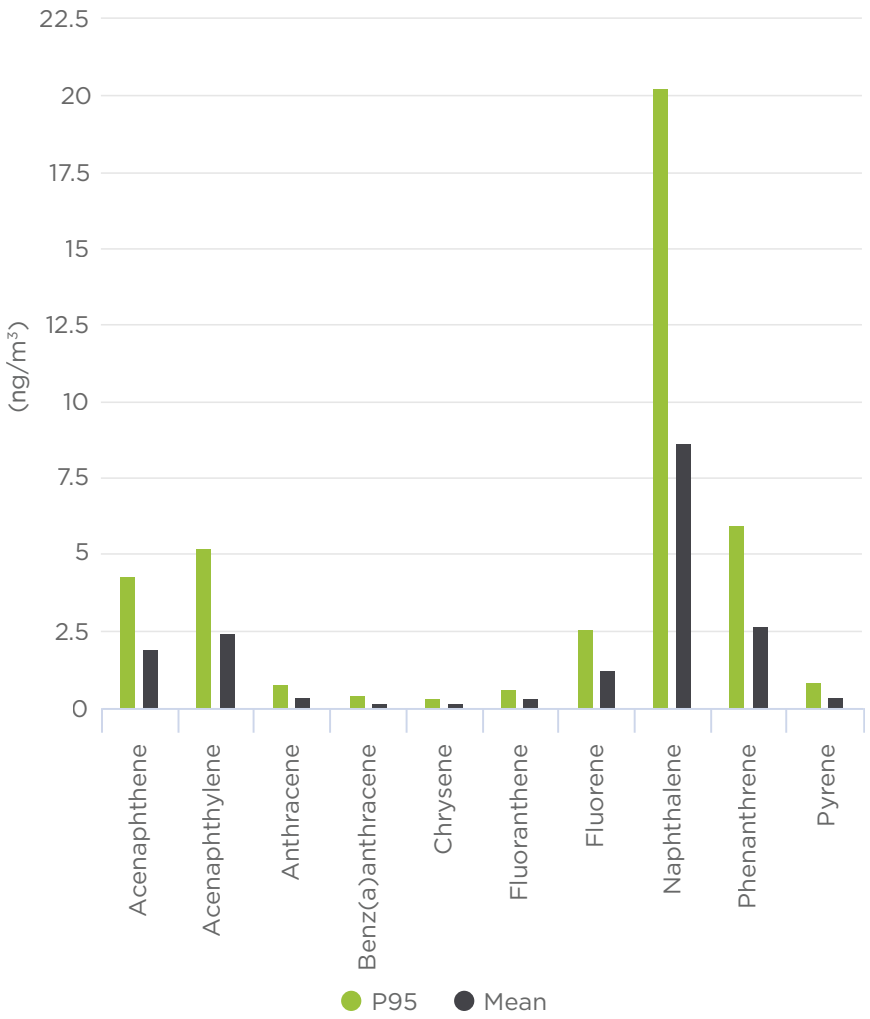
Anzac



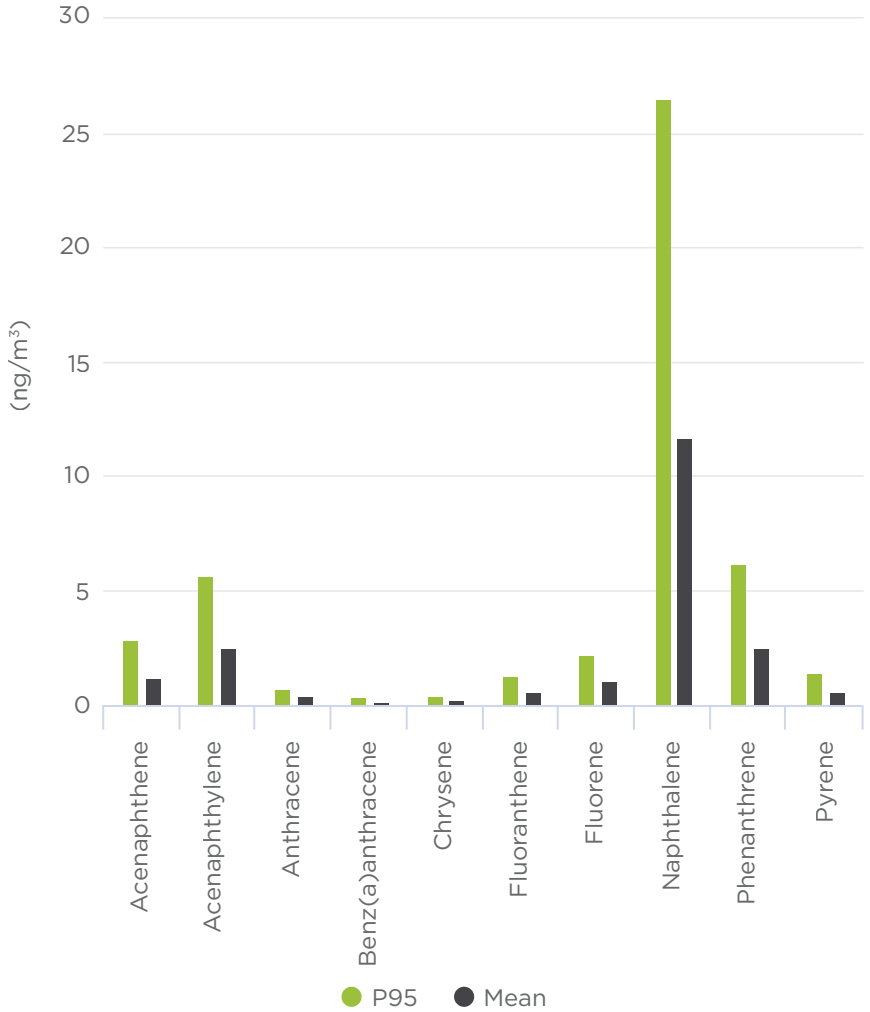
Athabasca Valley



Bertha Ganter - Fort McKay



Patricia McInnes

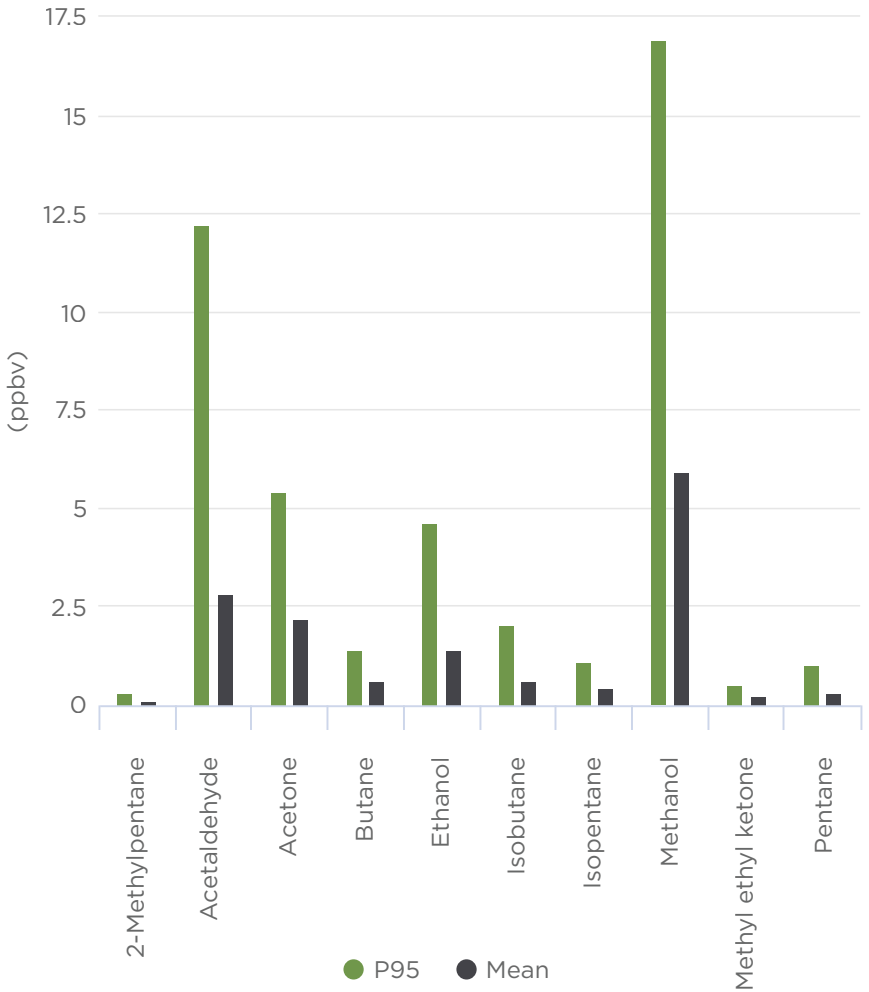


Volatite Organic Compounds (VOCs)

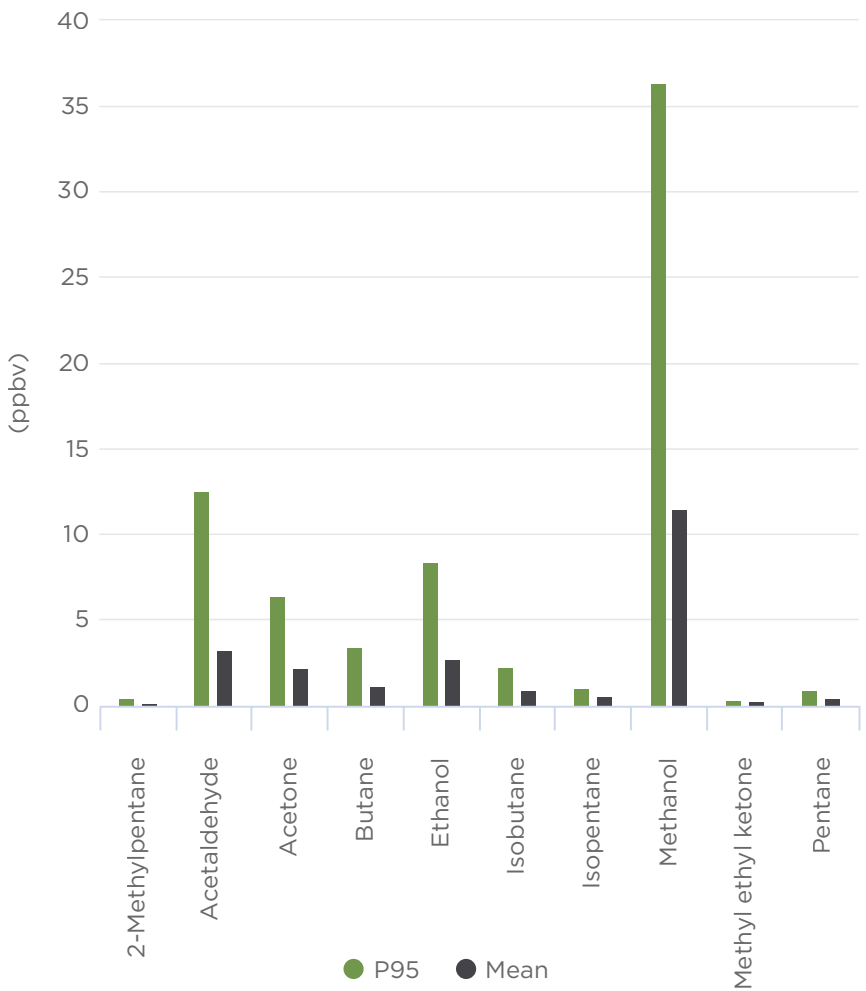
Volatile organic compounds (VOCs) are a group of chemical species that contain carbon, and react easily to become a gas. They may contain additional elements such as hydrogen, oxygen, fluorine, chlorine, bromine, sulphur, or nitrogen. VOCs are numerous, and come from both natural and human sources, and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

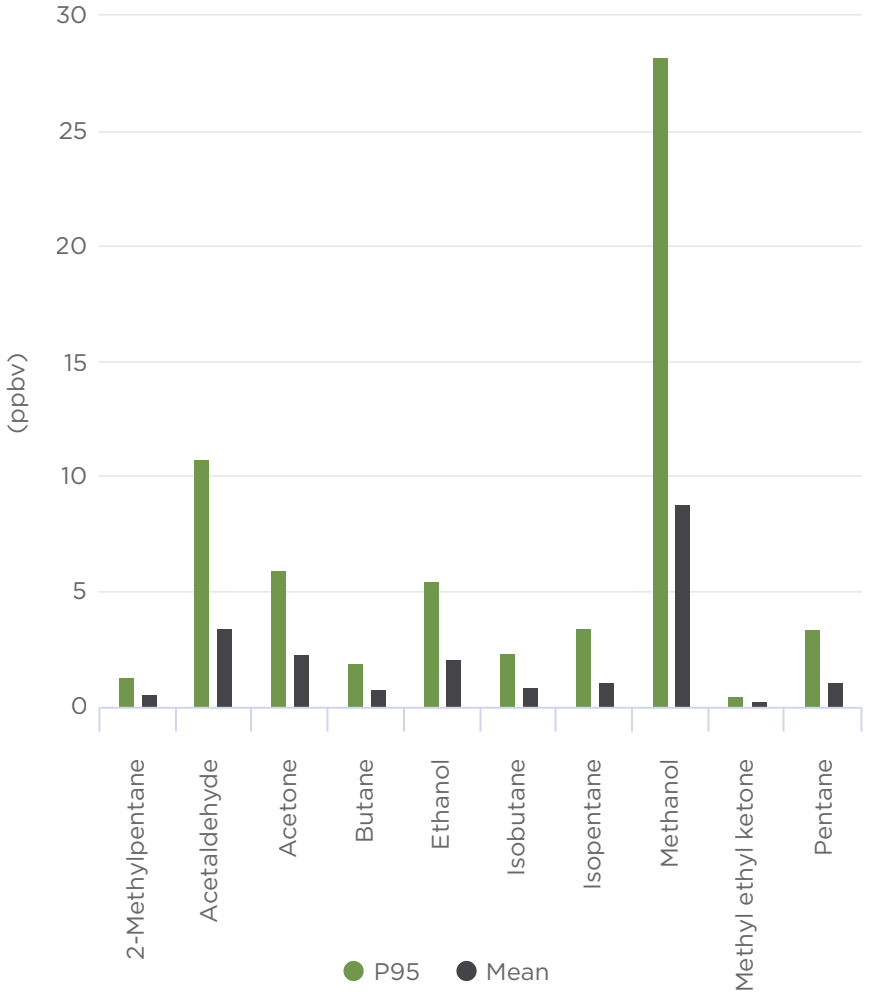
Anzac



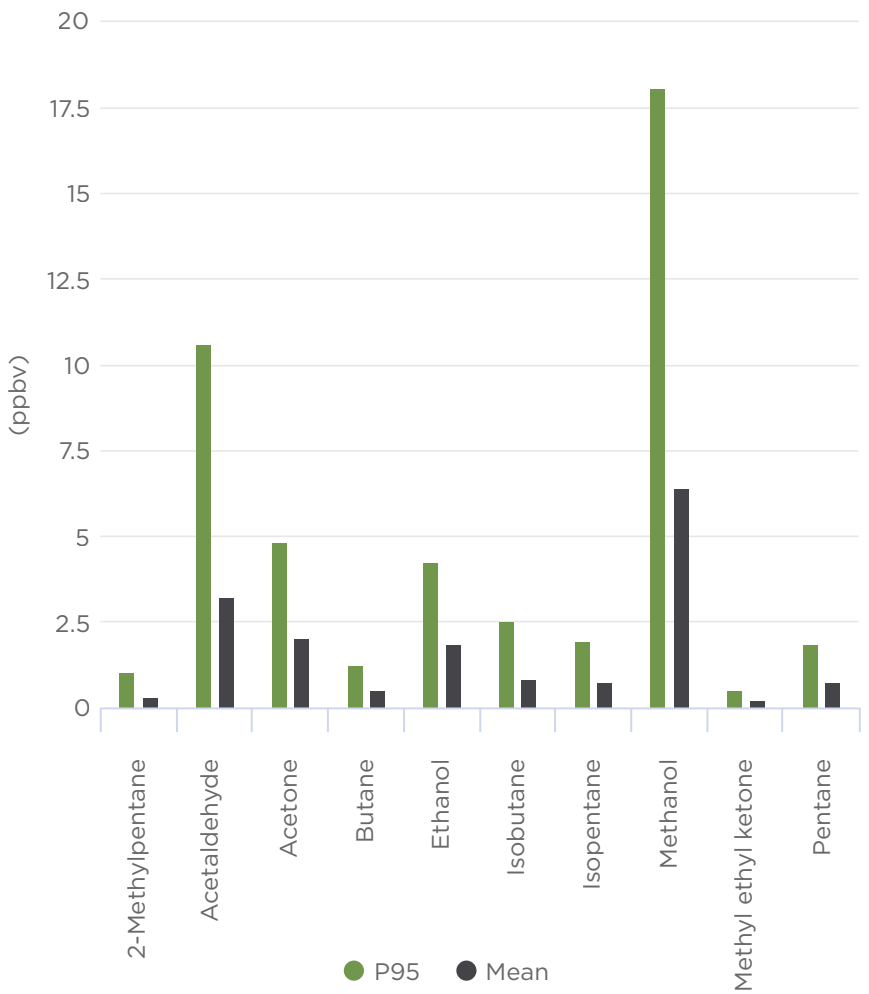
Athabasca Valley



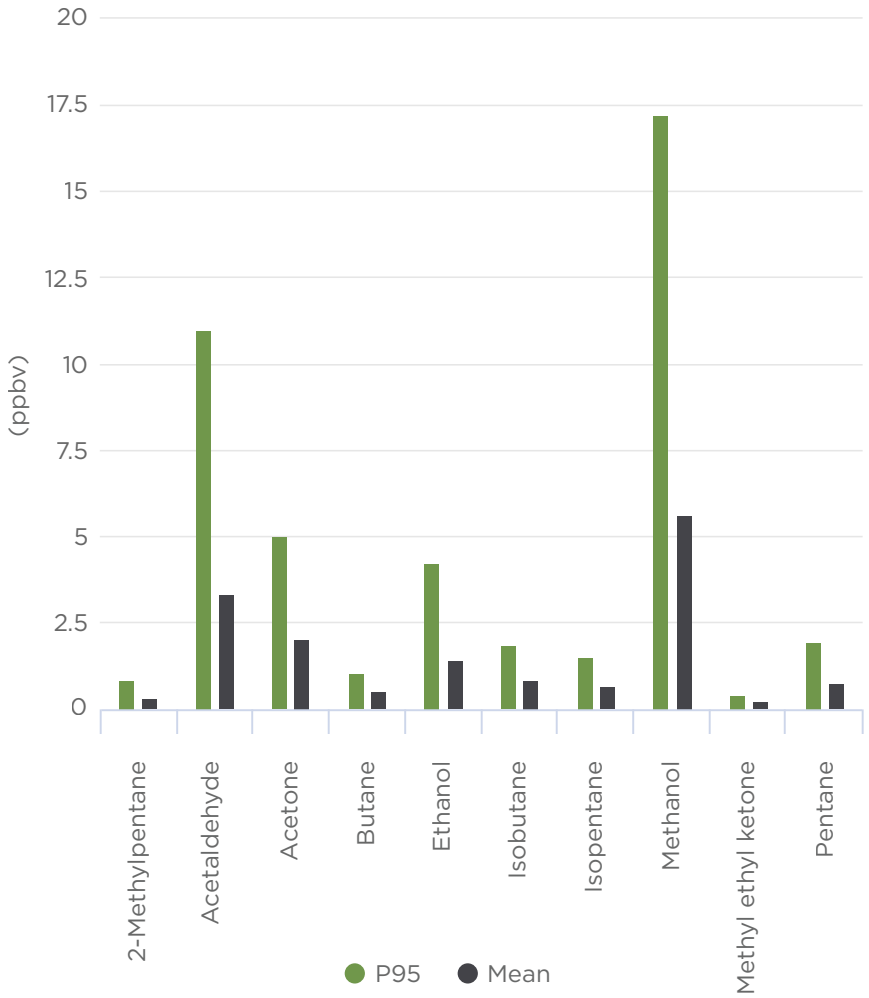
Barge Landing



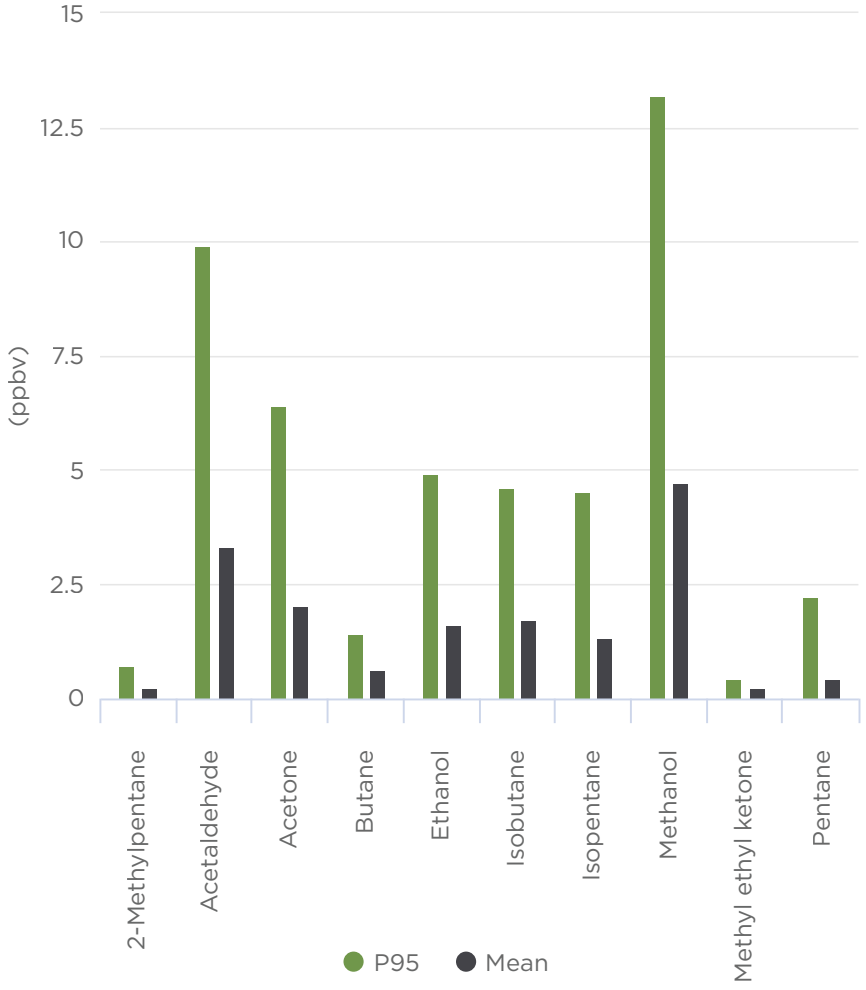
Bertha Ganter - Fort McKay



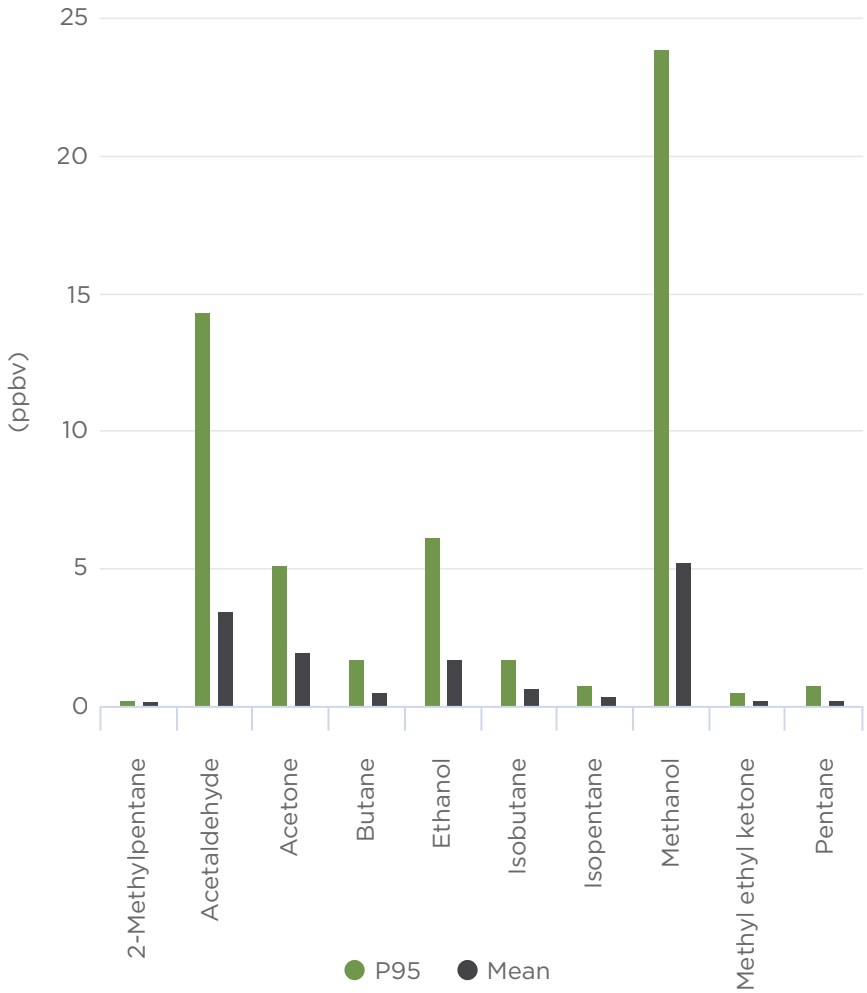
Fort McKay South



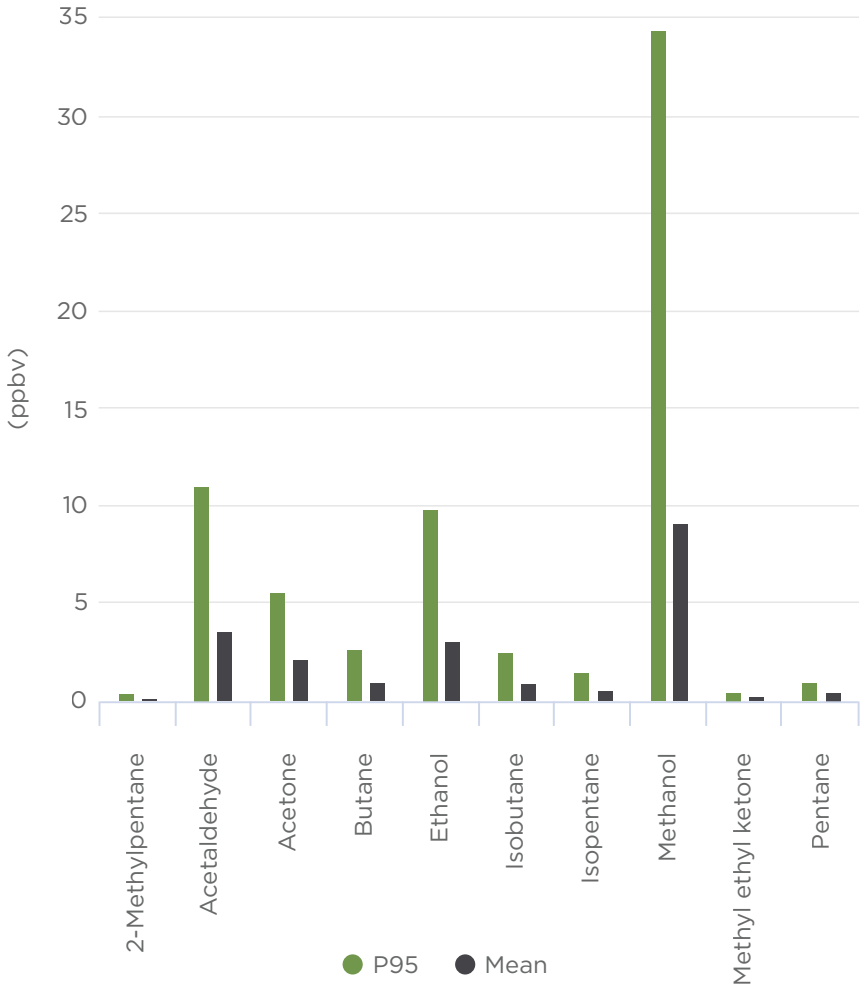
Horizon



Janvier



Patricia McInnes



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 2019 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.

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

Note: The ambient air quality values based on the 99th percentile of hourly data are all established as triggers in the management framework

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*

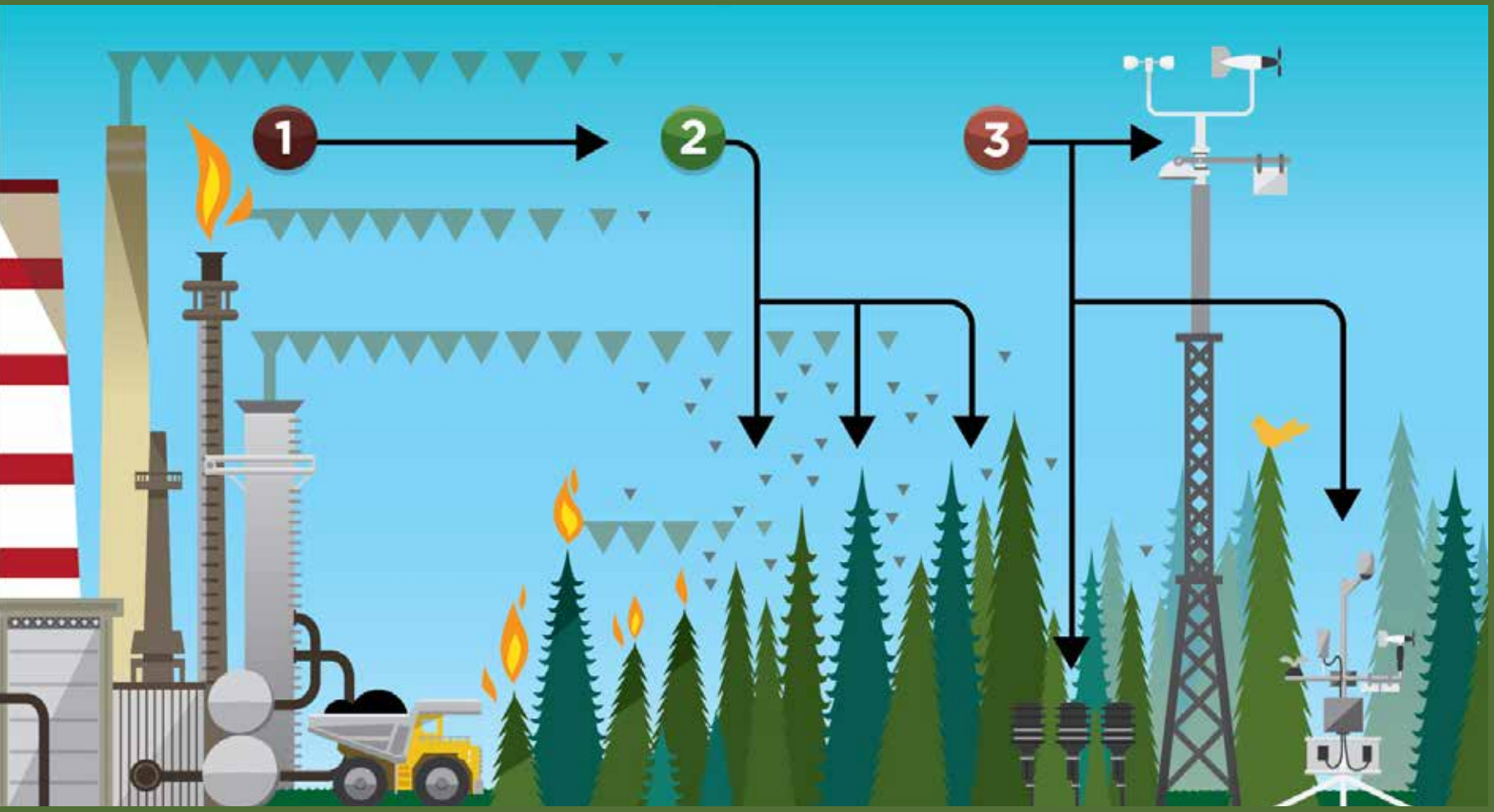
	NO_2		SO_2	
Station	Annual Average (ppb)	Annual 99th Percentile (ppb)	Annual Average (ppb)	Annual 99th Percentile (ppb)
Bertha Ganter-Fort McKay	8	35	1	11
Mildred Lake			1	15
Buffalo Viewpoint	5	33	1	11
Mannix			2	23
Patricia McInnes	5	29	1	9
Athabasca Valley	8	32	1	8
Fort Chipewyan	2	12	0	3
Barge Landing	10	43	1	7
Lower Camp			2	26
Fort McKay South	7	32	1	10
Anzac	2	16	1	4
Horizon	9	41	1	8
Wapasu	3	18	1	9
Stony Mountain	1	7	0	3
Firebag	4	28	1	8
MacKay River	2	22	1	8
Conklin	2	11	0	2
Janvier	1	8	0	2
Fort Hills	10	44	1	7
Surmont	5	19	2	12
Waskōw ohci Pimâtisiwin			1	9
Christina Lake	3	16	2	24
Jackfish 2/3	1	7	1	6

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.

The objective of the program is to determine cause-effect relationships between air pollutants and forest ecosystem health in the region. To meet this objective the WBEA operates both a long-term Forest Health Monitoring Program and an Atmospheric Pollutant Deposition Monitoring Program which monitor stressors (acidification/eutrophication) along the pathway (atmospheric transport) from source (industrial emissions) to the receiving environment (jack pine forests). This integrated program, as depicted in the image on the following page, allows for the determination of cause-effect relationships between air pollution and forest health.

In 2019, the WBEA completed the analysis of historical data collected by both programs, in combination with data collected by the Ambient Air Monitoring program, and published nine open access manuscripts in a Virtual Special Issue of the journal *Science of the Total Environment*. The special issue, entitled "Relationships Between Air Pollutants and Forest Ecosystem Health in the Oil Sands Region, AB, Canada" is available online at **sciencedirect.com**. To access key messages from the manuscripts or view the June 18, 2019 public presentation, visit **wbea.org/news/forest-health-monitoring-in-the-oil-sands-presentation**.



Terrestrial Enviromental Effects Monitoring

1. Source

Pollution is emitted into the air from a variety of sources

2. Deposit

The pollution may be deposited onto the surrounding forest

3. Measure

The WBEA collects samples and information to measure the effects of pollution on the enviroment

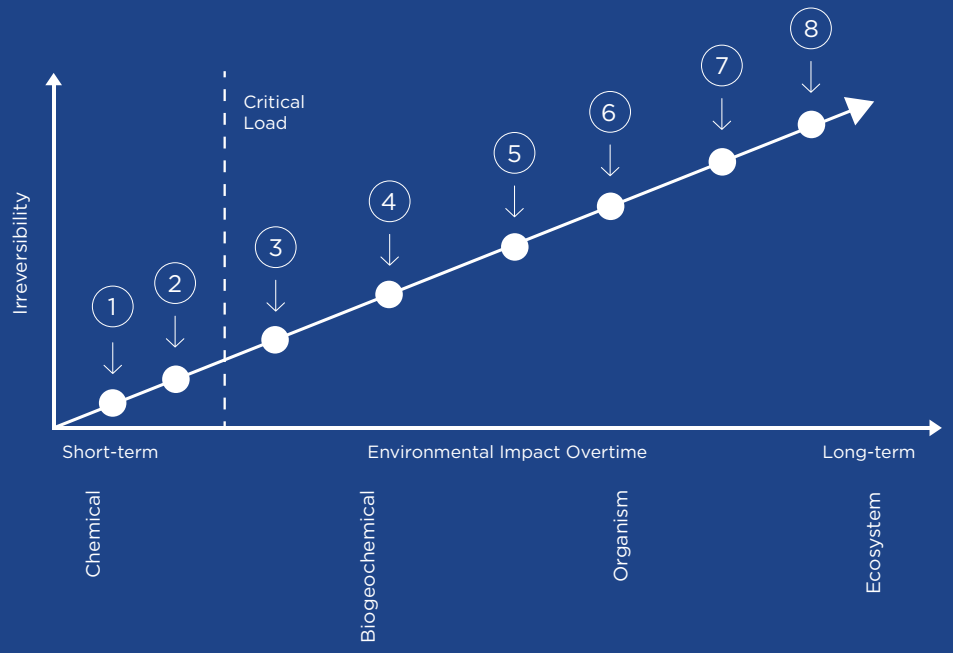
Forest Health Monitoring

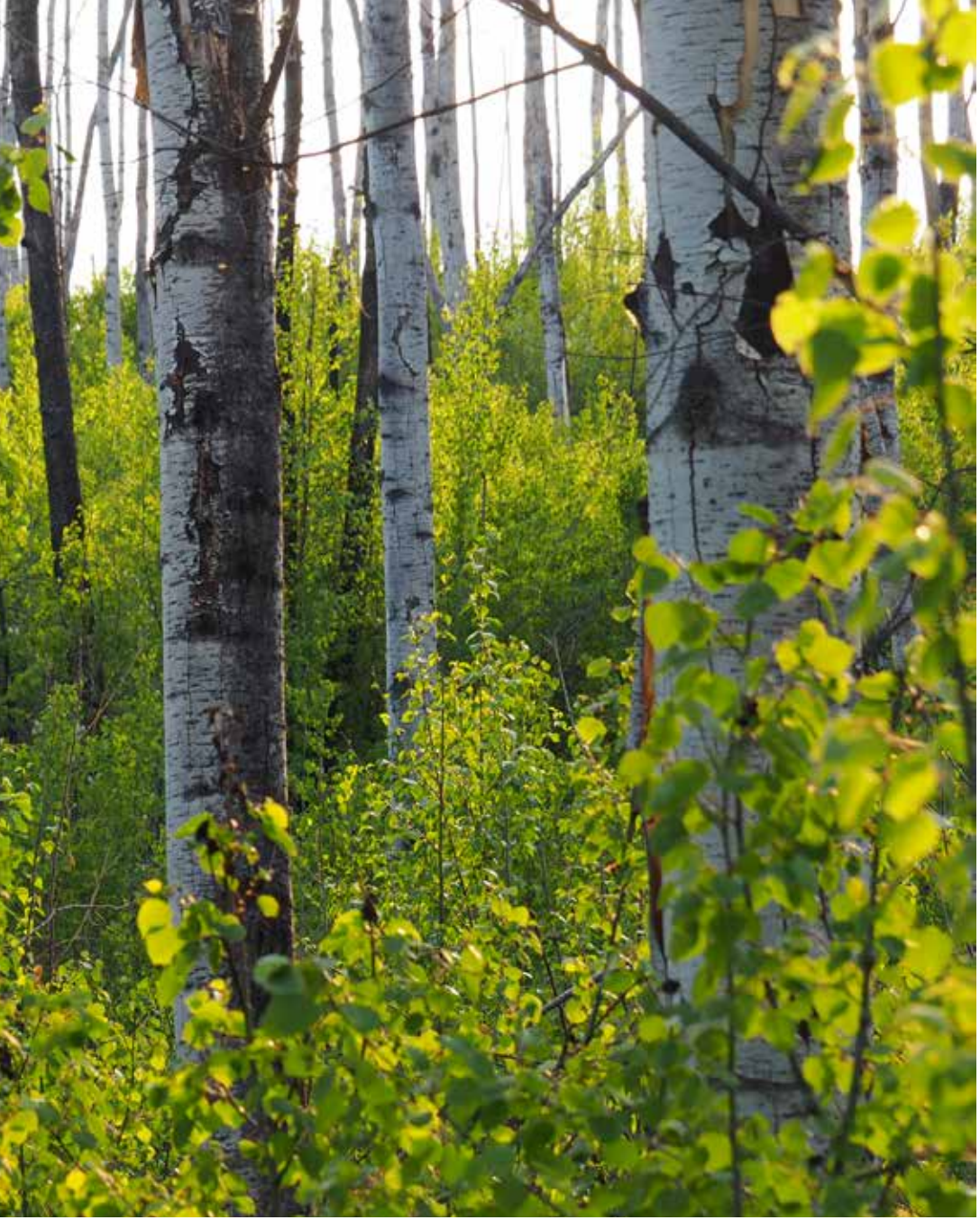
The Forest Health Monitoring program monitors jack pine forest sites to assess whether there are changes to biological, physical, and chemical indicators through a sampling campaign of soils and vegetation every six (6) years, as well as lichen sampling at varying intervals. During initial program development, 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.

The WBEA conducted the fourth intensive forest health sampling campaign in 2018, which included soil and needle sample collection, tree core collection, and documentation of various jack pine and forest stand characteristics. In 2019, this data was analyzed and reviewed and integration with the historical dataset was initiated to 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:AI, BS% C:N, nutrients)
4. Altered jack pine growth
5. Altered jack pine understory community composition
6. Altered aspen soil chemistry (BC:AI, BS% C:N, nutrients)
7. Altered aspen growth
8. Altered aspen understory community composition

Critical Load = the highest load that will not cause chemical changes leading to long-term harmful effects on the most sensitive ecological systems.





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).

The WBEA's time-integrated sampling laboratory reports are available to everyone at **wbea.org/network-and-data/integrated-data** and can be searched using the tool found at **wbea.org/network-and-data/integrated-data-search**

The list of parameters measured at deposition monitoring sites using passive air sampling is included in the table below.

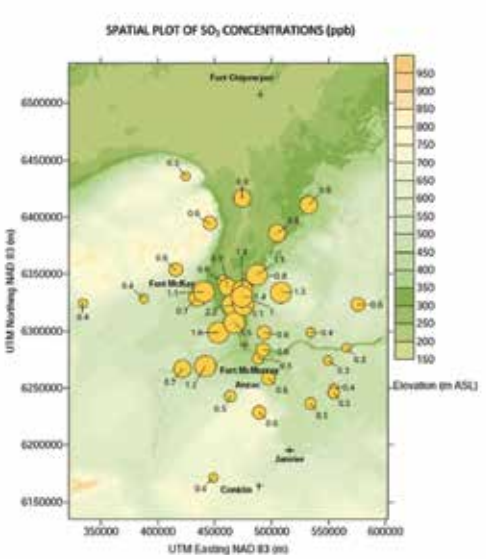
Passive Air Sampling Passive Sampler

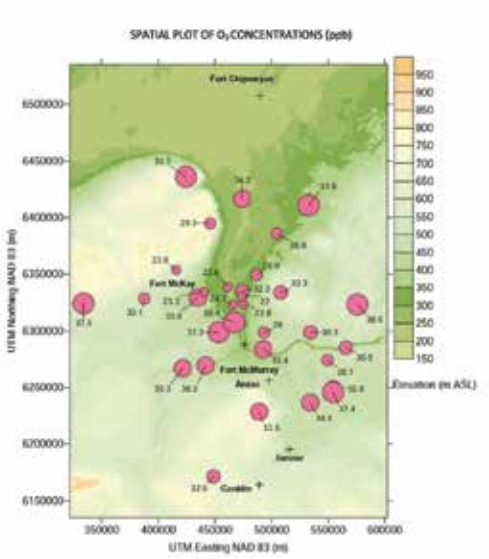
Site Name	HNO_3	NH_3	NO_2	SO_2	O_3
1001	✓	✓	✓	✓	✓
1002	✓	✓	✓	✓	✓
1004	✓	✓	✓	✓	✓
1007	✓	✓	✓	✓	✓
1008	✓	✓	✓	✓	✓
1023	✓	✓	✓	✓	✓
1027	✓	✓	✓	✓	✓
1947	✓	✓	✓	✓	✓
1991	✓	✓	✓	✓	✓
1992	✓	✓	✓	✓	✓
1993	✓	✓	✓	✓	✓
1994	✓	✓	✓	✓	✓
1995	✓	✓	✓	✓	✓
1996	✓	✓	✓	✓	✓
1997	✓	✓	✓	✓	✓
1998	✓	✓	✓	✓	✓
2001	✓	✓	✓	✓	✓
2005	✓	✓	✓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

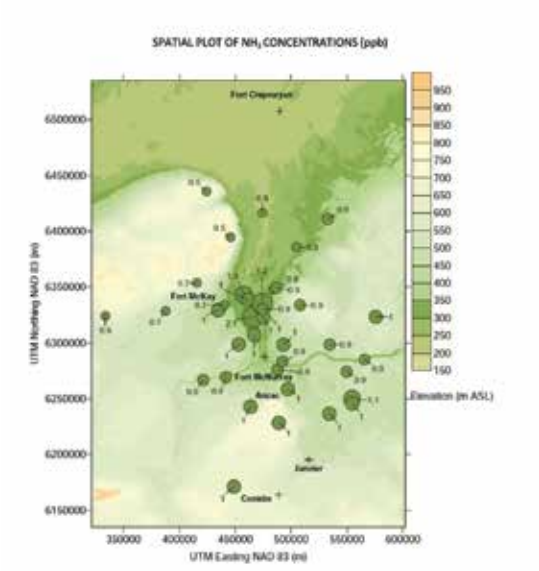
Site Name	HNO_3	NH_3	NO_2	SO_2	O_3
2054	✓	✓	✓	✓	✓
3009	✓	✓	✓	✓	✓
3011	✓	✓	✓	✓	✓
3016	✓	✓	✓	✓	✓
3083	✓	✓	✓	✓	✓
3086	✓	✓	✓	✓	✓
3088	✓	✓	✓	✓	✓
3092	✓	✓	✓	✓	✓
3096	✓	✓	✓	✓	✓
3212	✓	✓	✓	✓	✓
4000	✓	✓	✓	✓	✓
4001	✓	✓	✓	✓	✓
4002	✓	✓	✓	✓	✓
4003	✓	✓	✓	✓	✓
4004	✓	✓	✓	✓	✓
4014	✓	✓	✓	✓	✓
ATHV	✓	✓	✓	✓	✓
BGFM	✓	✓	✓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

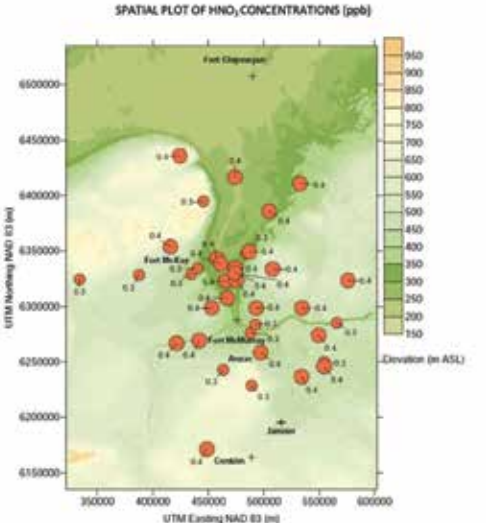
Passive Air Sampling

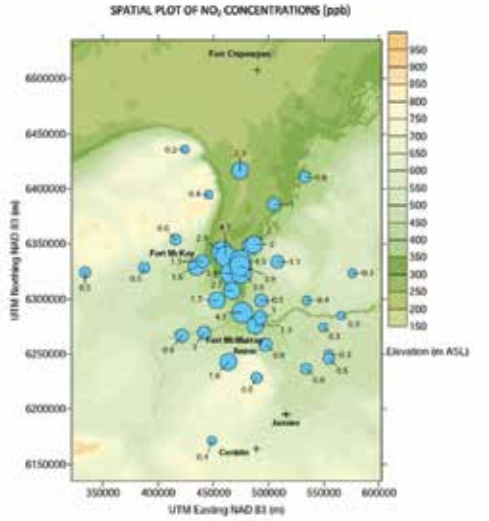
Passive air sampling uses a diffusive membrane to allow for the physical uptake of gas or vapour sample at a known rate. Data obtained from passive air sampling is used to model deposition trends across the region. Data collected in 2019 from passive air sampling for sulphur dioxide (SO2), nitrogen dioxide (NO2), and ozone (O3) is presented on the concentration maps; the bigger the circle the larger the concentration.











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

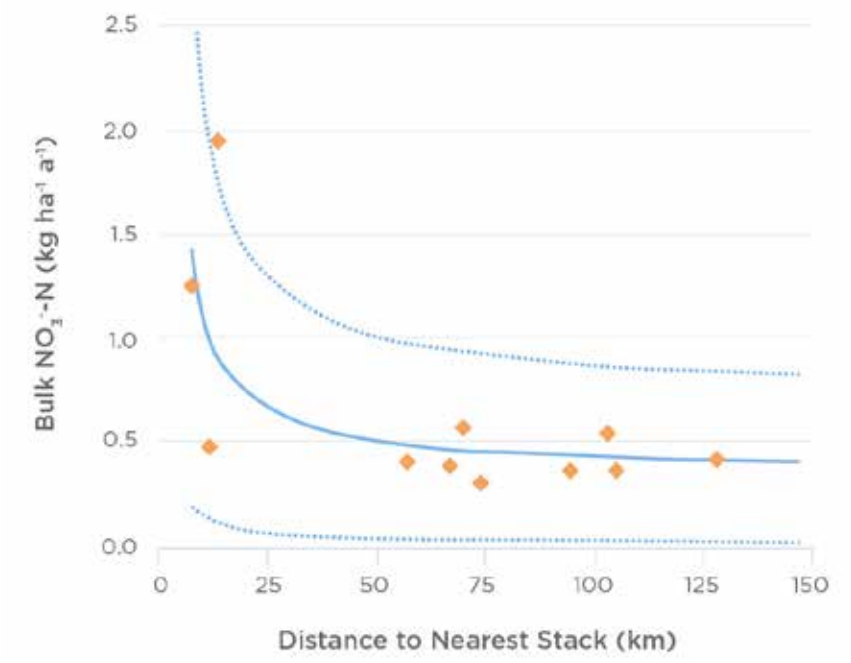
Passive deposition sampling is achieved through ion exchange resin technology (IER). A column of resin beads is affixed to precipitation collectors to capture charged chemical species (ions) in precipitation water. The graphs on pages 62-63 depict the deposition of ammonium (NH_{4+}), nitrate (NO_3^-), 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 on the right.

Deposition Sampling (IER)

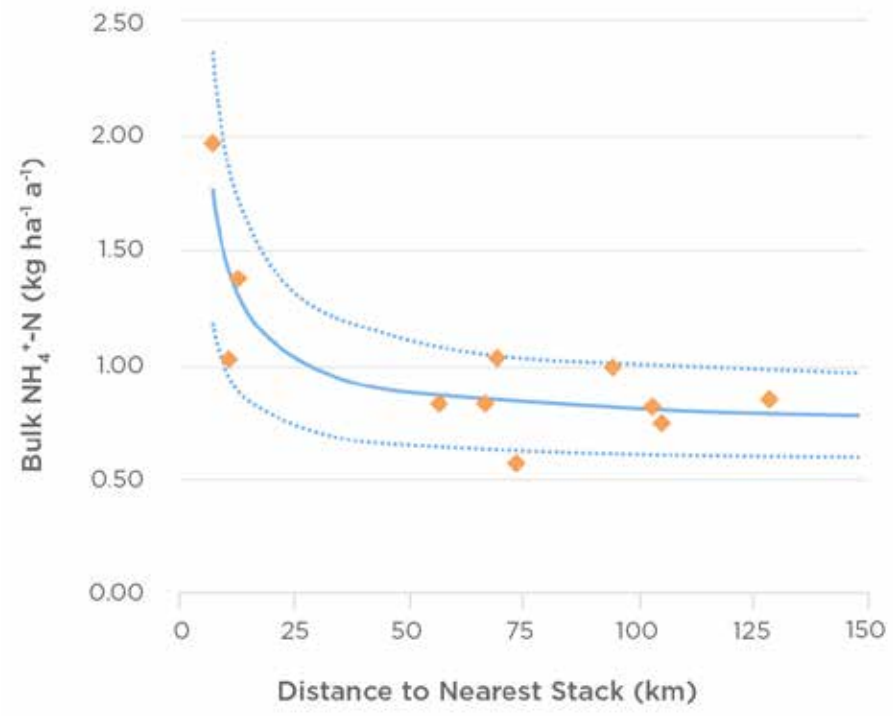
Site Name	NH_4	NO_3	PO_4	SO_4	Base Cation
2054	✓	✓	✓	✓	✓
2513	✓	✓	✓	✓	✓
3083	✓	✓	✓	✓	
3092	✓	✓	✓	✓	
3102	✓	✓	✓	✓	✓
3111	✓	✓	✓	✓	
3116	✓	✓	✓	✓	✓
3153	✓	✓	✓	✓	✓
3172	✓	✓	✓	✓	✓
3207	✓	✓	✓	✓	✓
3210	✓	✓	✓	✓	✓
3211	✓	✓	✓	✓	✓
3212	✓	✓	✓	✓	
3308	✓	✓	✓	✓	✓
3309	✓	✓	✓	✓	
3311	✓	✓	✓	✓	
3398	✓	✓	✓	✓	
3550	✓	✓	✓	✓	
ANZC	✓	✓	✓	✓	
BGFM	✓	✓	✓	✓	
1001	✓	✓	✓	✓	
1004	✓	✓	✓	✓	✓
1006	✓	✓	✓	✓	

Site Name	NH_4	NO_3	PO_4	SO_4	Base Cation
2001	✓	✓	✓	✓	
2010	✓	✓	✓	✓	
2012	✓	✓	✓	✓	
2013	✓	✓	✓	✓	
2050	✓	✓	✓	✓	
2554	✓	✓	✓	✓	
3003	✓	✓	✓	✓	
3008	✓	✓	✓	✓	
3009	✓	✓	✓	✓	
3011	✓	✓	✓	✓	
3052	✓	✓	✓	✓	
3072	✓	✓	✓	✓	
3098	✓	✓	✓	✓	
3107	✓	✓	✓	✓	
3202	✓	✓	✓	✓	
3253	✓	✓	✓	✓	
4000	✓	✓	✓	✓	
4001	✓	✓	✓	✓	
4002	✓	✓	✓	✓	
4003	✓	✓	✓	✓	
4004	✓	✓	✓	✓	
4014	✓	✓	✓	✓	

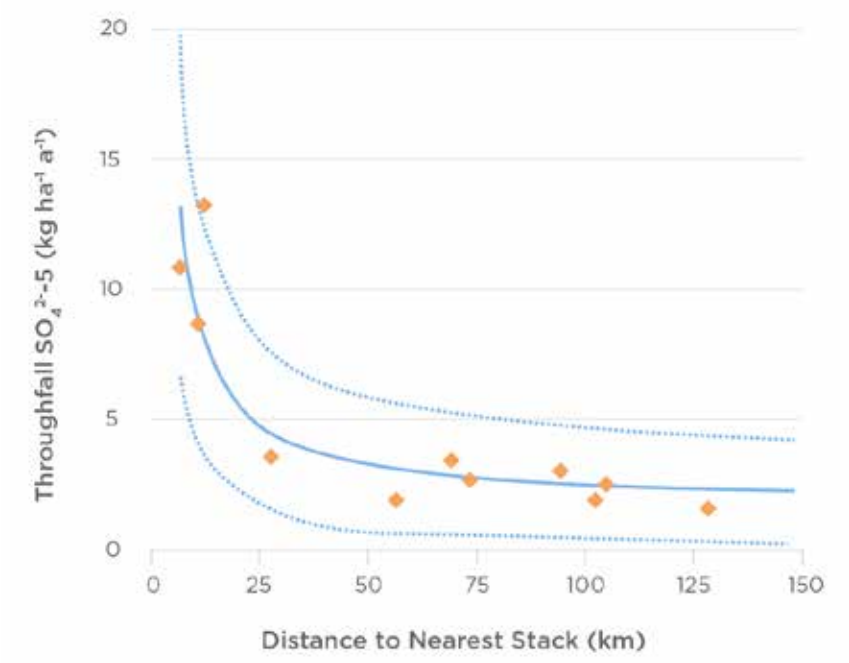
Bulk nitrate, as nitrogen



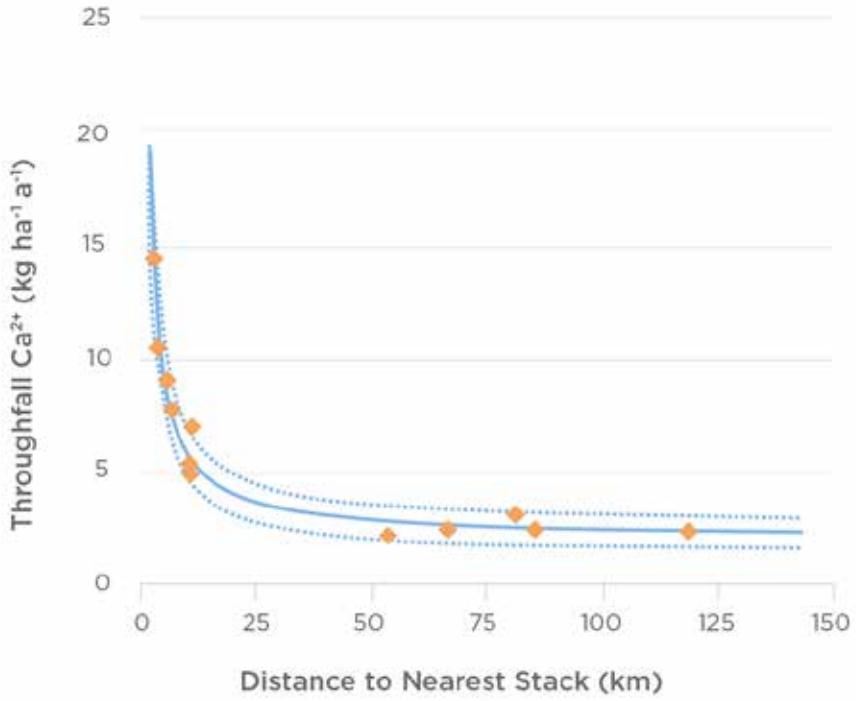
Bulk ammonium, as nitrogen



Throughfall sulphate, as sulphur



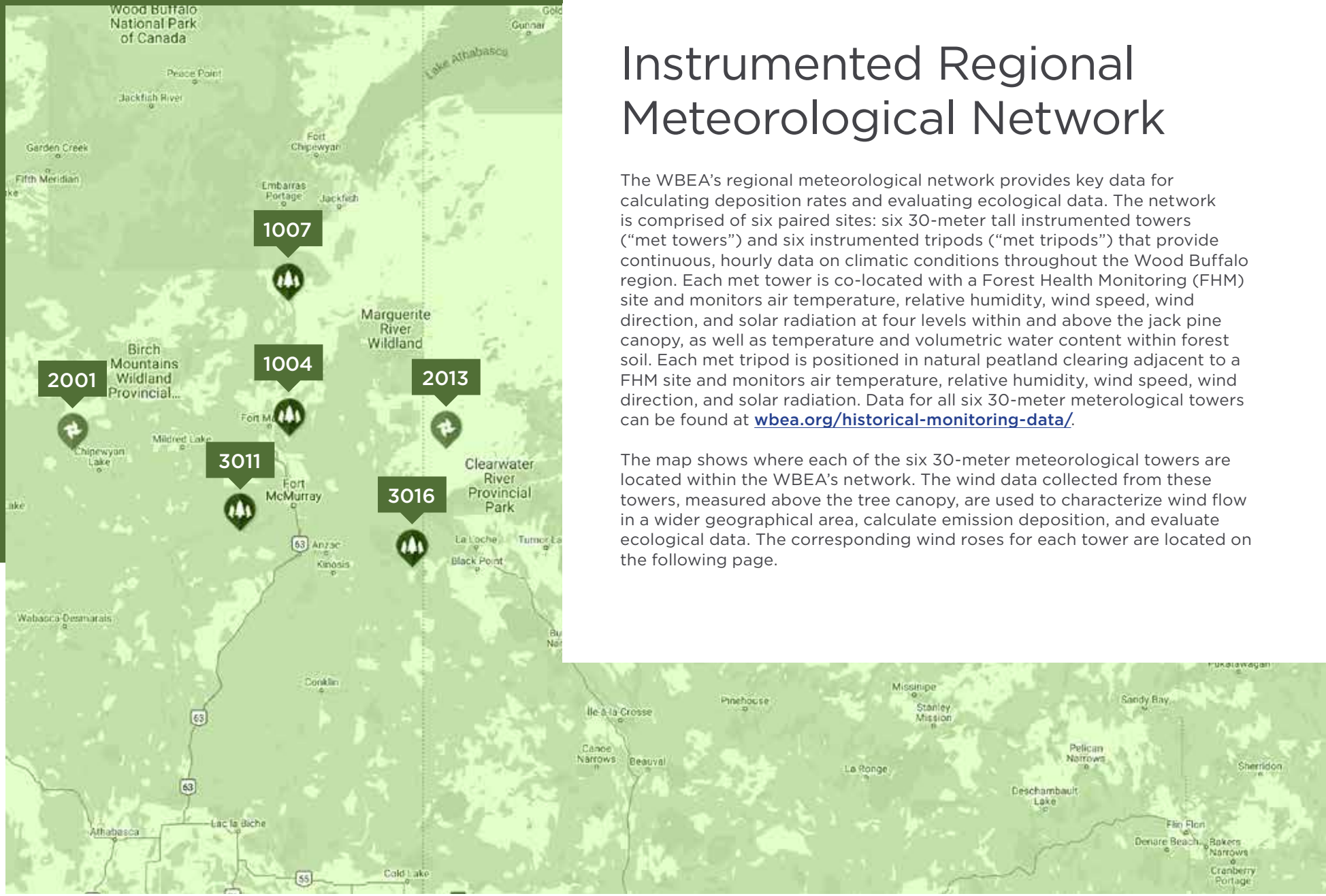
Throughfall calcium



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/historical-monitoring-data/.

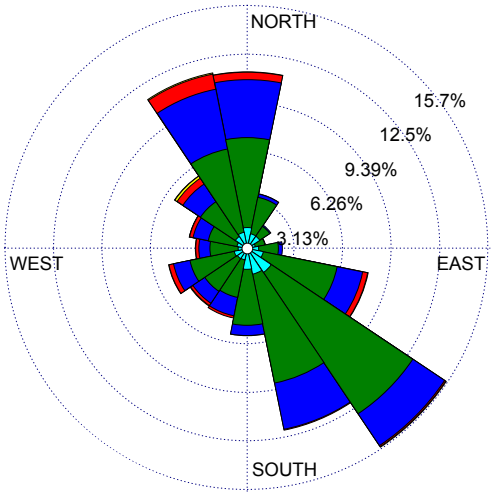
The map shows where each of the six 30-meter meteorological towers are located within the WBEA's network. The wind data collected from these towers, measured above the tree canopy, are used to characterize wind flow in a wider geographical area, calculate emission deposition, and evaluate ecological data. The corresponding wind roses for each tower are located on the following page.



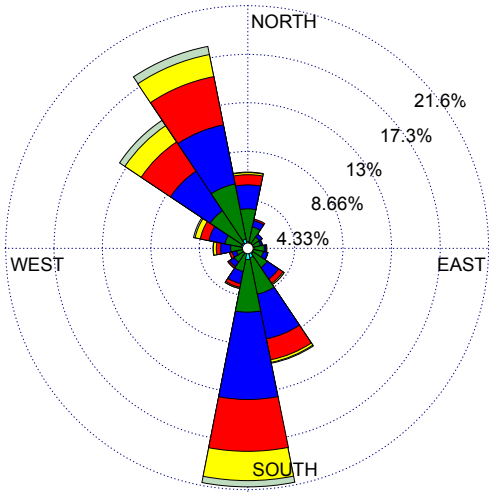
WIND SPEED (km/h)

> = 25 | 20 - 25 | 15 - 20 | 10 - 15 | 5 - 10 | 0.5 - 5

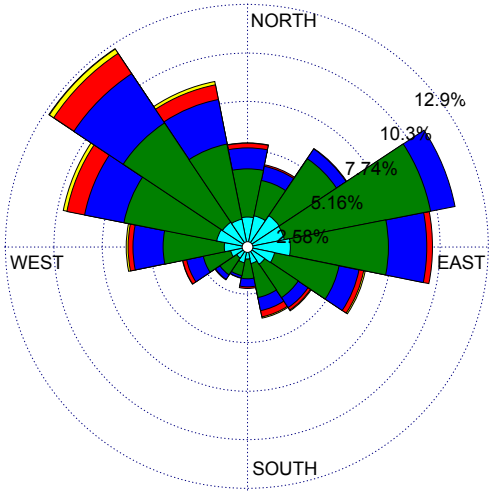
Met Tower 1004



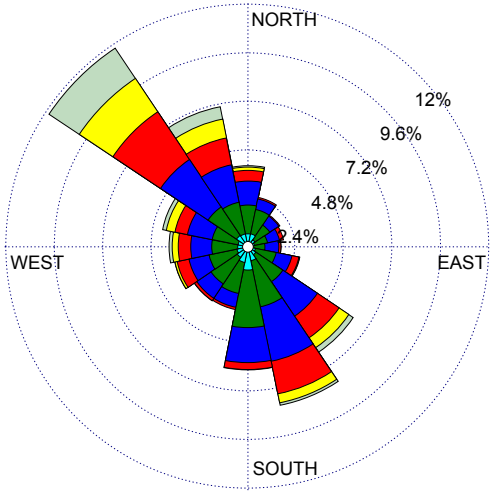
Met Tower 1007



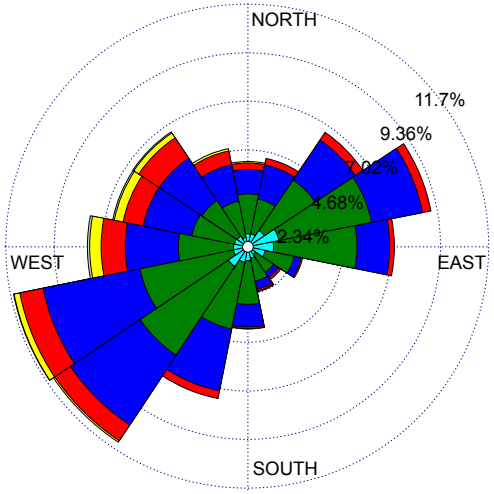
Met Tower 2001



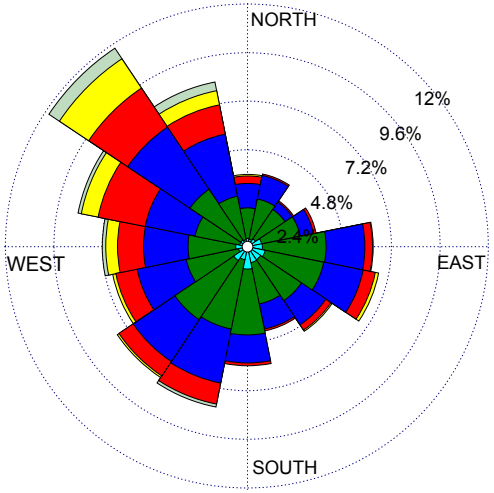
Met Tower 2013



Met Tower 3011



Met Tower 3016



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.

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 2019, Conklin Métis, Fort McKay Métis, Fort McKay First Nation, Fort McMurray Métis, and Fort McMurray First Nation 468 continued to develop and implement 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

The WBEA created the Community Odour Monitoring Program (COMP) app as an opportunity for people to provide information about the odours they experience throughout the RMWB, as outlined in the image on the following page. Currently, analyzers can measure the concentration of specific pollutants or groups of pollutants, but they cannot measure if an odour is present or how strong the odour would be. Therefore, the app allows the WBEA to compare the information people provide about odours to the ambient air data collected at WBEA air monitoring stations. The intent is to find whether there are trends in the ambient data when odours are present—such as elevated concentrations of odour-causing compounds.

The 2019 COMP Annual Report, as well as links to download the app on iOS and Android devices can be found at **comp.wbea.org**

Community Odour Monitoring Program

1. Source

Pollution is emitted into the air from a variety of sources

2. Smell

The pollution may cause odours - anyone who experiences an odour in the RMWB can submit their observations via the WBEA's COMP app

3. Share

Users can learn about odours and view all observations submitted at **comp.wbea.org**

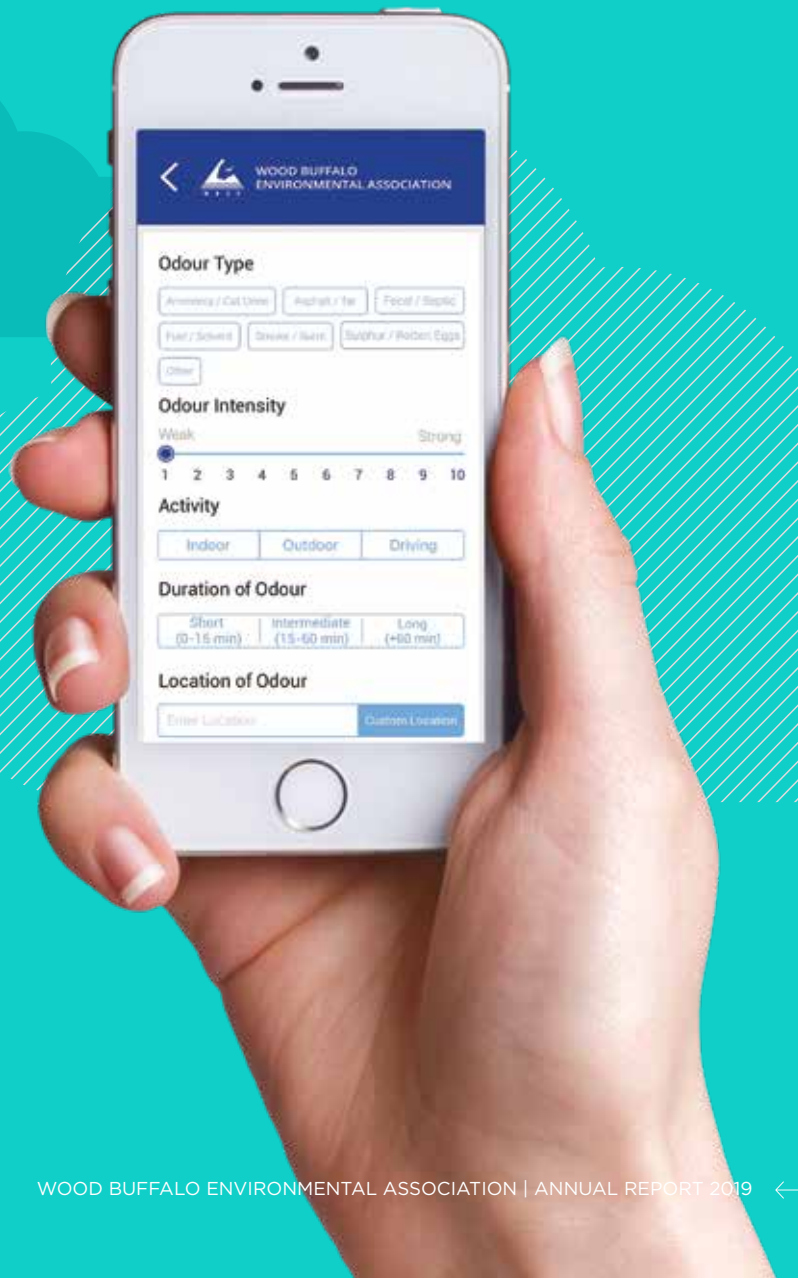
COMP NEEDS YOU!

The Community Odour Monitoring Program is still going on. To participate and provide information on the odours you experience in the Regional Municipality of Wood Buffalo:

1. Download the COMP App for iPhone or for Android devices
2. When you smell an odour in the air, submit an observation in the App

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

Learn more at **comp.wbea.org**



WBEA 2019 Membership

INDIGENOUS MEMBERS

Athabasca Chipewyan First Nation
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
Lakeland Métis Community Association
McMurray Métis
Mikisew Cree First Nation

NON-GOVERNMENT ORGANIZATION MEMBERS

Keyano College
Pembina Institute for Appropriate Development

GOVERNMENT MEMBERS

Alberta Energy Regulator
Alberta Environment and Parks
Alberta Health
Alberta Health Services
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
H.J. Baker Sulphur Canada ULC
Husky Oil Operations Ltd.
Imperial Oil Limited
Inter Pipeline Limited
MEG Energy Corp.
Parsons Creek Aggregates
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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