Fort Air Partnership

2018

Ambient Air Quality Monitoring Annual Network Report And Data Summary

FORT AIR PARTNERSHIP

We Monitor the Air You Breathe

FAP Technical Working Group April 24, 2019

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Abbreviations

24-hours	A calendar day, beginning at midnight
AAAQG	Alberta Ambient Air Quality Guideline
AAAQO	Alberta Ambient Air Quality Objective
AER	Alberta Energy Regulator
AMD	Air Monitoring Directive
AQM	Air Quality Monitoring
AQMS	Air Quality Management System
BTEX/S	Benzene, toluene, ethylbenzene, xylenes and styrene
CAAQS	Canadian Ambient Air Quality Standards
Calm	1-hour average wind speed is lower than 5 km/hour
CASA	Clean Air Strategic Alliance
CH_4	Methane
CWS	Canada-Wide Standard
EPEA	Alberta's Environmental Protection and Enhancement Act
FAP	Fort Air Partnership
H_2S	Hydrogen sulphide
MST	Mountain Standard Time
NAPS	National Air Pollution Surveillance
NMHC	Non-methane hydrocarbons
NH_3	Ammonia
NO_2	Nitrogen dioxide
NO	Nitric oxide
NO_X	Oxides of nitrogen
O_3	Ozone (present at ground level)
$PM_{2.5}$	Particulate matter with aerodynamic diameter less than 2.5 µm in diameter, referred to as fine particles
QA/QC	Quality assurance / quality control
SO_2	Sulphur dioxide
THC	Total hydrocarbons
TWG	Technical Working Group
VOC	Volatile organic compound

WD or WDR	Wind direction
WS or WSP	Wind speed

Units of Measurement

µg/m^3	micrograms per cubic meter
km/hr	kilometers per hour
ppb	parts per billion by volume
ppm	parts per million by volume

Note: Where the Alberta Government is mentioned in this report, the reference is to the Department that has authority over and regulates the industrial approvals of air monitoring and reporting. As of December 31, 2018, this department was Alberta Environment and Parks.

2018 Network Summary

Network Overview

During 2018 Fort Air Partnership (FAP) operated ten continuous ambient air quality monitoring stations. The tenth station, a portable monitoring station, began operation in April 2018. Table 1 describes the parameters measured at continuous stations as of the end of 2018.

In addition to the continuous network, FAP operated a regional passive monitoring network in 2018, monitoring for sulphur dioxide (SO_2) and hydrogen sulphide (H_2S) at 63 sites throughout the network.

Table 1: FAP continuous monitoring stations and parameters 2018

	Bruder-heim 1	Elk Island	Fort Sask	Gibbons	Lamont County	Range Road 220	Redwater	Ross Creek	Scotford (temp.)	Portable
Alberta Health Quality Index	✓	✓	✓	✓	✓		✓			✓
Ammonia (NH_3)			✓				✓	✓		*
Carbon Monoxide (CO)			✓							
Ethylene (C_2H_4)						✓		✓		*
Ozone (O_3)	✓	✓	✓	✓	✓		✓			✓
Total Hydrocarbons (THC)	✓		✓		✓	✓				*
Non-methane Hydrocarbons (NMHC)	✓		✓		✓	✓				*
Methane (CH_4)	✓		✓		✓	✓				*
Hydrogen Sulphide (H_2S)			✓	✓	✓		✓		✓	✓
Oxides of Nitrogen (NO_X)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Nitric Oxide (NO)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Nitrogen Dioxide (NO_2)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Fine Particulates ($PM_{2.5}$)	✓	✓	✓	✓	✓		✓			✓

Table 1: FAP continuous monitoring stations and parameters 2018 (continued)

	Bruder-heim 1	Elk Island	Fort Sask	Gibbons	Lamont County	Range Road 220	Redwater	Ross Creek	Scotford (temp.)	Portable
Sulphur Dioxide (SO_2)	✓	✓	✓	✓	✓		✓	✓	✓	✓
Benzene (C_6H_6)									✓	
Ethylbenzene (C_8H_{10})									✓	
Styrene (C_8H_8)									✓	
Toluene (C_7H_8)									✓	
Xylene ($C_{24}H_{30}$)									✓	
Air Temperature @ 2 meters	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Air Temperature @ 10 meters								✓		
Delta Temperature								✓		
Barometric Pressure						✓		✓		
Relative Humidity	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Solar Radiation								✓		
Vertical Wind Speed								✓		
Wind Speed and Wind Direction	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

*Analyzer may be installed on the Portable depending on the project

Continuous Monitoring Performance Measures

In 2018 the average monthly uptime of all continuous monitoring equipment in the network was **99.57%.** This overall operational time is the highest since FAP began recording these statistics in 2012. FAP's uptime target is 98.5% while the Alberta Government requires that monitoring equipment be fully operational a minimum of 90% of the time each month.

There was only one instance in 2018 where individual instrument operation uptimes fell below the minimum 90% monthly average required by the Alberta Government. This was reported to the Alberta Government and the operation problem promptly resolved.

Table 2: Data completeness 2018 (percent)

	Bruder-heim1	Elk Island	Fort Sask.	Gibbons	Lamont County	Portable Bon Accord	Range Road 220	Red-water	Ross Creek	Scotford Temp.
Wind Speed & Direction	100	98.1	100	100	100	100	99.9	100	100	100
Sulphur Dioxide SO_2	100	99.8	99.7	99.8	99.7	100		99.9	99.7	99.9
Nitric Oxide NO	99.8	99.0	99.7	99.9	99.9	100	100	99.9	99.5	99.9
Nitrogen Dioxide NO_2	99.8	99.0	99.7	99.9	99.9	100	100	99.9	99.5	99.9
Oxides of Nitrogen NOx	99.8	99.0	99.7	99.9	99.9	100	100	99.9	99.5	99.9
Ammonia NH_3			99.7					99.9	99.4	
Ozone O_3	99.6	98.8	100			99.9		100		
Hydrogen Sulphide H_2S			100	99.8	100	98.8				99.5
Ethylene C_2H_4							99.1		98.8	
Particulate Matter $PM_{2.5}$	99.6	98.2	97.5	99.8	99.2	98.5		100		
Total Hydrocarbon THC	93.5		99.4		98.8		98.9			
Methane CH_4	93.5		99.4		98.8		98.9			
Non-Methane Hydrocarbon NMHC	93.5		99.4		98.8		98.9			
Carbon Monoxide CO			100							
Benzene C_6H_6										98.2
Toluene C_7H_8										98.2
Ethylbenzene C_8H_{10}										98.3
Xylene $C_{24}H_{30}$										98.3
Styrene C_8H_8										98.3
Site Average	**99.76**	**98.64**	**99.62**	**99.88**	**99.63**	**99.72**	**99.61**	**99.94**	**99.75**	**99.17**

*The Portable station uptime is counted starting in April when the station was commissioned.

Monitoring Network Changes in 2018

FAP made the following changes to the continuous monitoring network in 2018, including improvements to infrastructure and equipment.

- A new Portable continuous monitoring station, the 10th station in the FAP network, was commissioned in April. This station is on a wheeled platform and intended to be moved to different sites around the Airshed. The first site for the Portable station was the Town of Bon Accord. The project locations for the portable station are selected by a subcommittee of the FAP Technical Working Group following a documented and FAP approved process.

- A new shelter was installed at Elk Island replacing the 20+ year old shelter that had been in use there since its inception.

- A new oxides of nitrogen analyzer was purchased for deployment in the network as per the FAP Capital Equipment Replacement Plan.

- Support equipment purchased as part of the Capital Plan also included two station computers, a zero air source, three power back-up supplies, two hydrogen generators and two barometric pressure sensors.

- A new collapsible tower was installed at the Bruderheim 1 site.

Air Quality Events and Exceedances Summary

Air quality measurements are compared hourly to Alberta Ambient Air Quality Objectives (AAAQO). Any exceedance of an AAAQO is reported to the Alberta Government and the cause of the exceedance investigated.

A complete listing of the AAAQO compounds and values can be found at:

http://aep.alberta.ca/air/legislation/ambient-air-quality-objectives/default.aspx.

Table 3: 2018 1-hour average exceedances of the AAAQO

One Hour Exceedances			
Parameter	**Exceedances**	**Dates**	**Attributed Cause**
Hydrogen Sulphide (H_2S)	**2**	January 20	Local Industry
	14	May 5,11,14,16,19,23,27	Local pond/marsh
	2	July 26, August 16	Local Industry
	2	August 19	Unattributed
Ozone (O_3)	**6**	August 9	Summertime smog
Fine Particulates ($PM_{2.5}$)	**1**	January 20	Unknown local source
	1	March 14	Regional effects from winter inversion
	1	May 14	Brush fires
	1	July 3	Summertime smog
	743	August 7 through 23	Wildfire smoke
	29	August 25	Wildfire smoke
	34	August 26	Wildfire smoke
Total	**836**		

Table 4: 2018 24-hour average exceedances of the AAAQO

24 Hour Exceedances			
Parameter	**Exceedances**	**Dates**	**Attributed Cause**
Hydrogen Sulphide (H_2S)	**4**	May 11, 14 23, 27	Local pond/marsh
Fine Particulates ($PM_{2.5}$)	**8**	March 8, 12,13,17	Regional effects from winter inversion
	34	August 7 through 11	Wildfire smoke
	62	August 14 through 23	Wildfire smoke
	13	August 25,26	Wildfire smoke
Total	**121**		

Air Quality Health Index Summary

The Air Quality Health Index (AQHI) was reported from six FAP stations in 2018. The AQHI is calculated by the Government of Alberta using FAP collected data. In Alberta the AQHI is calculated using fine particulate matter ($PM_{2.5}$), ozone (O_3), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and hydrogen sulphide (H_2S) data.

Table 5: Air Quality Health Index in FAP region by percent - 2018

		Risk Level (% of time)			
Station Name	Hours Monitored	Low Risk	Moderate Risk	High Risk	Very High Risk
Bon Accord*	5842	90.19%	8.37%	1.23%	0.21%
Bruderheim	8568	90.52%	7.97%	1.37%	0.14%
Elk Island	8215	90.23%	8.35%	1.17%	0.26%
Fort Saskatchewan	8347	83.01%	15.55%	1.29%	0.14%
Gibbons	8585	85.39%	12.88%	1.56%	0.16%
Lamont County	8572	90.74%	8.04%	1.14%	0.08%
Redwater	8453	88.70%	9.57%	1.63%	0.09%
Total hours	**56,496**	**49,973**	**5,760**	**763**	**86**

Table 6: Air Quality Health Index in FAP region number of hours - 2018

		Risk Level (# of hours)			
Station Name	Hours Monitored	Low Risk	Moderate Risk	High Risk	Very High Risk
Bon Accord*	5842	5269	489	72	12
Bruderheim	8568	7756	683	117	12
Elk Island	8215	7412	686	96	21
Fort Saskatchewan	8347	6929	1298	108	12
Gibbons	8585	7331	1106	134	14
Lamont County	8572	7778	689	98	7
Redwater	8453	7498	809	138	8
Total hours	56582	49973	5760	763	86

**The new Portable station began operating in April 2018.*

The higher the AQHI number, the greater the health risk. The index describes the level of health risk associated with the AQHI number as 'low', 'moderate', 'high' or 'very high', and suggests steps people can take to reduce exposure.

The following table details the occurrence of air quality events in 2018 and the number of hours with a high risk AQHI rating at each station during each event.

Table 7: Distribution of hours with an AQHI High or Very High Risk rating

	FAP Continuous Air Quality Monitoring Station															
	Bon Accord		Bruder-heim 1		Elk Island		Fort Sask.		Lamont County		Gibbons		Red-water *			
Air Quality Event Dates	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	Very High Risk	High Risk	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	Total Hrs.	Attributed Cause
Jan. 20	-	-	-	-	-	-	-	-	1	-	-	-	-	-	**1**	Unknown local source
Mar. 5	-	-	-	-	2	-	-	-	-	-	-	-	-	-	**2**	Winter-time inversion
Mar. 8	-	-	-	-	-	-	-	-	2	-	-	-	-	-	**2**	
Mar. 12-14	-	-	-	-	7		6		9	-	-	-	-	-	**22**	
May 14	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	Grass fires
July 3	-	-	-	-	-	-	-	-	1	-	-	-	-	-	**1**	Summer-time smog
Aug. 7	3	-	1	-	-	-	-	-	3	-	-	-	2	-	**9**	Wildfire smoke
Aug. 8	13	-	4	-	4	-	1	-	7	-	-	-	5	-	**34**	
Aug. 9	1	-	4	-		-	5	-	2	-	-	-	10	-	**22**	
Aug. 10	4	4	6	2	4	3	5	3	4	5	7	-	8	-	**55**	
Aug. 11	3	-	7	-	4	2	5	-	4	-	6	-	9	-	**40**	
Aug. 14	-	-	6	-	6	-	4	-	4	-	1	-	2	-	**23**	
Aug. 15	17	-	19	2	13	8	20	-	21	1	20	-	18	-	**139**	
Aug. 16	8	-	24	-	14	-	10	-	13	-	20	-	24	-	**113**	
Aug. 17	13	-	14	-	6	-	15	-	17	-	13	-	21	-	**99**	
Aug. 18	3	8	4	8	3	8	3	9	3	8	4	7	4	8	**80**	

	FAP Continuous Air Quality Monitoring Station															
	Bon Accord		Bruder-heim 1		Elk Island		Fort Sask.		Lamont County		Gibbons		Red-water *			
Air Quality Event Dates	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	Very High Risk	High Risk	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	Total Hrs.	Attributed Cause
Aug. 22	4	-	7	-	9	-	7	-	9	-	7	-	4	-	**47**	Wildfire smoke
Aug. 23	-	-	8	-	15	-	19	-	18	-	18	-	15	-	**93**	
Aug. 25	3	-	4	-	6	-	1	-	5	-	-	-	6	-	**25**	
Aug. 26	-	-	8	-		-	7	-	9	-	2	-	10	-	**36**	
Oct. 24	-	-	-	-	3	-	-	-	-	-	-	-	-	-	**3**	Local road paving
Oct. 31	-	-	-	-	-	-	-	-	2	-	-	-	-	-	**2**	Un-known
Total Hours	**72**	**12**	**117**	**12**	**96**	**21**	**108**	**12**	**134**	**14**	**98**	**7**	**138**	**8**	**849**	

2018 Summary of Exceedances

The data Fort Air Partnership collects is compared to Alberta Ambient Air Quality Objectives (AAAQO) set by the Government of Alberta. Exceedances are reported to the Government of Alberta and follow up information provided within seven days. August 2018 experienced heavy infiltrations of smoke from wildfires in British Columbia resulting in record numbers of fine particulate exceedances at FAP stations and across the Province.

Table 8: Summary of 2018 Exceedances and 5 years previous

Parameter Measured		2018	2017	2016	2015	2014	2013
Ammonia (NH_3)	1-hr	0	1	0	4	0	0
Benzene (C_6H_6)	1-hr	0	0	0	2	5	0
Carbon Monoxide (CO)	1-hr	0	0	0	0	0	0
	8-hr	0	0	0	0	0	0
Ethyl Benzene ($C_6H_5CH_2CH_3$)	1-hr	0	0	0	0	0	0
Ethylene (C_2H_4)	1-hr	0	0	0	0	0	0
	3-day	0	0	0	0	0	0
	Annual	0	0	0	0	0	0
Hydrogen Sulphide (H_2S)	1-hr	19	0	0	3	0	147
	24-hr	4	0	0	1	0	29
Nitrogen Dioxide (NO_2)	1-hr	0	0	0	0	0	0
	24-hr	0	0	0	0	0	0
	Annual	0	0	0	0	0	0
Ozone (O_3)	1-hr	6	0	0	3	0	0
Styrene ($C_6H_5CH=CH_3$)	1-hr	0	0	0	0	0	0
Sulphur Dioxide (SO_2)	1-hr	0	38	51	34	26	6
	24-hr	0	9	9	6	3	2
	30-day	0	1	2	0	0	0
	Annual	0	0	0	0	0	0
Fine Particulates ($PM_{2.5}$)	1-hr	810	69	35	144	13	15
	24-hr	119	29	11	27	12	11
Toluene ($C_6H_5CH_3$)	1-hr	0	0	0	0	0	0
Xylenes (o-, m- and p- isomers)	1-hr	0	0	0	0	0	0
Total		**958**	**147**	**108**	**224**	**59**	**210**

Note: The Scotford 2 station was moved in April of 2014 because of pipeline construction beginning in May. The new location for the station, named Scotford Temporary had no nearby wetlands, hence the decrease in H_2S exceedances from 2014 to 2015.

Introduction

The FAP Organization (2018)

The Fort Air Partnership (FAP) is a registered not-for-profit society established in 1997 to operate an air quality monitoring network in a 4,500-square kilometer area northeast of Edmonton that includes Fort Saskatchewan, Gibbons, Bon Accord, Bruderheim, Lamont, Redwater, Waskatenau, Thorhild, and Elk National Island Park. In November 2000, FAP became the fourth Airshed in Alberta recognized by the Clean Air Strategic Alliance (CASA).

FAP is a multi-stakeholder group with members from industry, provincial and municipal government, and the public. FAP members see the benefit of working collaboratively to meet the organization's vision and mission.

The FAP Board holds regular meetings that are open to the public. Decisions of the Board and its committees are made by consensus.

The FAP Vision:

"*Public, industry and government have a clear shared understanding of ambient air quality in the region".*

The FAP Mission:

"To operate a regional network to monitor and report credible and comprehensive ambient air quality information".

FAP uses a governance organizational structure, such that the Board of Directors establishes policy and strategic direction for the organization, and contracted staff and committees manage the operational details in accordance with the set direction. In 2018 FAP continued to operate with several committees including: An Executive Committee, a Technical Working Group (TWG) and related subcommittees, an External Relations Committee, a Finance Committee and a Governance Committee, which all make recommendations to the FAP Board of Directors. FAP operations were managed by an Executive Director, with contracted staff consisting of a Network Manager, a Communications Director, and an Administrative Assistant. FAP contracts air monitoring service providers who perform monitoring equipment operation, maintenance, calibration, and data validation and reporting.

Fort Air Partnership's monitoring and communications programs are funded by:

- Northeast Capital Industrial Association,
- Alberta Government
- Alberta's Industrial Heartland Association
- Environment and Climate Change Canada provides monitoring equipment for two continuous monitoring stations.

FAP works with other Airsheds provincially as part of the Alberta Airsheds Council. Airsheds in Alberta collaborate with both the provincial and federal government to implement successful air monitoring, reporting, and education within Alberta. Timely execution of environmental monitoring, and the provision of scientifically credible monitoring data to the public and policy makers for informed decision making are critical functions provided by Airsheds. An important aspect to this collaborative work is sharing of technical expertise and information through the Airsheds Council Technical Committee.

Fort Air Partnership Technical Working Group

FAP's TWG is primarily responsible for oversight of the implementation and operation of the monitoring network and provides technical guidance to FAP. The TWG meets once each month to review the data and network operations. The TWG also works under the leadership of the Network Manager to ensure that appropriate protocols are in place to assure data quality and guide air monitoring projects.

TWG members represent a wide range of technical air quality roles from industry, the Alberta Government (Health and Environment Ministries), and the Government of Canada (Environment Ministry), FAP's primary monitoring and data validation contractors, and members of the public. Committee members have substantial combined experience including monitoring technology, data analysis, laboratory analysis, quality systems, engineering, air quality modeling and regulatory reporting. Additionally, the TWG membership draws upon outside expertise from industry, air quality consultants, academia and government. Members of the TWG collaborate with other air monitoring agencies in Alberta and Canada. The FAP TWG chair also plays a leading role in a member committee of technical leads from all Airsheds in Alberta, which reports to the Alberta Airsheds Council. A list of TWG committee members on December 31, 2018 can be found in Appendix A. Lists of industry approval holders participating in FAP, as required in many cases by Environmental and Protection Enhancement Act (EPEA) operating approval clauses can be found in Appendix C.

2018 Ambient Air Quality Monitoring Program

2018 Continuous Monitoring Network

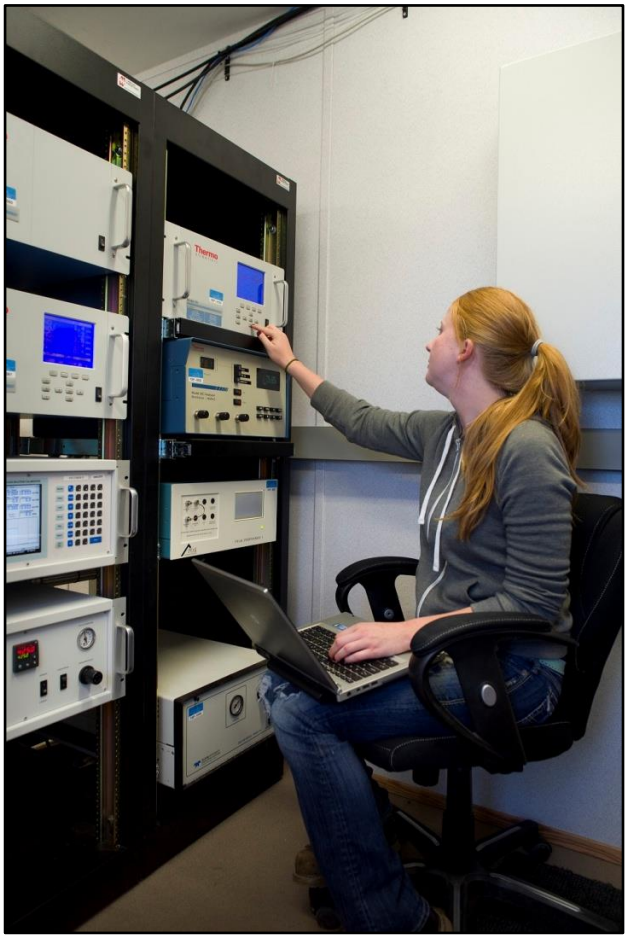
Continuous Monitoring Description

A continuous air monitoring station is a temperature-controlled shelter typically housing several different continuous ambient air analyzers. Continuous analyzers, as the name implies, run continuously, and store data in one-minute averages. Continuous analyzers are designed to measure ambient air for specific compounds. FAP uses different combinations of these analyzers at the various stations depending on the monitoring objectives of each station.

Every FAP station has a wind sensor atop a tower that is at least 10 meters tall. Stations also measure several meteorological conditions including wind speed and direction and ambient temperature.

Data acquisition and data quality control at these stations is discussed elsewhere in this report.

Figure 1: Continuous air monitoring station interior



Network Overview

Continuous Monitoring and Reporting Requirements

The FAP continuous monitoring network is composed of nine continuous monitoring stations and a tenth portable station that measure 20 air quality parameters along with meteorological conditions. The nine permanent continuous monitoring stations are all in the southern portion of the Airshed around population centres, industrial facilities, and downwind of these source areas. These stations each have individual objectives to focus on monitoring where people live (population exposure), characterizing regional sources, characterizing local industrial emissions, or characterizing air quality in a protected national park. The portable station moves around the Airshed to deal with short term projects or emerging issues. Monitoring and reporting protocols are structured to meet the requirements of the Alberta Government Air Monitoring Directive.

Several industrial facilities hold Environmental Protection and Enhancement Act (EPEA) operating approvals, or authorizations, and are required to either conduct, or fund through an Airshed such as FAP, ambient air quality monitoring as part of their conditions to operate. The FAP continuous monitoring stations, with the corresponding Approval holders as of December 31, 2018, are listed in Appendix C.

The FAP Network Monitoring Objectives

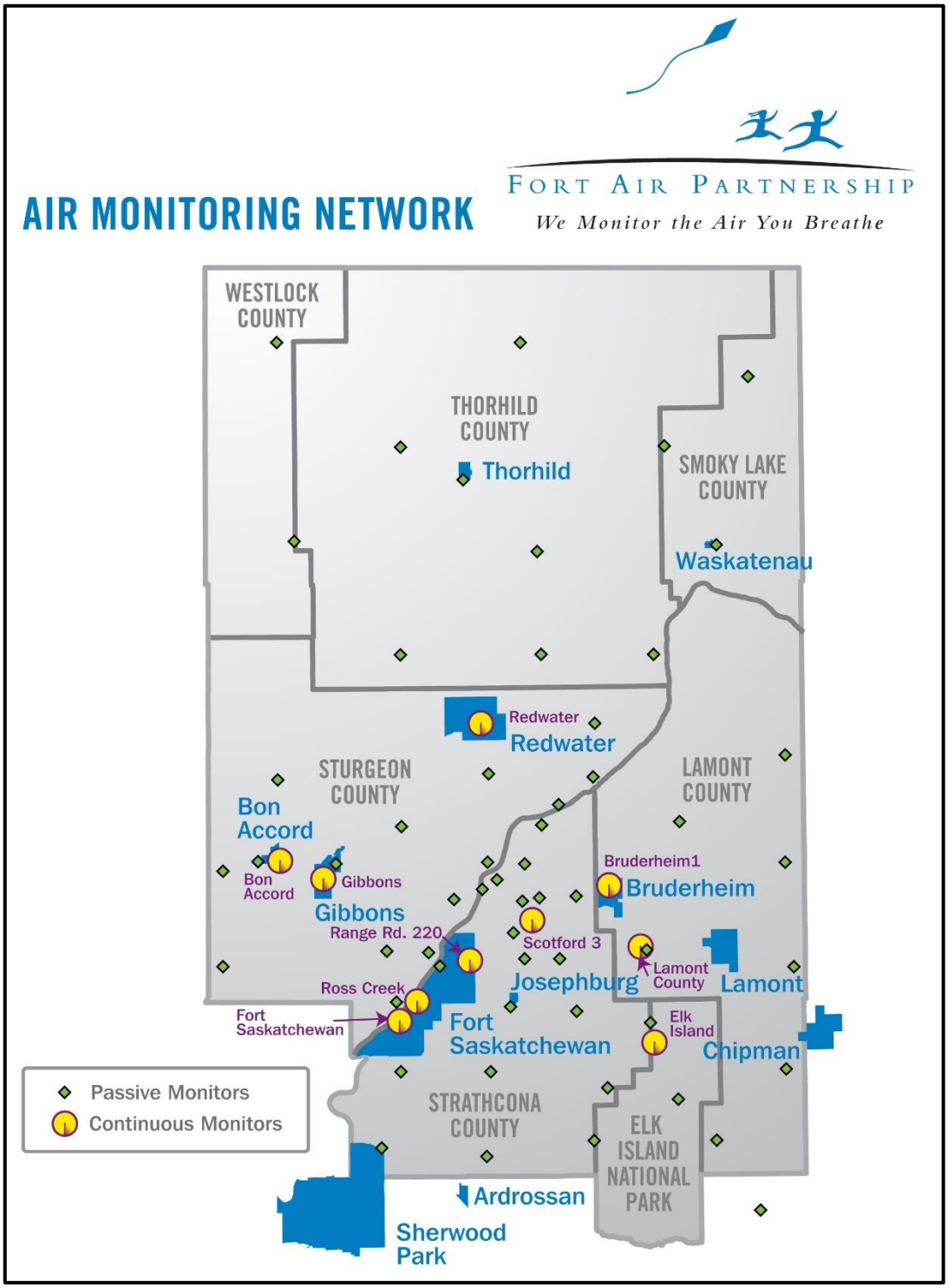
FAP has established several monitoring objectives to ensure that it meets the needs of all its stakeholders. These objectives guided a Network Assessment completed by an independent third party in 2012. FAP developed a comprehensive monitoring plan using the findings of that network assessment in 2015. This monitoring plans is revised as needed according to AMD requirements with updates of progress made on projects. These updates are provided to AEP every six months. While the design and operation of the monitoring network strives to meet FAP monitoring objectives, the overarching objective is that the monitoring must, at a minimum, meet regulatory requirements as set out by the Alberta Government including both Alberta Environment and Parks and the Alberta Energy Regulator.

The monitoring objectives for the FAP network are as follows:

- Understand spatial distribution of pollutants in the region
- Identify regional air quality trends
- Provide flexibility to characterize emerging issues, sources, and locations
- Provide appropriate information for evaluating population exposure to ambient air quality
- Provide information required to understand air quality impacts on the health of the environment
- Improve the ability to identify and apportion pollutant sources for purposes of air quality management
- Provide suitable input and validation information for air quality models

A clear, multi-layer, fine resolution map of the FAP Airshed with selectable layers can be downloaded at www.fortair.org or requested at info@fortairmail.org.

Figure 2: FAP Monitoring sites at December 31, 2018



FAP Continuous Monitoring Site Descriptions

Bruderheim 1 Station

Primary Monitoring Objective: To monitor ambient air quality where people live. For a complete list of monitoring objectives, see table in Appendix B.

Continuous Parameters Monitored: Methane and non-methane hydrocarbons, $NO/NO_X/NO_2$, ozone, $PM_{2.5}$, SO_2, ambient temperature, wind speed and direction. This station collects the data required to calculate the Air Quality Health Index.

Figure 3: Bruderheim 1 Station

Site Description: FAP has been operating a station in Bruderheim and reporting data to the Provincial Air Monitoring data warehouse since 2010. This station, formerly named Bruderheim was moved to the northwest corner of the Bruderheim school sports fields in 2016 and renamed Bruderheim 1. Bruderheim population is listed as 1,308 in the most recent census (2016).

Station changes (2018): A new 10-meter collapsible tower for the wind sensor was installed at the Bruderheim 1 station in 2018.

Elk Island Station

Primary monitoring objective: Understand the air quality impacts of a large Canadian city and concentrated heavy industry on a protected area. For a complete list of monitoring objectives, see table in Appendix B.

Continuous parameters monitored: $NO/NO_X/NO_2$, ozone, $PM_{2.5}$, SO_2, outdoor temperature and relative humidity, wind speed and wind direction. A wet deposition sampler is also at the site. This station collects the data required to calculate the Air Quality Health Index.

Figure 4: Elk Island Station

Site Description: This station is located within the boundaries of Elk Island National Park, between the administration building and Astotin Lake,

near the west entrance to the park at Township Road 544 near Range Road 203. FAP has been operating this station and reporting data to the Provincial Air Monitoring data warehouse since January 2003. This station was designated a National Air Pollution Surveillance (NAPS) station in 2008.

Station changes (2018): A new shelter (pictured) supplied by AEP replaced the old shelter at Elk Island Park in late 2018.

Fort Saskatchewan Station

Primary monitoring objective: Monitor air quality where people live and to establish air quality compliance to the AAAQOs. With the longest operational history and data record in the FAP network, it is an important station for understanding historical trends. It is a designated NAPS station. For a complete list of monitoring objectives, see table in Appendix B.

Continuous parameters monitored: Ammonia, carbon monoxide, H_2S, methane and non-methane hydrocarbons, $NO/NO_X/NO_2$, ozone, $PM_{2.5}$, SO_2, outdoor temperature and relative humidity, wind speed and direction. This station collects the data required to calculate the Air Quality Health Index.

Site description: This station is in the Airshed's largest population center (25,533 in 2017 census). It is located adjacent to a residential area of the City of Fort Saskatchewan near 92nd Street and 96th Avenue, 80 meters west of Highway 15, a major traffic artery, with an annual average daily traffic count of 20,770 vehicles per day in 2013. FAP has been operating this station and reporting data to the Provincial Air Monitoring data warehouse since January 2003. Data from this site goes back to 1993 in the Provincial Air Monitoring data warehouse.

Figure 5: Fort Saskatchewan Station

Gibbons Station

Primary Monitoring Objective: To monitor ambient air quality where people live. For a complete list of monitoring objectives, see table in Appendix B.

Continuous Parameters Monitored:
H_2S, $NO/NO_X/NO_2$, ozone, $PM_{2.5}$, SO_2, outdoor temperature and relative humidity, wind speed and direction. This station collects the data required to calculate the Air Quality Health Index.

Figure 6: Gibbons Station

Site Description: This station began operating and reporting data to the Provincial Air Monitoring data warehouse in February 2016. Alberta Environment and Parks has loaned FAP a $PM_{2.5}$ analyzer to enable the collection of data required to calculate the AQHI for this station. This station is at the rear of the Gibbons Town office located on 50th Avenue at 48th Street. Gibbons population is listed as 3,159 in the most recent census (2016).

Lamont County Station

Primary monitoring objective: Understand impacts of multiple pollutant sources in the region, which may include sources from Alberta's Industrial Heartland and from Strathcona industrial area, as well as from other sources in the City of Edmonton. This site was selected because modeling indicated that this elevated area of the region may experience higher concentrations of SO_2. The Lamont County Station is an EPEA compliance station. For a complete list of monitoring objectives, see table in Appendix B.

Figure 7: Lamont County Station

Continuous parameters monitored: H_2S, methane and non-methane hydrocarbons, $NO/NO_X/NO_2$, ozone, $PM_{2.5}$, SO_2, outdoor temperature and relative humidity, wind speed and direction. This station collects the data required to calculate the Air Quality Health Index. FAP has been operating this station and reporting data to the Provincial Air Monitoring data warehouse since January 2003.

Site description: This station is in a rural area located in a hay field, several kilometers away from industrial facilities and other large pollutant sources, approximately 6 km west of the town of Lamont. The station is on a hill, 1.5 kilometers south of Highway 15, about 250 meters west of Range Road 202.

Portable Station

Primary monitoring objective: The portable is used to meet various objectives depending on the specific location and/or project. Along with FAPs stated monitoring objectives the portable can also respond to local air quality concerns as is being done in the Town of Bon Accord. For a complete list of monitoring objectives, see table in Appendix B.

Continuous parameters monitored: H_2S, $NO/NO_X/NO_2$, SO2, outdoor temperature and relative humidity, wind speed and direction. Other parameters can be added as required to meet project monitoring objectives.

Site description: In 2018 the station was located on the southeast section of the town of Bon Accord at 48 avenue and 49 street. The station has been operating and reporting data to the Provincial Air Monitoring data warehouse since April 2018.

Portable changes (2018): The portable was deployed in the Town of Bon Accord.

Figure 8: Portable Station at Bon Accord

Range Road 220 Station

Primary monitoring objective: Monitor the impacts of local industrial emissions on air quality. For a complete list of monitoring objectives, see table in Appendix B.

Continuous parameters monitored: Ethylene, methane and non-methane hydrocarbons, $NO/NO_X/NO_2$, barometric pressure, outdoor temperature and relative humidity, wind speed and direction.

Site description: The station is located off Range Road 220 in an open area along the facility fence line east of the Dow Chemical ethylene production facilities. FAP has been operating this station and reporting data to the Provincial Air Monitoring data warehouse since January 2003.

Figure 9: Range Road 220 Station

Redwater Station

Primary monitoring objective: To monitor ambient air quality where people live. For a complete list of monitoring objectives, see table in Appendix B.

Continuous parameters monitored: **A**mmonia, $NO/NO_X/NO_2$, ozone, $PM_{2.5}$, SO_2, outdoor temperature and relative humidity, wind speed and direction.

Figure 10: Redwater Station

Site description: The Redwater air quality monitoring station was established in October 2017, replacing the Redwater Industrial station. A suitability assessment that was commissioned by FAP in 2017 identified this location as appropriate for enabling FAP to meet the set monitoring objectives. It is located near the center of the town of Redwater at 47th street and 49th avenue, just south of the town administration offices. The town of Redwater population is 2053 as of the most recent census (2016).

Ross Creek Station

Primary monitoring objective: To monitor the impacts of local industrial emissions on air quality. For a complete list of monitoring objectives, see table in Appendix B.

Continuous parameters monitored: Ammonia, ethylene, $NO/NO_X/NO_2$, SO_2, barometric pressure, solar radiation, relative humidity, temperature at 2 meters and 10 meters, vertical wind speed, wind speed and direction.

Site description: The station is located west of the Sherritt Fort Saskatchewan site, between the industrial facility and the City of Fort Saskatchewan. FAP has been operating this station and reporting data to the Provincial Air Monitoring data warehouse since January 2003.

Figure 11: Ross Creek Station

Scotford Temporary Station

The Scotford Temporary Station began operation at the current location in 2014. It is a relocation of the former Scotford 2 station.

Primary objective: The station is intended to monitor the impacts of local industrial emissions on air quality. The Scotford Temporary station is intended to meet EPEA operating approval conditions of two Approval holders. For a complete list of monitoring objectives, see table in Appendix B.

Continuous parameters monitored: H_2S, $NO/NO_X/NO_2$, SO_2, benzene, toluene, ethylbenzene, xylenes (o-, m- and p- isomers), styrene, outdoor temperature and relative humidity, wind speed and direction.

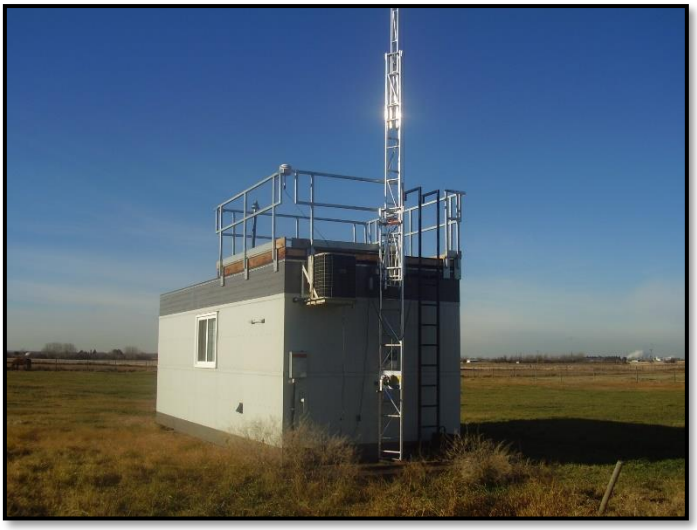


Figure 12: Scotford Temporary Station

Site description: The monitoring site is located to the south east of industrial facilities on Range Road 212, approximately 2 kilometers south of Highway 15. The station is in an open area located within a farmyard. The monitoring station was moved from the Scotford 2 location and began operation at this site in April 2014.

Monitoring Station Coordinates

Longitude and latitude coordinates for the FAP monitoring stations in 2018 are found in the following table.

Table 9: Continuous monitoring station locations

Station	Latitude	Longitude	Elevation	Year Established	Land Use
Bruderheim 1	53.805629 N	-112.925851 W	630 m	Mar 2016	Residential
Elk Island	53.68236 N	-112.86806 W	711 m	2003	Parkland
Fort Saskatchewan	53.69883 N	-113.22319 W	629 m	Jan 2003	Residential
Gibbons	53.827241 N	-113.327174W	673 m	Feb 2016	Residential
Lamont County	53.76036 N	-112.88017 W	727 m	Jan 2003	Agricultural
Portable at Bon Accord	53.835190 N	-113.409146 W	693	April 2018	Residential
Range Road 220	53.75245 N	-113.12582 W	625 m	Jan 2003	Industrial
Redwater	53.951834 N	-113.105857 W	627 m	Oct 2017	Residential
Ross Creek	53.71622 N	-113.19994 W	624 m	Jan 2003	Industrial
Scotford Temporary	53.756786 N	-113.028947 W	626 m	May 2014	Agricultural

Note: the year established reflects the date when data from that station was first reported to the Alberta Government Air Monitoring data warehouse

Continuous Monitoring Methods

Continuous monitoring methods are generally prescribed by the Alberta Government's Air Monitoring Directive. Details of the monitoring methods used by FAP are summarized in Appendix E.

Data Reporting

FAPs air monitoring data is reported in several ways:

- FAP maintains a near-real-time data portal for raw un-validated data for use by its members and the public at http://data.fortair.org/fortair.php
- Live, un-validated data is also reported hourly to the Alberta Government and retained for 225 days on the real-time website at: http://maps.srd.alberta.ca/AQHI/
- If the Air Quality Health Index approaches the *High Risk* to health category, medical officers from the local health authority are notified by Alberta Environment and Parks. Medical officers then decide whether to issue a public health or air quality advisory.
- Validated historical data, suitable for use in analysis and reports, is available from the Alberta Government air data warehouse website at: http://airdata.alberta.ca/
- Passive monitoring data tables are available upon request at info@fortairmail.org and at http://airdata.alberta.ca/

2018 Passive Monitoring Network

Passive Monitoring Description

Passive monitoring is a cost-effective solution for monitoring air quality at locations where continuous monitoring is not practical. Passive sampling devices can monitor air pollutants without the need for electricity, data loggers or pumps. Passive sampling devices are lightweight, portable and relatively simple to operate. No active movement of air through the sampler is necessary.

Passive sampling involves the exposure of a reactive surface to the air. Transfer of the pollutant occurs by diffusion from the air to the surface via naturally occurring air movement. The surface consists of a membrane that is impregnated with a reactive solution. The sampling devices are mounted under a hood to protect it from rain or snow. Samplers are exposed for one month and analysis is completed in a laboratory.

A major advantage of using a passive sampling system is that a network of multiple samplers can be used over a large area to determine the spatial variation of pollutant levels. Passive samplers are also useful for looking at long-term trends of air pollutants at specific locations. However, since a sample is exposed for a month, events that last for a short time may be "averaged out".

Figure 13: Passive monitoring site

Figure 14: Changing passive monitoring devices

FAP Passive Monitoring Network

The passive samplers used by FAP monitor for monthly average concentrations of pollutants. As of January 1, 2018, FAP added 6 additional sites to the network bringing the total number of sites in the network of passive monitors to 63 different locations. Thirty-seven (43) of these sites measure both sulphur dioxide (SO_2) and hydrogen sulphide (H_2S). Fourteen sites measure just SO_2 while 6 measure only H_2S. Samples are exchanged within three days of the end of each month and sent to a laboratory for analysis. Results from the passive monitors are submitted each month to the Alberta Government.

Passive Monitoring Network Site Descriptions

Passive samplers are intended to gather information over a broad spatial area and to measure trends over time. The majority of FAP passive monitoring sites are not selected based on a high likelihood of impingement, but rather on a spatial grid to establish a picture of comparative air quality throughout the Airshed. A few passive monitoring sites are located near local emission sources instead of on the spatial grid, which should be considered when interpreting the data.

The site coordinates and parameters measured at each passive monitoring site are listed in Table 10. Some sites are named if there is a recognizable nearby landmark or reference. To locate the sites, see the map in Figure 2.

Table 10: FAP passive monitoring sites in 2018

Site	Location	Longitude	Latitude	SO_2	H_2S	Date Started
1	Stocks Greenhouses	-113.246659	53.59633	1		July 1, 2005
2	Ardrossan northeast	-113.098671	53.58718	1		July 1, 2005
3	NE of Bruderheim	-112.82701	53.86667	1		July 1, 2005
4	Waskatenau	-112.77622	54.09875	1	1	July 1, 2005
5	Thorhild	-113.1331	54.15233	1		July 1, 2005
7	Bon Accord	-113.42423	53.83382	1		July 1, 2005
8	Gibbons	-113.31595	53.83163	1		July 1, 2005
10	Fort Augustus	-113.188293	53.75116	1		July 1, 2005
11	North of BA	-113.04892	53.83195	1		Jan 1,2006
12	TwpRd 564A RgeRd 212	-113.02542	53.86578	1	1	Jan 1,2006
14	Astotin Creek	-113.02553	53.80367		1	Jan 1,2006
15	Hwy 830 Twp Rd 560	-112.9765	53.80435	1		Jan 1,2006
17	Rge Rd 213 TwpRd 552	-113.04988	53.75373		1	Jan 1,2006
18	Rge Rd 211 TwpRd 552	-113.00044	53.74747	1	1	Jan 1,2006
20	Rge Rd 202	-112.87668	53.75937	1	1	Jan 1,2006

Table 10: FAP passive monitoring sites in 2018 - continued

Site	Location	Longitude	Latitude	SO_2	H_2S	Date Started
21	Josephburg east	-112.97535	53.70952	1	1	Jan 1,2006
22	Elk Island Park west gate	-112.87693	53.6876	1	1	Jan 1,2006
23	Goodhope	-112.95082	53.65668	1	1	Jan 1,2006
24	North of Scotford	-113.08703	53.82035	1	1	Jan 1,2006
26	Twp Rd 560 Rge Rd 221	-113.15109	53.8034	1	1	Jan 1,2006
27	N Sask. boat launch	-113.00035	53.88125	1	1	Jan 1,2006
28	Redwater Natural Area S	-112.95077	53.90445	1		Jan 1,2006
29	Redwater Natural Area N	-112.95213	53.94892	1	1	Jan 1,2006
30	Redwater south	-113.10012	53.9343	1	1	Jan 1,2006
31	Northwest of Scotford	-113.10838	53.81068	1	1	Aug 1,2006
32	Degussa	-113.1322	53.83328	1	1	Aug 1,2006
33	Twp Rd 552 Rge Rd 225	-113.24816	53.74508	1	1	Aug 1,2006
34	C&C Tree Farm	-113.48362	53.74538	1		Aug 1,2006
35	Bon Accord southwest	-113.47148	53.82524	1	1	Aug 1,2006
36	Galloway Seed	-113.22421	53.6576		1	Aug 1,2006
37	Twp Rd 564 Rge Rd 224	-113.22356	53.86307	1	1	Aug 1,2006
38	Peno	-112.67866	53.92182	1	1	Aug 1,2006
39	Saint Michael	-112.67831	53.83245	1	1	Aug 1,2006
40	Lamont east	-112.70287	53.74522	1	1	Aug 1,2006
41	Lily Lake	-113.39769	53.91981		1	Nov 1,2007
42	Radway - Val Soucy	-113.02451	54.00701	1	1	Nov 1,2007
43	Keyera Site	-113.16707	53.74515	1	1	Nov 1,2007
45	Scotford east	-113.06388	53.77449	1		Nov 1,2007
46	Josephburg	-113.0693	53.71279	1	1	Nov 1,2007
47	Southeast of FAP	-112.71777	53.54142	1		Nov 1,2007
48	Highway 63	-113.03010	54.09331	1	1	Aug 1,2008
49	Namepi Creek	-112.86401	54.00712	1	1	Aug 1,2008
50	Sprucefield	-112.84794	54.18045	1	1	Aug 1,2008
51	Hollow Lake	-112.72578	54.23882	1	1	Aug 1,2008
52	Abee	-113.05062	54.26821	1	1	Aug 1,2008
53	Tawatinaw - Clearbrook	-113.40057	54.26815	1	1	Aug 1,2008
54	Elbridge	-113.22504	54.18131	1	1	Aug 1,2008
55	Taylor Lake	-113.37483	54.10185	1	1	Aug 1,2008
56	Opal	-113.22475	54.00706	1	1	Aug 1,2008
57	Scotford 2	-113.05088	53.80118	1	1	Aug 1,2008
58	Ft Saskatchewan	-113.22319	53.69883	1	1	July 1,2015
59	Partridge Hill	-113.09843	53.65791	1	1	June 1, 2010
60	Oxbow Lake	-112.95166	53.59954	1	1	June 1, 2010
61	Drygrass Lake	-112.77896	53.59954		1	June 1, 2010
62	FAP East boundary	-112.68102	53.65779	1	1	June 1, 2010

Table 10: FAP passive monitoring sites in 2018 - continued

Site	Location	Longitude	Latitude	SO_2	H_2S	Date Started
63	Elk Island Park	-112.85717	53.63338		1	June 1, 2010
64	Agrium Redwater	-113.09922	53.84369	1		July 1, 2015
66	Plains Midstream # 1	-113.14935	53.75258	1	1	Jan 1, 2018
67	Plains Midstream # 2	-113.16301	53.75970	1	1	Jan 1, 2018
68	ARC Resources Site 1	-113.07492	53.95639	1	1	Jan 1, 2018
69	ARC Resources Site 2	-113.06591	53.96872	1	1	Jan 1, 2018
70	ARC Resources Site 3	-113.07796	53.94359	1	1	Jan 1, 2018
71	ARC Resources Site 4	-113.02543	53.92183	1	1	Jan 1, 2018

Passive Monitoring for Compliance to EPEA Approvals

FAP performs passive monitoring on behalf of approval holders, per Table 11. Air quality monitoring reports are submitted monthly to the Alberta Government. Data is archived in the Government data warehouse.

Table 11: Passive monitoring requirements (December 31, 2018)

Passive Monitoring Network	Facility	EPEA Approval Number
FAP operates a total of 57 SO_2 locations 49 H_2S locations on behalf of partners	ACCEL Energy (4 sites H_2S, 4 sites SO_2)	150-03-02
	Keyera Energy (4 sites H_2S, 4 sites SO_2)	10235-02-03
	Pembina NGL (2 sites H_2S, 2 sites SO_2)	9995-02-05
	Plains Midstream (2 sites H_2S, 2 sites SO_2)	10081-03-00

2018 Monitoring Results

2018 Ambient Air Monitoring Data and Discussion

Continuous Monitoring Results by Compound

Ammonia

Ammonia (NH_3) is a colourless gas with the well-known pungent odour found in household cleaners. NH_3 can be produced by both natural and anthropogenic sources. Some natural sources of NH_3 include the decay of plant material and animal waste. A small portion is also released during respiration. In Alberta, the fertilizer industry is the main industrial source of NH_3. This industry produces synthetic NH_3 for either direct application to soil as a fertilizer, or as a raw material for use in the production of other high nitrogen fertilizer products. The other significant source of NH_3 in Alberta is commercial livestock feedlots, specifically from their large amounts of animal waste.

Sources of ammonia in the Airshed are primarily from industrial sources in the production of fertilizer but can also be formed from natural sources such as the decay of plant material and animal waste.

The AAAQO for ammonia is:

- 1-hour average concentration 2000 ppb

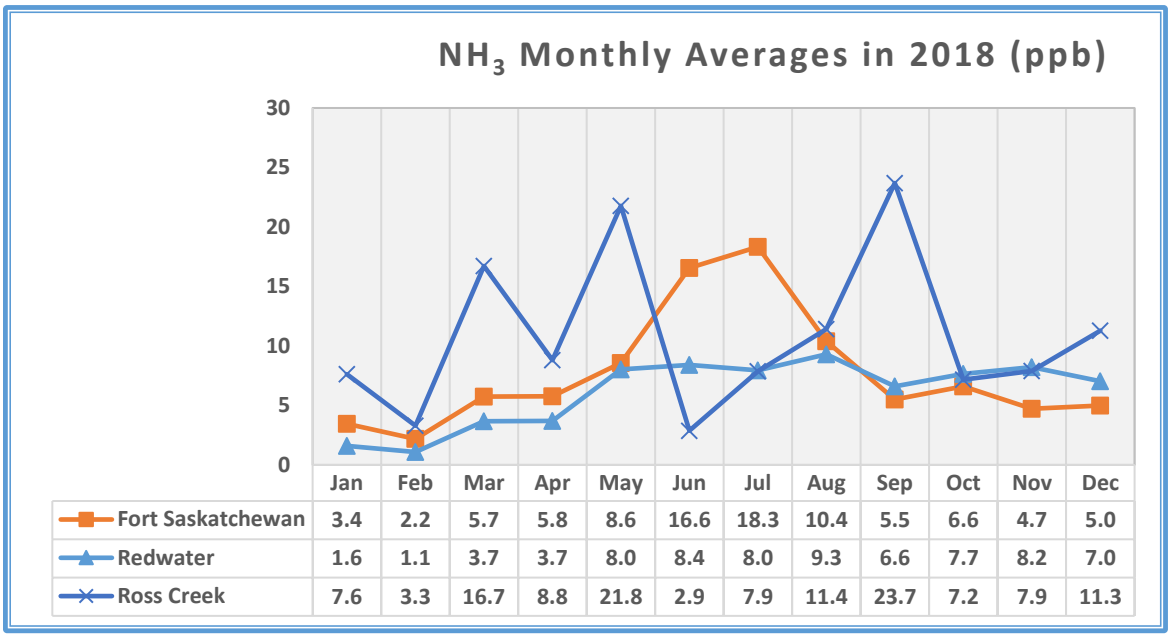
There were no exceedances of the NH_3 AAAQO recorded at any FAP stations in 2018.

Comparing air quality monitoring data at the three FAP stations that measure NH_3 in the FAP region for 2018 against the ammonia AAAQO, it was observed that the maximum 1-hour average concentration of NH_3 was 822 ppb measured at the Ross Creek station in September. The measurement is approximately 41% of the 1-hr AAAQO.

A summary of NH_3 concentrations recorded in 2018 at individual stations and a comparison with the previous 6 years is presented in the figures and tables below.

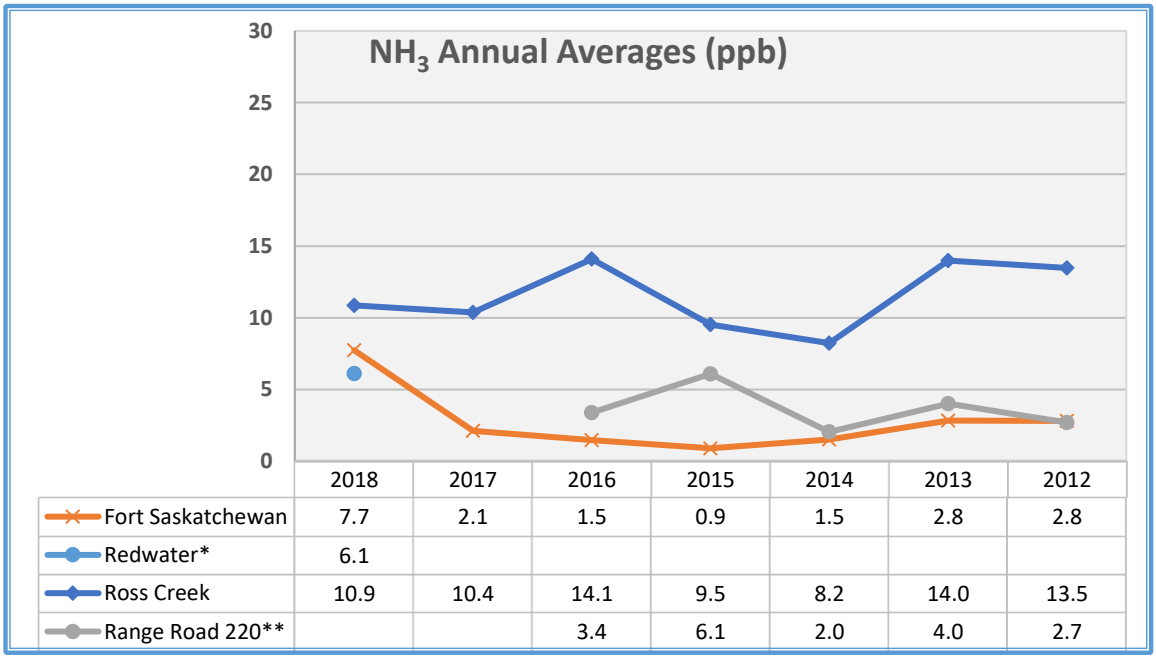
Ammonia (continued)

Figure 15: Monthly average NH_3 concentrations (ppm) in 2018



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fort Saskatchewan	3.4	2.2	5.7	5.8	8.6	16.6	18.3	10.4	5.5	6.6	4.7	5.0
Redwater	1.6	1.1	3.7	3.7	8.0	8.4	8.0	9.3	6.6	7.7	8.2	7.0
Ross Creek	7.6	3.3	16.7	8.8	21.8	2.9	7.9	11.4	23.7	7.2	7.9	11.3

Figure 16: Annual average NH_3 concentrations (ppm) - historical



	2018	2017	2016	2015	2014	2013	2012
Fort Saskatchewan	7.7	2.1	1.5	0.9	1.5	2.8	2.8
Redwater*	6.1						
Ross Creek	10.9	10.4	14.1	9.5	8.2	14.0	13.5
Range Road 220**			3.4	6.1	2.0	4.0	2.7

***** The Redwater station began operation October 2017

** Ammonia monitoring was stopped at Range Road 220 in January 2017

Carbon Monoxide

Carbon monoxide (CO) is a colourless, odourless gas present in small amounts in the atmosphere primarily from incomplete combustion of carbon-based fuels such as gasoline, oil and wood. The major source of CO in urban locations is motor vehicle exhaust emissions. Minor sources include fireplaces, industry, aircraft and natural gas combustion. Forest fires are also a significant natural source of CO.

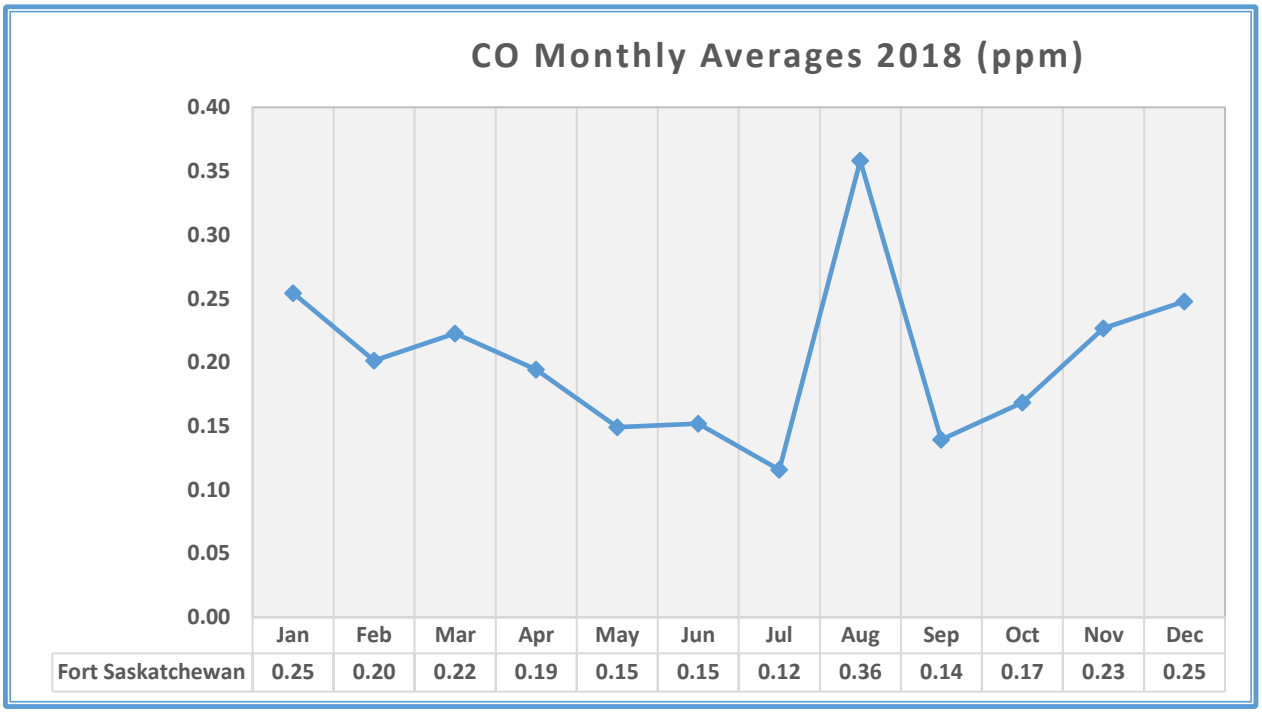
The AAAQOs for carbon monoxide are:

- 1-hour average concentration 13 ppm
- 8-hour average concentration 5 ppm

Comparing air quality monitoring data for 2018 at Fort Saskatchewan station against the AAAQOs for carbon monoxide, it was observed that the maximum 1-hour average concentration of CO was 1.55 ppm in August, about 12% of the 1-hr AAAQO.

Graphs of CO concentrations recorded at Fort Saskatchewan station, the only FAP station that monitors CO and a comparison with the previous 7 years is presented in the figures below.

Figure 17: Monthly average CO concentrations Fort Saskatchewan – 2018

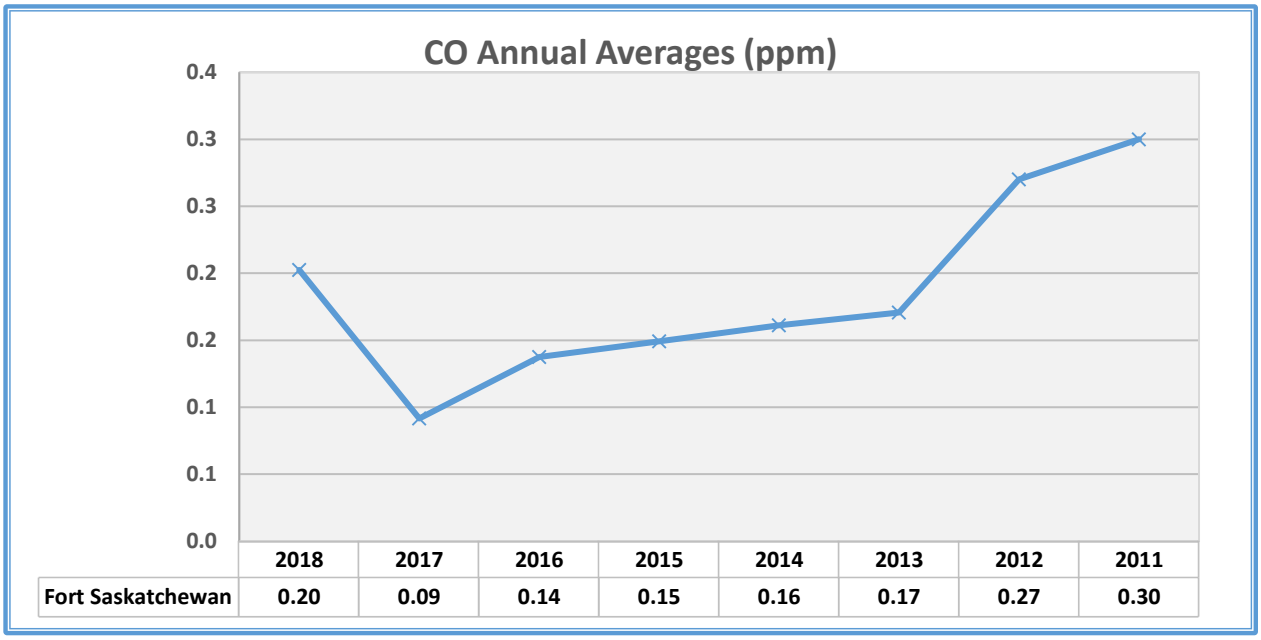


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fort Saskatchewan	0.25	0.20	0.22	0.19	0.15	0.15	0.12	0.36	0.14	0.17	0.23	0.25

The higher than usual CO measured in August was likely due to the extended periods with heavy forest fire smoke experienced in the entire region.

Carbon Monoxide (continued)

Figure 18: Annual average CO concentrations Fort Saskatchewan (ppm) – historical



	2018	2017	2016	2015	2014	2013	2012	2011
Fort Saskatchewan	0.20	0.09	0.14	0.15	0.16	0.17	0.27	0.30

Ethylene

Ethylene is a naturally occurring compound in ambient air. It is produced at low levels by soil microorganisms, algae, lichens and plants. Other natural sources of ethylene include volcanic activity and combustion in forest and grass fires. In Alberta, the concentration in ambient air resulting from these natural sources is typically low.

Anthropogenic sources of ethylene include combustion of fossil fuels, and processing of natural gas in petrochemical facilities (e.g. production of plastics).

The AAAQOs for ethylene are:

- 1-hour average concentration 1044ppb
- 3-day average 40 ppb
- Annual mean 26 ppb

Comparing air quality monitoring data for 2018 in the FAP region against the AAAQOs for ethylene, it was observed that:

- There were no exceedances of the AAAQO for ethylene in 2018.
- The maximum one-hour average concentration measured in 2018 was 334.6 ppb at Range Road 220 station on May 11th (32% of the AAAQO).
- The maximum 3-day average concentration measured in 2018 was 14.7 ppb at the Ross Creek station from November 12th to 14th (37% of the AAAQO).
- The annual average at Range Road 220 was 1.7 ppb (6.5% of the annual objective) and Ross Creek 1.6 ppb (6.1% of the annual objective).

A summary of ethylene concentrations recorded in 2018 at individual stations and a comparison with the previous 6 years are presented in the figures and tables below.

Ethylene (continued)

Figure 19: Monthly average Ethylene concentrations (ppb) in 2018

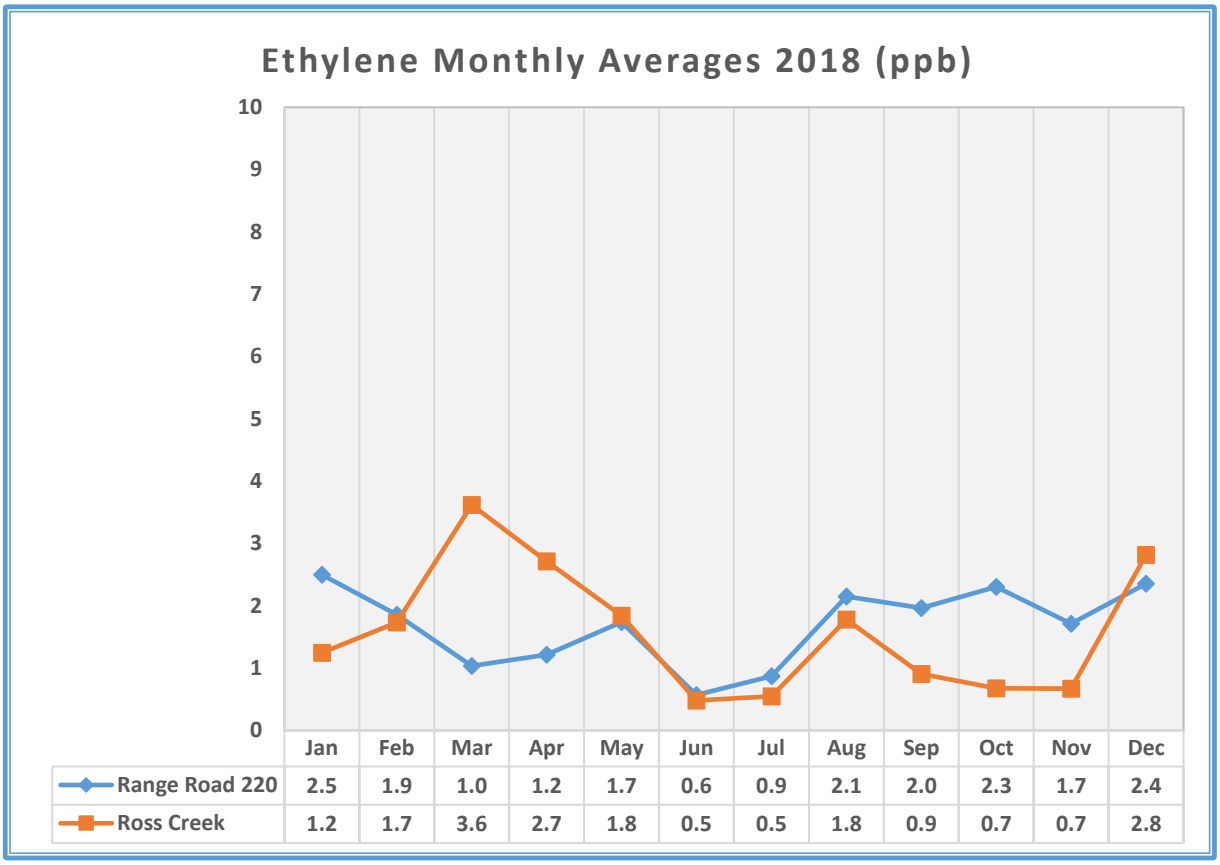
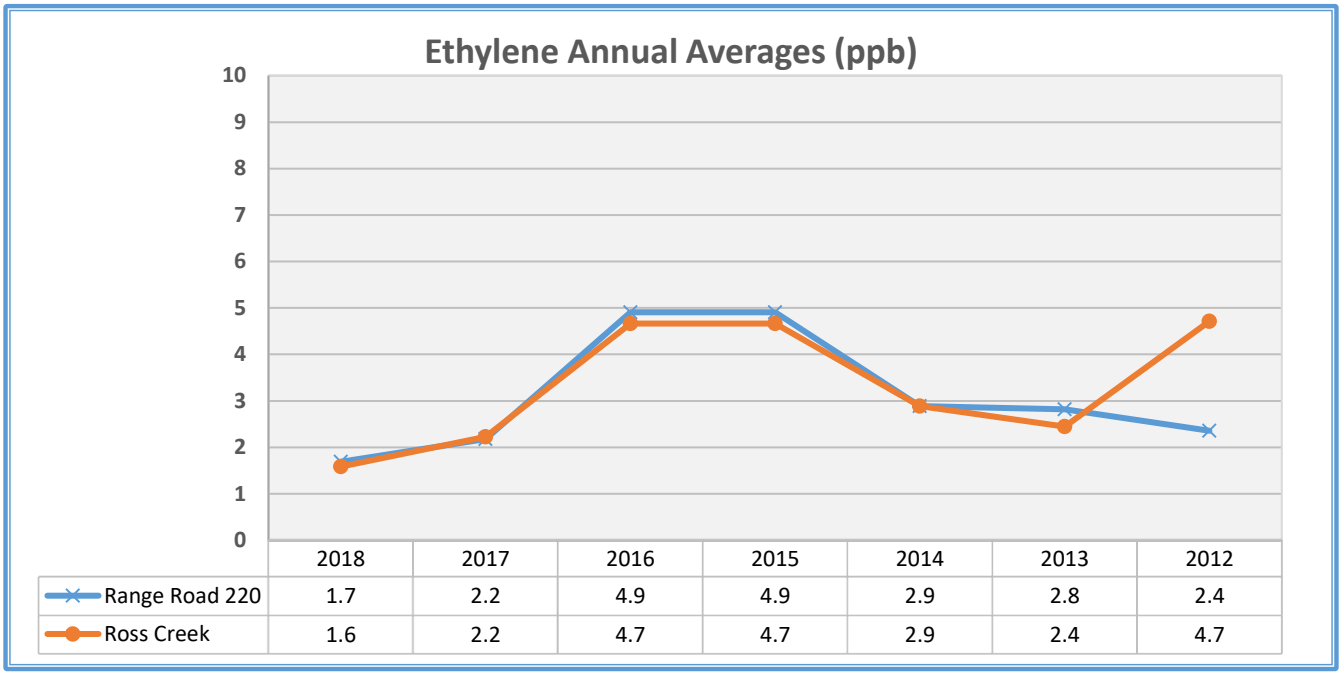


Table 12: Maximum 1-hour average Ethylene concentrations (ppb) in 2018

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Range Road 220	75.0	38.2	24.6	77.6	334.6	31.2	27.2	60.2	23.3	72.7	37.4	55.1
Ross Creek	60.4	13.3	52.8	18.6	90.5	7.1	41.2	107.3	5.5	7.0	13.9	74.9

Ethylene (continued)

Figure 20: Annual average Ethylene concentrations (ppb) - historical



	2018	2017	2016	2015	2014	2013	2012
Range Road 220	1.7	2.2	4.9	4.9	2.9	2.8	2.4
Ross Creek	1.6	2.2	4.7	4.7	2.9	2.4	4.7

Fine Particulates ($PM_{2.5}$)

Fine particulate matter (PM2.5) consists of tiny particles, 2.5 microns in size and smaller. In comparison, a strand of human hair is about 70 microns in width. Sources of PM2.5 include soil, roads, agricultural dust, vehicles, industrial emissions, smoke from forest fires, cigarettes, household heating, fireplaces and barbecues. Secondary particulate matter may also be produced in the atmosphere through complex chemical processes involving other substances. Particulates can come from both solid matter and liquid aerosols.

In high concentrations, suspended particulates may lead to human health problems. Inhaling particulate matter can make breathing more difficult or may aggravate existing lung and heart problems. Smaller particles have the ability to travel deep into the lungs where they may cause permanent lung damage.

Higher values of $PM_{2.5}$ typically occur during winter temperature inversions when air movement is limited, or in summer during periods of very warm weather with little or no wind coupled with smoke from forest fires. Periods of higher particulate measurements in 2017 occurred through July and August when Alberta experienced smoke from wildfires in British Columbia for extended periods. When higher particulate measurements did occur, it was most often seen throughout the Airshed and the larger Capital Region area. These higher values were measured at several stations at the same time and were often slow to disperse depending on weather patterns in British Columbia and Alberta.

The AAAQO for $PM_{2.5}$ is:

- 24-hour average concentration 30 µg/m^3

There is also an Air Quality Guideline for $PM_{2.5}$:

- 1-hour average concentration 80 µg/m^3

A one-hour average concentration of 80µg/m^3 will trigger an AQHI in the "High Risk' category.

There is also a national standard (CAAQS) for $PM_{2.5,}$ just as there is for ozone (O_3) as described in the section above.

The following figure summarizes the CAAQS management level and threshold for $PM_{2.5}$. Alberta's six air zones are assessed for achievement against these values. Fort Air Partnership falls within the North Saskatchewan Air Zone.

Figure 21: Air Quality Management System Thresholds

Air Management Threshold Values				
	Substance:	Ozone	$PM_{2.5}$	
	Averaging time:	8 Hours	Annual	24 Hours
Management Level	Red	Actions for Achieving Air Zone CAAQS		
	Threshold:	63 ppb	10.0 µg/m^3	28 µg/m^3
	Orange	Actions for Preventing CAAQS Exceedance		
	Threshold:	56 ppb	6.4 µg/m^3	19 µg/m^3
	Yellow	Actions for Preventing Air Quality Deterioration		
	Threshold:	50 ppb	4.0 µg/m^3	10 µg/m^3
	Green	Actions for Keeping Clean Areas Clean		

All provinces and territories including Alberta must annually report the status of air quality as compared to these national standards. The 2014-2016 Alberta Air Zones Report was released in November of 2018.

Fine Particulates (continued)

Comparing air quality monitoring data in the Fort Air Partnership region for 2018 against the AAAQO, it was observed that there were 810 1-hour Guideline exceedances and 117 24-hour AAAQO exceedances of fine particulates ($PM_{2.5}$) throughout the network. The majority of these exceedances were in August and attributed to smoke from wildfires in British Columbia Only 4 of the 1-hour and 8 of the 24-hour exceedances were attributed to a cause other than wild fire smoke.

The highest 1-hour average recorded was386.7 µgr/m^3 occurring on August 18th at Gibbons, 483% of the Guideline. There were 3 1-hour averages recorded that were greater than 400% of the Guideline and 37 1-hour averages recorded greater than 300% of the Guideline.

The following tables break down the exceedances and the attributed causes at each station.

Table 13: 2018 1-hour average exceedances of the AAAQG for $PM_{2.5}$

Station	Highest 1 hour average (µgr/m^3)	Exceedances	Date(s)	Attributed Cause
Gibbons	105.1	1	January 20	Localized source/event
Gibbons	88.2	1	March 14	Winter inversion
Bruderheim1	81.6	1	May 14	Brush fires near Bruderheim
Gibbons	81	1	July 3	Regional conditions
Bruderheim1 Elk Island, Fort Sask, Gibbons, Lamont Cnty, Redwater, Bon Accord	386.7	806	August 7-26	Wildfire smoke

Fine Particulates (continued)

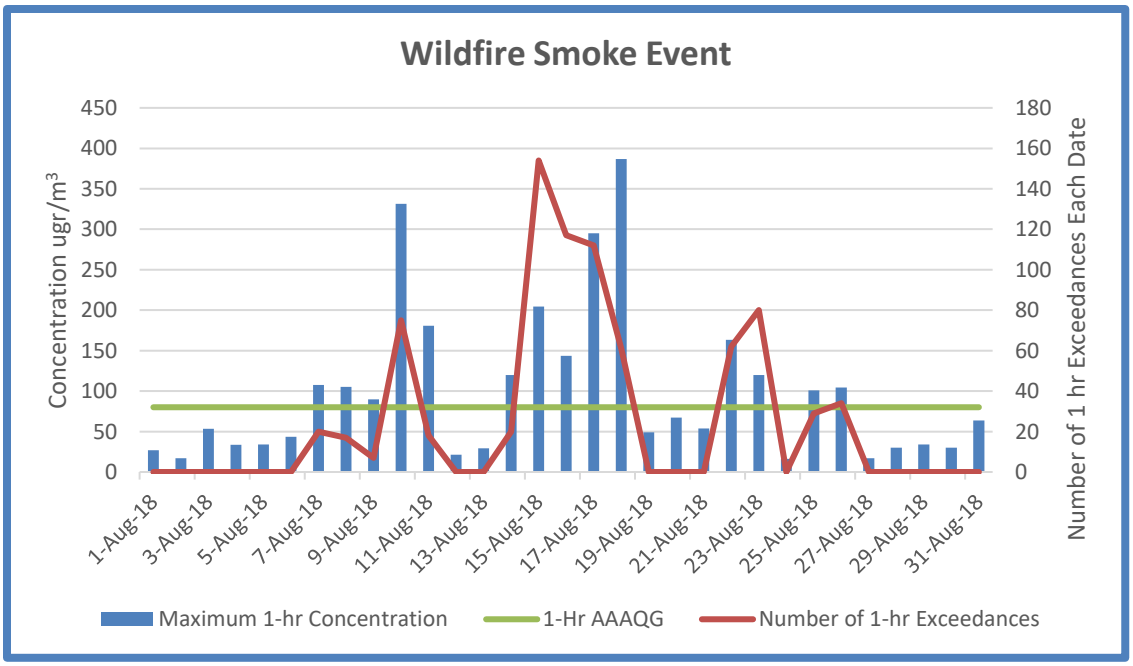
Table 14: 2018 24-hour average exceedances of the AAAQO for $PM_{2.5}$

Station	Highest 24 hour average (µgr/m³)	Exceedances	Date(s)	Attributed Cause
Fort Saskatchewan, Gibbons	34.4	2	March 8	Winter inversion
Bruderheim 1, Fort Saskatchewan, Gibbons, Redwater	39.7	5	March 12 & 13	Winter inversion
Fort Saskatchewan	33.5	1	March 17	Winter inversion
Bruderheim1 Elk Island, Fort Sask, Gibbons, Lamont Cnty, Redwater, Bon Accord	147.4	109	August 7-26	Wildfire smoke

There were several days in August where air quality was affected by heavy wild fire smoke across the entire FAP region, the Alberta Capital Region and even at times across much of Alberta. Of interest is the maximum 1-hour and 24-hour averages in August.

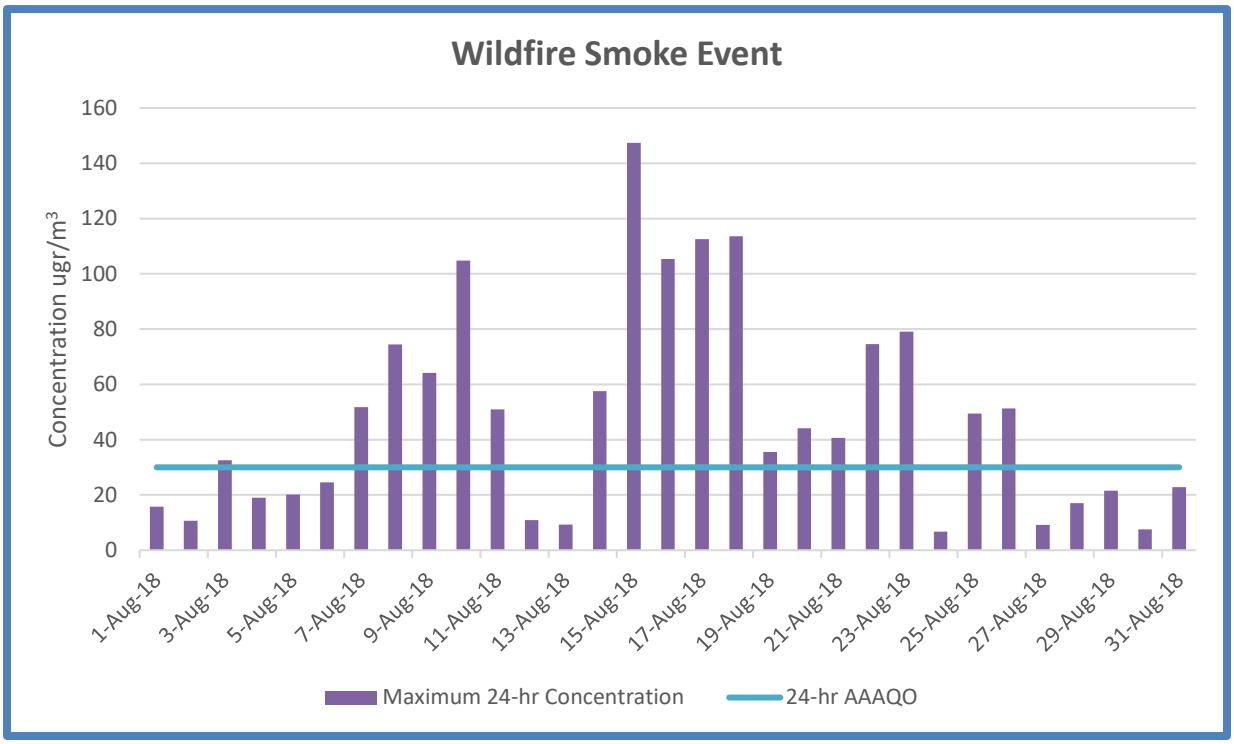
The following 2 figures show the maximum 1-hour average with the number of exceedances registered each date, and the maximum 24-hour averages measured at FAP monitoring stations during the 2018 wild fire smoke event.

Figure 22: Maximum 1-hr $PM_{2.5}$ averages in the FAP network and number of exceedances



Fine Particulates (continued)

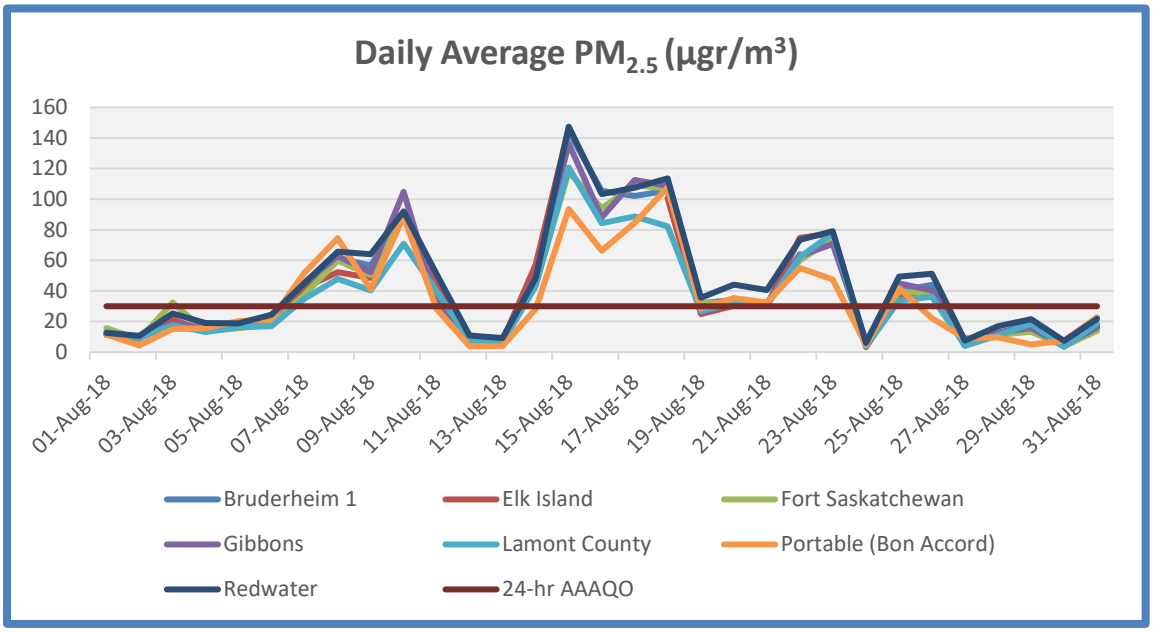
Figure 23: Maximum 24-hr $PM_{2.5}$ averages in the FAP network



Fine Particulates (continued)

The figure below shows the $PM_{2.5}$ daily averages (24hr) at FAP stations during the wildfire smoke event as superimposed with a line representing the AAAQO.

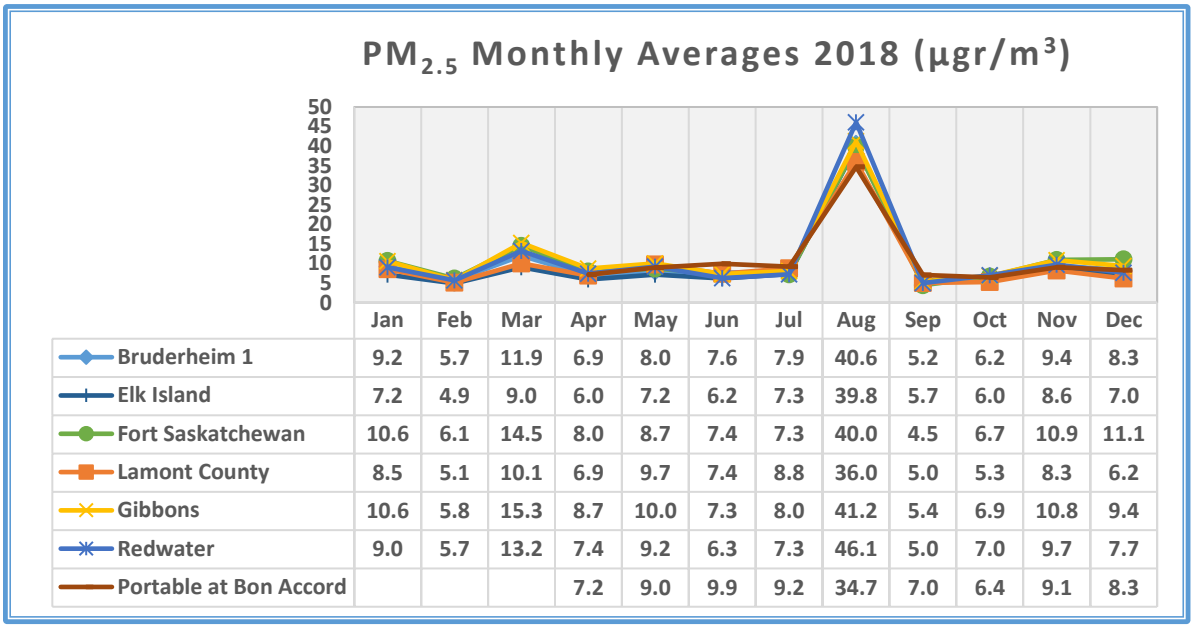
Figure 24: Daily $PM_{2.5}$ averages at FAP stations in August



A summary of $PM_{2.5}$ concentrations recorded in 2018 at individual stations and a comparison with the previous 6 years are presented in the figures and tables below.

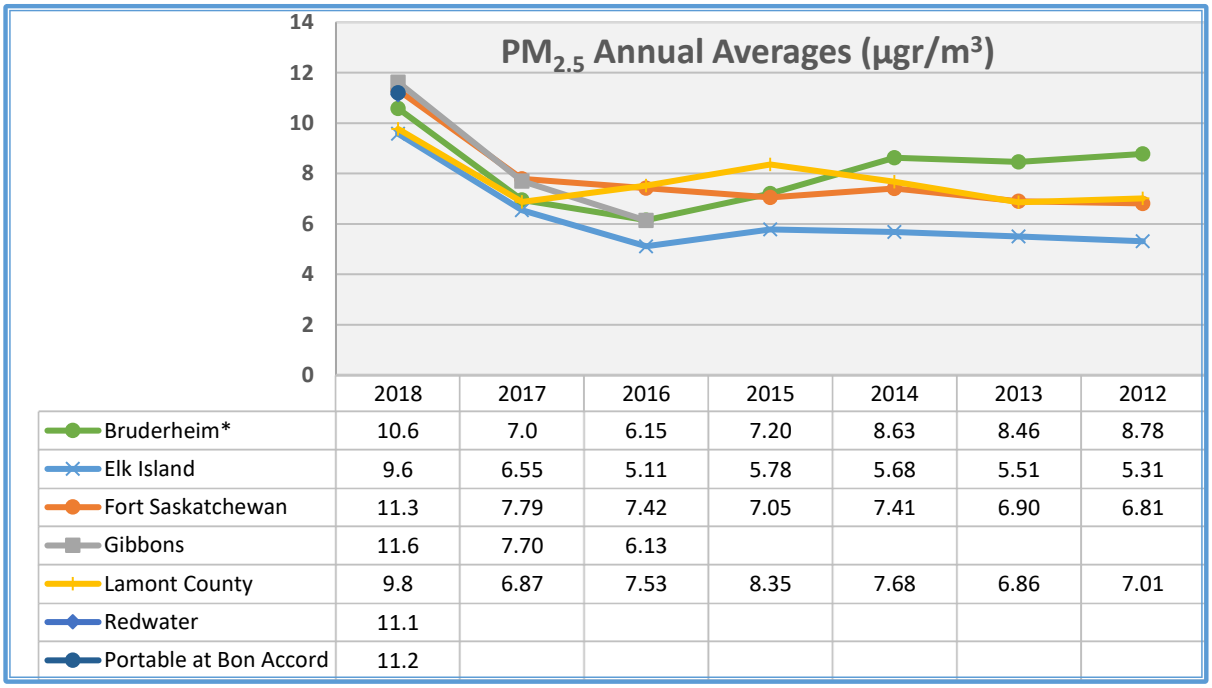
Fine Particulates (continued)

Figure 25: Monthly average $PM_{2.5}$ concentrations (µg/m^3) in 2018



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bruderheim 1	9.2	5.7	11.9	6.9	8.0	7.6	7.9	40.6	5.2	6.2	9.4	8.3
Elk Island	7.2	4.9	9.0	6.0	7.2	6.2	7.3	39.8	5.7	6.0	8.6	7.0
Fort Saskatchewan	10.6	6.1	14.5	8.0	8.7	7.4	7.3	40.0	4.5	6.7	10.9	11.1
Lamont County	8.5	5.1	10.1	6.9	9.7	7.4	8.8	36.0	5.0	5.3	8.3	6.2
Gibbons	10.6	5.8	15.3	8.7	10.0	7.3	8.0	41.2	5.4	6.9	10.8	9.4
Redwater	9.0	5.7	13.2	7.4	9.2	6.3	7.3	46.1	5.0	7.0	9.7	7.7
Portable at Bon Accord				7.2	9.0	9.9	9.2	34.7	7.0	6.4	9.1	8.3

Figure 26: Annual average $PM_{2.5}$ concentrations at FAP stations (µgr/m^3) - historical

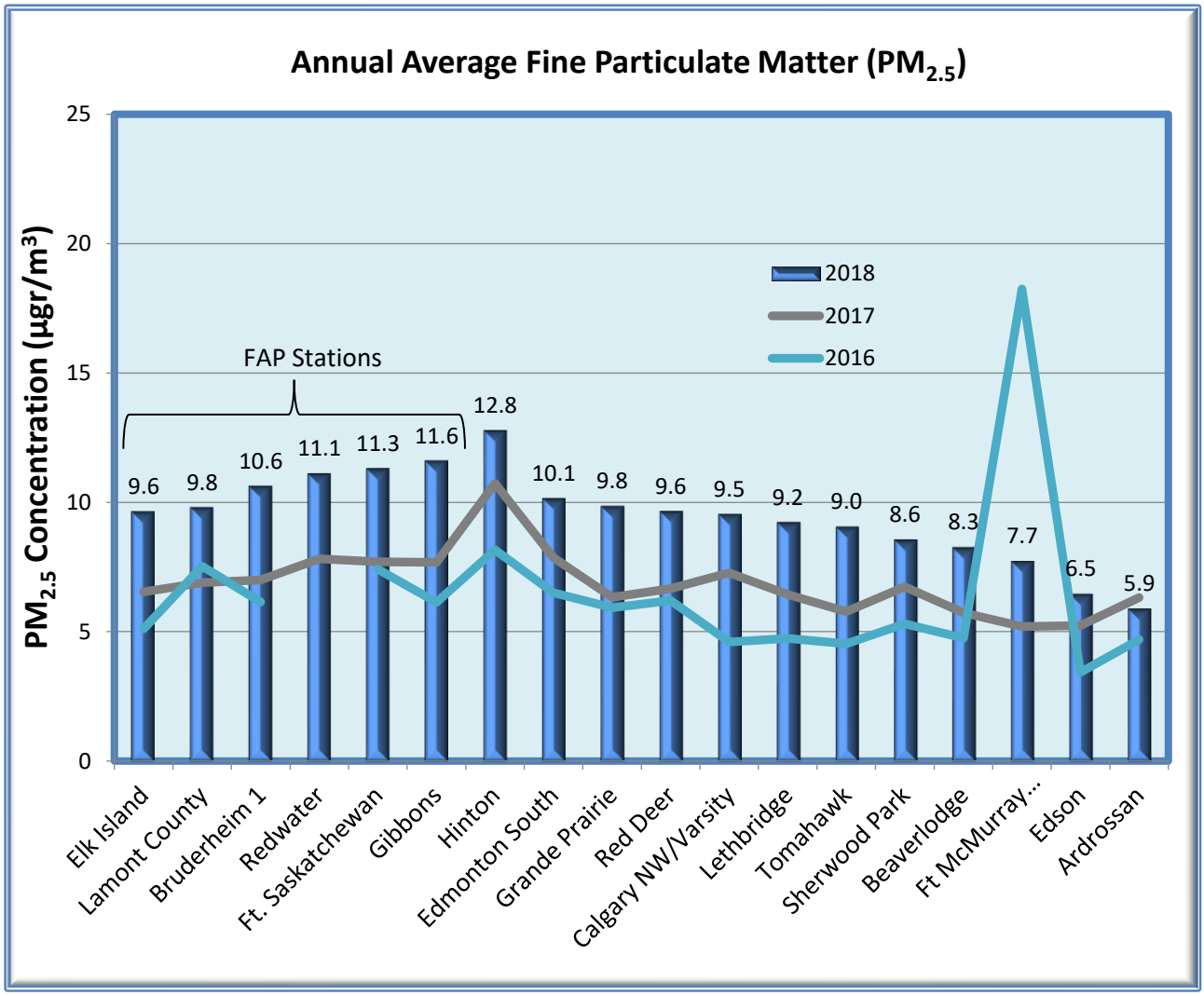


	2018	2017	2016	2015	2014	2013	2012
Bruderheim*	10.6	7.0	6.15	7.20	8.63	8.46	8.78
Elk Island	9.6	6.55	5.11	5.78	5.68	5.51	5.31
Fort Saskatchewan	11.3	7.79	7.42	7.05	7.41	6.90	6.81
Gibbons	11.6	7.70	6.13				
Lamont County	9.8	6.87	7.53	8.35	7.68	6.86	7.01
Redwater	11.1						
Portable at Bon Accord	11.2						

*The Bruderheim station was moved in 2016 and renamed Bruderheim 1
Bruderheim 2016 average includes data from both Bruderheim and Bruderheim1 stations

Fine Particulates (continued)

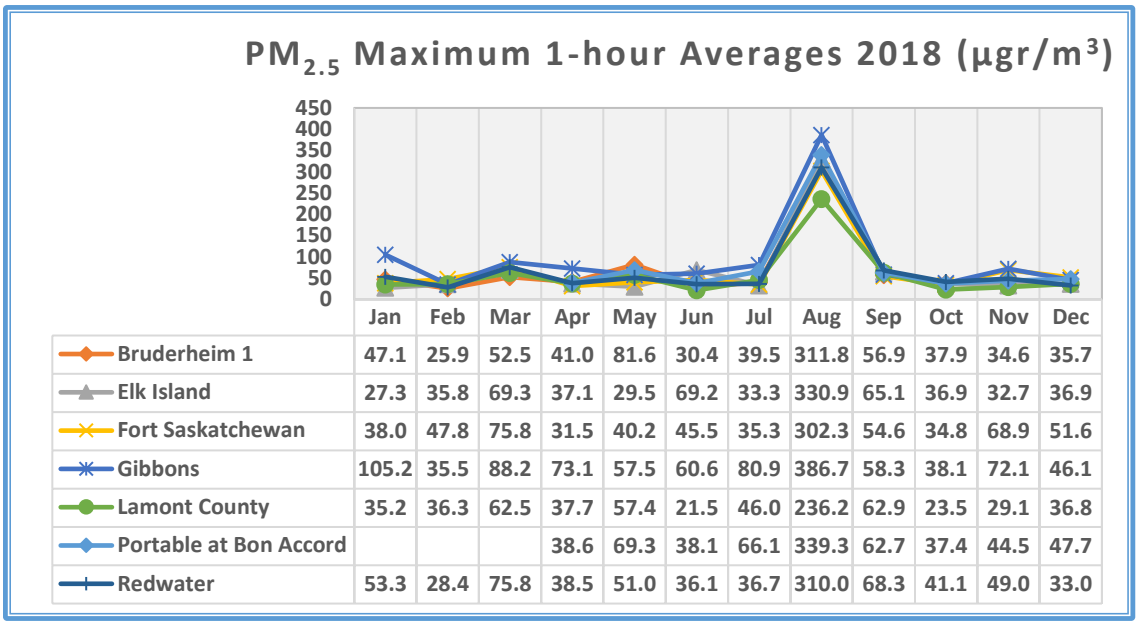
Figure 27: Annual average $PM_{2.5}$ concentrations in Alberta (µgr/m^3)



*Bruderheim 2016 average includes data from both Bruderheim and Bruderheim 1 stations

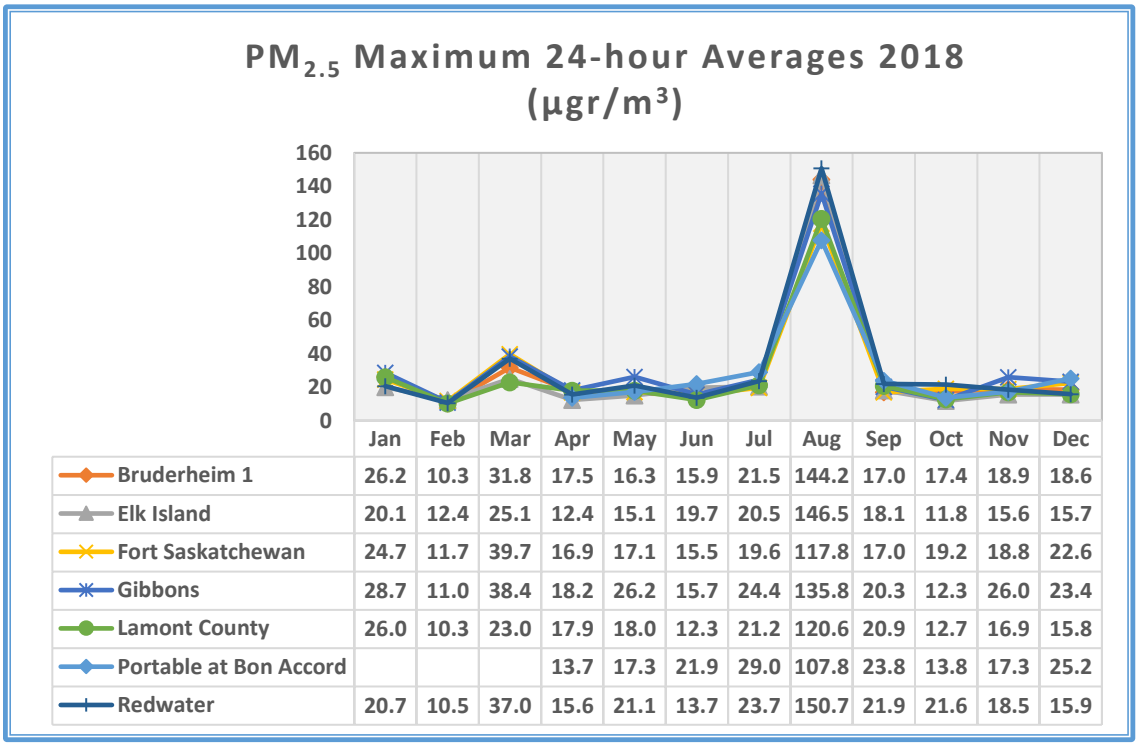
Fine Particulates (continued)

Figure 28: Maximum 1-hour average $PM_{2.5}$ concentrations at FAP stations (µgr/m^3)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bruderheim 1	47.1	25.9	52.5	41.0	81.6	30.4	39.5	311.8	56.9	37.9	34.6	35.7
Elk Island	27.3	35.8	69.3	37.1	29.5	69.2	33.3	330.9	65.1	36.9	32.7	36.9
Fort Saskatchewan	38.0	47.8	75.8	31.5	40.2	45.5	35.3	302.3	54.6	34.8	68.9	51.6
Gibbons	105.2	35.5	88.2	73.1	57.5	60.6	80.9	386.7	58.3	38.1	72.1	46.1
Lamont County	35.2	36.3	62.5	37.7	57.4	21.5	46.0	236.2	62.9	23.5	29.1	36.8
Portable at Bon Accord				38.6	69.3	38.1	66.1	339.3	62.7	37.4	44.5	47.7
Redwater	53.3	28.4	75.8	38.5	51.0	36.1	36.7	310.0	68.3	41.1	49.0	33.0

Figure 29: Maximum 24-hour average $PM_{2.5}$ concentrations at FAP stations (µgr/m^3)



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bruderheim 1	26.2	10.3	31.8	17.5	16.3	15.9	21.5	144.2	17.0	17.4	18.9	18.6
Elk Island	20.1	12.4	25.1	12.4	15.1	19.7	20.5	146.5	18.1	11.8	15.6	15.7
Fort Saskatchewan	24.7	11.7	39.7	16.9	17.1	15.5	19.6	117.8	17.0	19.2	18.8	22.6
Gibbons	28.7	11.0	38.4	18.2	26.2	15.7	24.4	135.8	20.3	12.3	26.0	23.4
Lamont County	26.0	10.3	23.0	17.9	18.0	12.3	21.2	120.6	20.9	12.7	16.9	15.8
Portable at Bon Accord				13.7	17.3	21.9	29.0	107.8	23.8	13.8	17.3	25.2
Redwater	20.7	10.5	37.0	15.6	21.1	13.7	23.7	150.7	21.9	21.6	18.5	15.9

Hydrocarbons

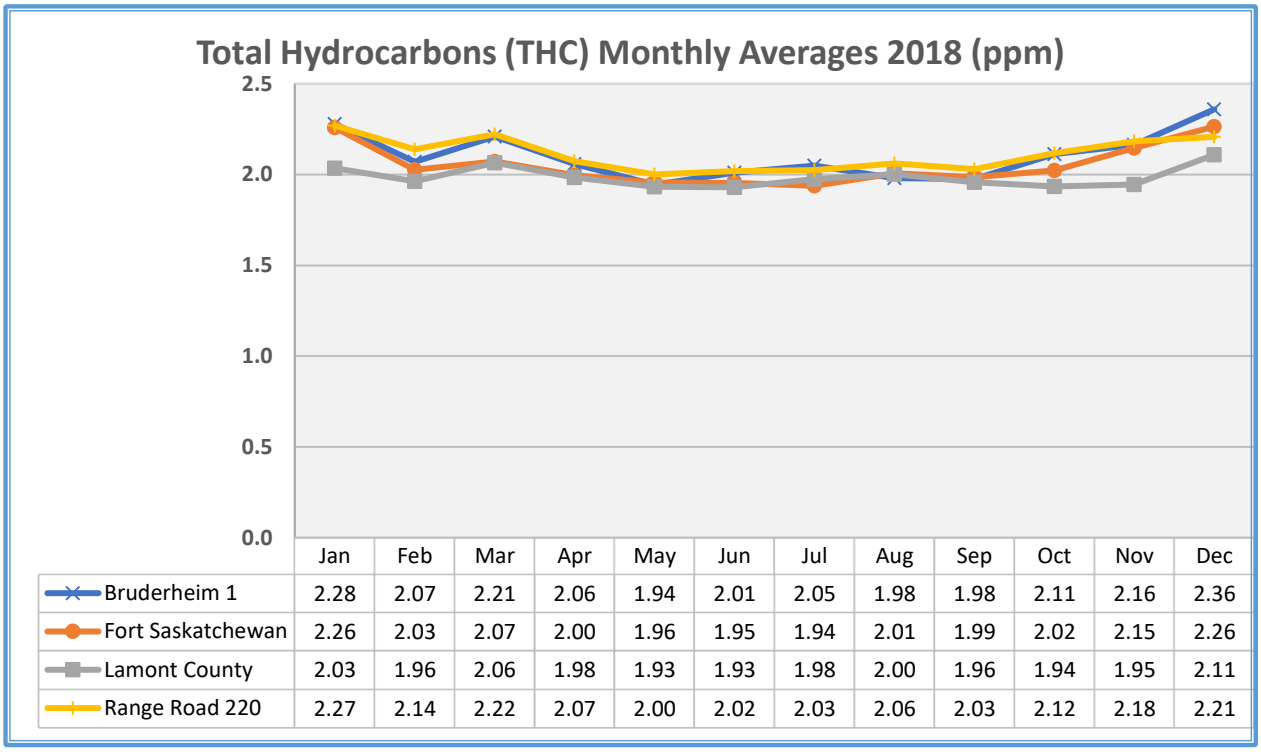
Total hydrocarbons (THC) refer to a broad family of chemicals that contain carbon and hydrogen atoms. Total hydrocarbons are the sum of non-reactive and reactive hydrocarbons.

The major reactive hydrocarbon in the atmosphere is methane. Major worldwide sources of atmospheric methane include wetlands, ruminants such as cows, energy use, landfills, and burning biomass such as wood. Methane is the primary component of natural gas.

The reactive (or non-methane) hydrocarbons consist of many volatile organic compounds (VOC's), some of which react with oxides of nitrogen in the atmosphere to form ozone. While Alberta does not have ambient air quality objectives (AAAQO) for total hydrocarbons, methane or non-methane hydrocarbons, the oxidation of hydrocarbons in the atmosphere contributes to an increased amount of nitrogen oxides and ozone, which do have objectives. Additionally, there are objectives for specific reactive hydrocarbons such as benzene, toluene, ethylbenzene, xylenes, styrene and ethylene.

A summary of hydrocarbon concentrations recorded in 2018 at individual stations and a comparison with the previous 6 years are presented in the figures and tables below. Note that the Bruderheim station was moved in March 2016 and renamed Bruderheim1.

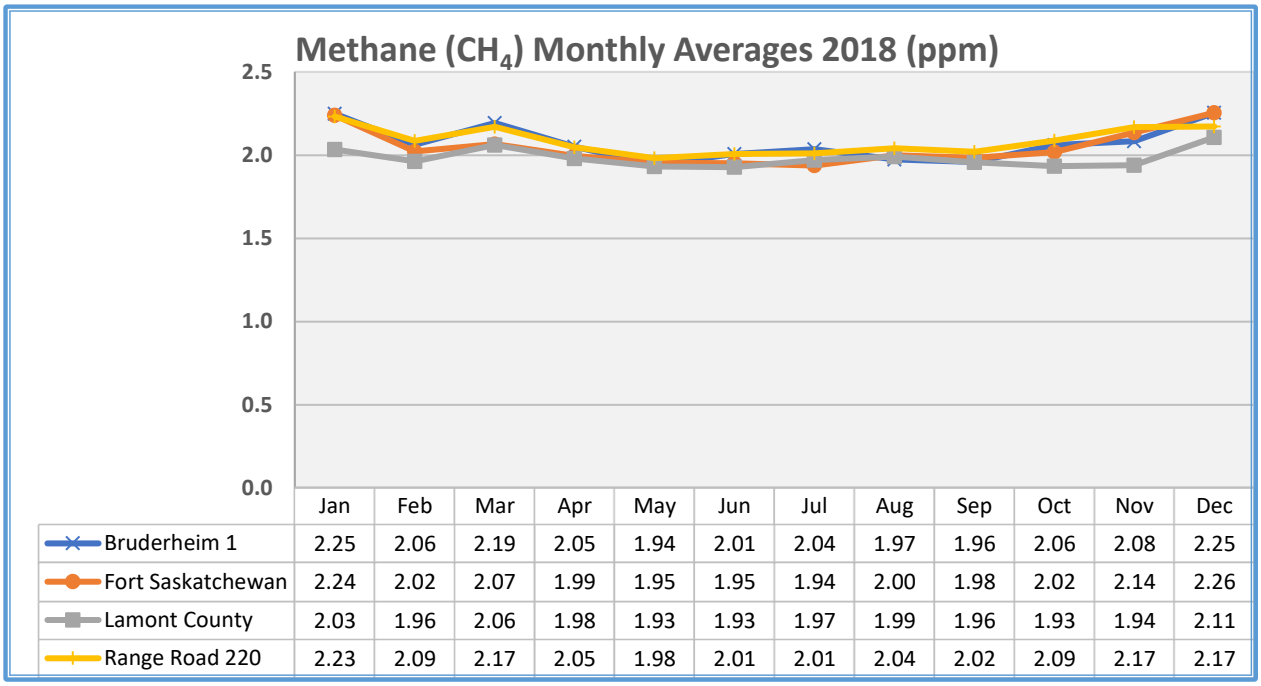
Figure 30: Monthly average Total Hydrocarbons (ppm) in 2018



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bruderheim 1	2.28	2.07	2.21	2.06	1.94	2.01	2.05	1.98	1.98	2.11	2.16	2.36
Fort Saskatchewan	2.26	2.03	2.07	2.00	1.96	1.95	1.94	2.01	1.99	2.02	2.15	2.26
Lamont County	2.03	1.96	2.06	1.98	1.93	1.93	1.98	2.00	1.96	1.94	1.95	2.11
Range Road 220	2.27	2.14	2.22	2.07	2.00	2.02	2.03	2.06	2.03	2.12	2.18	2.21

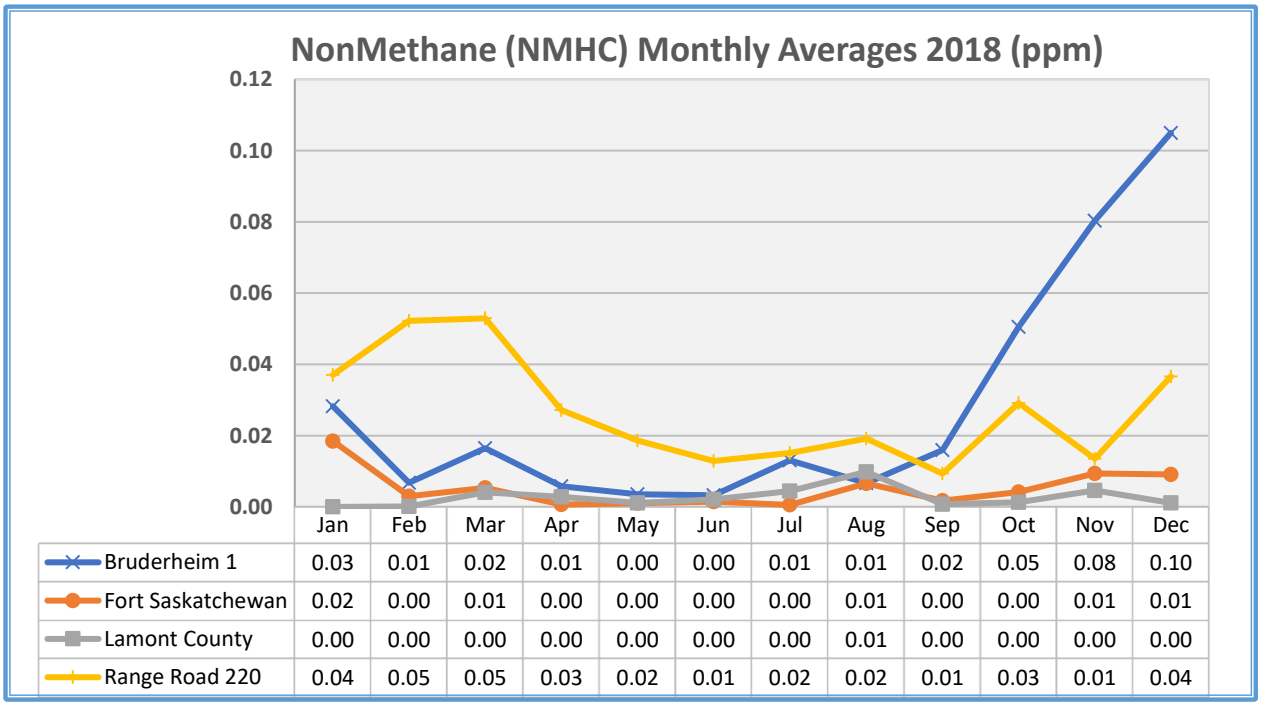
Hydrocarbons (continued)

Figure 31: Monthly average Methane concentrations (ppm) in 2018



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bruderheim 1	2.25	2.06	2.19	2.05	1.94	2.01	2.04	1.97	1.96	2.06	2.08	2.25
Fort Saskatchewan	2.24	2.02	2.07	1.99	1.95	1.95	1.94	2.00	1.98	2.02	2.14	2.26
Lamont County	2.03	1.96	2.06	1.98	1.93	1.93	1.97	1.99	1.96	1.93	1.94	2.11
Range Road 220	2.23	2.09	2.17	2.05	1.98	2.01	2.01	2.04	2.02	2.09	2.17	2.17

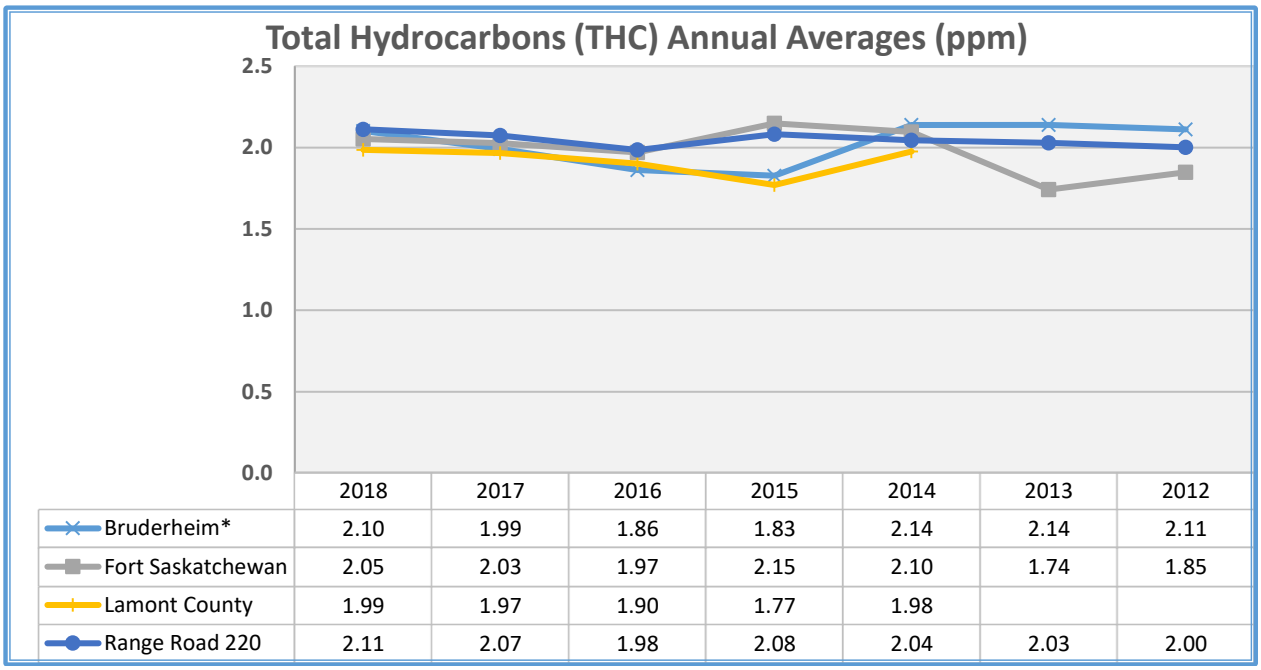
Figure 32: Monthly average Non-Methane Hydrocarbon concentrations (ppm) in 2018



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bruderheim 1	0.03	0.01	0.02	0.01	0.00	0.00	0.01	0.01	0.02	0.05	0.08	0.10
Fort Saskatchewan	0.02	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01
Lamont County	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Range Road 220	0.04	0.05	0.05	0.03	0.02	0.01	0.02	0.02	0.01	0.03	0.01	0.04

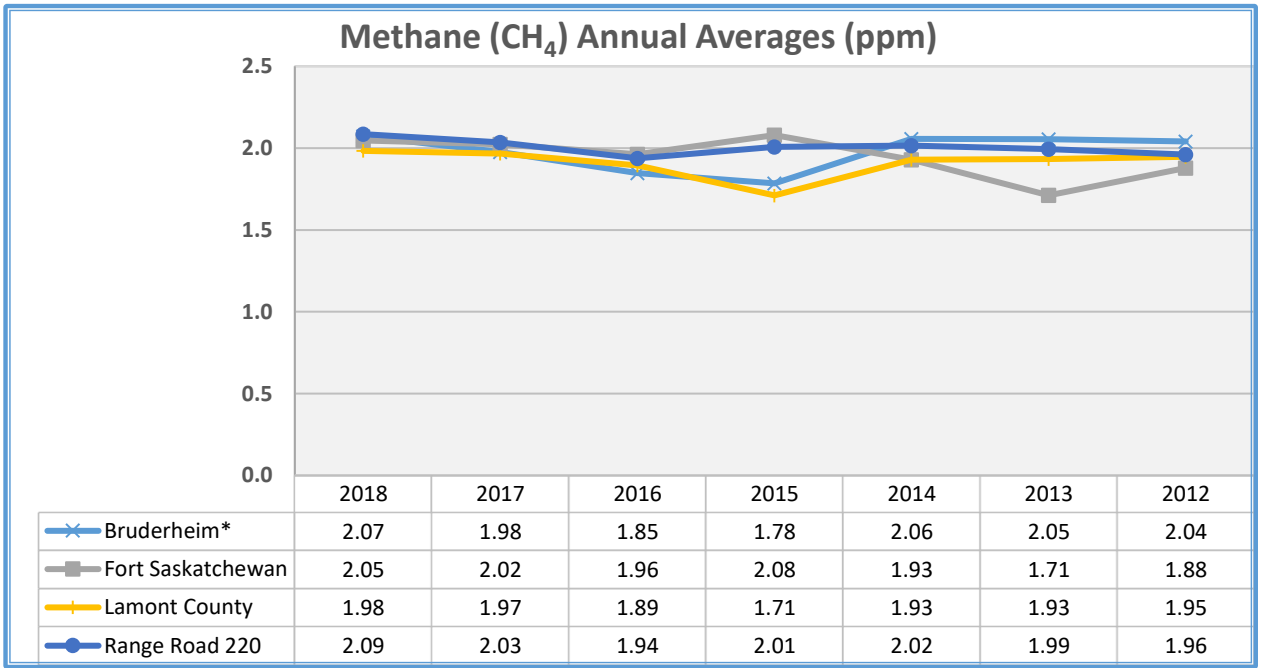
Hydrocarbons (continued)

Figure 33: Annual average THC concentrations (ppm) – historical



	2018	2017	2016	2015	2014	2013	2012
Bruderheim*	2.10	1.99	1.86	1.83	2.14	2.14	2.11
Fort Saskatchewan	2.05	2.03	1.97	2.15	2.10	1.74	1.85
Lamont County	1.99	1.97	1.90	1.77	1.98		
Range Road 220	2.11	2.07	1.98	2.08	2.04	2.03	2.00

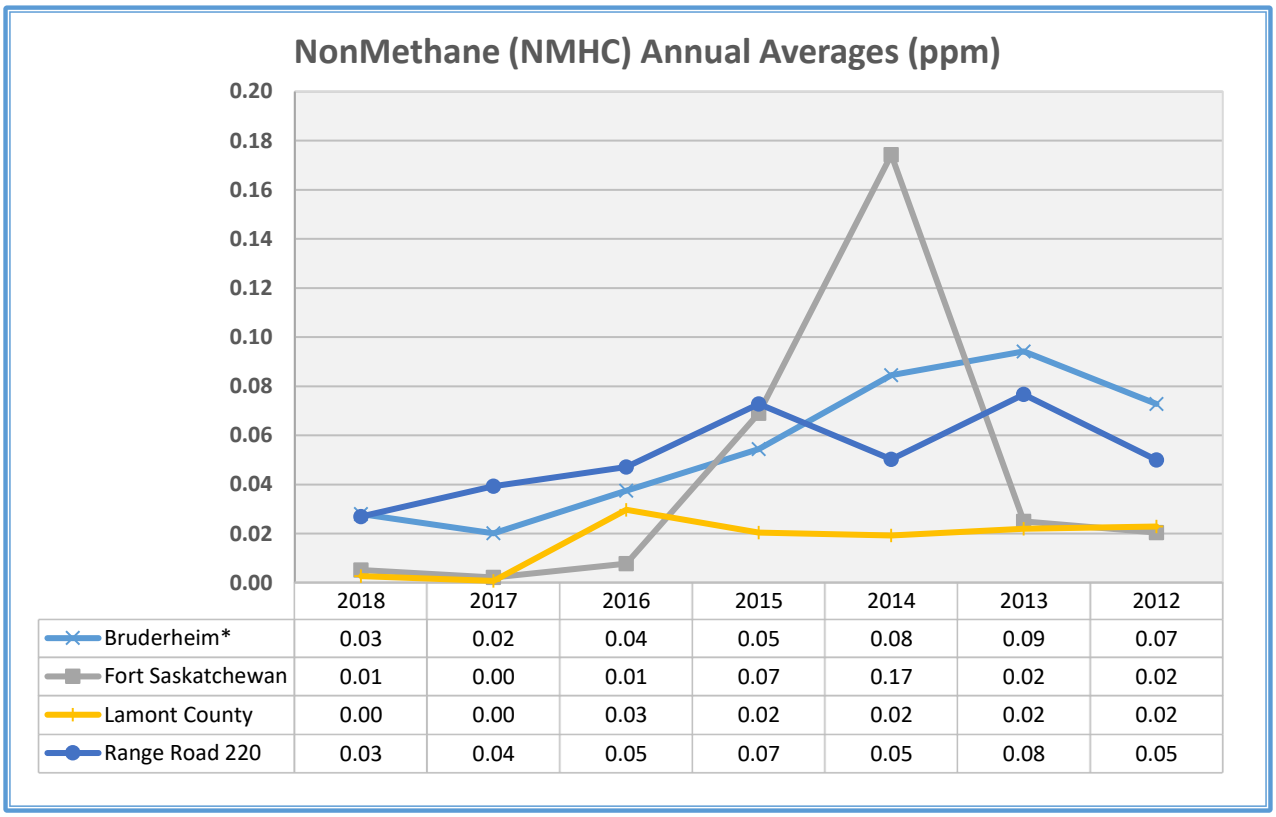
Figure 34: Annual average CH_4 concentrations (ppm) – historical



	2018	2017	2016	2015	2014	2013	2012
Bruderheim*	2.07	1.98	1.85	1.78	2.06	2.05	2.04
Fort Saskatchewan	2.05	2.02	1.96	2.08	1.93	1.71	1.88
Lamont County	1.98	1.97	1.89	1.71	1.93	1.93	1.95
Range Road 220	2.09	2.03	1.94	2.01	2.02	1.99	1.96

Hydrocarbons (continued)

Figure 35: Annual average NMHC concentrations (ppm) – historical



	2018	2017	2016	2015	2014	2013	2012
Bruderheim*	0.03	0.02	0.04	0.05	0.08	0.09	0.07
Fort Saskatchewan	0.01	0.00	0.01	0.07	0.17	0.02	0.02
Lamont County	0.00	0.00	0.03	0.02	0.02	0.02	0.02
Range Road 220	0.03	0.04	0.05	0.07	0.05	0.08	0.05

Hydrocarbons (continued)

Although the average and maximum hydrocarbon values recorded are similar at the various monitoring sites, it should be noted that the Bruderheim station has historically measured brief hydrocarbon "spikes" that the other stations have not. The source has not been determined but it is likely from a nearby source due to the short duration of these events and the volatile nature of hydrocarbons.

Table 15: Maximum 1-hour average Hydrocarbon concentrations (ppm) in 2018

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Total Hydrocarbons THC (PPM)												
Bruderheim 1	4.50	3.56	4.63	4.33	3.43	3.81	6.71	3.85	3.45	4.47	4.11	5.13
Fort Saskatchewan	3.94	2.69	3.05	2.36	2.40	2.31	2.35	2.88	2.77	2.96	3.54	3.67
Lamont County	2.50	2.29	2.55	2.46	2.39	2.95	3.59	3.06	2.91	2.47	2.93	2.68
Range Road 220	3.26	12.2	7.72	3.19	5.33	3.47	3.83	3.10	3.64	4.48	3.36	3.77
Methane CH_4 (PPM)												
Bruderheim 1	4.12	3.20	4.10	3.90	3.14	3.47	5.60	3.46	3.08	3.82	3.54	4.29
Fort Saskatchewan	3.23	2.67	2.87	2.36	2.40	2.22	2.26	2.58	2.43	2.78	3.53	3.54
Lamont County	2.49	2.29	2.54	2.31	2.36	2.87	3.57	2.92	2.90	2.47	2.60	2.66
Range Road 220	3.11	2.73	2.99	2.62	2.52	3.03	2.65	2.66	2.54	2.68	3.13	3.51
Non-Methane Hydrocarbons NMHC (PPM)												
Bruderheim 1	0.64	1.16	1.48	0.61	0.29	0.34	2.80	0.42	0.37	0.65	0.57	0.88
Fort Saskatchewan	1.78	0.58	0.43	0.12	0.22	0.33	0.19	0.57	0.85	0.99	0.47	0.44
Lamont County	0.00	0.01	0.09	0.16	0.03	0.11	0.13	0.35	0.02	0.08	0.41	0.07
Range Road 220	1.11	9.42	5.15	0.82	3.23	1.30	1.80	1.08	1.67	2.48	1.05	1.29

Hydrogen Sulphide

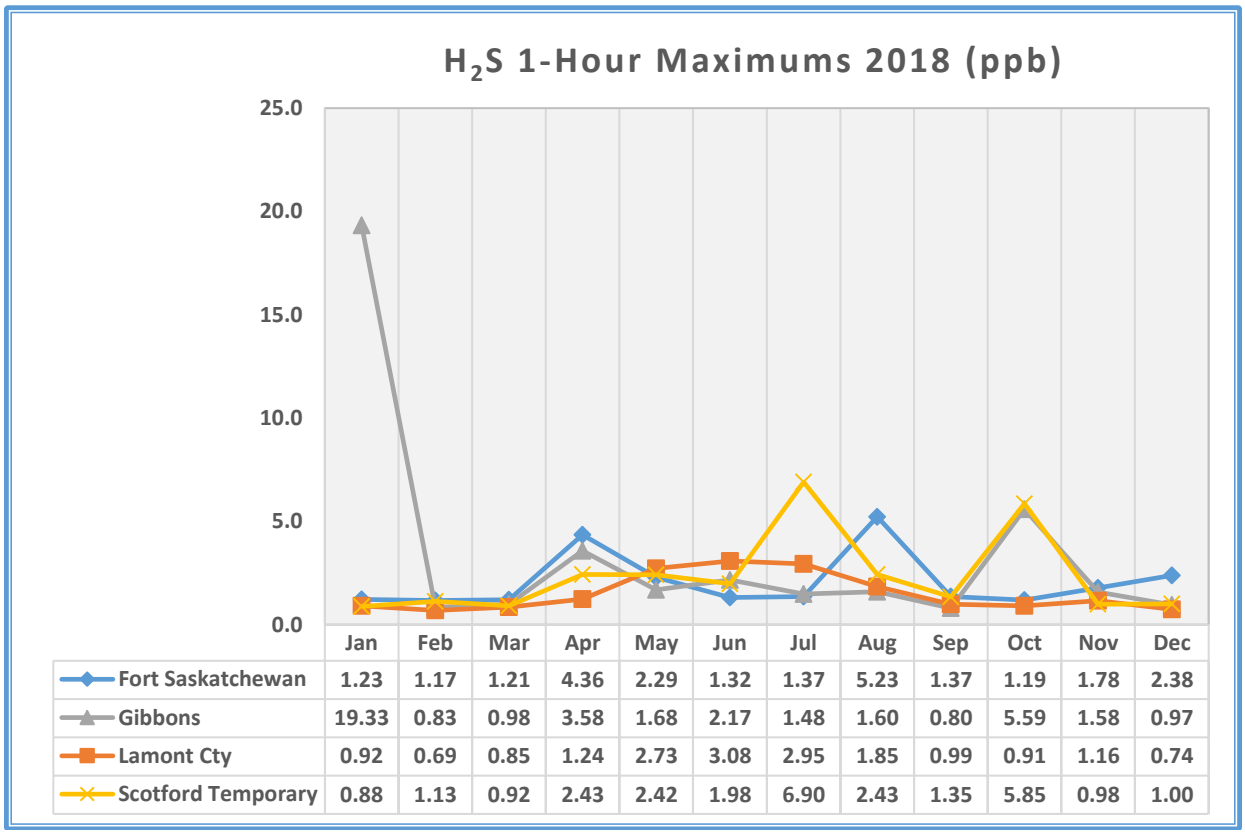
Hydrogen sulphide (H_2S) is a colourless gas with a rotten egg odour. Industrial sources of H_2S include fugitive emissions (leakages) from petroleum refineries, tank farms for unrefined petroleum products, natural gas plants, petrochemical plants, sewage treatment facilities, and animal feedlots. Natural sources of H_2S include sloughs, swamps and lakes.

The AAAQOs for H_2S are:

- 1-hour average concentration 10ppb
- 24-hour average concentration 3ppb

There were 20 exceedances of the 1-hour and 4 exceedances 24-hour AAAQO for H_2S in 2018. Details of these exceedances are provided earlier in this report

Figure 36: Maximum 1-hour average H_2S concentrations (ppb) in 2018

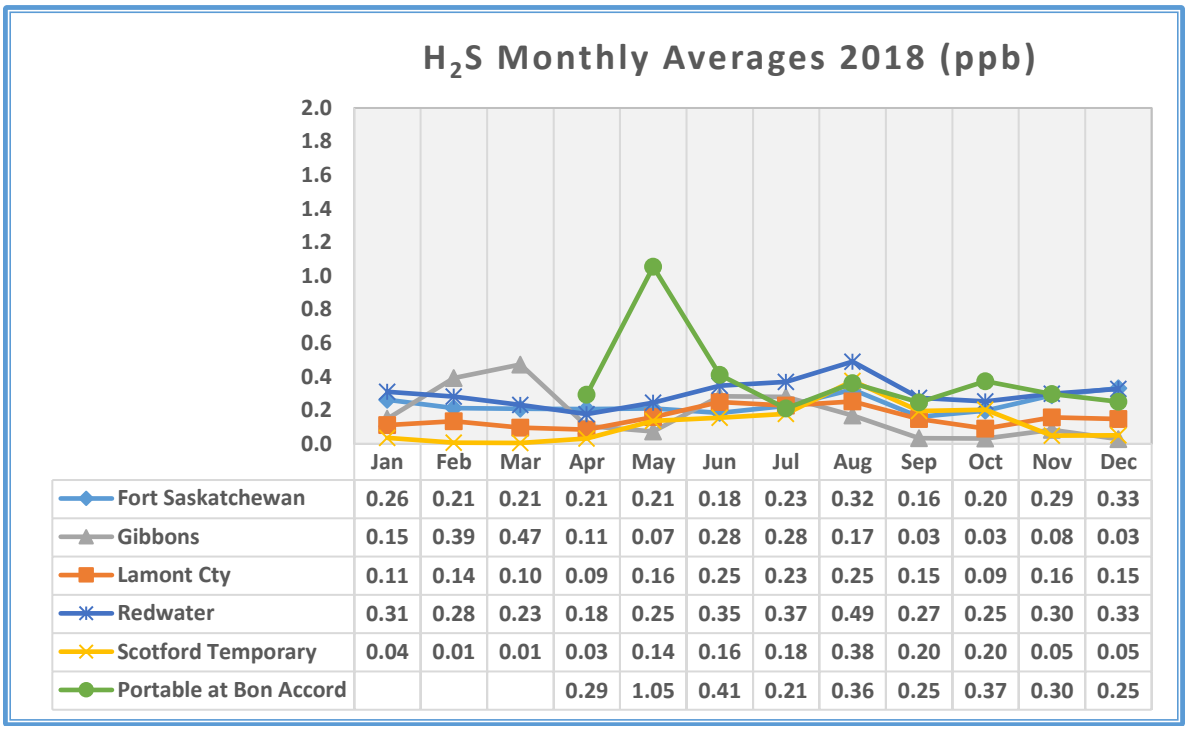


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fort Saskatchewan	1.23	1.17	1.21	4.36	2.29	1.32	1.37	5.23	1.37	1.19	1.78	2.38
Gibbons	19.33	0.83	0.98	3.58	1.68	2.17	1.48	1.60	0.80	5.59	1.58	0.97
Lamont Cty	0.92	0.69	0.85	1.24	2.73	3.08	2.95	1.85	0.99	0.91	1.16	0.74
Scotford Temporary	0.88	1.13	0.92	2.43	2.42	1.98	6.90	2.43	1.35	5.85	0.98	1.00

A summary of H_2S concentrations recorded in 2018 at individual stations and a comparison with the previous 6 years are presented in the figures and tables below.

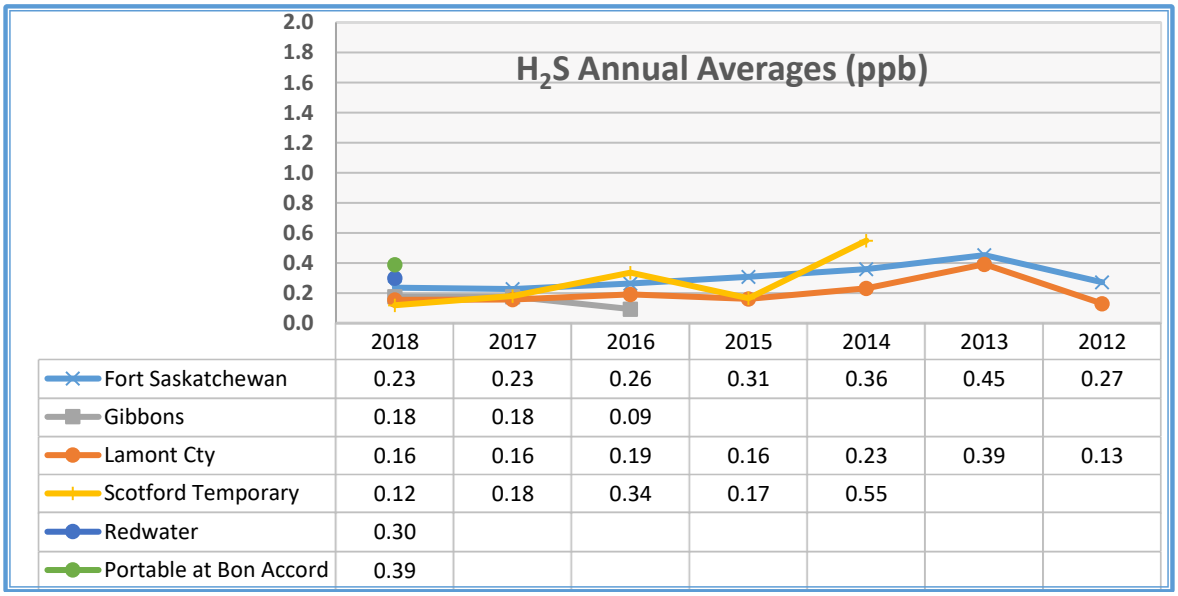
Hydrogen Sulphide (continued)

Figure 37: Monthly average H_2S concentrations (ppb) in 2018



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Fort Saskatchewan	0.26	0.21	0.21	0.21	0.21	0.18	0.23	0.32	0.16	0.20	0.29	0.33
Gibbons	0.15	0.39	0.47	0.11	0.07	0.28	0.28	0.17	0.03	0.03	0.08	0.03
Lamont Cty	0.11	0.14	0.10	0.09	0.16	0.25	0.23	0.25	0.15	0.09	0.16	0.15
Redwater	0.31	0.28	0.23	0.18	0.25	0.35	0.37	0.49	0.27	0.25	0.30	0.33
Scotford Temporary	0.04	0.01	0.01	0.03	0.14	0.16	0.18	0.38	0.20	0.20	0.05	0.05
Portable at Bon Accord				0.29	1.05	0.41	0.21	0.36	0.25	0.37	0.30	0.25

Figure 38: Annual average H_2S concentrations at FAP stations (ppb) - historical



	2018	2017	2016	2015	2014	2013	2012
Fort Saskatchewan	0.23	0.23	0.26	0.31	0.36	0.45	0.27
Gibbons	0.18	0.18	0.09				
Lamont Cty	0.16	0.16	0.19	0.16	0.23	0.39	0.13
Scotford Temporary	0.12	0.18	0.34	0.17	0.55		
Redwater	0.30						
Portable at Bon Accord	0.39						

Note: The Redwater station began operations late in 2017
The Gibbons station began operations in February 2016.
The Scotford 2 station was moved in April 2014 and became Scotford Temporary

Oxides of Nitrogen

Oxides of nitrogen (NO_x) are the total of nitrogen dioxide (NO_2) and nitric oxide (NO). During high temperature combustion, such as burning of natural gas, coal, oil and gasoline, atmospheric nitrogen may combine with molecular oxygen to form NO. NO is colourless and odourless. Most NO in the ambient air will react with O_3 to form NO_2. NO_2 is a reddish-brown gas with a pungent odour and is partially responsible for the "brown haze" observed near large cities.

Transportation (automobiles, locomotives and aircraft) is the major source of NO_x in Alberta. Other significant sources include industrial sources (oil and gas industries). Smaller sources of NO_x include natural gas combustion, heating fuel combustion, and forest fires.

The AAAQOs for NO_2 are:

- 1-hour average concentration 159 ppb
- Annual average concentration 24 ppb

Comparing the air quality monitoring data in the FAP region during 2018 against the AAAQOs, it was observed that there were no exceedances of the 1-hour AAAQO for NO_2. The annual average concentration at each FAP station was well below the AAAQO.

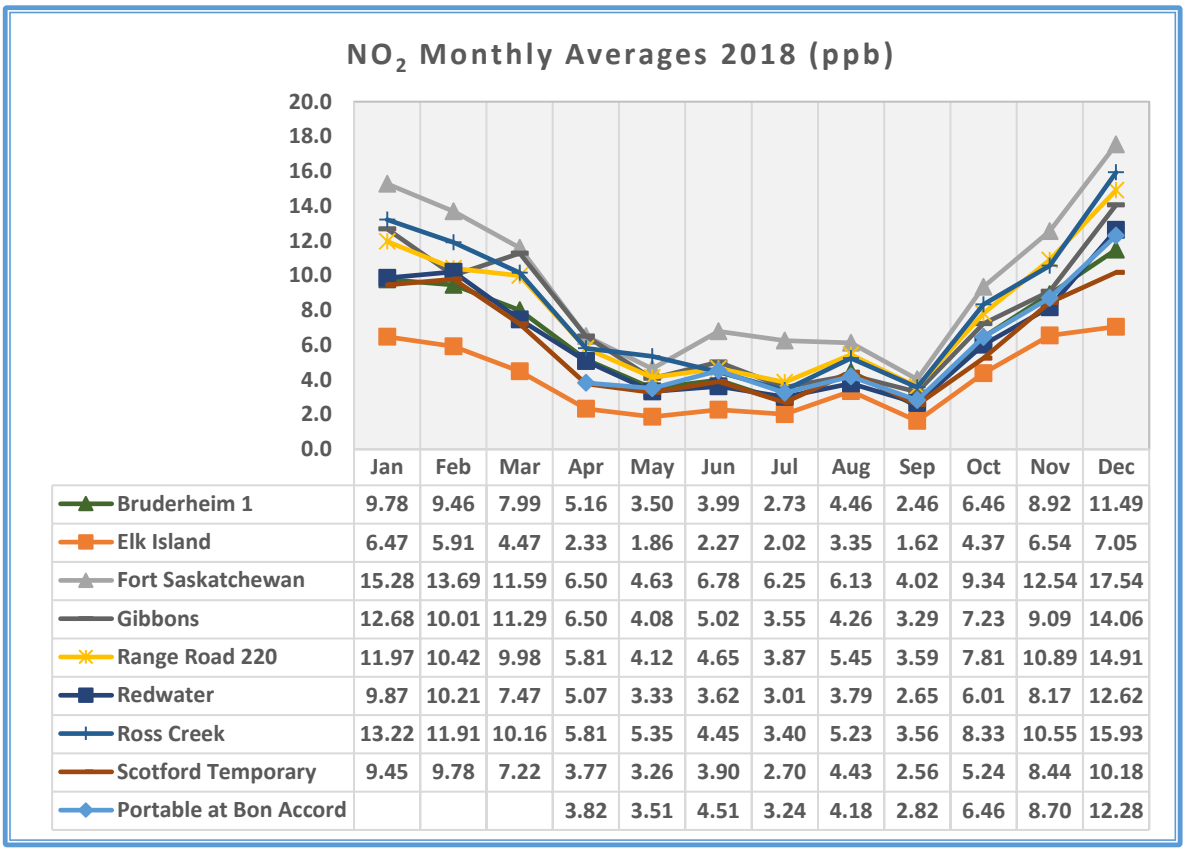
The maximum annual average NO_2 concentration measured was 9.5 ppb at the Fort Saskatchewan station (39% of the annual AAAQO).

While there is no AAAQO for monthly average concentrations of NO_2, the monthly averages values are useful to show that variation in NO_2 concentrations is seasonal. The maximum monthly NO_2 values occur during the winter months of November to February (refer to Figure 31). This normally occurs due to lower atmospheric mixing heights during colder weather where emissions tend to accumulate near the ground and not disperse as readily, this is commonly referred to as a temperature inversion.

A summary of NO_2 concentrations recorded at individual stations and a comparison with the previous 6 years are presented in the figures and tables below.

Oxides of Nitrogen (continued)

Figure 39: Monthly average NO_2 concentrations (ppb) in 2018

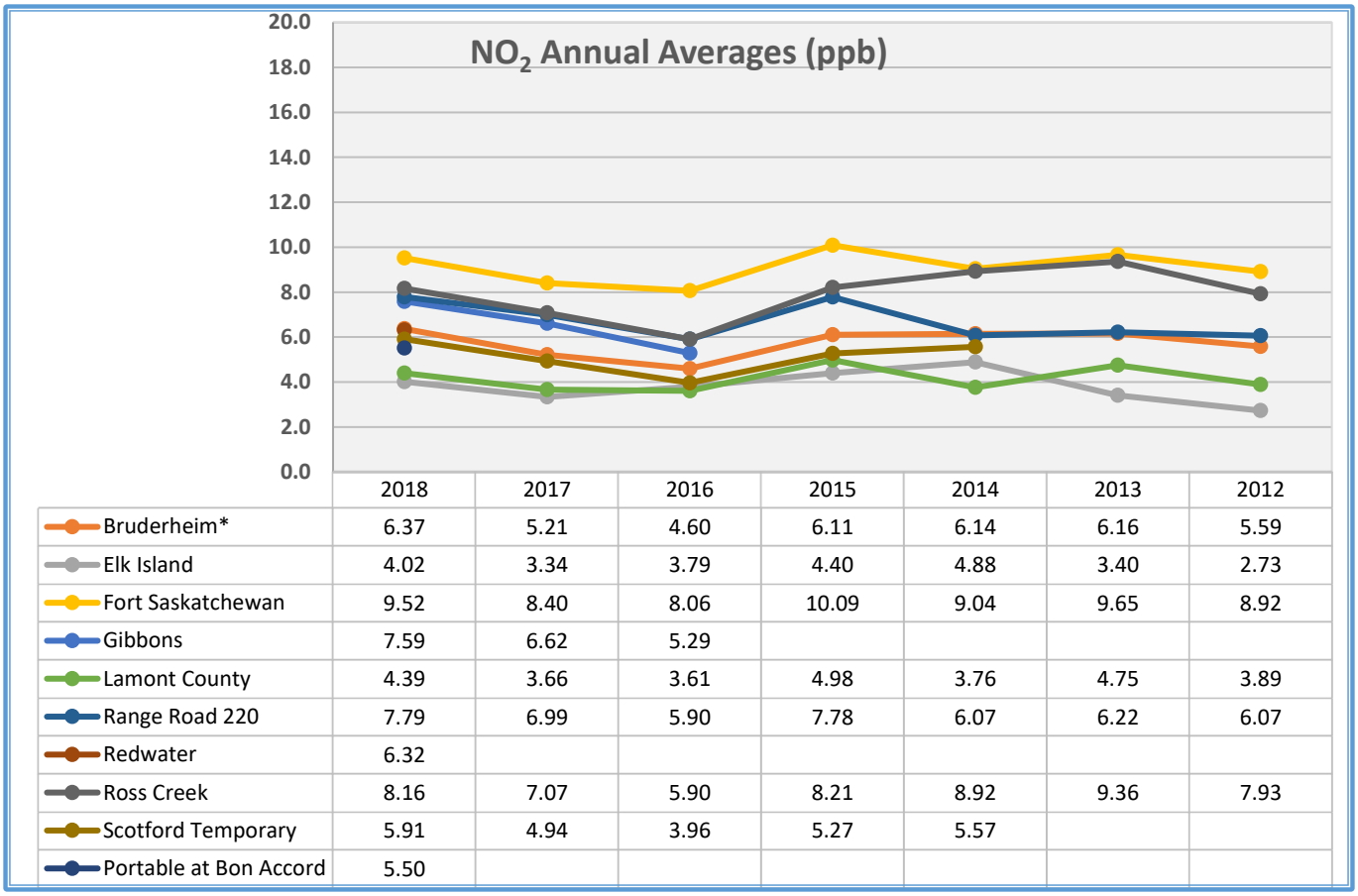


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bruderheim 1	9.78	9.46	7.99	5.16	3.50	3.99	2.73	4.46	2.46	6.46	8.92	11.49
Elk Island	6.47	5.91	4.47	2.33	1.86	2.27	2.02	3.35	1.62	4.37	6.54	7.05
Fort Saskatchewan	15.28	13.69	11.59	6.50	4.63	6.78	6.25	6.13	4.02	9.34	12.54	17.54
Gibbons	12.68	10.01	11.29	6.50	4.08	5.02	3.55	4.26	3.29	7.23	9.09	14.06
Range Road 220	11.97	10.42	9.98	5.81	4.12	4.65	3.87	5.45	3.59	7.81	10.89	14.91
Redwater	9.87	10.21	7.47	5.07	3.33	3.62	3.01	3.79	2.65	6.01	8.17	12.62
Ross Creek	13.22	11.91	10.16	5.81	5.35	4.45	3.40	5.23	3.56	8.33	10.55	15.93
Scotford Temporary	9.45	9.78	7.22	3.77	3.26	3.90	2.70	4.43	2.56	5.24	8.44	10.18
Portable at Bon Accord				3.82	3.51	4.51	3.24	4.18	2.82	6.46	8.70	12.28

Note: The Portable at Bon Accord began operation in April 2018
The Redwater station began operation October 2017

Oxides of Nitrogen (continued)

Figure 40: Annual average NO_2 concentrations at FAP stations (ppb)

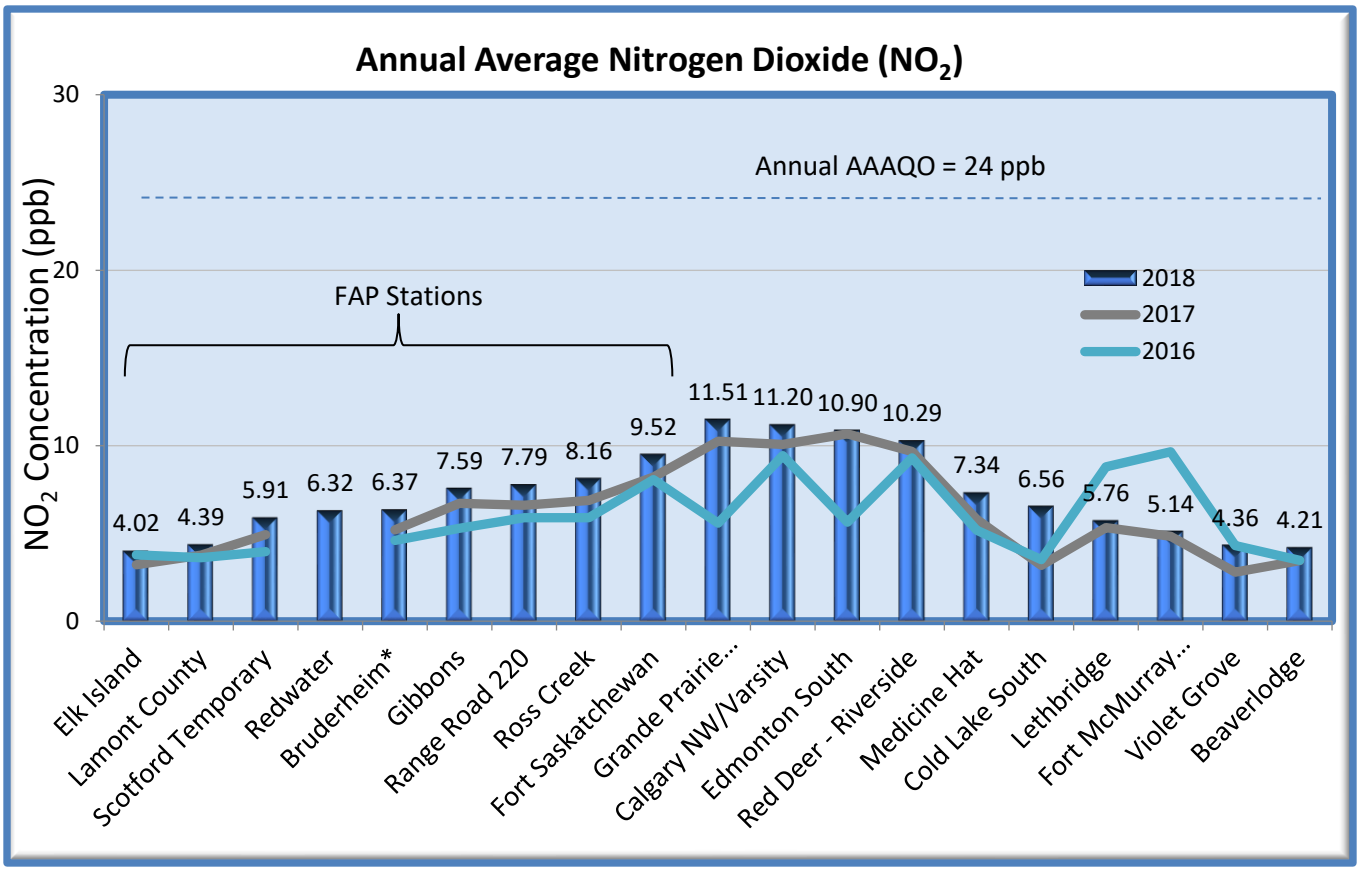


	2018	2017	2016	2015	2014	2013	2012
Bruderheim*	6.37	5.21	4.60	6.11	6.14	6.16	5.59
Elk Island	4.02	3.34	3.79	4.40	4.88	3.40	2.73
Fort Saskatchewan	9.52	8.40	8.06	10.09	9.04	9.65	8.92
Gibbons	7.59	6.62	5.29				
Lamont County	4.39	3.66	3.61	4.98	3.76	4.75	3.89
Range Road 220	7.79	6.99	5.90	7.78	6.07	6.22	6.07
Redwater	6.32						
Ross Creek	8.16	7.07	5.90	8.21	8.92	9.36	7.93
Scotford Temporary	5.91	4.94	3.96	5.27	5.57		
Portable at Bon Accord	5.50						

*The Bruderheim station was moved and was renamed Bruderheim 1 in March 2016
The Gibbons station began operations in February 2016
The Redwater station began operation October 2017

Oxides of Nitrogen (continued)

Figure 41: Annual average NO_2 concentrations in Alberta (ppb)



*The Bruderheim station was moved in 2016 and renamed Bruderheim 1
Bruderheim 2016 average includes data from both Bruderheim and Bruderheim1 stations

Nitric oxide (NO) and oxides of nitrogen (NO_x) are also measured at FAP monitoring stations. Data for these parameters are available through the Government of Alberta data warehouse at http://airdata.alberta.ca/

Ozone

Unlike other pollutants, ozone (O_3) is not emitted directly by anthropogenic activities. O_3 in the lower atmosphere is produced by a complicated set of chemical reactions involving oxides of nitrogen (NO_x) and volatile organic compounds (VOCs) in the presence of sunlight. O_3 is also transported to the ground from the "ozone rich" upper atmosphere by natural weather processes. O_3 and its precursors, such as NO_x and VOCs, may also be carried from upwind sources such as urban centers and industrial complexes. This phenomenon can be observed particularly in summer in Alberta when warm temperatures (~30 °C) coupled with light winds and abundant sunshine result in an air quality condition referred to as summertime smog.

O_3 concentrations are generally lower at urban locations than at rural locations. This is due to the destruction of O_3 by nitric oxide (NO) that is emitted by the combustion of fossil fuels. A significant natural source of VOCs in remote and rural areas in Alberta is emissions from trees and vegetation. O_3 levels are usually higher during the spring and summer months due to increased transport from the upper atmosphere and more sunlight, which allows O_3 forming chemical reactions to occur more rapidly.

At normal outdoor concentrations, O_3 is a colourless, odourless gas. However, O_3 does have a characteristic sharp 'very fresh air' odour at very high concentrations, such as that experienced immediately after lightning storms.

The AAAQO for ozone is:

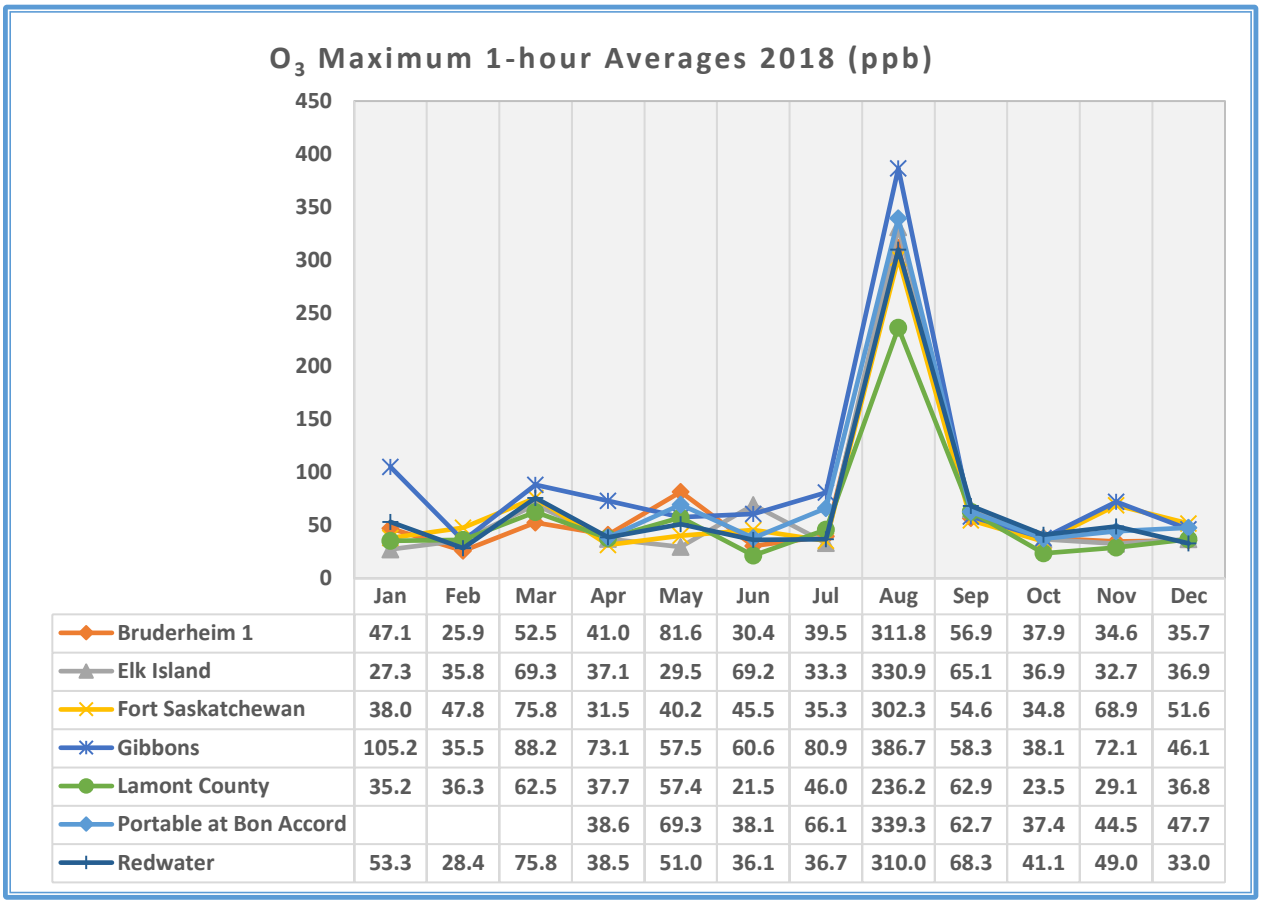
- 1-hour average concentration 82 ppb

There were six exceedances of the 1-hour AAAQO for ozone at any FAP stations in 2018. The highest 1-hour average for ozone was 101.2 ppb occurring on August 9th at the Redwater station. The six exceedances occurred at four different stations all on the same day. All six exceedances were attributed to summertime smog.

Ozone (continued)

The following figure shows the maximum 1-hour average concentrations recorded in each month at all FAP stations that measure ozone.

Figure 42: Maximum 1-hour average Ozone concentrations (ppb) in 2018



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bruderheim 1	47.1	25.9	52.5	41.0	81.6	30.4	39.5	311.8	56.9	37.9	34.6	35.7
Elk Island	27.3	35.8	69.3	37.1	29.5	69.2	33.3	330.9	65.1	36.9	32.7	36.9
Fort Saskatchewan	38.0	47.8	75.8	31.5	40.2	45.5	35.3	302.3	54.6	34.8	68.9	51.6
Gibbons	105.2	35.5	88.2	73.1	57.5	60.6	80.9	386.7	58.3	38.1	72.1	46.1
Lamont County	35.2	36.3	62.5	37.7	57.4	21.5	46.0	236.2	62.9	23.5	29.1	36.8
Portable at Bon Accord				38.6	69.3	38.1	66.1	339.3	62.7	37.4	44.5	47.7
Redwater	53.3	28.4	75.8	38.5	51.0	36.1	36.7	310.0	68.3	41.1	49.0	33.0

Ozone (continued)

There is also a national standard for ozone. The Air Quality Management System (AQMS) is a national approach to air quality management in Canada with the goal of achieving better air quality and significant health and environmental benefits for Canadians through keeping clean areas clean and continuous improvement. A component of the system is the Canadian Ambient Air Quality Standards (CAAQS), which have been developed for fine particulate matter ($PM_{2.5}$) and ozone.

The following figure summarizes the CAAQS management level and threshold for ozone. Alberta's six air zones are assessed for achievement against these values. Fort Air Partnership falls within the North Saskatchewan Air Zone

Figure 43: Air Quality Management System Thresholds

Air Management Threshold Values				
	Substance:	Ozone	$PM_{2.5}$	
	Averaging time:	8 Hours	Annual	24 Hours
Management Level	Red	Actions for Achieving Air Zone CAAQS		
	Threshold:	63 ppb	10.0 µg/m^3	28 µg/m^3
	Orange	Actions for Preventing CAAQS Exceedance		
	Threshold:	56 ppb	6.4 µg/m^3	19 µg/m^3
	Yellow	Actions for Preventing Air Quality Deterioration		
	Threshold:	50 ppb	4.0 µg/m^3	10 µg/m^3
	Green	Actions for Keeping Clean Areas Clean		

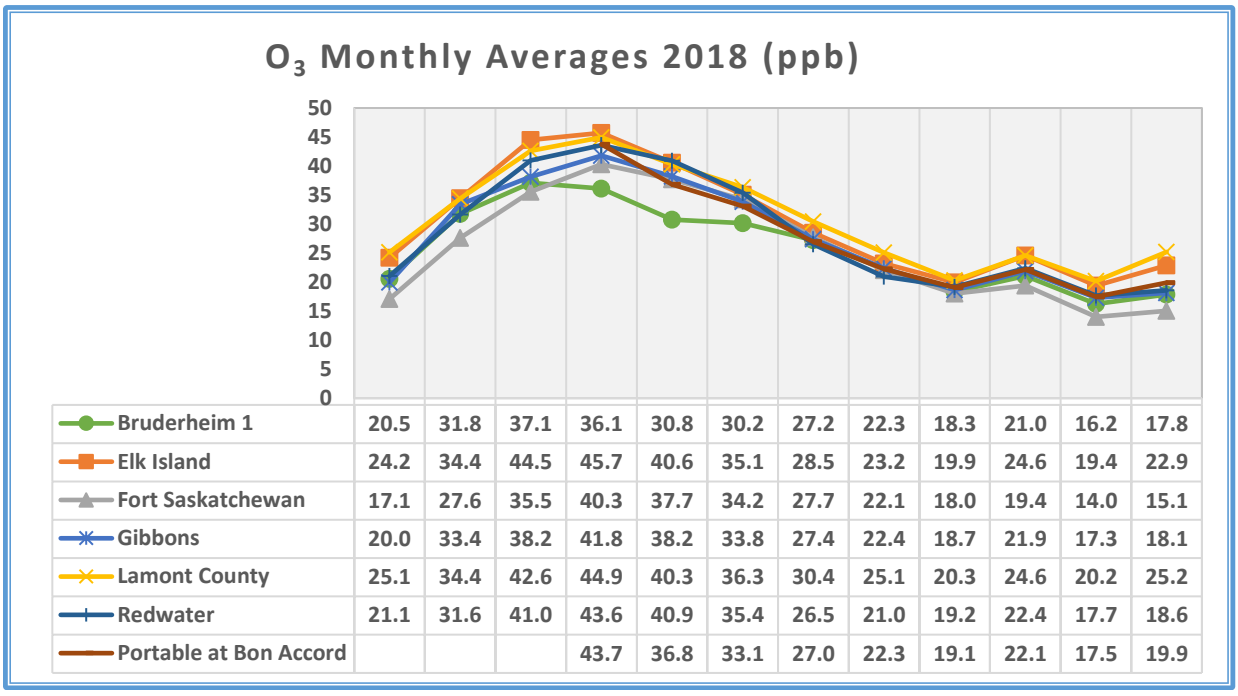
All provinces and territories including Alberta must annually report the status of air quality as compared to the new national standards. 2015 was the first year that $PM_{2.5}$ and O_3 levels were evaluated and reported against the new Canadian Ambient Air Quality Standards (CAAQS), using data collected from 2011 to 2013. The 2014-2016 Alberta Air Zones Report was released in November of 2018.

A summary of O_3 concentrations recorded in 2018 at individual stations and a comparison with the previous 6 years are presented in the figures and tables below.

The highest monthly average concentrations tend to occur during the spring months, when the overall background levels are highest. The highest maximum one-hour values tend to occur later in the summer, during hot summer afternoons under low wind conditions. Peak concentrations for ozone are relevant because of potential health effects.

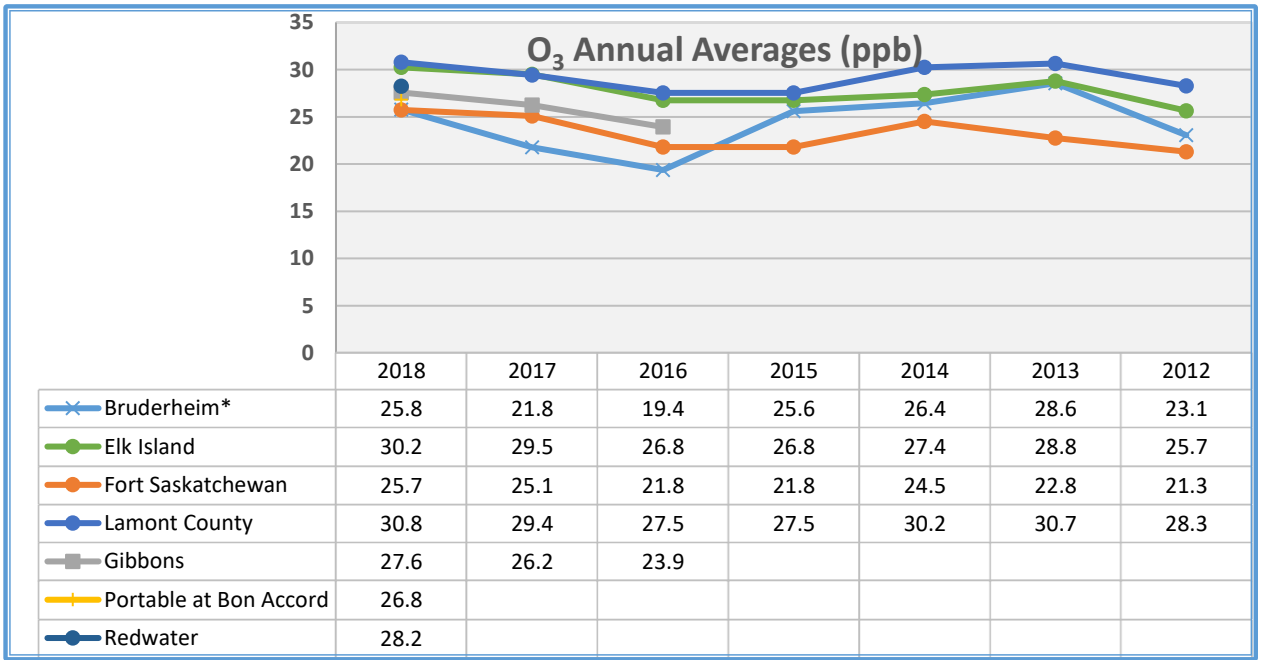
Ozone (continued)

Figure 44: Monthly average O_3 concentrations (ppb) in 2018



Bruderheim 1	20.5	31.8	37.1	36.1	30.8	30.2	27.2	22.3	18.3	21.0	16.2	17.8
Elk Island	24.2	34.4	44.5	45.7	40.6	35.1	28.5	23.2	19.9	24.6	19.4	22.9
Fort Saskatchewan	17.1	27.6	35.5	40.3	37.7	34.2	27.7	22.1	18.0	19.4	14.0	15.1
Gibbons	20.0	33.4	38.2	41.8	38.2	33.8	27.4	22.4	18.7	21.9	17.3	18.1
Lamont County	25.1	34.4	42.6	44.9	40.3	36.3	30.4	25.1	20.3	24.6	20.2	25.2
Redwater	21.1	31.6	41.0	43.6	40.9	35.4	26.5	21.0	19.2	22.4	17.7	18.6
Portable at Bon Accord				43.7	36.8	33.1	27.0	22.3	19.1	22.1	17.5	19.9

Figure 45: Annual average O_3 concentrations at FAP stations (ppb)

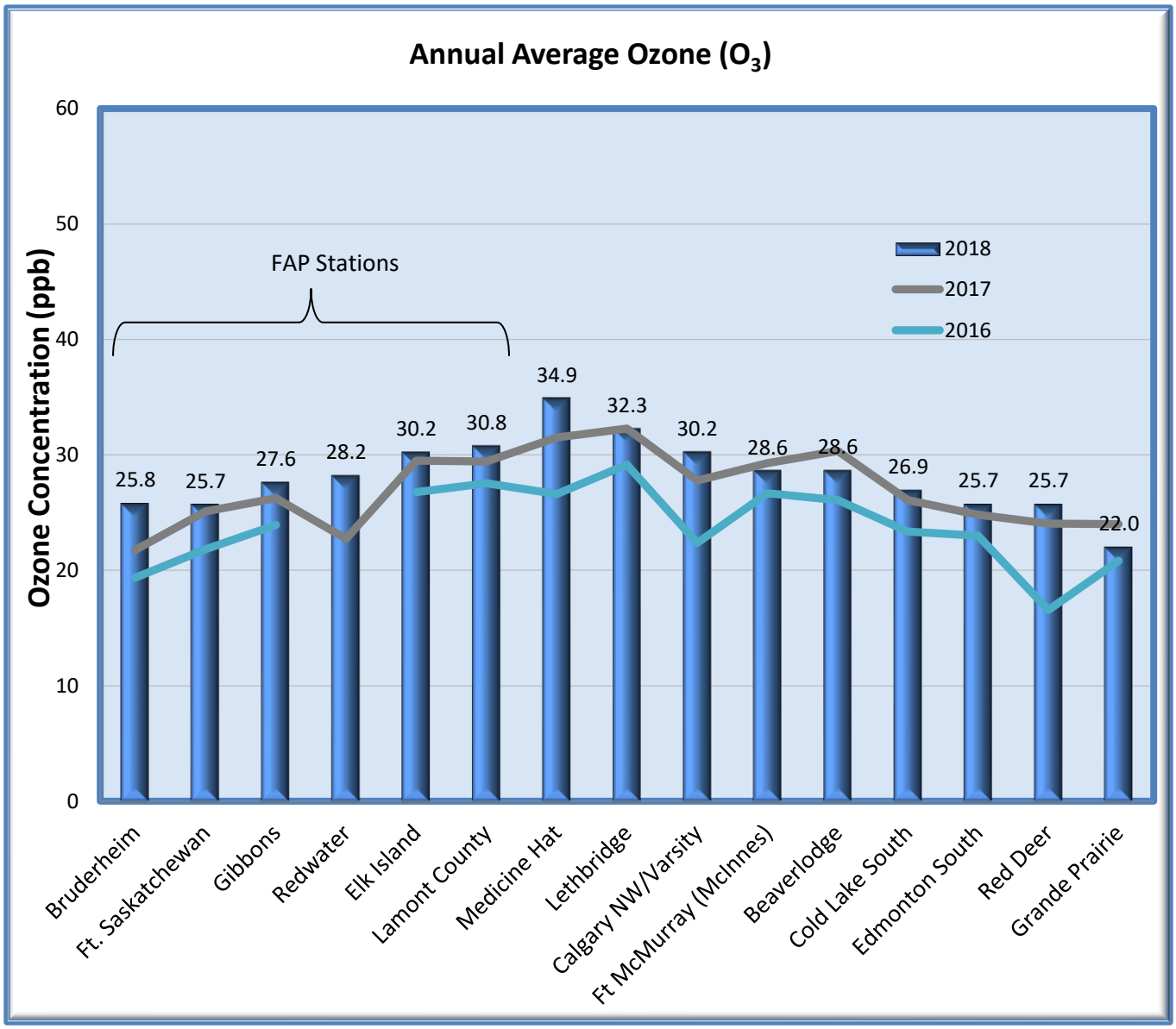


	2018	2017	2016	2015	2014	2013	2012
Bruderheim*	25.8	21.8	19.4	25.6	26.4	28.6	23.1
Elk Island	30.2	29.5	26.8	26.8	27.4	28.8	25.7
Fort Saskatchewan	25.7	25.1	21.8	21.8	24.5	22.8	21.3
Lamont County	30.8	29.4	27.5	27.5	30.2	30.7	28.3
Gibbons	27.6	26.2	23.9				
Portable at Bon Accord	26.8						
Redwater	28.2						

*The Bruderheim station was moved in 2016 and renamed Bruderheim 1
Bruderheim 2016 average includes data from both Bruderheim and Bruderheim1 stations

Ozone (continued)

Figure 46: Annual average O_3 concentrations in Alberta (ppb)



Sulphur Dioxide

Sulphur dioxide (SO_2) is a colourless gas with a pungent odour. In Alberta, natural gas processing plants are responsible for close to half of the SO_2 emissions in the province. Sources of SO_2 in the Airshed are primarily industrial sources, from both within and outside the FAP boundary.

The AAAQOs for sulphur dioxide are:

- 1-hour average concentration 172 ppb
- 24-hour average concentration 48 ppb
- 30-day average concentration 11 ppb
- Annual average concentration 8 ppb

There were no exceedances of any of the AAAQOs for SO_2 at any of the FAP monitoring stations in 2018.
Comparing air quality monitoring data in the Fort Air Partnership region for 2018 against the AAAQO, it was observed that the maximum 1-hour average was 27.5% of the AAAQO while eth highest 24-hour average was 15.2% of that AAAQO. The maximum 1 and 24-hour averages at each FAP continuous monitoring station are shown in the table below.

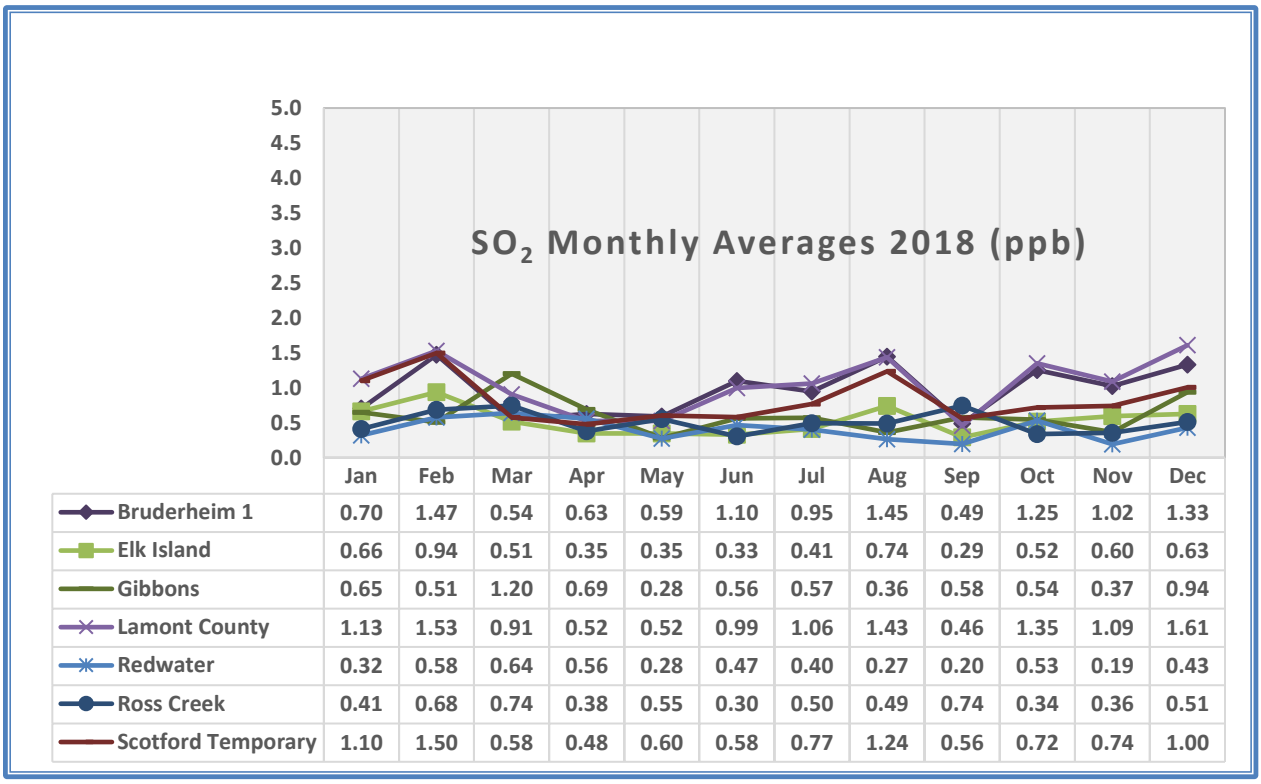
Table 16: 2018 maximum averages and AAAQOs for SO_2

Station	Highest 1-hour average (ppb)	% of AAAQO	Date Time	Highest 24-hour average (ppb)	% of AAAQO	Date
Bruderheim 1	47.31	27.5%	Oct 24, 13:00	6.6	13.8%	Nov 13
Elk Island	26.03	15.1%	Aug 8, 10:00	4.05	8.4%	Aug 8
Fort Saskatchewan	20.49	11.9%	Mar 13, 16:00	3.5	7.3%	Aug 23
Gibbons	45.21	26.3%	Jul 3, 09:00	5.13	10.7%	Jul 3
Lamont County	41.25	24.0%	Aug 20, 11:00	7.3	15.2%	Nov 13
Portable at Bon Accord	35.68	20.7%	Jul 3, 09:00	3.41	7.1%	Jul 3
Redwater	33.47	19.5%	Apr 20, 13:00	4.27	8.9%	Apr 19
Ross Creek	28.23	16.4%	Jul 25, 10:00	4.23	8.8%	Aug 23
Scotford Temporary	21.50	12.5%	Oct 5, 13:00	6.47	13.5%	Jan 26

Sulphur Dioxide (continued)

A summary of SO_2 concentrations recorded in 2018 at individual stations and a comparison with the previous 6 years are presented in the figures and tables below.

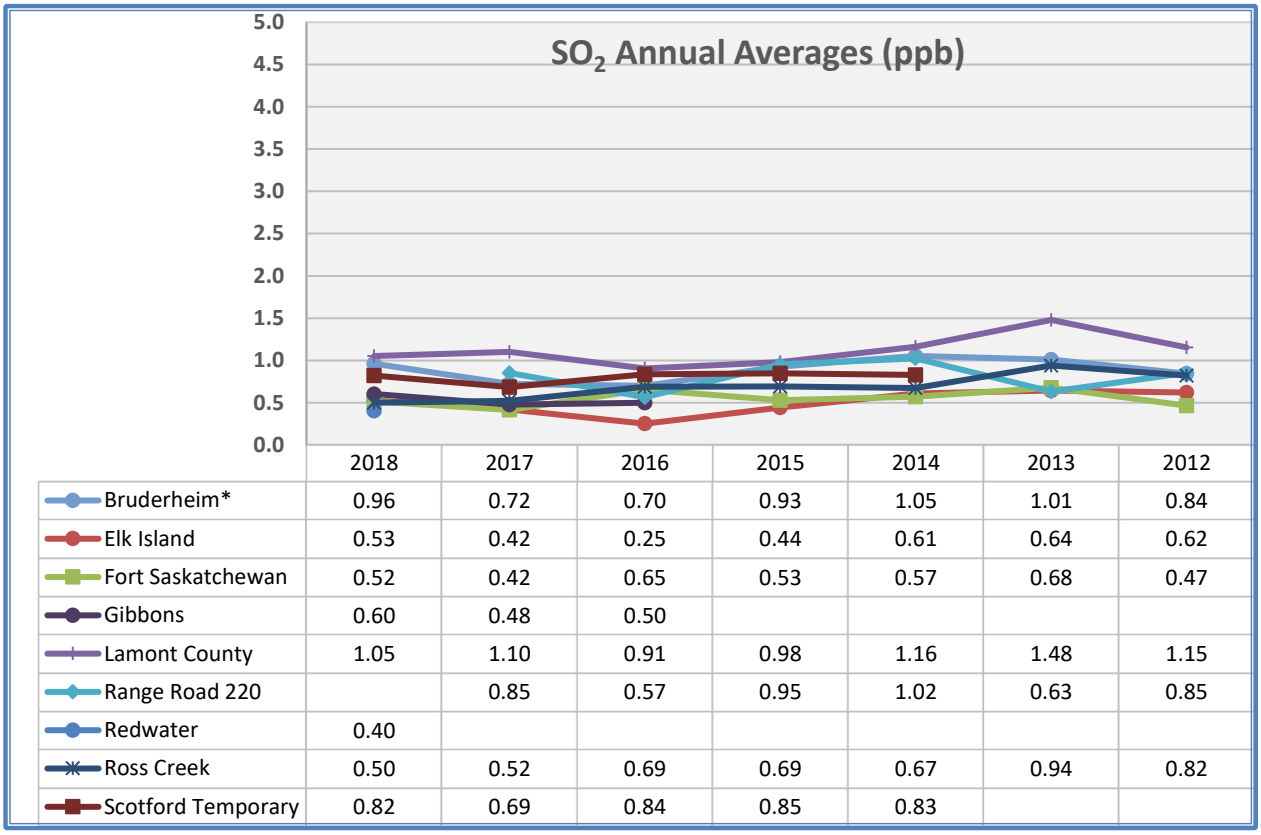
Figure 47: Monthly average SO_2 concentrations (ppb) in 2018



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bruderheim 1	0.70	1.47	0.54	0.63	0.59	1.10	0.95	1.45	0.49	1.25	1.02	1.33
Elk Island	0.66	0.94	0.51	0.35	0.35	0.33	0.41	0.74	0.29	0.52	0.60	0.63
Gibbons	0.65	0.51	1.20	0.69	0.28	0.56	0.57	0.36	0.58	0.54	0.37	0.94
Lamont County	1.13	1.53	0.91	0.52	0.52	0.99	1.06	1.43	0.46	1.35	1.09	1.61
Redwater	0.32	0.58	0.64	0.56	0.28	0.47	0.40	0.27	0.20	0.53	0.19	0.43
Ross Creek	0.41	0.68	0.74	0.38	0.55	0.30	0.50	0.49	0.74	0.34	0.36	0.51
Scotford Temporary	1.10	1.50	0.58	0.48	0.60	0.58	0.77	1.24	0.56	0.72	0.74	1.00

Sulphur Dioxide (continued)

Figure 48: Annual average SO_2 concentrations at FAP stations (ppb)



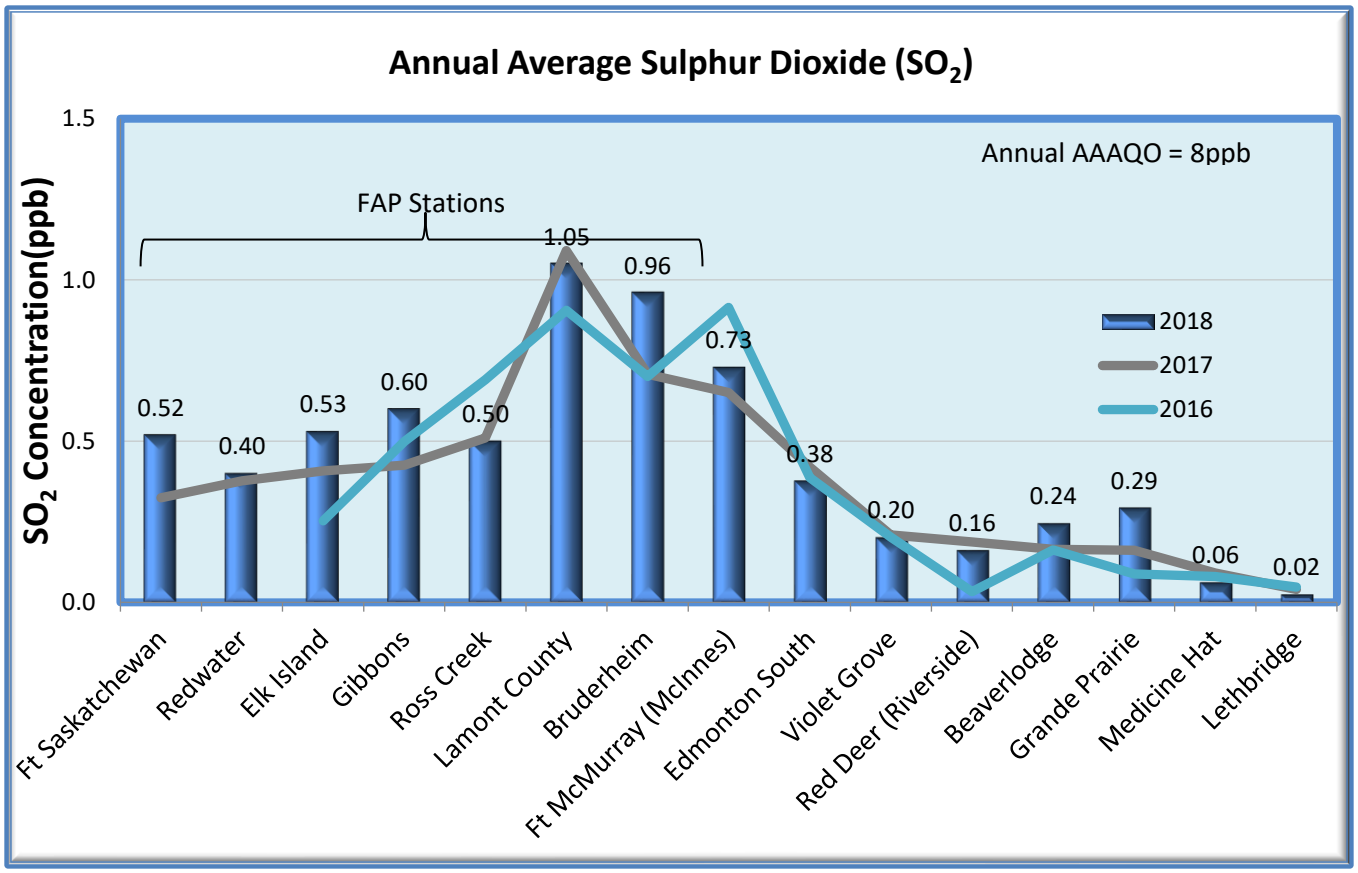
	2018	2017	2016	2015	2014	2013	2012
Bruderheim*	0.96	0.72	0.70	0.93	1.05	1.01	0.84
Elk Island	0.53	0.42	0.25	0.44	0.61	0.64	0.62
Fort Saskatchewan	0.52	0.42	0.65	0.53	0.57	0.68	0.47
Gibbons	0.60	0.48	0.50				
Lamont County	1.05	1.10	0.91	0.98	1.16	1.48	1.15
Range Road 220		0.85	0.57	0.95	1.02	0.63	0.85
Redwater	0.40						
Ross Creek	0.50	0.52	0.69	0.69	0.67	0.94	0.82
Scotford Temporary	0.82	0.69	0.84	0.85	0.83		

Notes:

- The Bruderheim* station was moved in 2016 and renamed Bruderheim 1. The Bruderheim 2016 annual average includes data from both Bruderheim and Bruderheim1 stations
- SO_2 monitoring was stopped at Range Road 220 in January 2017
- The Redwater station began operation October 2017

Sulphur Dioxide (continued)

Figure 49: Annual average SO_2 concentrations in Alberta (ppb)



*Bruderheim station moved within the town in 2016, data combines both locations

Volatile Organic Compounds (VOCs)

Benzene, toluene, ethylbenzene, o-xylene, mp-xylenes, and styrene (BTEX/S)

BTEX/S fall into the group of compounds known as non-methane or VOC's. These compounds are typically found in petroleum products, such as gasoline and diesel fuel and have a characteristic strong odour. Significant sources of VOCs in Alberta are vegetation, automobile emissions, gasoline dispensing and storage tanks, petroleum and chemical industries, dry cleaning, fireplaces, natural gas combustion. The major source of VOCs in most urban areas is vehicle exhaust emissions.

BTEX/S has been measured on a semi-continuous (four samples per hour) basis at the Scotford 2 and subsequently at Scotford Temporary stations since January 2007.

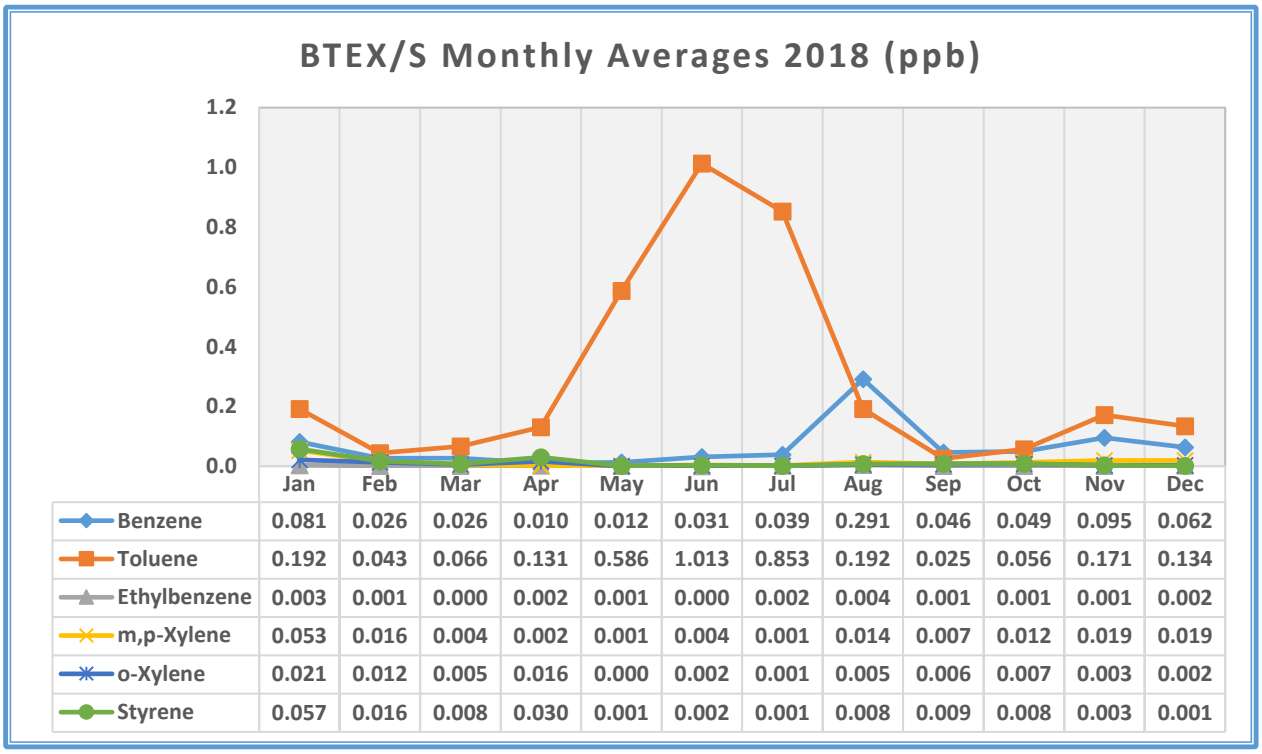
There were no exceedances for any of the BTEX/S compounds in 2018.

A summary of the BTEX and styrene concentrations recorded in 2018 at Scotford Temporary and a comparison with the previous 6 years are presented in the figures and tables below.

The slight increase in toluene in 2017 and 2018 is due to off-gassing of a sealant used on the roof of the monitoring station shelter itself.

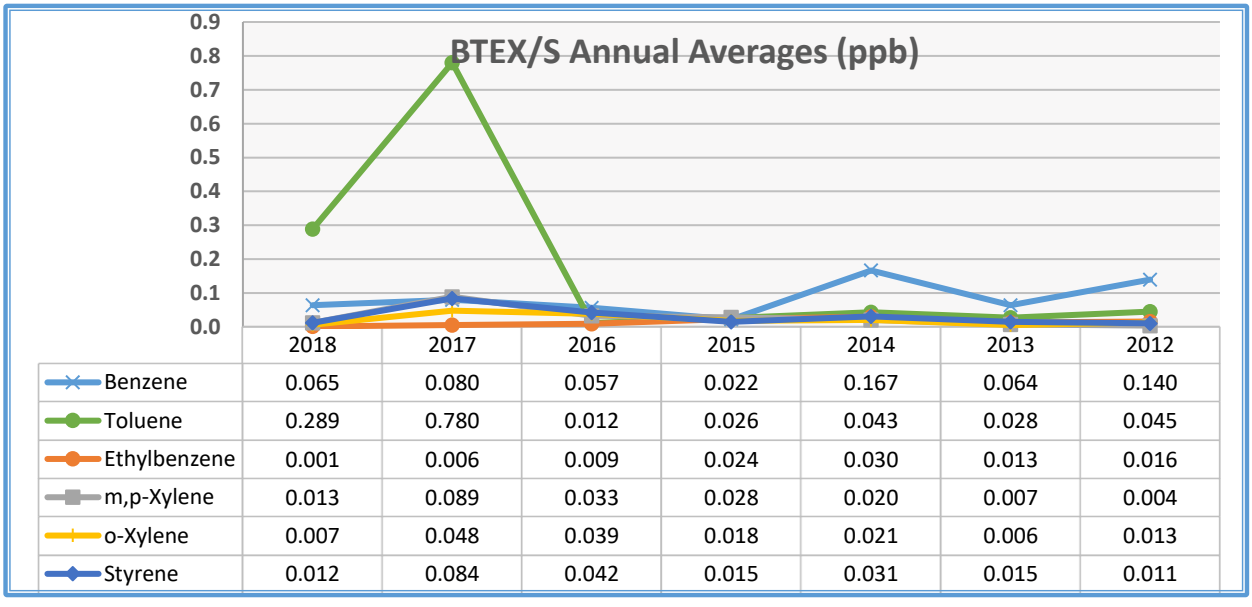
Volatile Organic Compounds (continued)

Figure 50: Monthly average BTEX/S concentrations (ppb) in 2018



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Benzene	0.081	0.026	0.026	0.010	0.012	0.031	0.039	0.291	0.046	0.049	0.095	0.062
Toluene	0.192	0.043	0.066	0.131	0.586	1.013	0.853	0.192	0.025	0.056	0.171	0.134
Ethylbenzene	0.003	0.001	0.000	0.002	0.001	0.000	0.002	0.004	0.001	0.001	0.001	0.002
m,p-Xylene	0.053	0.016	0.004	0.002	0.001	0.004	0.001	0.014	0.007	0.012	0.019	0.019
o-Xylene	0.021	0.012	0.005	0.016	0.000	0.002	0.001	0.005	0.006	0.007	0.003	0.002
Styrene	0.057	0.016	0.008	0.030	0.001	0.002	0.001	0.008	0.009	0.008	0.003	0.001

Figure 51: Annual average BTEX/S concentrations (ppb) – historical

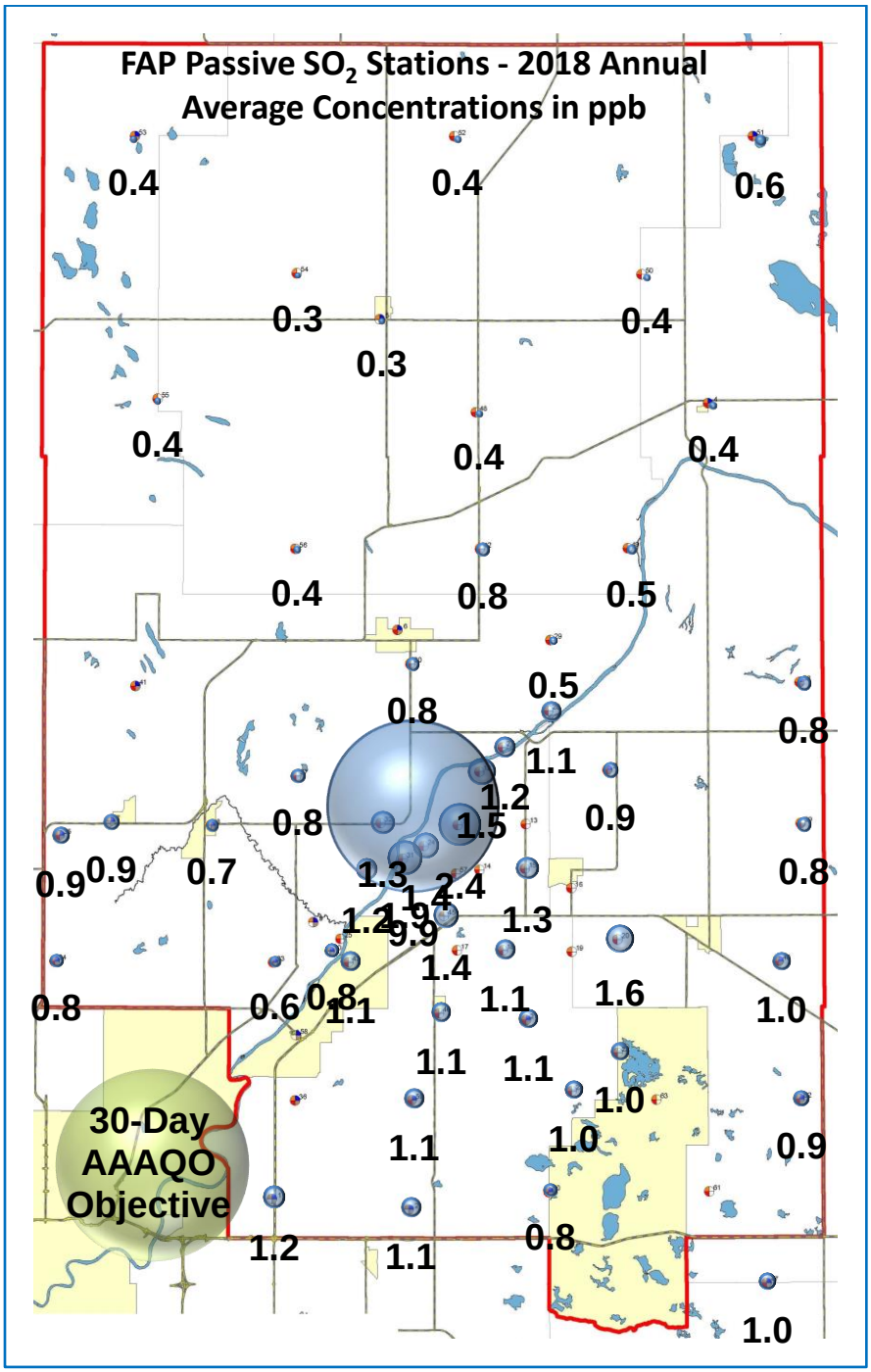


	2018	2017	2016	2015	2014	2013	2012
Benzene	0.065	0.080	0.057	0.022	0.167	0.064	0.140
Toluene	0.289	0.780	0.012	0.026	0.043	0.028	0.045
Ethylbenzene	0.001	0.006	0.009	0.024	0.030	0.013	0.016
m,p-Xylene	0.013	0.089	0.033	0.028	0.020	0.007	0.004
o-Xylene	0.007	0.048	0.039	0.018	0.021	0.006	0.013
Styrene	0.012	0.084	0.042	0.015	0.031	0.015	0.011

2018 Passive Monitoring Results

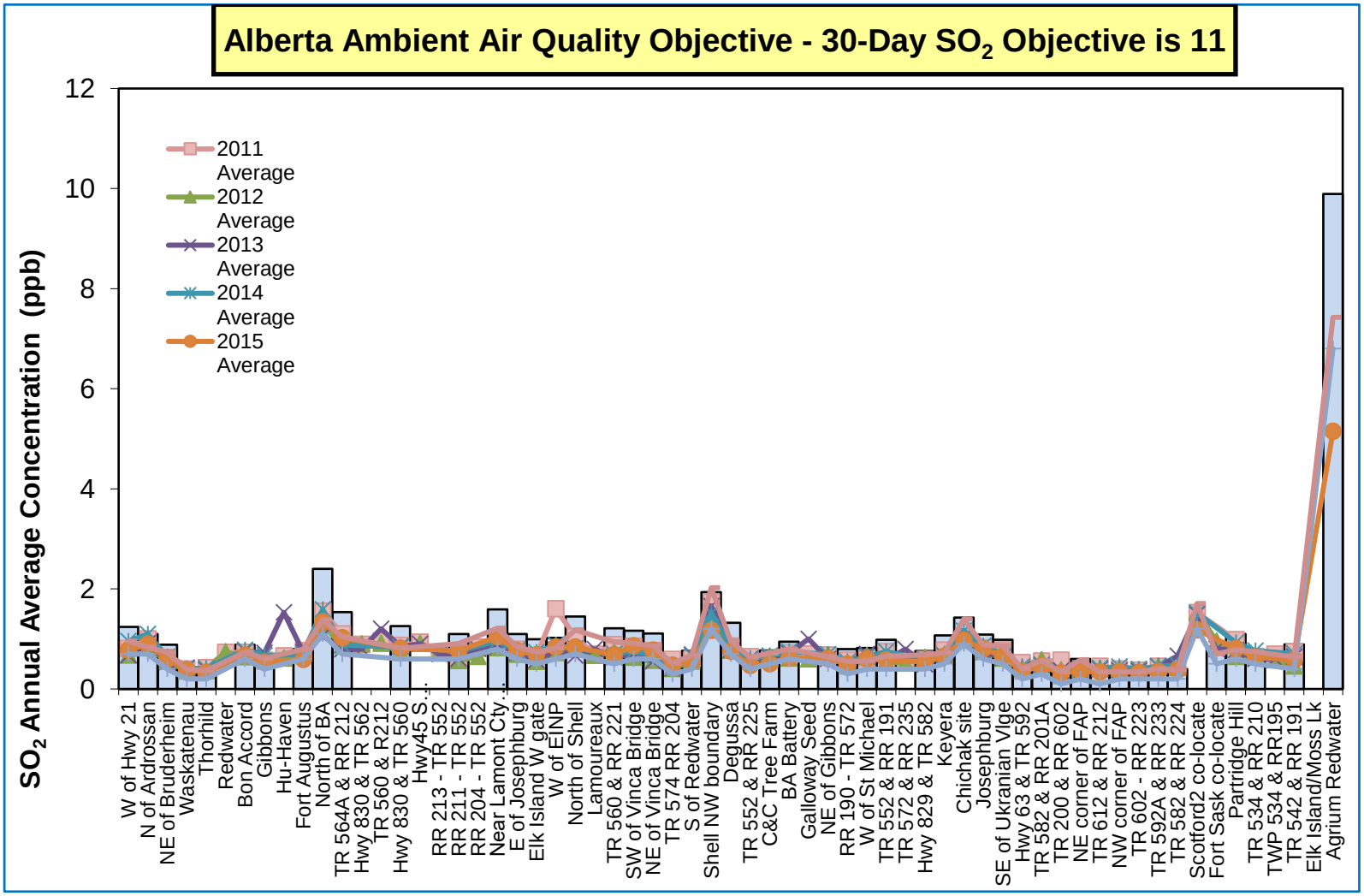
Sulphur Dioxide

Figure 52: 2018 Map of Annual average SO_2 concentrations (ppb)



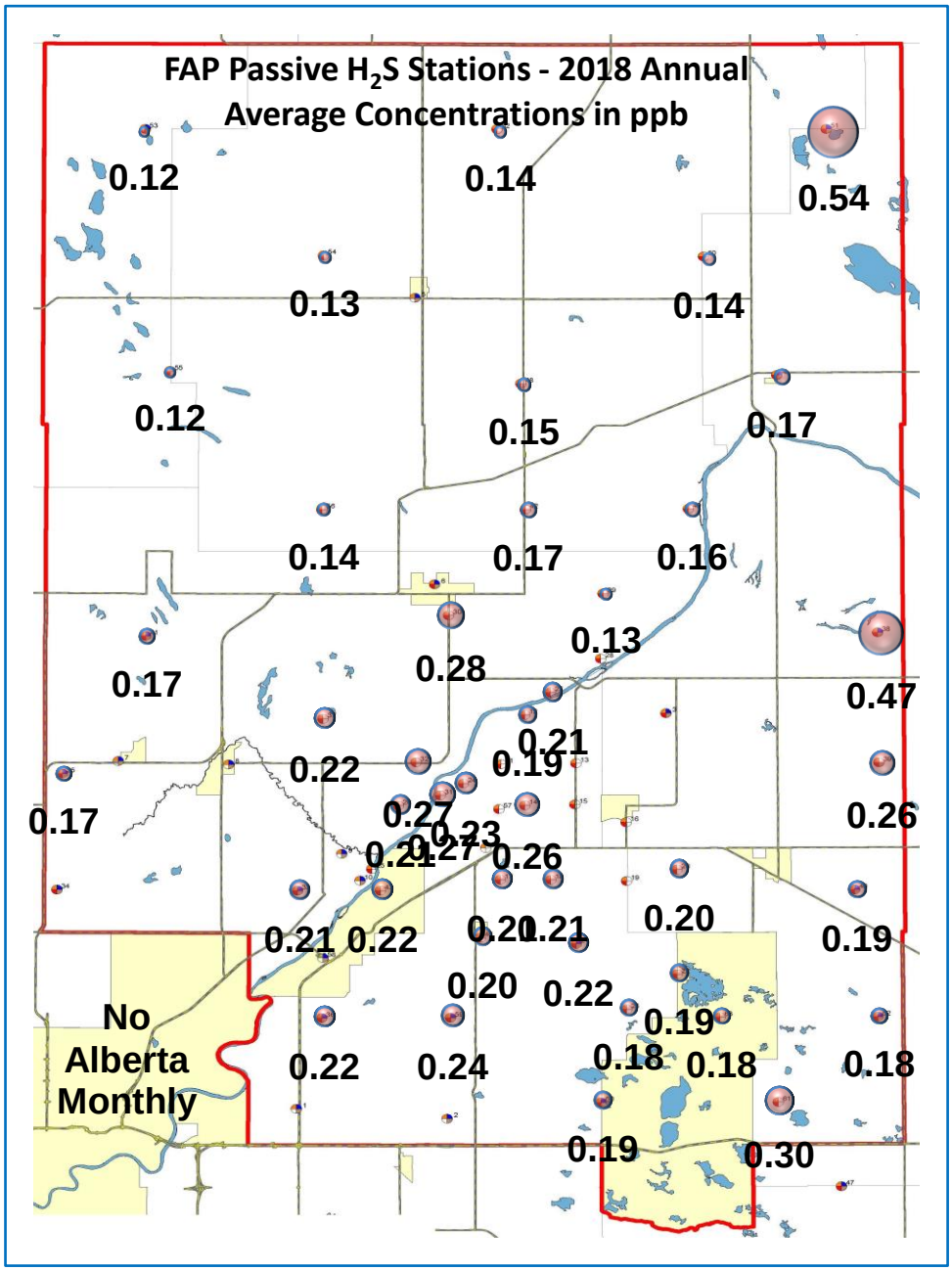
Note: the area of the bubble represents the concentration measured at the geographic center of the bubble, not the geographic area impacted

Figure 53: Passive monitoring annual averages: SO_2 (ppb) - historical



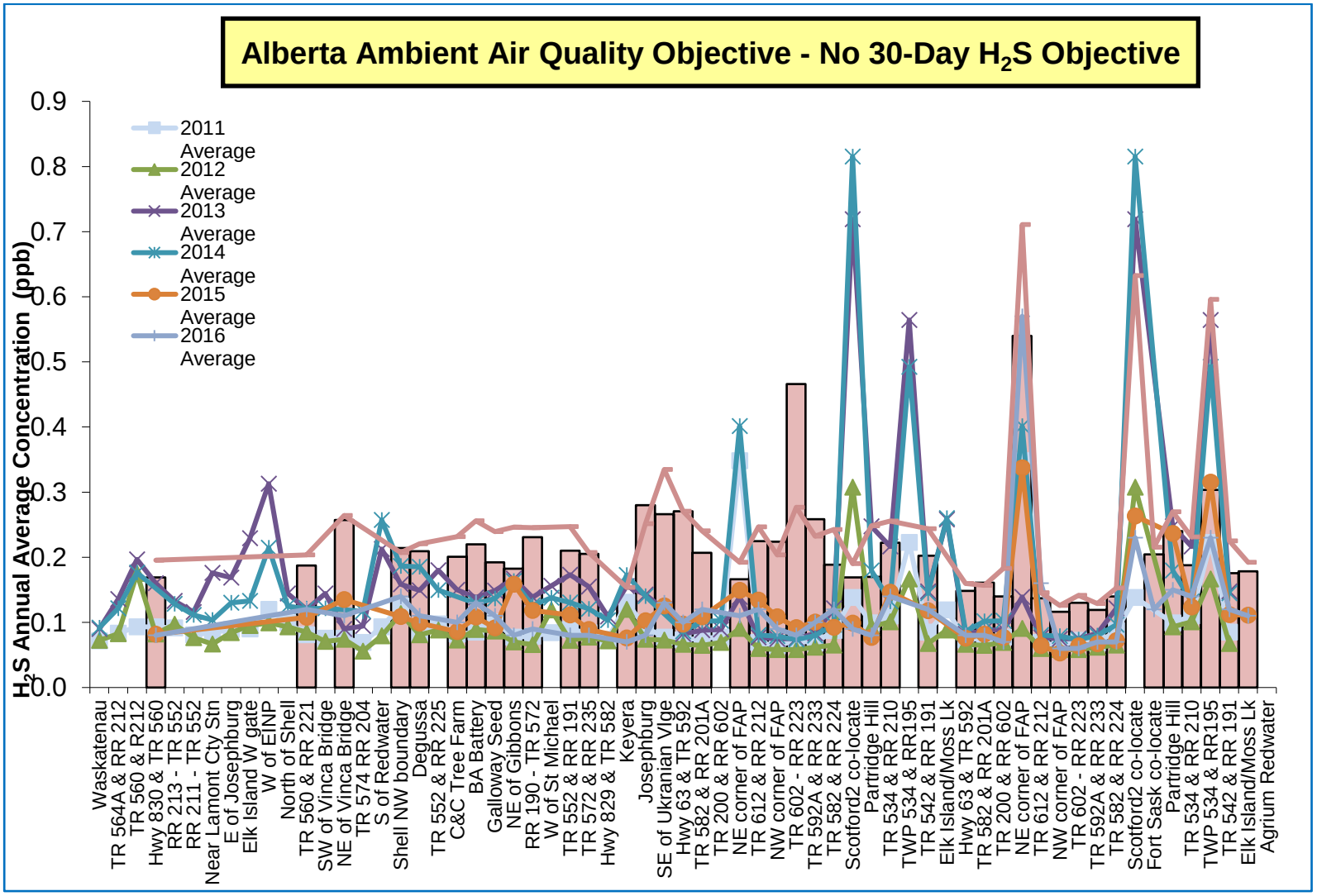
Hydrogen Sulphide

Figure 54: 2018 Map of Annual average H_2S concentrations (ppb)



Note: the area of the bubble represents the concentration measured at the geographic center of the bubble, not the geographic area impacted

Figure 55: Passive monitoring annual averages: H_2S (ppb) - historical



Other Technical Airshed Programs and Activities

Monitoring Plan Update

Airsheds in Alberta, including FAP, are required to file monitoring plans with the Alberta Government. In 2015, a detailed 5-year FAP Monitoring Plan was submitted and approved by the Alberta Government. Updates to the monitoring plan are filed every 6 months detailing progress towards proposed changes in monitoring and identifying any further new projects or changes to the monitoring network.

Following is a listing of the FAP network changes or new projects proposed in the 2015 Monitoring Plan. All changes have been approved by the Alberta Government. The date of implementation or status is included in italics.

- New permanent station in the vicinity of Gibbons
  (new station in Gibbons began operation February 2016)
- New portable monitoring station
  (station began operation April 2018)
- Relocation of the Redwater Industrial monitoring station
  (new station in Redwater began operations October 2017)
- Relocation of the Scotford 2 Monitoring Station
  (site identified and approved, proceeding toward site construction and station move late 2018)
- Discontinue redundant monitoring analyzers
  (SO_2 and NH_3 removed from Range Rd 220 station January 2017)
- Organic Hydrocarbons Sampling
  - Subproject 1: VOC Sampling project at Bruderheim
    (Phase 1 of the sampling had been completed July 2014-March 2015)
    (Phase 2 sampling ran from August 2017 till July 2018)
  - Subproject 2: VOC Sampling in Area of Oil and Gas Development
    (nonmethane hydrocarbon sampling will be added to the portable station depending on sampling objectives at a given site)
- Upgrade $PM_{2.5}$ technology
  (Completed October 2017 with start-up of the Redwater station. All stations with PM2.5 now operate approved equivalent method samplers)
- $PM_{2.5}$ Co-located filter sampling
  (2-year project, sampling from July 2015 to August 2017. Report completed December 2017)

All planned projects have been implemented or are underway. FAP will be required to file a new 5-year monitoring plan in 2020.

Volatile Organics Speciation Project

FAP completed a Volatile Organic Compound (VOC) speciation project at the Bruderheim 1 station that ran from August 2017 to July 2018. 24-hour samples were taken every 6 days while additional 1-hour samples were triggered on elevated measurements of the continuous non-methane hydrocarbon analyzer on site.

VOC Speciation was recommended in a network assessment completed for the FAP network in 2012 and included as a project in the FAP Monitoring Plan submitted to Alberta Environment and Parks in 2015. the results of this project may be valuable to help understand the impact of the oil and gas wells on air quality in the region, especially a populated area such as Bruderheim.

The Air Quality Health Index (AQHI) is currently the primary means to report potential air quality impact to human health. In the 2012 Network Assessment, it was noted that while acute exposures are the most important from a public health awareness perspective, chronic exposures also need to be considered. These long-term exposures expanded the list of pollutants of interest.

In a previous 19-month, short-term monitoring study of volatile organic compounds (VOCs) in the airshed in 2006, it was determined that most VOCs were at much lower concentrations than at other National Air Pollutant Surveillance (NAPS) sites throughout Canada where VOCs had been monitored. However, all other monitoring sites compared were in much more populated areas (with much higher urban emissions) than at the FAP sites (e.g., Edmonton, Ontario). Moreover, the addition and expansion of industrial facilities and increase in oil and gas wells within the airshed may have increased local VOC emissions since 2006.

A summary report for the 2017-2018 VOC Speciation Project is under development as of the date of this report.

Fine Particulate Matter Response Plan

Fort Air Partnership continued to support the Capital Region Oversight Advisory Committee implementation of a Fine Particulate Matter Response Plan for the Capital Region throughout 2018. The Fine Particulate Matter Response Plan includes recommended actions to:

- reduce $PM_{2.5}$ concentrations in the outside air
- improve knowledge of $PM_{2.5}$ in the Capital Region
- engage with people about their responsibilities to reduce ambient $PM_{2.5}$

Implementation of the Fine Particulate Matter Response Plan will be evaluated and reported against the new Canadian Ambient Air Quality Standards (CAAQS) that have been adopted nationally for $PM_{2.5}$. Measurements of $PM_{2.5}$ taken by Fort Air Partnership and other airsheds will be compared to these new CAAQS.

Fort Air Partnership's air monitoring stations measure the amount of fine particulate matter in the air. Higher measurements are often recorded in cold winter months. Cold temperatures and stagnant air can create a build-up of pollutants near the ground, particularly during a weather phenomenon called a temperature inversion where cold air is trapped near the ground by a layer of warm air. The warm air acts like a lid, holding these pollutants down until wind, rain or snow storms helps to disperse them. Some examples of actions that people can take during the wintertime to reduce their contribution to $PM_{2.5}$ include carpooling, not idling their cars when parked and working from home if possible.

In 2018 FAP began a 2-year fine particulate matter speciation project in Fort Saskatchewan. Results from this project will add an additional piece of information that can help to inform the committee and implementation of the Particulate Matter Response Plan for the Capital Region of which our region is a part of .

Live to Web Data Feed

FAP continues to provide a free, on-line data feed that allows anyone to check out air quality readings at any time. People can search by station, or by substance, and get hour-by-hour current or historic raw data in an easy-to-understand format. The technical sister to this public service allows regulators, technical group users and emergency responders to receive minute-by-minute data in near real time.

The data available on the FAP live data site are raw numbers but quality controls ensure the data is validated before being permanently stored in the Alberta Government Air Data Warehouse.

Appendices

Appendix A: Technical Working Group Members

(As of December 31, 2018)

Harry Benders
(Chair)
Network Manager
Fort Air Partnership

Patrick Andersen B.Sc.
Andersen Science Consulting

Nadine Blaney, B.Sc.
Executive Director
Fort Air Partnership

Saminda Chandraratne, B.Sc., PGD., EP
EHS Supervisor
Chemtrade Logistics

Michael Cody MSc., RPF
Specialist, Land and Biodiversity
Cenovus Energy Inc.

Jeff Cooper C. Tech
AQM Operations Manager,
WSP

Doug Hurl
EHS Manager
Umicore Canada Inc.

Stephanie Kozey
EH&S Regulatory Specialist
Dow Chemical Canada ULC

Gerry Mason CRSP
Manager, ESH
Oerlikon Metco (Canada) Inc.

Maxwell Mazur M.Sc.
Air Quality Specialist
Alberta Environment and Parks

Moe Ouellet
Environmental Specialist
Pembina Pipeline Corp.

Keith Purves
FAP Vice Chair and Public Member
Fort Air Partnership

Marianne Quimpere EP
Environmental Advisor
Sherritt International Corporation

Stephen Raye
Regulatory and Advocacy Focal
Shell Scotford

Karlee Searle B.Sc.
Environmental Advisor
Nutrien Redwater Fertilizer

James Sievwright
Meteorological Technologist
Environment and Climate Change Canada

Shane Taylor
Alberta Environment and Parks

Jocelyn Thrasher-Haug M.Sc., P.Ag., P.Biol.
Manager, Environmental Planning
Strathcona County

Darcy Walberg
Operations Environmental
Specialist
Northwest Redwater Partnership

Alan Wesley
Public Member
Fort Air Partnership

Technical Working Group Corresponding Members

Laurie Danielson, PhD., P. Chem.
Executive Director
Northeast Capital Industrial Association

Kathryn Dragowska
Chemtrade Logistics

Jeff Hamilton
Pembina Pipeline Corp.

Appendix B: Monitoring Objectives

Table 17: FAP Monitoring Objectives

Ranking	Objective
Priority 1	Understand spatial distribution of pollutants in the region
	Identify regional air quality trends
	Provide flexibility to characterize emerging issues, sources, and locations.
Priority 2	Provide appropriate information for evaluating population exposure to ambient air quality
	Provide information required to understand air quality impacts on the health of the environment
Priority 3	Improve the ability to identify and apportion pollutant sources for purposes of air quality management
	Provide suitable input and validation information for air quality models

Appendix C: Industry Participants in FAP

Table 18: Industry Participants in FAP (Dec. 31, 2018)

A.
As funders of FAP through Northeast Capital Industrial Association and participation on the FAP Board of Directors

- Nutrien Redwater
- ME Global

B.
As funders of FAP through Northeast Capital Industrial Association and participation in the Technical Working Group

- Accel Energy
- Cenovus Energy
- Chemtrade Logistics
- Dow Chemical Canada ULC
- North West Redwater Partnership
- Nutrien
- Pembina Pipeline Corp.
- Shell Scotford (Shell Chemicals, Shell Refinery and Shell Upgrader)
- Sherritt International Corp.
- Oerlikon Metco (Canada) Inc.
- Umicore Canada Inc.

C. As funders of FAP through Northeast Capital Industrial Association

- Accel Energy
- Access Pipeline
- Air Liquide Canada Inc.
- Aux Sable Canada
- Cenovus Energy
- Chemtrade Logistics (CSC)
- Chemtrade Logistics (Sulphides)
- Dow Chemical Canada ULC
- Evonik
- Keyera Energy
- MEGlobal Canada Inc.
- MEG Energy
- North West Redwater Partnership
- Nutrien Fort Saskatchewan
- Nutrien Redwater
- Oerlikon Metco (Canada)
- Pembina NGL Corp.
- Plains Midstream Canada
- Praxair Canada Inc.
- Shell Scotford (Shell Chemicals, Shell Refinery and Shell Upgrader)
- Sherritt International Corp.
- Umicore Canada Inc.
- Value Creation

Appendix D: Passive Data Summary Tables

Table 19: 2018 Passive monitoring monthly averages: SO_2 (ppb)

Site	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	Max
1	Stocks Greenhouses	2.0	1.8	1.6	0.6	0.6	0.7	1.1	1.6	0.6	1.2	1.1	1.4	1.2	2.0
2	Ardrossan northeast	1.8	1.8	1.4	0.7	0.3	0.6	1.1	1.1	0.6	1.0	1.3	1.5	1.1	1.8
3	Bruderheim northeast	0.7	1.6	0.9	0.5	0.8	1.3	0.9	1.3	0.3	0.6	0.8	1.3	0.9	1.6
4	Waskatenau	0.5	0.8	0.4	0.3	0.2	0.5	0.4	0.5	0.2	0.4	0.5	0.5	0.4	0.8
5	Thorhild	0.4	0.3	0.6	0.3	0.4	0.3	0.3	0.4	0.2	0.3	0.3	0.4	0.3	0.6
7	Bon Accord	1.1	1.2	1.6	0.9	0.5	0.8	0.6	0.7	0.6	0.8	0.8	1.4	0.9	1.6
8	Gibbons	0.9	0.6	1.4	0.8	0.5	0.8	0.6	0.5	0.6	0.6	0.5	0.6	0.7	1.4
10	Fort Augustus	0.8	1.6	1.0	0.6	0.5	0.8	0.7	1.0	0.7	0.5	0.6	0.9	0.8	1.6
11	North of BA	1.1	4.7	1.4	1.1	1.7	3.0	2.6	3.2	1.2	3.7	1.3	2.5	2.4	4.7
12	TwpRd 564A RgeRd 212	1.3	2.7	1.8	0.7	0.7	1.1	1.8	2.4	0.7	1.8	1.2	2.6	1.5	2.7
15	Hwy 830 Twp Rd 560	0.8	2.3	1.0	0.8	1.0	1.3	1.2	1.6	0.5	1.8	0.9	1.8	1.3	2.3
18	Rge Rd 211 TwpRd 552	1.2	1.9	1.4	0.7	1.0	0.7	0.9	1.1	0.5	1.1	1.1	1.6	1.1	1.9
20	Rge Rd 202	1.5	2.6	1.5	0.8	0.9	1.2	1.2	2.1	0.6	1.8	1.9	2.6	1.6	2.6
21	Josephburg east	1.2	1.9	1.0	0.6	0.5	0.8	1.0	1.5	0.5	1.2	1.3	1.3	1.1	1.9
22	Elk Island Park west gate	1.1	1.7	1.0	0.5	0.5	0.6	0.9	1.2	0.4	0.9	1.0	1.9	1.0	1.9
23	Goodhope	1.3	1.8	1.2	0.7	0.5	0.5	0.8	1.4	0.5	0.8	1.0	1.5	1.0	1.8
24	North of Scotford	0.9	2.5	1.0	1.3	1.2	1.4	1.7	1.8	0.9	1.6	1.2	2.4	1.4	2.5
26	Twp Rd 560 Rge Rd 221	1.2	1.3	3.0	0.8	1.0	1.1	1.0	1.0	1.3	0.8	0.8	1.2	1.2	3.0
27	Boat Launch	1.2	1.9	0.9	0.5	0.6	0.8	1.3	1.9	0.6	1.6	1.6	1.6	1.2	1.9
28	Redwater Natural Area S	0.8	2.1	0.6	0.5	0.5	0.6	1.3	1.7	0.5	1.4	1.8	2.2	1.1	2.2
29	Redwater Natural Area N	0.6	1.0	0.5	0.4	0.2	0.6	0.5	0.4	0.2	0.4	0.5	0.7	0.5	1.0
30	Redwater south	0.9	1.0	1.8	0.7	0.4	1.1	0.7	0.7	0.3	0.6	0.4	0.7	0.8	1.8
31	Northwest of Scotford	1.6	1.8	2.0	1.9	1.9	2.5	2.5	1.5	1.6	2.2	1.8	2.0	1.9	2.5
32	Degussa	1.1	1.3	1.7	1.1	0.9	1.8	1.6	1.2	1.9	0.9	1.3	1.8	1.3	1.9
33	Twp Rd 552 Rge Rd 225	0.7	1.0	1.1	0.7	0.5	0.6	0.6	0.7	0.5	0.3	0.6	0.7	0.6	1.1
34	C&C Tree Farm	1.0	0.9	1.5	0.7	0.5	0.6	0.5	0.5	0.5	0.7	0.7	1.2	0.8	1.5
35	Bon Accord southwest	1.2	1.0	1.8	0.9	0.6	0.6	0.8	0.9	0.7	0.8	1.0	1.0	0.9	1.8
37	Twp Rd 564 Rge Rd 224	0.8	0.8	1.6	0.7	0.5	0.9	0.7	0.5	0.8	0.7	0.6	1.2	0.8	1.6
38	Peno	0.8	1.5	0.8	0.4	0.8	0.9	0.7	0.9	0.3	0.6	0.6	0.9	0.8	1.5
39	Saint Michael	0.9	1.6	1.0	0.5	0.4	0.8	0.9	0.8	0.3	0.4	0.7	1.0	0.8	1.6
40	Lamont east	1.0	1.8	1.4	0.5	0.6	0.8	0.6	1.0	0.4	0.9	0.7	1.6	1.0	1.8
42	Radway - Val Soucy	0.7	1.2	1.4	0.5	0.3	0.7	0.5	0.5	0.2	0.6	0.6	1.0	0.8	1.4
43	Keyera Site	0.8	1.4	1.3	0.7	0.8	1.2	1.2	1.7	0.9	0.7	0.8	1.2	1.1	1.7
45	Scotford east	1.7	2.6	0.9	0.8	1.3	*N/A*	*N/A*	2.0	1.5	1.2	1.2	1.5	1.4	2.6
46	Josephburg	1.1	2.1	0.9	0.8	0.5	0.8	0.8	1.4	0.8	1.0	1.5	1.4	1.1	2.1
47	Southeast of FAP	1.4	2.0	0.9	0.6	0.5	0.6	0.8	1.1	0.4	0.9	1.0	1.3	1.0	2.0
48	Highway 63	0.5	1.1	0.5	0.4	0.3	0.3	0.3	0.3	*N/A*	0.0	0.2	0.4	0.4	1.1
49	Namepi Creek	0.5	1.1	0.5	0.5	0.3	0.6	0.5	0.6	0.3	0.5	0.5	0.7	0.5	1.1
50	Sprucefield	0.5	0.7	0.9	0.3	0.2	0.6	0.3	0.3	0.2	0.2	0.3	0.4	0.4	0.9
51	Hollow Lake	0.6	0.4	N/A	0.3	0.3	1.5	1.1	1.1	0.3	0.1	0.6	0.7	0.6	1.5
52	Abee	0.5	0.6	0.9	0.4	0.2	0.3	0.3	0.4	0.2	0.2	0.3	0.5	0.4	0.9
53	Tawatinaw - Clearbrook	0.5	0.5	1.2	0.3	0.2	0.3	0.2	0.3	0.2	0.3	0.4	0.5	0.4	1.2
54	Elbridge	0.5	0.4	0.6	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.4	0.3	0.6
55	Taylor Lake	0.4	0.4	0.7	0.4	0.3	0.3	0.4	0.4	0.3	0.4	0.3	0.4	0.4	0.7
56	Opal	0.5	0.6	0.6	0.3	0.3	0.5	0.2	0.3	0.3	0.4	0.4	0.5	0.4	0.6
57	Scotford 2	1.8	1.6	*Not in Service*								1.7	3.4	*I/D*	*I/D*
58	Fort Saskatchewan	0.7	1.6	1.1	0.5	0.6	0.6	1.1	0.9	0.7	0.6	0.8	1.1	0.8	1.6
59	Partridge Hill	1.5	2.0	1.4	0.7	0.4	0.6	1.0	1.4	0.6	0.9	1.6	1.6	1.1	2.0
60	Oxbow Lake	1.2	1.5	1.0	0.7	0.4	0.6	0.9	0.9	0.4	0.5	0.7	0.8	0.8	1.5
62	FAP East Boundary	0.7	1.8	1.1	0.5	0.7	0.8	0.9	1.0	0.4	0.8	0.8	1.4	0.9	1.8
64	Agrium Redwater	11.3	2.2	18.4	3.5	7.3	9.1	8.8	4.5	15.9	12.3	7.3	18.9	9.9	18.9
66	Plains Midstream # 1	1.0	1.6	1.2	0.7	0.6	0.9	0.9	1.1	0.7	0.6	0.7	1.0	0.9	1.6
67	Plains Midstream # 2	0.7	1.2	1.0	0.7	0.8	1.1	0.9	1.1	0.5	0.6	0.7	1.0	0.9	1.2
68	ARC Resources Site 1	0.5	0.9	0.7	0.7	0.5	0.9	0.9	0.7	0.3	0.5	0.3	0.6	0.6	0.9
69	ARC Resources Site 2	0.6	1.1	0.8	0.6	0.4	0.8	0.6	0.4	0.2	0.4	0.5	0.9	0.6	1.1
70	ARC Resources Site 3	1.0	1.2	1.0	0.9	0.5	1.1	1.1	0.9	0.5	1.0	0.7	1.0	0.9	1.2
71	ARC Resources Site 4	0.9	1.3	1.0	0.7	0.4	0.9	0.8	0.6	0.4	0.7	0.6	0.9	0.8	1.3
	Average	1.1	1.5	1.5	0.7	0.7	1.0	1.0	1.1	0.8	1.0	1.0	1.5	1.0	
	Maximum	11.3	4.7	18.4	3.5	7.3	9.1	8.8	4.5	15.9	12.3	7.3	18.9		18.9

N/A: no sample I/D: insufficient data Reportable Detection Limit: 0.2 ppb

Table 20: 2018 Passive monitoring monthly averages: H_2S (ppb)

Site	Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg	Max
4	Waskatenau	0.21	0.19	0.13	0.06	0.18	0.23	0.28	0.27	0.10	0.11	0.20	0.18	0.17	0.28
12	TwpRd 564A RgeRd 212	0.22	0.17	0.16	0.07	0.19	0.22	0.35	0.24	0.13	0.13	0.19	0.20	0.19	0.35
14	Astotin Creek	0.25	0.18	0.20	0.08	0.21	0.31	0.62	0.47	0.22	0.17	0.21	0.30	0.26	0.62
17	Rge Rd 213 TwpRd 552	0.23	0.19	0.16	0.11	0.22	0.21	0.35	0.30	0.19	0.19	0.19	0.20	0.21	0.35
18	Rge Rd 211 TwpRd 552	0.27	0.18	0.24	0.12	0.18	0.24	0.30	0.25	0.14	0.12	0.15	0.25	0.21	0.30
20	Rge Rd 202	0.21	0.14	0.20	0.09	0.30	0.29	0.29	0.28	0.16	0.09	0.15	0.22	0.20	0.30
21	Josephburg east	0.20	0.15	0.15	0.08	0.21	0.27	0.56	0.41	0.13	0.14	0.21	0.20	0.22	0.56
22	Elk Island Park west gate	0.19	0.14	0.17	0.09	0.27	0.30	0.33	0.31	0.14	0.09	0.12	0.18	0.19	0.33
23	Goodhope	0.20	0.16	0.16	0.10	0.14	0.21	0.37	0.31	0.16	0.10	0.18	0.18	0.18	0.37
24	North of Scotford	0.21	0.24	0.26	0.15	0.25	0.26	0.42	0.28	0.12	0.13	0.21	0.32	0.23	0.42
26	Twp Rd 560 Rge Rd 221	0.25	0.18	0.25	0.15	0.15	0.17	0.21	0.22	0.11	0.15	0.24	0.50	0.21	0.50
27	Boat Launch	0.29	0.24	0.27	0.12	0.20	0.23	0.30	0.24	0.10	0.17	0.21	0.19	0.21	0.30
29	Redwater Natural Area N	0.18	0.14	0.15	0.05	0.13	0.17	0.21	0.18	0.07	0.06	0.12	0.16	0.13	0.21
30	Redwater south	0.34	0.14	0.20	0.15	0.32	1.06	0.32	0.23	0.12	0.12	0.15	0.17	0.28	1.06
31	Northwest of Scotford	0.26	0.21	0.27	0.11	0.24	0.25	0.31	0.27	0.14	0.24	0.46	0.47	0.27	0.47
32	Degussa	0.39	0.13	0.20	0.27	0.34	0.23	0.55	0.38	0.15	0.13	0.19	0.22	0.27	0.55
33	Twp Rd 552 Rge Rd 225	0.27	0.17	0.27	0.15	0.17	0.19	0.24	0.26	0.15	0.18	0.22	0.23	0.21	0.27
35	Bon Accord southwest	0.19	0.16	0.20	0.09	0.22	0.13	0.19	0.29	0.08	0.12	0.17	0.19	0.17	0.29
36	Galloway Seed	0.25	0.24	0.17	0.15	0.20	0.23	0.32	0.32	0.18	0.17	0.25	0.21	0.22	0.32
37	Twp Rd 564 Rge Rd 224	0.32	0.13	0.16	0.10	0.20	0.27	0.58	0.28	0.11	0.14	0.16	0.20	0.22	0.58
38	Peno	0.23	0.09	0.11	0.08	1.31	1.12	0.98	0.57	0.13	0.11	0.14	0.22	0.47	1.31
39	Saint Michael	0.22	0.17	0.15	0.10	0.21	0.37	0.54	0.48	0.13	0.10	0.17	0.18	0.26	0.54
40	Lamont east	0.24	0.16	0.13	0.09	0.24	0.26	0.27	0.29	0.12	0.09	0.12	0.18	0.19	0.29
41	Lily Lake	0.41	0.13	0.11	0.10	0.12	0.15	0.21	0.28	0.10	0.11	0.15	0.12	0.17	0.41
42	Radway - Val Soucy	0.22	0.16	0.13	0.08	0.16	0.24	0.24	0.23	0.09	0.10	0.16	0.18	0.17	0.24
43	Keyera Site	0.19	0.18	0.19	0.19	0.19	0.18	0.34	0.29	0.19	0.21	0.23	0.23	0.22	0.34
46	Josephburg	0.17	0.19	0.13	0.14	0.23	0.21	0.26	0.33	0.14	0.15	0.17	0.19	0.20	0.33
48	Highway 63	0.19	0.12	0.11	0.09	0.12	0.17	0.21	0.18	*NA*	0.09	0.13	0.20	0.15	0.09
49	Namepi Creek	0.18	0.15	0.11	0.07	0.15	0.22	0.28	0.28	0.09	0.08	0.11	0.21	0.16	0.28
50	Sprucefield	0.18	0.15	0.12	0.07	0.17	0.19	0.24	0.17	0.08	0.08	0.13	0.17	0.14	0.24
51	Hollow Lake	0.19	0.20	0.15	0.06	0.25	0.86	1.83	2.24	0.36	0.07	0.17	0.29	0.54	2.24
52	Abee	0.20	0.15	0.13	0.05	0.23	0.14	0.21	0.20	0.08	0.09	0.11	0.17	0.14	0.23
53	Tawatinaw - Clearbrook	0.19	0.12	0.13	0.06	0.08	0.10	0.17	0.17	0.06	0.08	0.11	0.16	0.12	0.19
54	Elbridge	0.18	0.12	0.13	0.06	0.13	0.17	0.17	0.17	0.09	0.09	0.15	0.15	0.13	0.18
55	Taylor Lake	0.16	0.11	0.14	0.06	0.12	0.13	0.15	0.15	0.07	0.10	0.12	0.15	0.12	0.16
56	Opal	0.19	0.12	0.16	0.08	0.13	0.12	0.21	0.14	0.07	0.10	0.15	0.21	0.14	0.21
57	Scotford 2	0.35	0.13	*Not in Service*								0.21	0.43	*I/D*	*I/D*
58	Fort Saskatchewan	0.23	0.21	0.17	0.14	0.12	0.18	0.24	0.29	0.17	0.19	0.21	0.31	0.20	0.31
59	Partridge Hill	0.25	0.17	0.19	0.18	0.17	0.25	0.57	0.52	0.17	0.18	0.16	0.15	0.24	0.57
60	Oxbow Lake	0.19	0.14	0.16	0.11	0.22	0.26	0.34	0.31	0.17	0.10	0.13	0.18	0.19	0.34
61	Drygrass Lake	0.24	0.16	0.21	0.21	0.58	0.63	0.50	0.62	0.22	0.13	0.16	0.18	0.30	0.63
62	FAP East Boundary	0.20	0.11	0.13	0.08	0.34	*NA*	0.29	0.27	0.15	0.09	0.13	0.15	0.18	0.08
63	Elk Island Park	0.18	0.18	0.14	0.08	0.16	0.23	0.29	0.32	0.15	0.09	0.14	0.18	0.18	0.32
66	Plains Midstream # 1	0.23	0.19	0.17	0.14	0.19	0.20	0.34	0.29	0.18	0.13	0.25	0.28	0.22	0.34
67	Plains Midstream # 2	0.21	0.17	0.18	0.20	0.12	0.17	0.28	0.24	0.13	0.16	0.22	0.36	0.20	0.36
68	ARC Resources Site 1	0.24	0.26	0.20	0.13	0.25	0.36	0.59	0.52	0.20	0.19	0.20	0.22	0.28	0.59
69	ARC Resources Site 2	0.22	0.15	0.11	0.07	0.26	0.34	0.30	0.19	0.07	0.10	0.16	0.18	0.18	0.34
70	ARC Resources Site 3	0.52	0.16	0.25	0.08	0.22	0.59	0.83	0.52	0.22	0.18	0.23	0.17	0.32	0.83
71	ARC Resources Site 4	0.27	0.30	0.27	0.12	0.22	0.27	0.23	0.20	0.13	0.11	0.17	0.18	0.21	0.30
	Average	0.24	0.17	0.17	0.11	0.23	0.29	0.38	0.34	0.14	0.13	0.18	0.22	0.21	
	Maximum	0.52	0.30	0.27	0.27	1.31	1.12	1.83	2.24	0.36	0.24	0.46	0.50		2.24

N/A: no sample
I/D: insufficient data
Reportable Detection Limit: 0.02 ppb

Appendix E: Continuous Monitoring Methods, Limits and Sampling Details

Table 21: Continuous monitoring methods, limits, and sampling details (Dec 31, 2018)

Parameter	Instrument Make and Model	Units	Sampling Duration and Frequency	Full Scale Range	Detection Limit	Method of Detection	Calibration Method	Precision	Accuracy
Sulphur Dioxide (SO_2)	Thermo 43i	ppb or ppm	1-second samples averaged to 1-min & 1-hr	0 - 500 ppb	1 ppb 0.4ppb RMS 0.5ppb RMS	Pulsed fluorescence	Dynamic dilution of compressed gas standard	1% of reading or 1ppb (whichever is greater)	43i NA
Hydrogen Sulphide (H_2S)	Thermo 45C Thermo 450i	ppb or ppm	1-second samples averaged to 1-min & 1-hr	0 - 100 ppb 0 - 0.1 ppm	1 ppb 0.4 ppb RMS	Pulsed fluorescence with converter	Dynamic dilution of compressed gas standard	45C and 450i 1% of reading or 1ppb (whichever is greater)	45C NA 450i NA
Nitric Oxide, Oxides of Nitrogen, Nitrogen Dioxide (NO, NO_x, NO_2)	Thermo 42C Thermo 42i Thermo 17C Thermo 17i	ppb or ppm	1-second samples averaged to 1-min & 1-hr	0 - 500 ppb	0.4 ppb 0.4 ppb 1.0ppb	Chemi-luminescence	Dynamic dilution of compressed gas standard	42C and 42i ± 0.4ppb (500 ppb range) 17C NA	42C NA 42i NA 17C NA 17i NA
Ammonia (NH_3)	Thermo 17C Thermo17i	ppm	1-second samples averaged to 1-min & 1-hr	0 - 5 ppm	1.0 ppb	Chemi-luminescence with total nitrogen converter	Dynamic dilution of compressed gas standard	17C NA 17i ± 0.4ppb 500 ppb range	17C NA 17i NA

Table 21: Continuous monitoring methods, limits, and sampling details (Dec 31, 2018) - continued

Parameter	Instrument Make and Model	Units	Sampling Duration and Frequency	Full Scale Range	Detection Limit	Method of Detection	Calibration Method	Precision	Accuracy
Ozone (O_3)	Thermo 49c Thermo 49i	ppb or ppm	1-second samples averaged to 1-min & 1-hr	0 - 500 ppb 0 - 0.5 ppm	1.0 ppb 0.5ppb RMS	Ultraviolet photometry	O_3 Reference Bench	49c 1.0ppb 49i 1.0ppb	49i NA
Ethylene	Peak Performer	ppb	200 seconds (18 samples per hour)	0 - 2000 ppb	1 ppb	Gas chromatography with flame ionization detector	Dynamic dilution of compressed gas standard	NA	NA
Carbon Monoxide (CO)	Thermo 48i	ppm	1-second samples averaged to 1-min & 1-hr	0 - 50 ppm	0.04 ppm	Gas filter correlation	Dynamic dilution of compressed gas standard	±1% or 0.02 ppm	±1% or 0.02 ppm
Hydrocarbons (methane-NMHC or THC)	Thermo 55C Thermo 55i	ppm	2.5 minutes with 24 samples per hour	0 - 20 ppm methane 0 - 20 ppm NMHC 0 - 40 ppm THC	20 ppb Methane 50 ppb NMHC (as propane)	Gas chromatography with flame ionization detector	Dynamic dilution of compressed gas standard	±2% of measured value	±2% of measured value
Particulates $PM_{2.5}$	SHARP 5030 SHARP 5030i	µg/m^3	Continuous sampling data stored in 1-min & 1-hr averages	0 - 1000 µg/m^3	0.2 µg/m^3	Hybrid beta attenuation and nephelometer	Light transmitting foils	±2 µg/m^3<80 µg/m^3 ±5 µg/m^3>80 µg/m-3	±5% (compared to 24-hr FRM)

Table 21: Continuous monitoring methods, limits, and sampling details (Dec 31, 2018) - continued

Parameter	Instrument Make and Model	Units	Sampling Duration and Frequency	Full Scale Range	Detection Limit	Method of Detection	Calibration Method	Precision	Accuracy
Particulates $PM_{2.5}$	Grimm 180	$\mu g/m^3$	Continuous sampling data stored in 1-min & 1-hr averages	0 - 1000 $\mu g/m^3$	0.2 $\mu g/m^3$	Spectrometry	Factory	±5%	±2%
Benzene, Toluene, Ethylbenzene, Xylene, Styrene	Spectras GC955	ppb	Samples taken every 15 or 30 minutes	Benzene & Ethylbenzene 0 – 20ppb Toluene, Styrene	0.02ppb	Gas chromatography with FID detection	Dynamic dilution of compressed gas standard	<3% at 1 ppb for benzene	NA
Wind Speed Wind Direction (WS / WD)	RM Young 5305	km/hr	1-second samples averaged to 1-min & 1-hr	0 – 100 km/hr 0 - 360 degrees	WSP 0.4 m/s WDR 0.5 m/s	3 cup anemometer and wind vane	Known RPM Standard or Factory	NA	NA
Temperature	Vaisala HMP60	°C	1-second samples	-40 to +60	NA	Platinum resistance detector	Comparison to Reference Standard	NA	±0.6°C
Barometric Pressure	Serta 270	mmHg	1-second samples averaged to 1-min & 1-hr	500 - 900 mmHg	±2 mmHg	Ceramic sensing capsule coupled with capacitive sensor	Comparison to Reference Standard	±0.01	±0.05%

Table 21: Continuous monitoring methods, limits, and sampling details (Dec 31, 2018) - continued

Parameter	Instrument Make and Model	Units	Sampling Duration and Frequency	Full Scale Range	Detection Limit	Method of Detection	Calibration Method	Precision	Accuracy
Relative Humidity	Vaisala HMP60	%	1-second samples averaged to 1-min & 1-hr	0 - 100%	NA	capacitive relative humidity sensor	Factory	NA	0°to +40°C ±3% (0 to 90% RH) ±5% (90 to 100% RH) -40° to 0°C and +40° to +60°C: ±5% (0 to 90% RH) ±7% (90 to 100% RH)
Solar Radiation	Kipp and Zonen SP Lite	watts/m2	1-second samples averaged to 1-min & 1-hr	400-1100 nm spectral range	60 to 100 µV/W/m2 (Sensitivity)	Photodiode detector	Factory	NA	NA
Vertical Wind Speed	Gill Model 27106	km/hr	1-second samples averaged to 1-min & 1-hr	1	0.3 m/s	Helicoid propeller with tech-generator transducer	Mechanical RPM standard	NA	NA
Delta Temperature	Met One 064-1 (two probes)	°C	1-second samples averaged to 1-min & 1-hr	-30 to +50	NA	Solid state multi element thermistor	Comparison to Reference Standard	NA	±0.15°C (0.27°F) throughout range

Appendix F: Data Acquisition, Validation and Reporting Procedures

Air quality monitoring instrumentation is connected digitally to a data logger at each station. The data logger stores monitoring information in engineering units each second. One-minute and one-hour average values are calculated by the data logger. These one-minute and hourly-average data packets along with operational information on each sensor and the site itself are retrieved every minute from the data logger through the internet via automatic polling.

Automatic alarm set points trigger a notification to technicians of any data that is above a predetermined set point, (including levels that exceed the AAAQOs). The technician will assess the situation and notify the Alberta Government and local facility operators as necessary.

Operation alarms are also configured so technicians get automatic alerts if the operational parameters of an analyzer are outside set points. These alarms also automatically invalidate the data. The operator can then verify these operational alarms and confirm the corrective actions.

Data Quality Control Procedures

In order to assure data collection quality and operational uptime, the following general procedures are performed.

- Gas analyzers are automatically subjected to a daily zero and single high point test.
- The data acquisition system automatically flags data that are outside normal operating ranges.
- Daily review of the daily zero and single point tests from each analyzer is completed by FAP's contractors, with technicians dispatched to investigate/correct as necessary.
- Daily review of the data, including inspection for anomalies and any flags that may have been applied automatically by the data logger, with technicians dispatched to investigate/correct as necessary.
- Daily data review includes cross-network comparison of measurements of the same substances or meteorological conditions to look for anomalies at one station that might indicate a problem.
- For compounds that are subject to Alberta Guidelines or Objectives, alarm set-points are automatically triggered when ambient concentrations exceed the Guidelines or Objectives. This initiates a reporting protocol to AEP, including an investigation into the likely cause.

- Each analyzer is subjected to an up scale and zero as-found test and at least a 4-point calibration each month. BTEX and ethylene analyzers that are non-linear by design are tested with a zero and 5 upscale points. Calibration reports are retained, and copies are submitted to AEP monthly. Calibration forms use automatic formatting to highlight results that approach the limits set by AEP. Calibration factors arising from this calibration may be applied to the data as appropriate.
- Alberta Environment and Parks personnel conduct performance audits of analyzers once a year, verifying that each analyzer is working properly in accordance with the AMD. Auditors also make suggestions for improvements to the monitoring operation at the stations. Follow-up actions to the audit, if necessary, are defined and implemented per the AEP Audit Follow-up Protocol.
- FAP may conduct internal ad-hoc audits of analyzer performance.
- The FAP TWG conducts reviews of data and zero/span charts at each meeting.
- FAP uses a subcommittee of the TWG to review data validation outcomes at selected stations for selected months from time to time. FAP also may contract an independent data validation contractor to run a parallel data validation on selected months and stations.
- Operations contractors are observed performing calibrations. The procedure they use is compared to the AMD and their own applicable SOPs. Where noted, corrections are recorded and made and reported to the TWG.
- FAP uses a process to verify operation and validity of the in-situ calibrators and dedicated gases used at each continuous monitoring station. This includes:
  - Calibration system verifications at AEP labs against AEP standards.
  - Calibration gases used in FAP network are EPA protocol grade of 1 per cent accuracy where available for the mixture and verified by AEP.
  - Third party calibrations using equipment and gases owned by the contractor from time to time.
  - Cylinders are replaced when they expire (normally 2 years) even if they are not empty.
  - Photometer verifications by AEP for NO_2 and O_3 calibrations if Gas Phase Titration (GPT) procedure is not used.
  - Regular Flow Measurements, flow calibrations and calibration system maintenance as specified by the AMD and manufacturer specifications, or if flow anomalies are suspect.

Data Validation Processes

Data validation is conducted by a contractor to FAP. Secondary checks of data reports are done by the FAP Network Manager as well as Technical Working Group members every month. Validated data and daily span tests are reviewed holistically by the Technical Working Group monthly to identify any possible anomalies and trends that may warrant another look.

The following data validation procedures are performed by the Data Validation Contractor to FAP every month.

- One-minute, five-minute, 60-minute, 24-hr, and monthly averages are calculated from 1-second data the data logger gathers from each sensor.
- Data is baseline-corrected by interpolation between consecutive valid zero points.
- Data is reviewed in several ways:
  - Data is plotted and examined together, comparing complementary or related parameters within a station.
  - Information in the station logs, the daily zeroes and spans, and calibration reports are considered.
  - Outliers, flat lines, and other data irregularities are investigated.
  - Data flags are applied as required.

Raw data is maintained unaltered within the central database.

Higher level data validation is performed monthly by the FAP Network Manager for all station in in the network, with an additional validation step by Approval Holders for some stations, prior to submitting reports or posting data to the Government data warehouse.

Reporting Protocol

Reporting of FAP's continuous and passives data and monitoring operations is required by the Alberta Government is accomplished in a number of ways:

- Near real time raw un-verified data is sent hourly to the Alberta Government website for public availability. This data is used for AQHI reporting and forecasting and is available in near real time on several subsequent websites across Canada and North America.
- Exceedances of AAAQOs are reported to Alberta Government's Environmental Service Response Centre as per timelines FAP has established and are followed up with further information within 7 days.

- Instrument operational time below 90% in a month is reported to Alberta Government's Environmental Service Response Centre as soon as it is known and followed up with further information and a corrective action letter within 7 days.

- An ambient air quality monitoring report is prepared with validated data for each monitoring station and all passive sites and submitted monthly to the Alberta Government. The report's contents are prescribed by the Air Monitoring Directive.

- Validated data is posted to the Alberta Government ambient air quality database each month.

- Validated data from FAP stations is downloaded from the Alberta Government database annually by Environment and Climate Change Canada and incorporated into the national database managed for use in national trend analysis and policy construct.

- A summary report is prepared for each monitoring station and all passive sites and submitted annually to the Alberta Government. The report's contents are prescribed by the Air Monitoring Directive.

- This Technical Annual Report provides additional information. It documents the status of the monitoring network and summarizes the regional air monitoring results with historical comparisons and details of AAAQO exceedances as well as comparisons of key parameters over time and with other locations across Alberta.

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