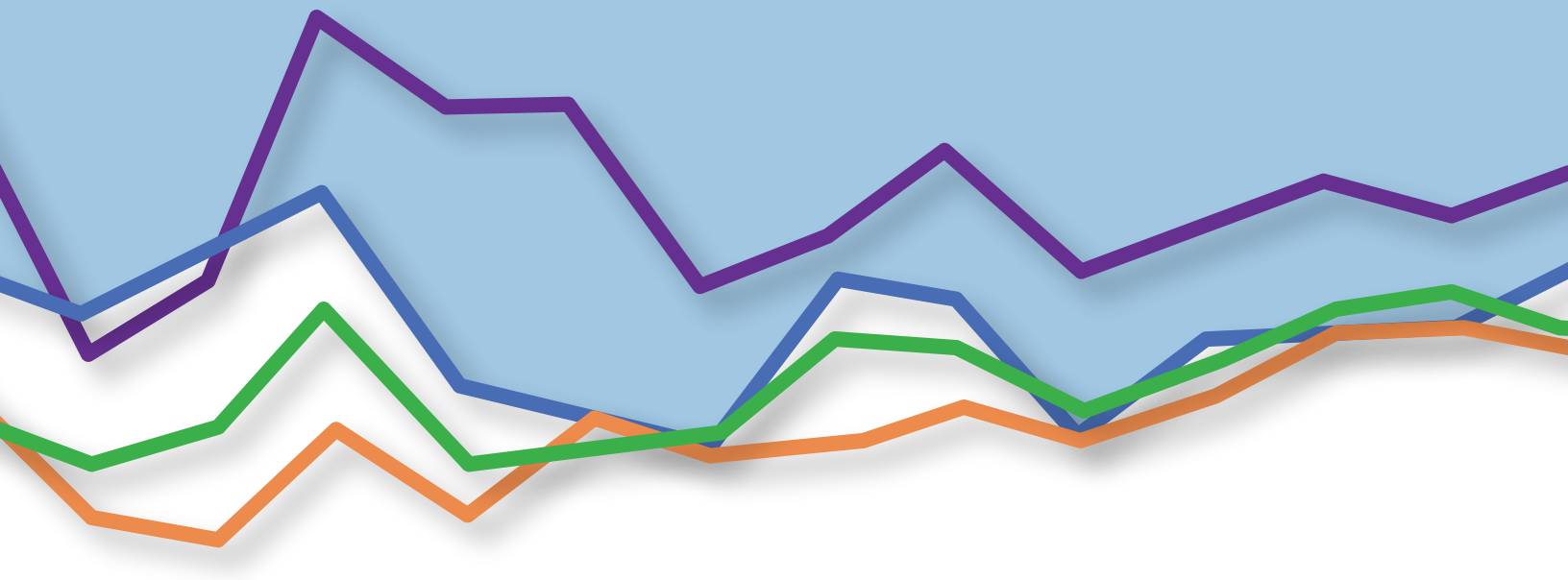

Air Quality
TRENDING &
COMPARISON
Report
FORT AIR PARTNERSHIP
We Monitor the Air You Breathe



EXECUTIVE SUMMARY

This report provides air quality trending and comparison information, with data going back as far as 1991, for fine particulate matter, ozone, sulphur dioxide, nitrogen dioxide and carbon monoxide. Trends and comparisons are shown among stations that monitor for these substances and have the longest data sets within the Fort Air Partnership (FAP) Airshed, and between FAP's Fort Saskatchewan station and other selected Alberta, national and international locations.

Many of the trends and comparisons for the five substances reviewed in this report show notable changes from year to year that can be tied to major natural events like forest fires, or changes over a longer period of time attributed to the introduction of environmental policies or the application of new technologies. In some cases, there is insufficient data or supplementary information available to draw conclusions about why certain trends are occurring, or the results of comparisons.

Fine Particulate Matter

$PM_{2.5}$

Within the Airshed and provincially, levels of fine particulate matter fluctuate year over year. Years significantly impacted by forest fires show a predictable increase in fine particulate matter levels. Within the Airshed, the Elk Island station had consistently lower levels of fine particulate matter the majority of the time. This is likely due to the station being far removed from industrial and urban sources. The Bruderheim station shows consistently higher levels. This is likely due to the wind direction at this site coming predominantly from the south and south-southwest (approximately 23% of the time from 2011 to 2018), which is downwind of both urban and industrial sources.

When compared to five other urban locations in Alberta, FAP's Fort Saskatchewan station is comparable to other locations across the province. A comparison to national and international locations shows Fort Saskatchewan experiencing among the lowest concentrations of fine particulate matter. This is to be expected given that Fort Saskatchewan is a smaller urban centre than many of the other compared locations.

Ozone

O_3

Ozone results show that FAP's rural stations, located at Bruderheim, Lamont County and Elk Island, had higher annual average concentrations than Fort Saskatchewan throughout the years. There are likely two reasons for this: rural areas with significant vegetation emit natural compounds that go on to create more ozone than found in cities, and secondly, in cities more ozone is destroyed by nitric oxide in a process called ozone scavenging. The combustion of fossil fuels generates nitric oxide, something that occurs much more frequently in urban areas.

Compared to other locations across Alberta, except for Lethbridge, Fort Saskatchewan shows consistently higher annual averages of ozone. While less ozone is expected in large urban centers due to ozone scavenging by nitric oxide, Lethbridge, a larger city than Fort Saskatchewan, had the highest overall annual ozone average. This may be because, as the southernmost station in the comparison, the city has warmer mean temperatures. Warmer temperatures can result in higher ozone levels.

When compared to national and international locations, Fort Saskatchewan experiences among the lowest ozone concentrations. This is to be expected since most of these locations have much larger populations than Fort Saskatchewan. Although that can lead to ozone scavenging as previously explained, once ozone precursors (substances that can form ozone in combination with sunlight) reach a certain level, secondary ozone formation can occur. This can increase ozone levels in urban centers.

Sulphur Dioxide

SO_2

Decreasing sulphur levels in both diesel and gasoline, reduced flaring from oil and gas wells province-wide and improved industrial technology have all contributed to a decrease in sulphur dioxide levels over the years, both regionally and across Alberta. Statistics show sulphur dioxide levels in the Airshed have always been well below the annual Alberta Ambient Air Quality Objectives (AAAQO) of eight parts per billion (ppb), with the highest year having an annual average of two ppb. Fort Saskatchewan has sulphur dioxide levels comparable to other provincial locations, and experiences among the lowest annual average sulphur dioxide concentration when compared nationally and internationally.

Nitrogen Dioxide

NO_2

Nitrogen dioxide levels within FAP's Airshed and across Alberta are trending downward, likely due to increased efficiencies in home heating and energy use by vehicles in the past several decades. Compared to other locations in the Airshed, nitrogen dioxide levels are the highest in Fort Saskatchewan. This is to be expected since urban areas have a larger number of nitrogen dioxide sources such as home heating, vehicles and commercial activities. Annual averages in the Airshed have always been well below the annual AAAQO of 24 ppb, with the highest levels reaching just over 14 ppb in the 1990s.

A provincial comparison shows that larger urban centres such as Calgary and Edmonton have the highest annual nitrogen dioxide averages simply because they have a greater number of nitrogen dioxide sources. When compared nationally and internationally, Fort Saskatchewan nitrogen dioxide averages are trending lower than most locations.

Carbon Monoxide

CO

The only FAP station that measures carbon monoxide is Fort Saskatchewan. Both locally and provincially, there has been a significant downward trend in carbon monoxide levels since 1991. This can be attributed to improvements in vehicle efficiency and emissions reduction technology. There was insufficient data that could be sourced to provide an international comparison. However, annual carbon monoxide averages in Fort Saskatchewan are comparable to other locations in Alberta and across Canada.

BACKGROUND

About Fort Air Partnership

Fort Air Partnership (FAP) is a not-for-profit organization formed in 1997 to monitor the air people breathe within a 4,500 square kilometre Airshed located immediately north and east of Edmonton, Alberta, Canada. The FAP area (referred to as the "Airshed" in this report) includes the city of Fort Saskatchewan, the towns of Gibbons, Bon Accord, Bruderheim, Lamont, Redwater, Waskatenau, portions of the counties of Sturgeon, Westlock, Thorhild, Lamont and Strathcona, and Elk Island National Park. Alberta's Industrial Heartland is located within FAP's borders. FAP collects and reports on air quality data in a region encompassing one of the most concentrated industrial development areas in Alberta.

FAP's work is open and transparent, governed by a multi-stakeholder Board of Directors, guided by a scientific Technical Working Group and driven by national and provincial standards. Continuous data is collected 24 hours a day, seven days a week and made available to anyone.

Purpose of this Report

FAP provides stakeholders and the public with air quality data and information in a variety of ways, including a live data website, weekly and quarterly air quality summaries and annual reports. A **five year summary of AQHI results for the FAP Airshed** was completed in 2017. This Trending and Comparison Report is another step towards making more air quality information available to the public and other stakeholders.

This report provides trending and comparison information for fine particulate matter, sulphur dioxide, nitrogen dioxide, carbon monoxide and ozone. All of these substances, with the exception of ozone, are referred to as Criteria Air Contaminants by the Government of Canada's Environment and Climate Change department. Criteria Air Contaminants are classified as such because they contribute to smog, poor air quality and acid rain. Ozone was also included in this report since it is a substance that has an established **Canadian Ambient Air Quality Standard** (CAAQS) and is used in the calculation of the **Air Quality Health Index** (AQHI).

Each section for the five substances included in this report is organized into three subsections. The first subsection provides comparisons of stations within FAP's Airshed that monitor these substances. The second compares FAP's Fort Saskatchewan station (the longest operating station within the Airshed) with other cities in Alberta, and the third compares Fort Saskatchewan with national and international locations. Some stations began operating later than others so some charts show data gaps.

Section I: Comparison of FAP Stations

This section provides a summary of trends within the FAP Airshed for stations that monitor the five substances included in this report. The Fort Saskatchewan station was the first permanent air monitoring station in the region, beginning operation in 1991. Lamont County and Elk Island began operating in 2003, and Bruderheim was added in 2010.

In this report, data for the stations is shown from the year the station began operating, as long as that initial year had a minimum of nine months of data. FAP took over operation of the Fort Saskatchewan station from the Government of Alberta in 2003. For details about data prior to 2003 please contact **Alberta Environment and Parks**.

A. FORT SASKATCHEWAN STATION

The Fort Saskatchewan station's primary monitoring objectives are to monitor air quality where people live and understand historical trends. It is located next to a residential area in the City of Fort Saskatchewan near 92nd Street and 96th Avenue, 80 meters west of Highway 15.

B. ELK ISLAND STATION

The Elk Island station's primary monitoring objective is to understand the air quality impacts of a large Canadian city and a nearby concentration of heavy industry on a protected area. It 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 and Range Road 203.

C. LAMONT COUNTY STATION

The Lamont County station's primary monitoring objective is to understand the impacts of multiple sources in the region. This may include sources from Alberta's Industrial Heartland and from the Strathcona Industrial Area, as well as from other sources in and around the City of Edmonton. This site was selected because modeling completed in the early 2000s indicated that since this area of the region is at a higher elevation than the surrounding area, it may experience higher concentrations of sulphur dioxide.

The station is in a rural area on farmland, approximately six kilometres 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.

D. BRUDERHEIM STATION:

The Bruderheim station's primary monitoring objective is to monitor air quality where people live. It is in the northwest corner of the Bruderheim School's sports field (48 Street and 52 Avenue in Bruderheim).

Section II: Comparison of Fort Saskatchewan to Alberta Locations

This category provides a comparison of a station representative of our Airshed (Fort Saskatchewan) to other cities in Alberta. A range of locations was chosen, from large urban areas such as Edmonton and Calgary, to smaller populated centres such as Red Deer and Lethbridge, to an industrialized area like Fort McMurray. Data for some locations is a combined average of several air quality monitoring stations within that respective city. This could include a combination of urban, industrial and residential stations.

The FAP Airshed borders the city limits of Edmonton. Quite often, air quality events in the Airshed are linked to an air quality event that impacts a much larger region. For example, elevated fine particulate matter during a wintertime **temperature inversion** or elevated ozone on a hot summer day. In these cases, typically all stations in the Edmonton Metropolitan Region, including those within the FAP Airshed, experience elevated levels.

Section III: Comparison of Fort Saskatchewan to Canadian and International Locations

The last category in this report provides a comparison of Fort Saskatchewan to locations across Canada and internationally. Locations were chosen to provide a wide variety of population sizes. They vary from a large populated centre such as London to a smaller populated centre such as Stockholm, high industrial density areas such as Sarnia or Galveston and low industrial density areas in cities such as Montreal or Seattle.

Locations such as Hong Kong and Paris were chosen for general interest. All locations were pre-chosen without prejudice for how the Fort Saskatchewan station would compare. Again, data for some of these locations is a combined average of several air quality monitoring stations in that location`s area. This could include a combination of urban, industrial and residential stations.

Air Quality Monitoring

FAP monitors and reports on ambient air quality from 10 continuous monitoring stations. The four stations included in this report were chosen because they have the longest monitoring data sets.

FAP monitors for 19 substances and several weather conditions such as temperature, wind direction, wind speed, relative humidity and barometric pressure. The collected data is used to compare to government standards, including **Alberta Ambient Air Quality Objectives** (AAAQOs). Data used by the Government of Alberta to calculate an AQHI. It is also used for calculations against the Canadian Ambient Air Quality Standards (CAAQS).

TABLE 1: CURRENT AAAQOS FOR SUBSTANCES INCLUDED IN THIS REPORT

Substance	Averaging Time	Measurement**
Carbon Monoxide	1-hour	13 ppm
	8-hour	5 ppm
Nitrogen Dioxide	1-hour	159 ppb
	Annual	24 ppb
Ozone	1-hour daily maximum	76 ppb
Fine Particulate Matter* (2.5 microns)	24-hour	29 µg/ m^3
Sulphur Dioxide	1-hour	172 ppb
	24-hour	48 ppb
	30-day	11 ppb
	Annual	8 ppb

** There is also a 1-hour average guideline in Alberta for fine particulate matter set at 80 µg/m^3*
***ppb = parts per billion, ppm = parts per million, µg/ m^3 = micrograms per cubic metre of air*

AAAQOs: Regulatory tools used to manage pollutant levels based on their potential risk to human health and the environment. AAAQOs are established by the Government of Alberta, under the Alberta Environmental Protection and Enhancement Act. Alberta Environment and Parks works with a variety of stakeholders, including other government departments, the scientific community, environmental organizations, industry and the general public to develop and review objectives.

AAAQOs provide environmental and human health protection to an extent technically and economically feasible, as well as consider what is socially and politically acceptable. Environmental managers use these to manage air quality affected by factors such as industrialization and urbanization. The data for the substances included in this report have been reported as annual averages; only sulphur dioxide and nitrogen dioxide have annual average AAAQOs to compare to. Please refer to Table 1 for other AAAQOs in place for the substances included in this report.

AQHI: Converts hourly measurements of fine particulate matter, ozone and nitrogen dioxide in the air to a number from one to 10, with a higher number indicating a greater risk to human health. The **Alberta AQHI** augments the national AQHI formulation to better account for rapidly changing air quality and to include additional pollutants. The AQHI informs the public about current or predicted air quality conditions so they can make decisions regarding their outdoor activities in the event of changes to air quality. The AQHI is designed as a communication tool. It is not used by environmental managers to monitor and measure long-term trends in air quality or to assign management actions.

from four of these stations marked in purple on the map

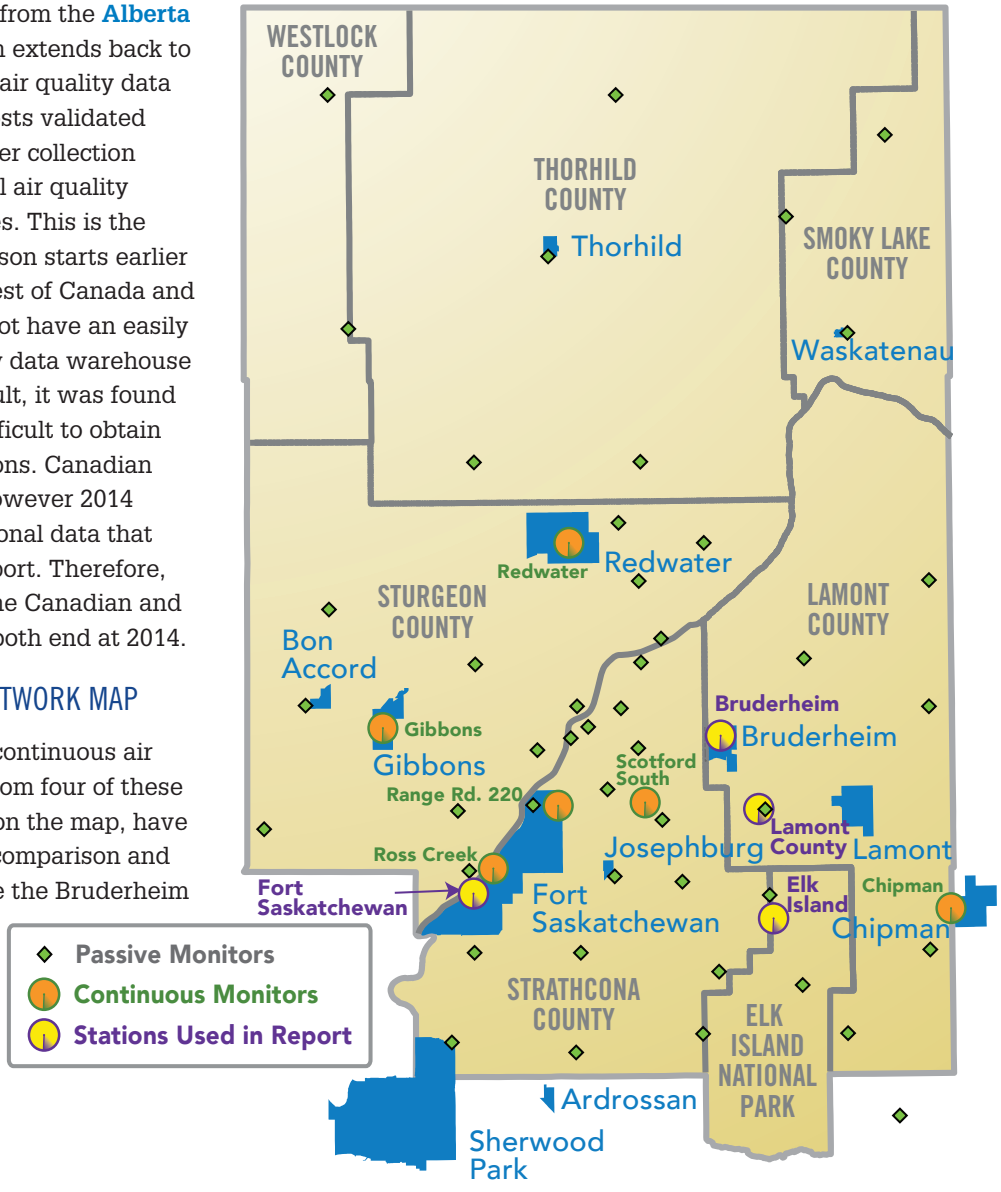
CAAQS: These standards are used to manage pollutant levels based on their potential risk to human health and the environment. CAAQS are not established to indicate whether health or environmental effects have occurred but act to give regulators a heads-up so that preventative management actions can be taken before effects are measured. Currently there are CAAQS metrics in place for ozone, fine particulate matter, nitrogen dioxide and sulphur dioxide.

CAAQS calculate metrics for a three-year period and exclude exceptional events that cannot be directly controlled by management actions, such as smoke from forest fires. This report assesses data using arithmetic averages of all data collected so it is not possible to compare the annual averages summarized in this report to CAAQS metrics.

Data Availability

Alberta data was retrieved from the **Alberta Air Data Warehouse**, which extends back to the beginning of electronic air quality data recording in Alberta and posts validated data more expeditiously after collection than federal or international air quality monitoring data warehouses. This is the reason the Alberta comparison starts earlier and extends to 2018. The rest of Canada and international locations do not have an easily accessible public air quality data warehouse similar to Alberta. As a result, it was found to be considerably more difficult to obtain recent data for these locations. Canadian data is available to 2016, however 2014 is the most recent international data that could be located for this report. Therefore, for comparison purposes, the Canadian and international comparisons both end at 2014.

FIGURE 1: MONITORING NETWORK MAP



FAP has 10 fully equipped continuous air monitoring stations. Data from four of these stations, marked in purple on the map, have been included in this data comparison and trending report. Please note the Bruderheim station was relocated in 2016 to a new location 500 meters away from the previous site. The data from these two stations has been combined into one data set for 2016.

TRENDS & COMPARISONS

Fine Particulate Matter

Fine particulate matter ($PM_{2.5}$) 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 $PM_{2.5}$ 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 levels of $PM_{2.5}$ typically occur during winter temperature inversions when air movement is limited, or in the summer months during periods of very warm weather with little or no wind. This is particularly problematic when coupled with smoke from forest fires.

$PM_{2.5}$ is measured and reported in micrograms per cubic meter ($\mu g/m^3$) throughout this report. While there is no annual average AAAQO in place for $PM_{2.5}$, Alberta does have a 24-hour objective and 1-hour guideline for $PM_{2.5}$, noted in Table 1.

CAAQS calculate a three-year average of the 98th percentile of the daily 24-hour average concentrations, while the US National Ambient Air Quality Standards are calculated as an annual mean averaged over three years. In both cases exceptional and natural events such as forest fires are backed out of the calculations. It should be noted that exceptional and natural events were not removed from the annual averages presented in this report, so years in which forest fires impacted $PM_{2.5}$ levels are clearly evident in the following three charts.

FIGURE 2: FINE PARTICULATE MATTER AT FORT AIR PARTNERSHIP STATIONS

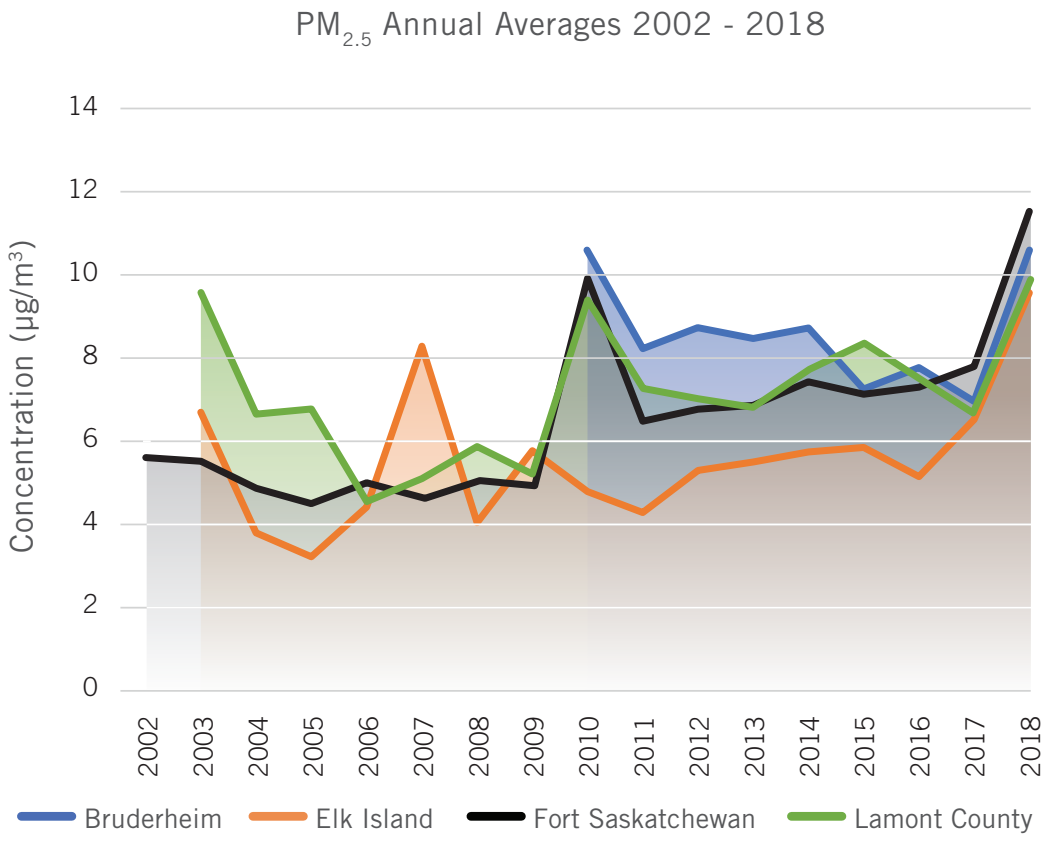


Figure 2 provides a comparison of the four FAP stations included in this report. The Fort Saskatchewan, Lamont County and Bruderheim stations all experienced PM2.5 peaks in 2010. There are two reasons for PM2.5 levels peaking in 2010. One was smoke from wildfires, predominately in British Columbia, which affected a large area of Alberta during much of August that year. The second was temperature inversions that occurred during the winter season. A temperature inversion is when a layer of warm air traps a layer of cold air beneath it, effectively trapping pollutants at ground level.

In 2010, elevated $PM_{2.5}$ levels throughout the Capital Region due to wintertime temperature inversions triggered the development of a **Capital Region Particulate Matter Response Plan**. For the majority of the time, the Elk Island station had consistently lower levels of $PM_{2.5}$. This is likely due to the station being located far from industrial and urban sources. The Bruderheim station shows consistently higher levels, likely due to the site being predominantly downwind of both urban and industrial sources. The wind direction at this site comes from the south and south-southwest (approximately 23% of the time from 2011 to 2018).

The drastic increase in 2018 annual average was due to severe wildfires in British Columbia, which impacted air quality throughout Alberta for several weeks during the summer months.

FIGURE 3: FINE PARTICULATE MATTER AT FORT SASKATCHEWAN AND SELECT ALBERTA LOCATIONS

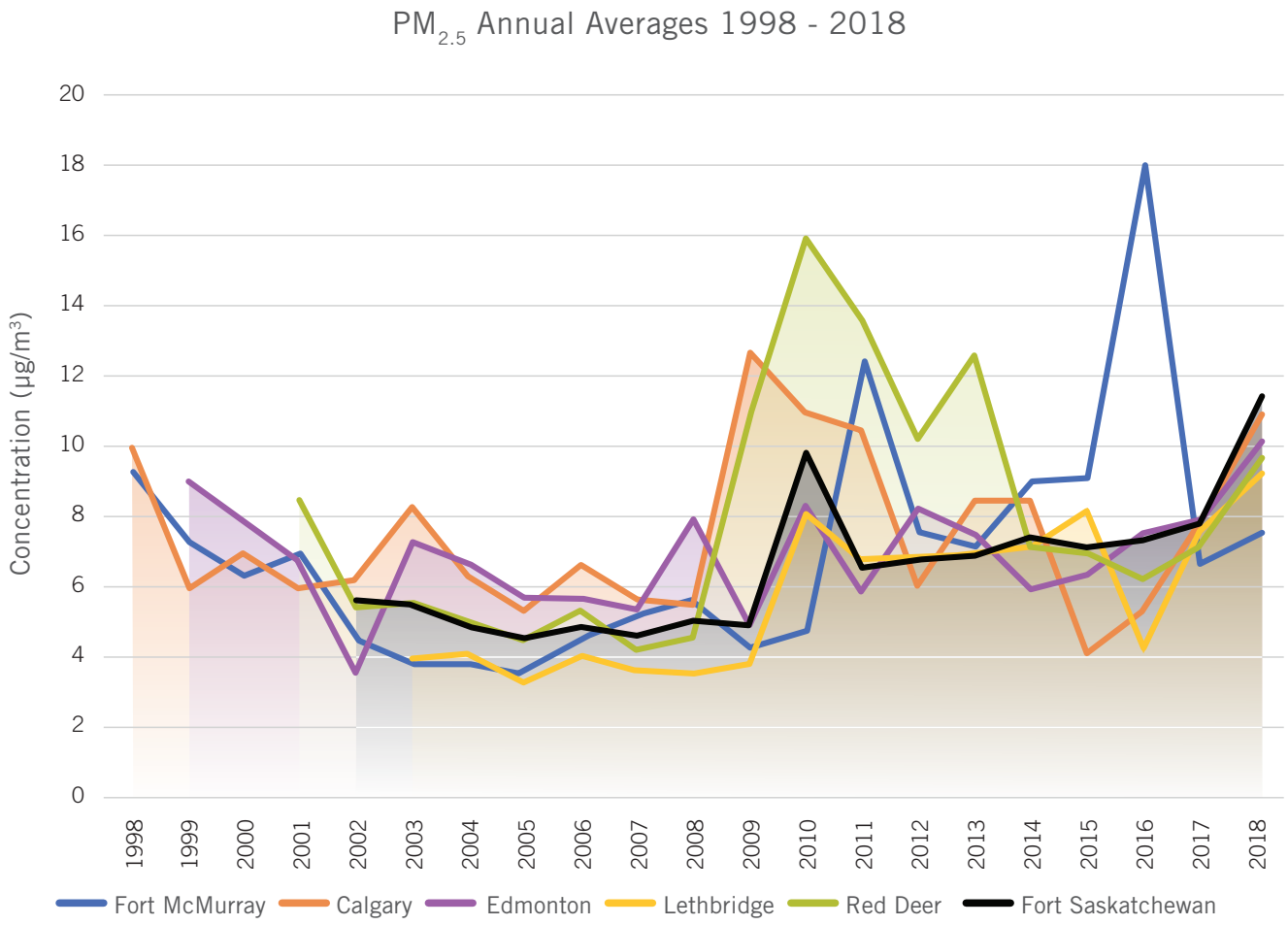
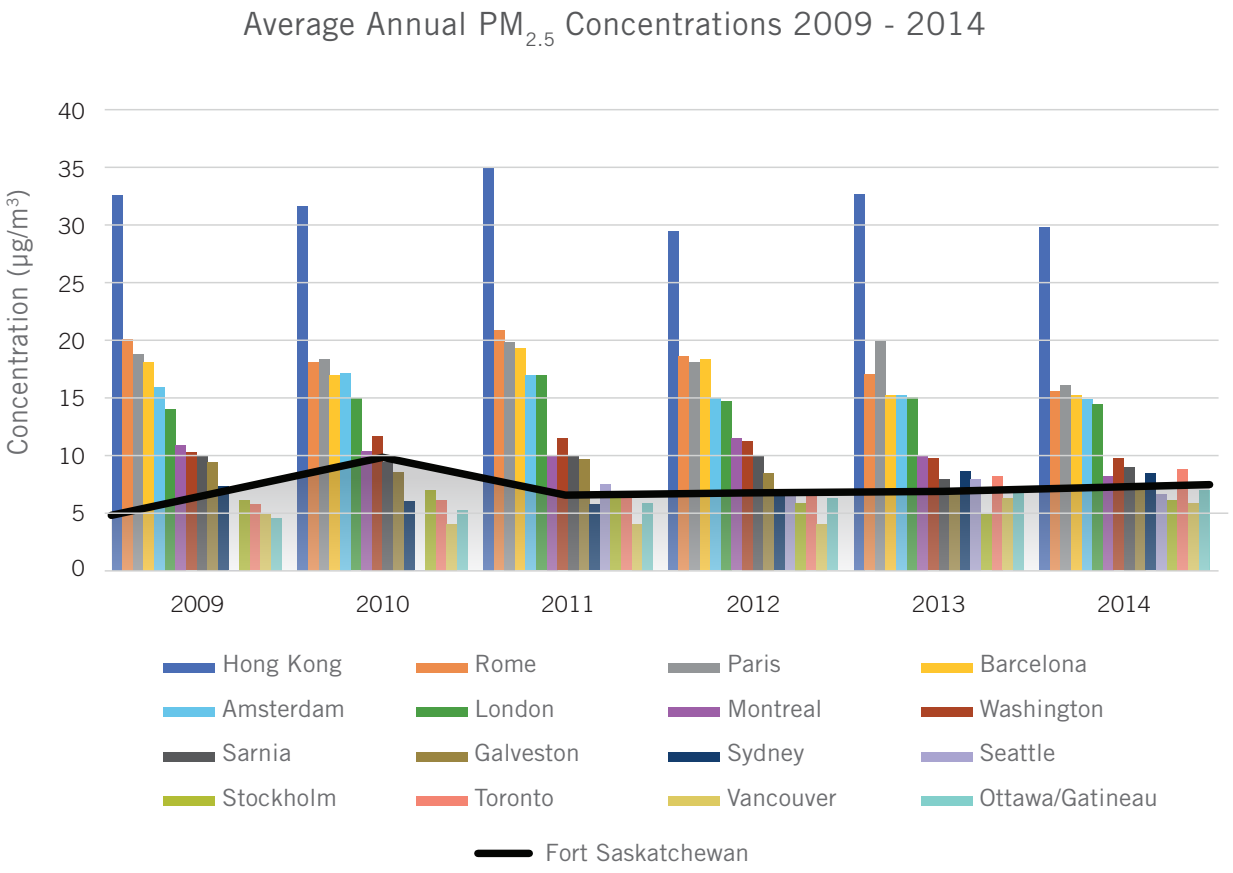


Figure 3 provides a comparison of the Fort Saskatchewan station to other stations across Alberta. FAP data begins in 2001 when a fine particulate matter sampler was first installed at the Fort Saskatchewan station. 2010 sees an increase across the entire province in annual $PM_{2.5}$ averages due to the impact of wildfires that year. There is an evident increase in $PM_{2.5}$ in Fort McMurray in 2016. This was due to intense wildfires burning near the city, forcing an evacuation of Fort McMurray in May of that year. The increase in 2018 annual averages was due to severe wildfires in British Columbia, which impacted air quality throughout Alberta for several weeks during the summer months.

FIGURE 4: FINE PARTICULATE MATTER AT FORT SASKATCHEWAN AND SELECTED CANADIAN AND INTERNATIONAL CITIES

When compared to sites across both Canada and internationally from 2009 to 2014, Figure 4 shows Fort Saskatchewan as experiencing among the lowest concentrations of $PM_{2.5}$. This is to be expected given that Fort Saskatchewan is a smaller urban center than all of the locations included in the comparison.



Note: cities displayed in the bar chart left to right, follow the order of the cities listed in the legend as read from left to right in row 1, row 2 and so on.

Ozone

Unlike other pollutants, ozone (O_3) is not emitted directly by anthropogenic (human) 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. A significant natural source of VOCs in remote and rural areas of Alberta is emissions from trees and vegetation.

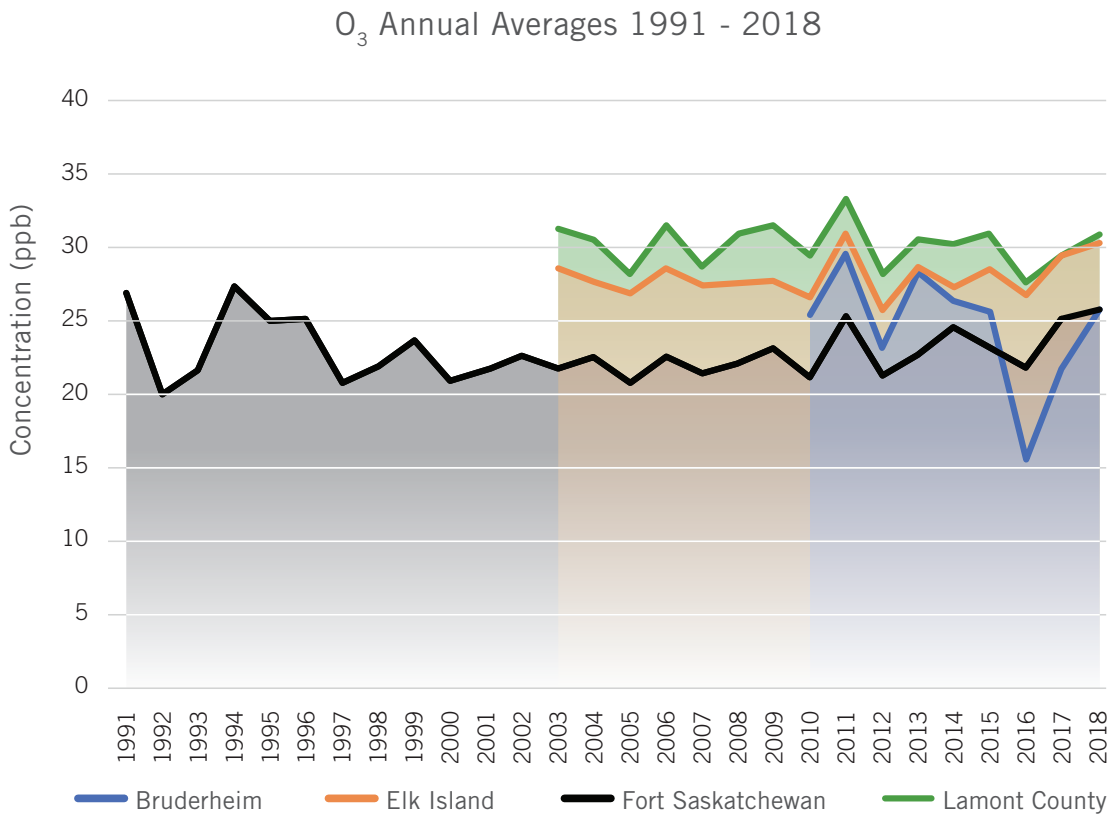
O_3 is also transported to the ground from the "ozone rich" upper atmosphere by natural weather processes. O_3 and substances that form ozone, such as NO_x and VOCs, may also be carried from upwind sources such as urban centres and industrial complexes. This phenomenon can be observed in Alberta particularly in summer when warm temperatures, reaching 30°C or more, 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) generated by the combustion of fossil fuels, known as ozone scavenging. O_3 levels are usually higher during the spring and summer months because of increased concentrations coming from the upper atmosphere coupled with more sunlight, which leads to more rapid chemical reactions that form O_3.

At normal outdoor concentrations, O_3 is a colourless, odourless gas. However, O_3 does have a characteristically sharp 'very fresh air' odour at very high concentrations, such as that experienced immediately after lightning storms. O_3 is reported as parts per billion (ppb) throughout this report. A pinch of salt in a 10-ton bag of potato chips or one drop of ink in a large gasoline tanker truck would equal approximately one ppb.

While there is no annual average AAAQO in place for O_3, Alberta does have a 1-hour objective for O_3 as listed in Table 1. A jurisdictional scan throughout both North America and Europe found that there are no annual average ozone objectives present in those locations. An annual average maximum daily 8-hour O_3 standard, similar to the CAAQS, seems to be the norm. Therefore, a direct comparison of results presented in the charts to an established objective or standard is not possible.

FIGURE 5: OZONE AT FORT AIR PARTNERSHIP STATIONS



The Fort Saskatchewan station has the longest O_3 data set, starting in 1991. The Elk Island and Lamont County stations began monitoring for O_3 in 2003. The Bruderheim station began in 2010. The Lamont County and Elk Island sites experienced the highest O_3 levels overall in the FAP network. Several factors contribute to this including the stations being some distance away from urban and industrial sources. This allows for long-range transport of both O_3 and the substances that form ozone (VOCs and NO_x). This can lead to increased O_3 formation downwind of where those substances are emitted. These two stations are also in rural locations and so could experience higher levels of O_3 because of increased vegetation in the area.

Fort Saskatchewan has the lowest O_3 levels in the network. This is likely due to O_3 scavenging, which occurs in urban areas when NO emitted by vehicles, home heating and other sources reacts with O_3 to form nitrogen dioxide (NO_2).

FIGURE 6: OZONE AT FORT SASKATCHEWAN AND SELECT ALBERTA LOCATIONS

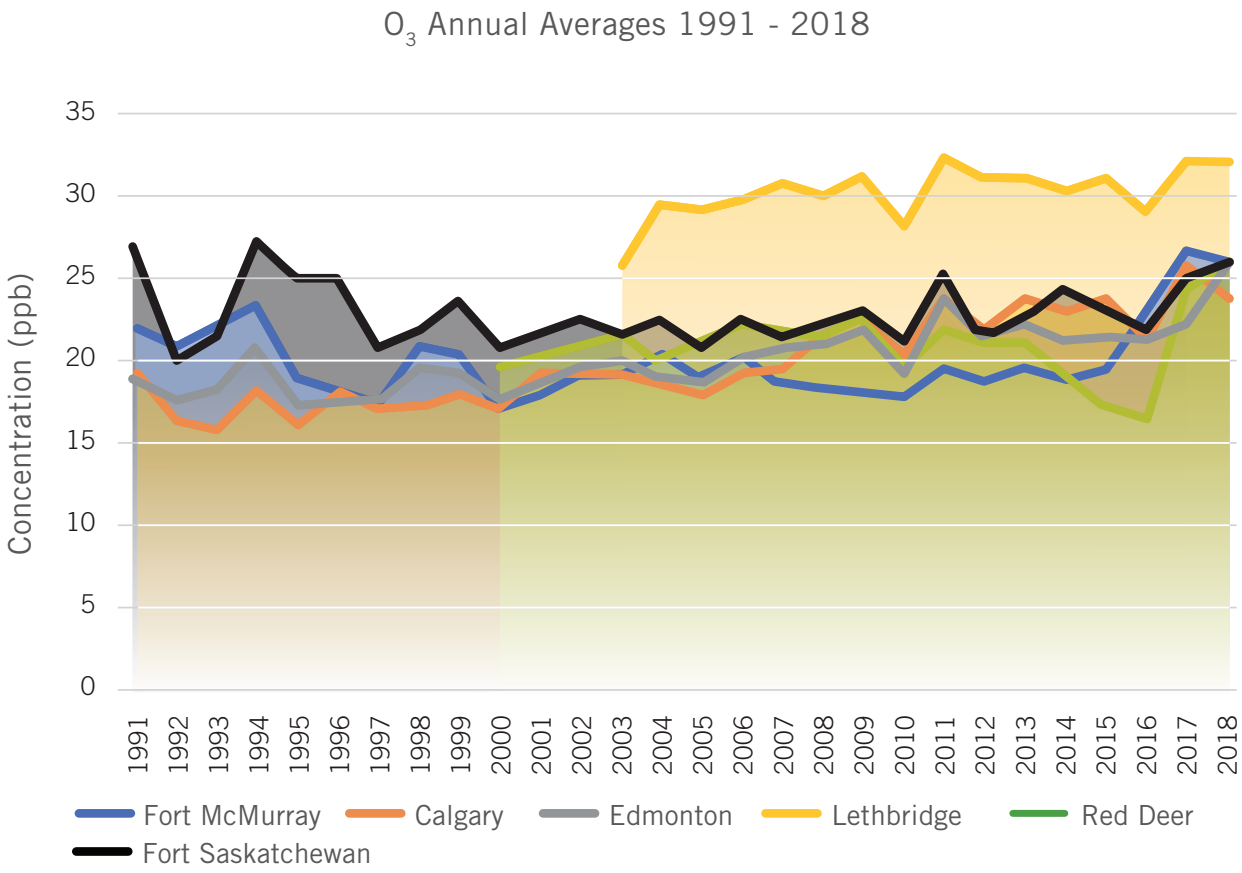
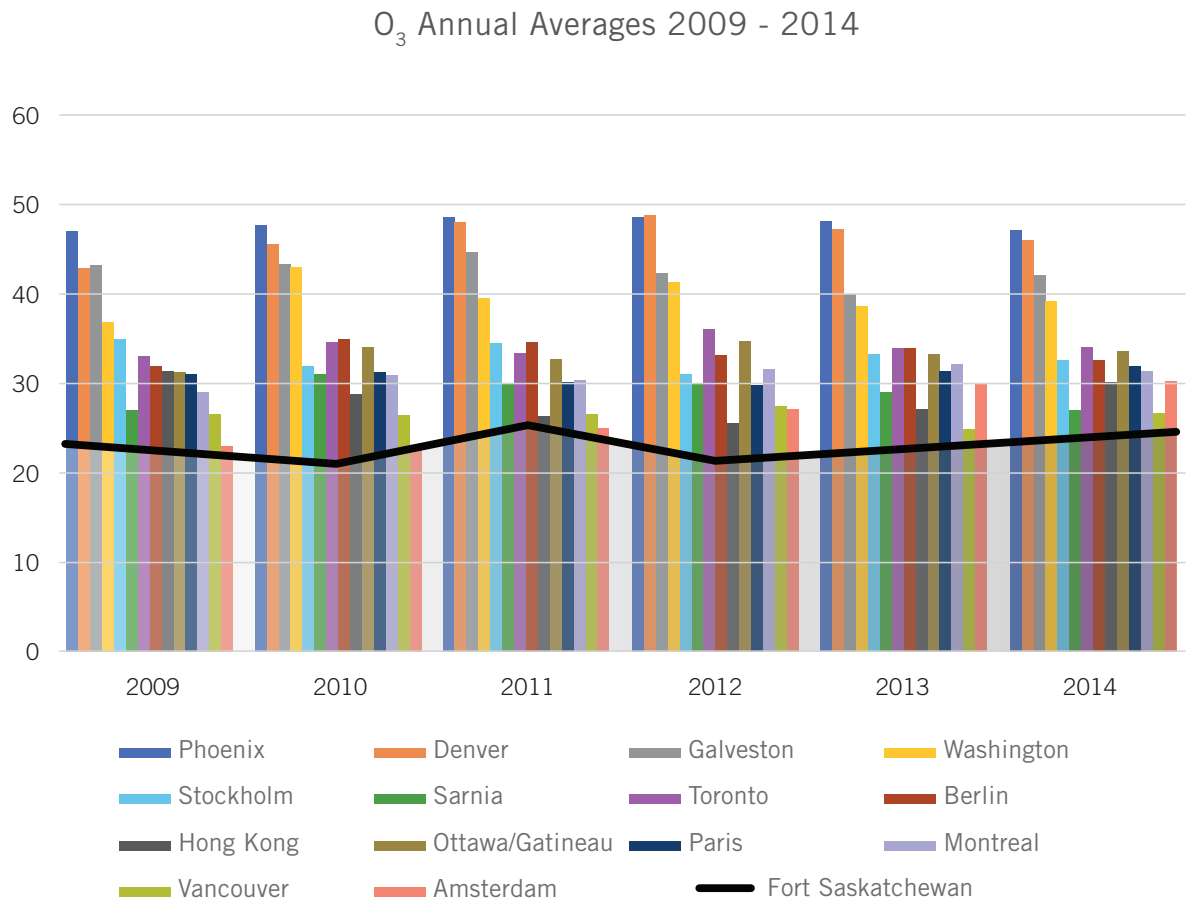


Figure 6 shows that when compared to other locations across Alberta, Fort Saskatchewan is on the upper end of the O_3 chart, with the exception of Lethbridge. This is likely because Fort Saskatchewan is being compared to larger urban locations such as Calgary and Edmonton, where ozone scavenging is more likely to occur. Lethbridge is the southernmost station in this comparison, which has warmer mean temperatures in the spring and summer. This could explain why this location has the highest overall O_3 average.

FIGURE 7: OZONE AT FORT SASKATCHEWAN AND SELECT CANADIAN AND INTERNATIONAL CITIES



Note: Cities displayed in the bar chart left to right, follow the order of the cities listed in the legend as read from left to right.

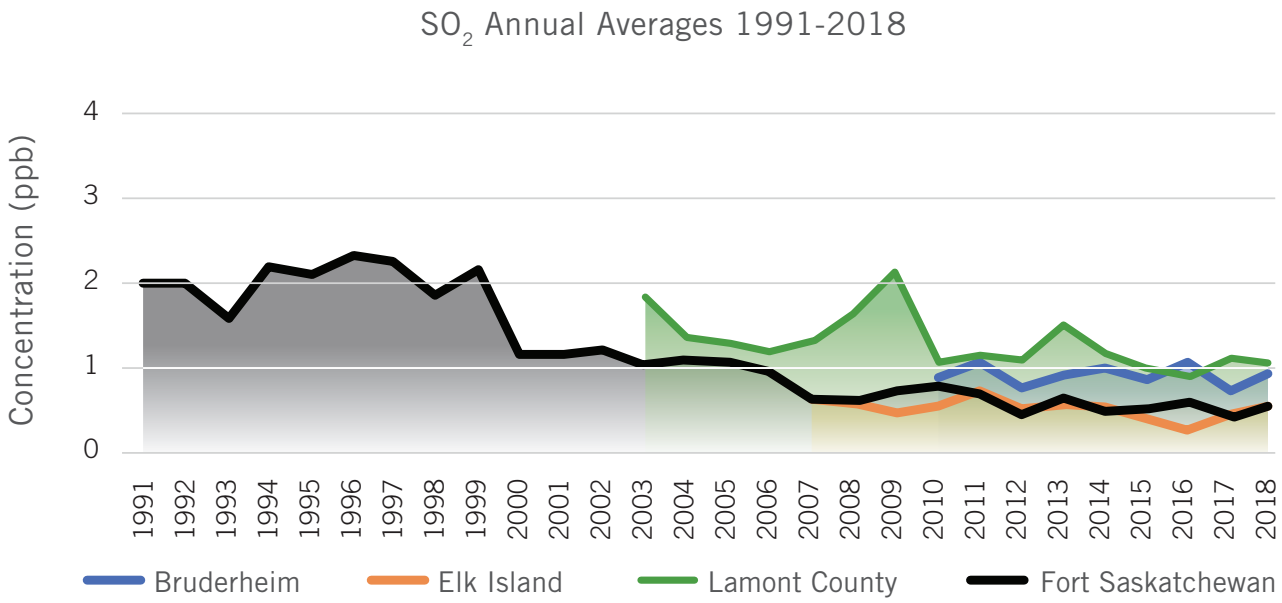
Figure 7 shows that when compared to locations across Canada and internationally from 2009 to 2014, Fort Saskatchewan experiences among the lowest concentrations of O_3. Although O_3 scavenging does occur in more populated areas, once ozone forming substances reach a certain level, secondary O_3 formation can occur, thereby increasing annual average O_3 levels.

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 FAP's boundaries. SO_2 is reported as parts per billion (ppb) throughout this report. Alberta has established an annual average AAAQO for SO_2 at eight parts per billion (ppb). The annual AAAQO for SO_2 from 1991-2011 was 30. In 2011 it was lowered to eight. Alberta also has 1-hour, 24-hour and 30-day objectives for SO_2 as listed in Table 1.

FIGURE 8: SULPHUR DIOXIDE AT SELECT FORT AIR PARTNERSHIP STATIONS

Sulphur dioxide monitoring began in 1991 at the Fort Saskatchewan station, with the Lamont County station coming online in 2003, the Elk Island station in 2007 and the Bruderheim station in 2010. Figure 8 shows SO_2 levels at the Fort Saskatchewan station decreasing over time since 2001. Although there are some variations in SO_2 levels throughout the time period covered in this report, the highest annual average recorded is still well below the annual AAAQO of eight ppb. The highest annual average recorded at the Fort Saskatchewan station in the 1990s was just over two ppb.



There has been industrial growth in the region since 1991. However according to a Canada-wide Fraser Institute **Air Quality Summary Report** released in 2017, emissions of sulphur oxides (SO_x) in Canada from the oil and gas industry decreased by 56.1% between 1990 and 2014.

Another significant impact on ambient SO_2 levels across Canada was the decrease of allowable sulphur content in fuels. Regulation changes in 1997 led to decreased sulphur content in diesel from 5,000 parts per million (ppm) to 500 ppm. In 2006 an additional regulation on gasoline required a sulphur content decrease from 300 ppm to 150 ppm. These two measures may account for the overall annual average SO_2 decreases after each of those years. A report released by the Canadian Fuels Association, titled **Canada's Refining Industry 2018 Sector Performance Report**, illustrates the historical timeline of these significant decreases in sulphur content in both diesel and gasoline.

The **Alberta Energy Regulator's Directive 60** (at the time called Guide 60) came into effect in 1999. A 2002 Clean Air Strategic Alliance (CASA) report titled **Gas Flaring and Venting in Alberta: Report and Recommendations for the Upstream Petroleum Industry by the Flaring/Venting Project Team** stated that implementation of Guide 60 resulted in a 53% reduction in solution gas flaring relative to a 1996 baseline. Likewise, the 2017 Fraser Institute report previously referenced shows that oil well gas flaring and venting across Canada dropped from 1,808 million cubic metres per year in 1996 to 920 million cubic metres per year in 2014 (a 49% reduction). It's expected this would have an impact on SO_2 levels since there are many oil and gas wells within the FAP Airshed.

FIGURE 9: SULPHUR DIOXIDE AT FORT SASKATCHEWAN AND SELECT ALBERTA LOCATIONS

As Figure 9 shows, Fort Saskatchewan annual average SO_2 levels are comparable to other locations across the province. All stations in this 28-year comparison are trending downwards, by as much as 300% at some locations. This is likely due to several factors as mentioned previously, including lower sulphur content of fuels, decreased oil and gas flaring and improvements in industrial technology throughout the province.

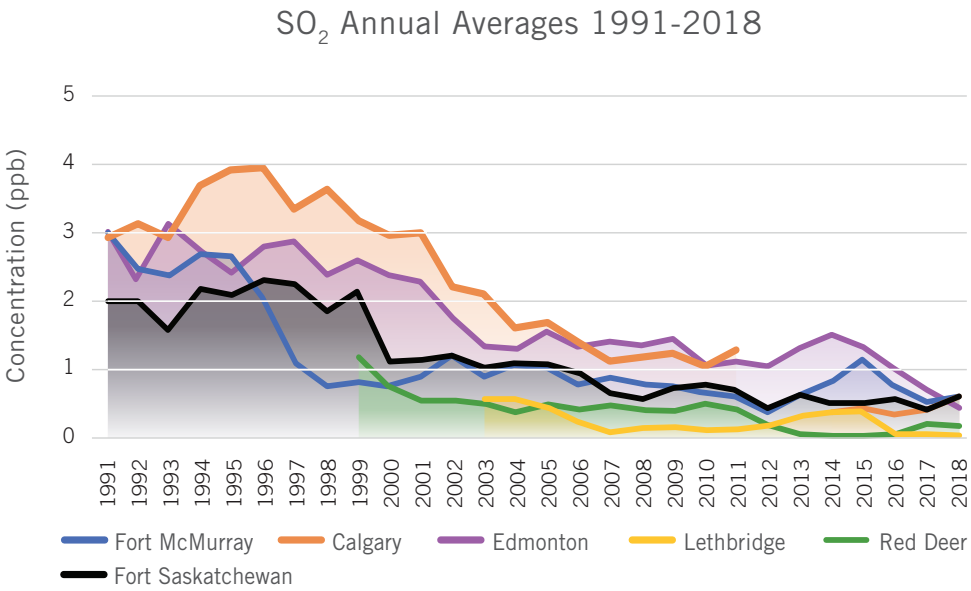
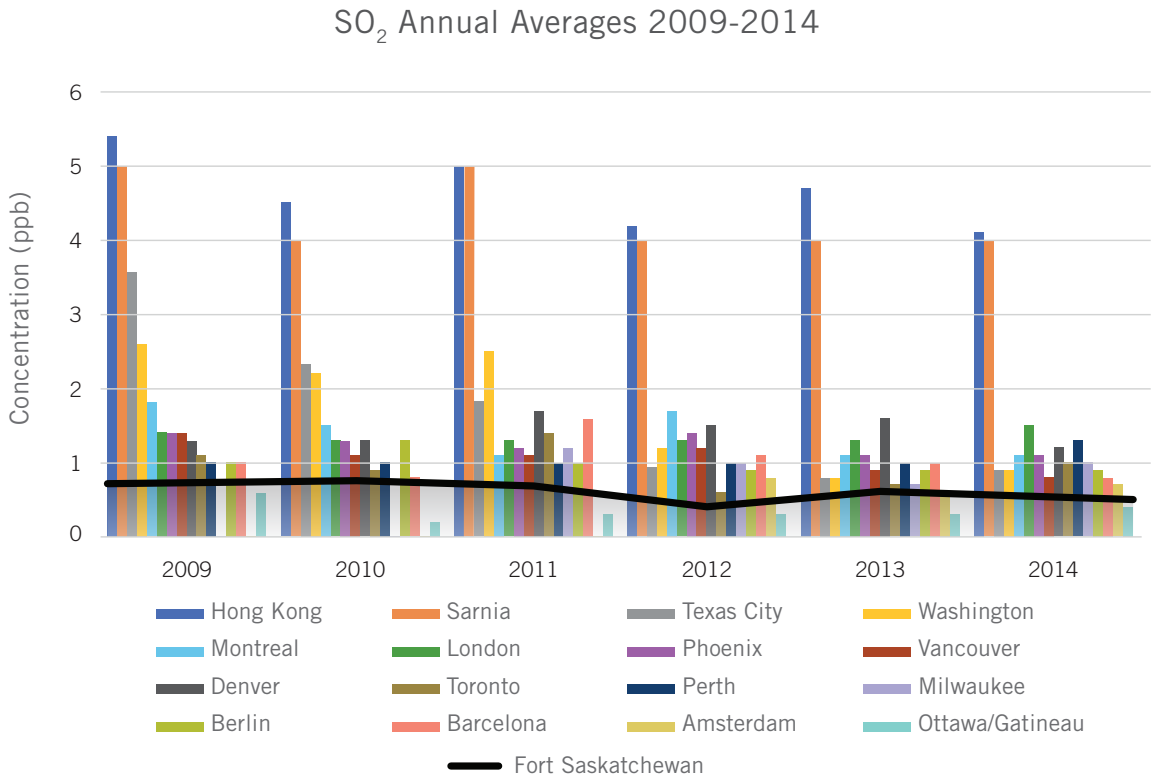


FIGURE 10: SULPHUR DIOXIDE AT FORT SASKATCHEWAN AND SELECT CANADIAN AND INTERNATIONAL CITIES

When compared to locations across Canada and internationally from 2009 to 2014, Figure 10 shows Fort Saskatchewan experiencing among the lowest annual average SO_2 concentrations.



Note: cities displayed in the bar chart left to right, follow the order of the cities listed in the legend as read from left to right.

Nitrogen Dioxide

Nitrogen Dioxide (NO_2) is a component of nitrogen oxides (NO_x), along with nitric oxide (NO), nitrous oxide (N_2O) and nitrogen pentoxide (NO_5). Most NO in the ambient air will react readily with ozone to form nitrogen dioxide. NO_2 is a reddish-brown gas with a pungent odour and is partially responsible for the "brown haze" often observed over large cities.

Sources of NO_x in Alberta include transportation, oil and gas industry, natural gas combustion, heating fuel combustion (including home heating) and forest fires.

NO_2 is reported as parts per billion (ppb) throughout this report. Since 2011, Alberta has had an annual AAAQO for NO_2 at 24 ppb. The annual AAAQO for NO_2 from 1991-2011 was 60ppb. Alberta also has 1-hour objective for NO_2 as listed in Table 1.

FIGURE 11: NITROGEN DIOXIDE AT SELECT FORT AIR PARTNERSHIP STATIONS

The Fort Saskatchewan station began monitoring for NO_2 in 1991. The Lamont County and Elk Island stations began monitoring for NO_2 in 2003 and 2006 respectively while the Bruderheim station began in 2010. Figure 11 shows a higher annual average concentration overall at Fort Saskatchewan than the other three stations. This is because the station is in an urban area with a larger number of NO_2 sources such as home heating, vehicles and commercial activities. However, all averages are well below the annual AAAQO of 24 ppb, with the highest levels reaching just over 14 ppb in the 1990s.

NO_2 levels at the Fort Saskatchewan station are trending downward, likely due to increased efficiencies in home heating and energy use by vehicles since 1991. The 2017 Fraser Institute Air Quality Summary Report attributed the largest source of reduction in NO_2 emissions across Canada to transportation. NO_2 emissions fell by 43% between 1990 and 2014. During the same period, a 28% reduction in NO_2 emissions from increased efficiencies in fuel combustion and power generation also contributed to the decline in NO_x emissions.

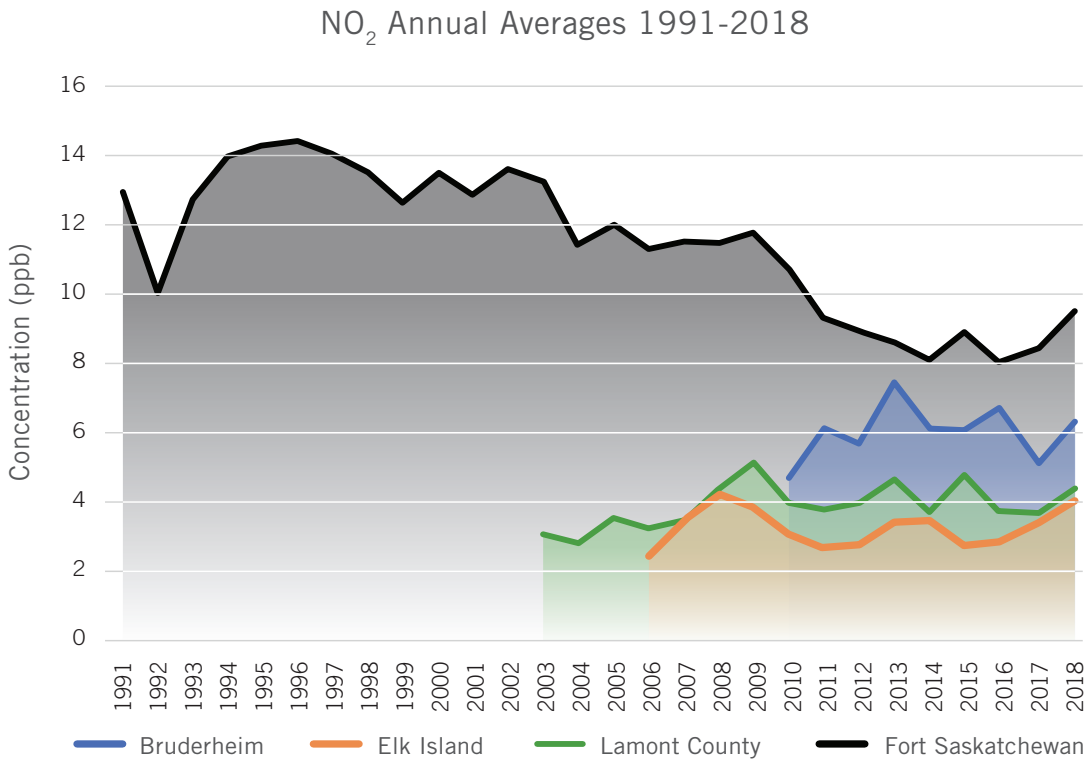


FIGURE 12: NITROGEN DIOXIDE AT FORT SASKATCHEWAN AND SELECT ALBERTA LOCATIONS

When comparing NO_2 levels across Alberta, Figure 12 shows that larger urban centres such as Calgary and Edmonton have the highest annual NO_2 averages simply because they have a greater number of NO_2 sources. The overall trend across the province is downward, likely due to efficiency improvements in vehicle energy use, emissions control and home heating technology.

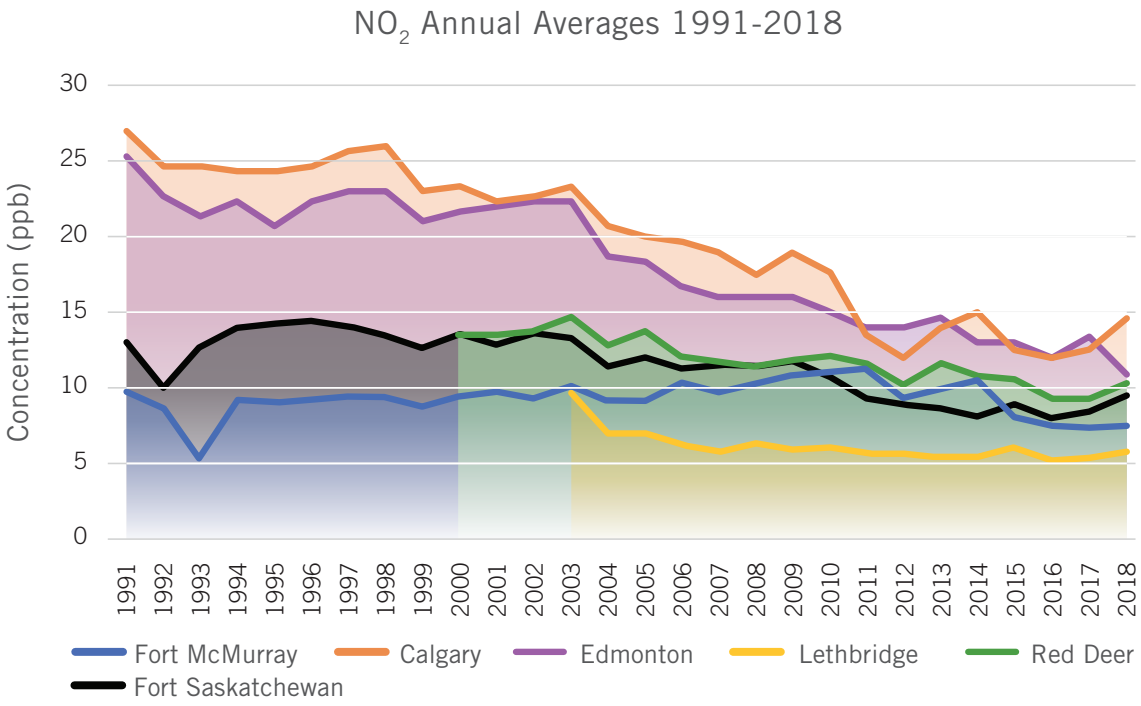
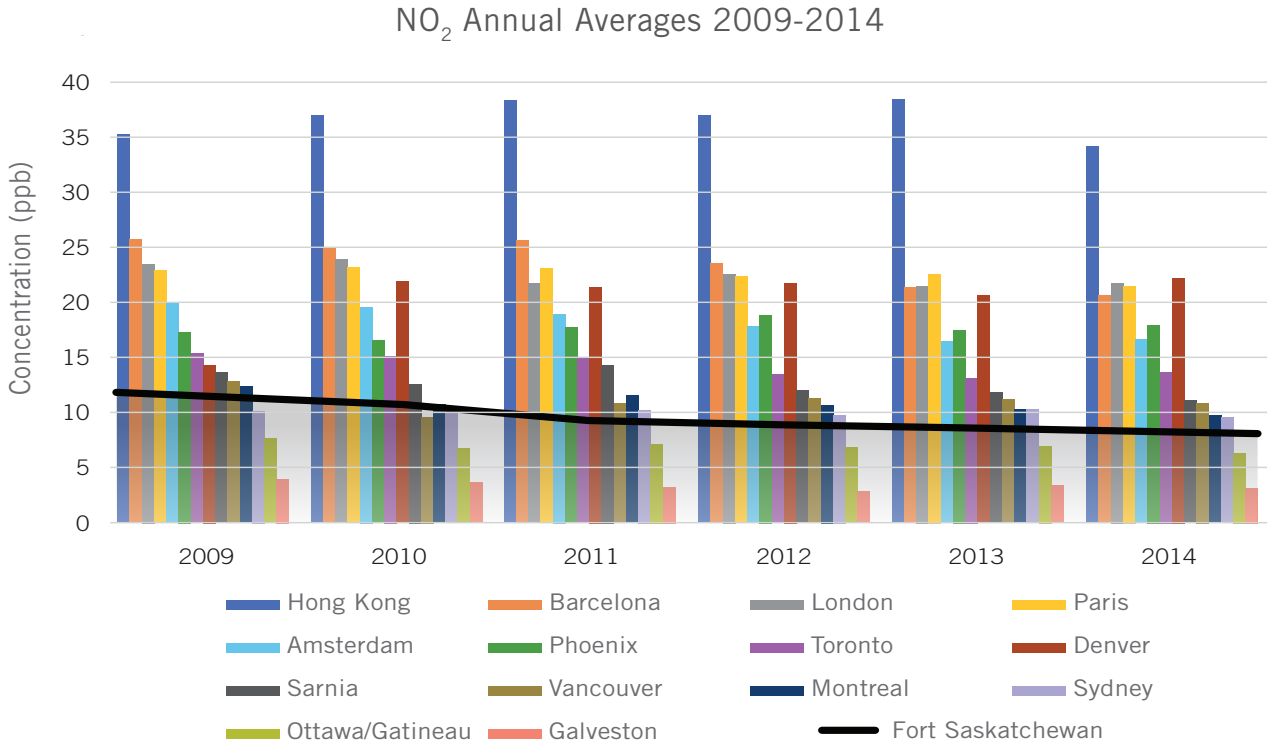


FIGURE 13: NITROGEN DIOXIDE AT FORT SASKATCHEWAN AND SELECT CANADIAN AND INTERNATIONAL CITIES

When compared to locations across Canada and internationally from 2009 to 2014, Figure 13 shows annual NO_2 averages for most locations trending higher than Fort Saskatchewan, with the exception of Montreal, Sydney, Ottawa and Galveston.



Note: cities displayed in the bar chart left to right, follow the order of the cities listed in the legend as read from left to right.

Carbon Monoxide

Carbon monoxide (CO) is a colourless, odourless gas present in small amounts in the atmosphere. CO is primarily generated by the 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 a significant natural source of CO.

While there is no annual average AAAQO in place for CO, Alberta does have 1-hour and 8-hour average objectives for CO as listed in Table 1. A jurisdictional scan throughout North America and Europe found that there are no annual CO objectives present in those locations. Hourly or daily standards, similar to Alberta, seem to be the norm. Therefore, a direct comparison of results presented in the charts below to an established objective or standard is not possible.

FIGURE 14: CARBON MONOXIDE AT THE FORT SASKATCHEWAN STATION

In the FAP Airshed, CO is only monitored at the Fort Saskatchewan station. Figure 14 shows a downward trend since 1998. This is largely due to improvements in vehicle efficiency and emissions reduction technology. According to a Canada-wide air quality summary report released by the Fraser Institute in 2017, carbon monoxide emissions in Canada decreased 61.8% between 1990 and 2014. The largest reduction in emissions came from transportation (70%). This reduction was attributed to the introduction of more efficient and cleaner emissions technology in vehicles.

Figure 14: CO Annual Averages 1999-2018

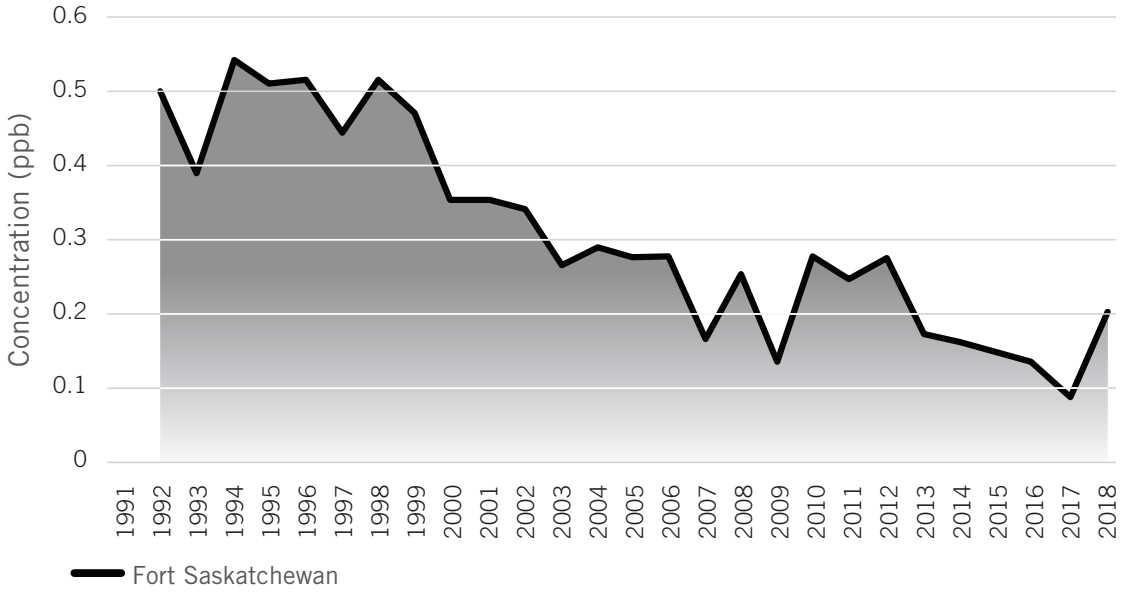


FIGURE 15: CARBON MONOXIDE AT FORT SASKATCHEWAN AND SELECT ALBERTA LOCATIONS

Figure 15 shows that Fort Saskatchewan CO levels are comparable to other locations across the province. Calgary and Edmonton have the highest CO annual average levels. This is due to higher traffic volumes as compared to other Alberta locations. Vehicle efficiency and emissions improvements have contributed to a downward trend in CO emissions for all air monitoring stations in Alberta, which is most evident in locations with higher traffic volumes such as Calgary and Edmonton.

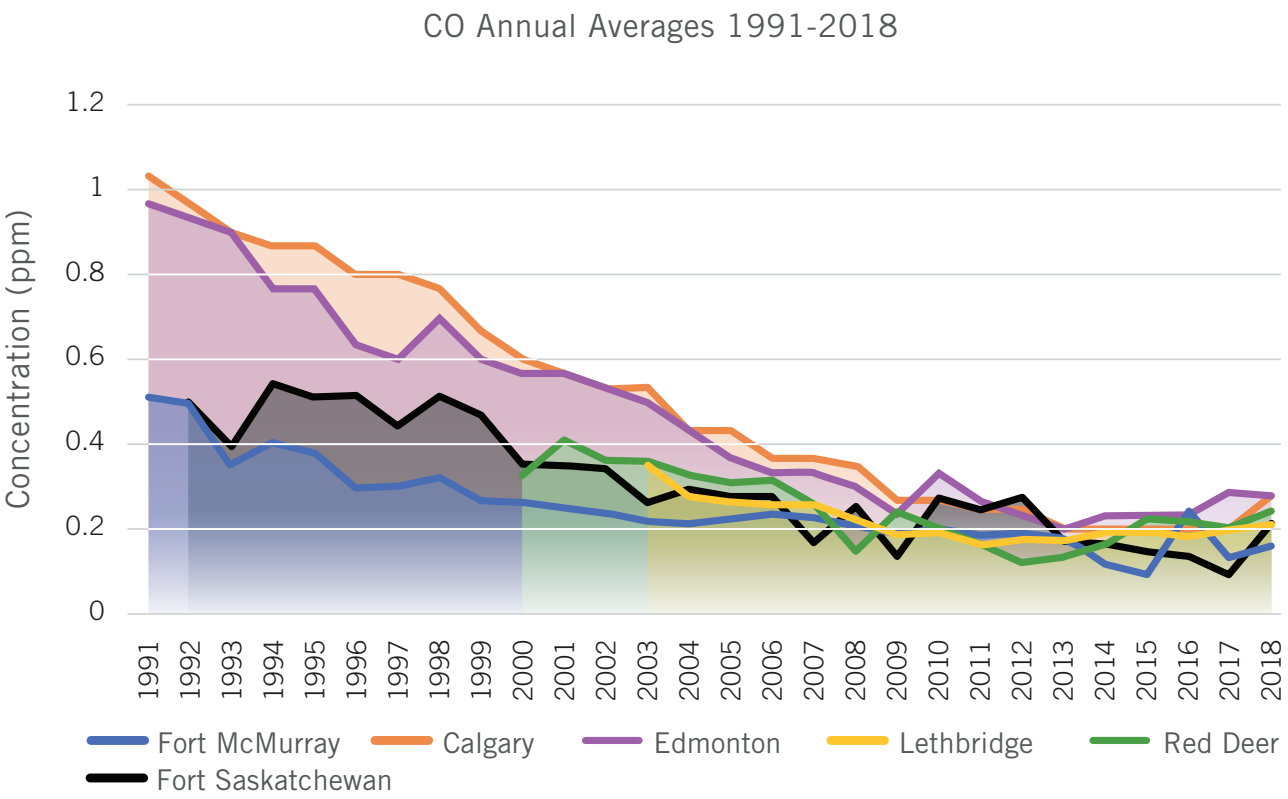
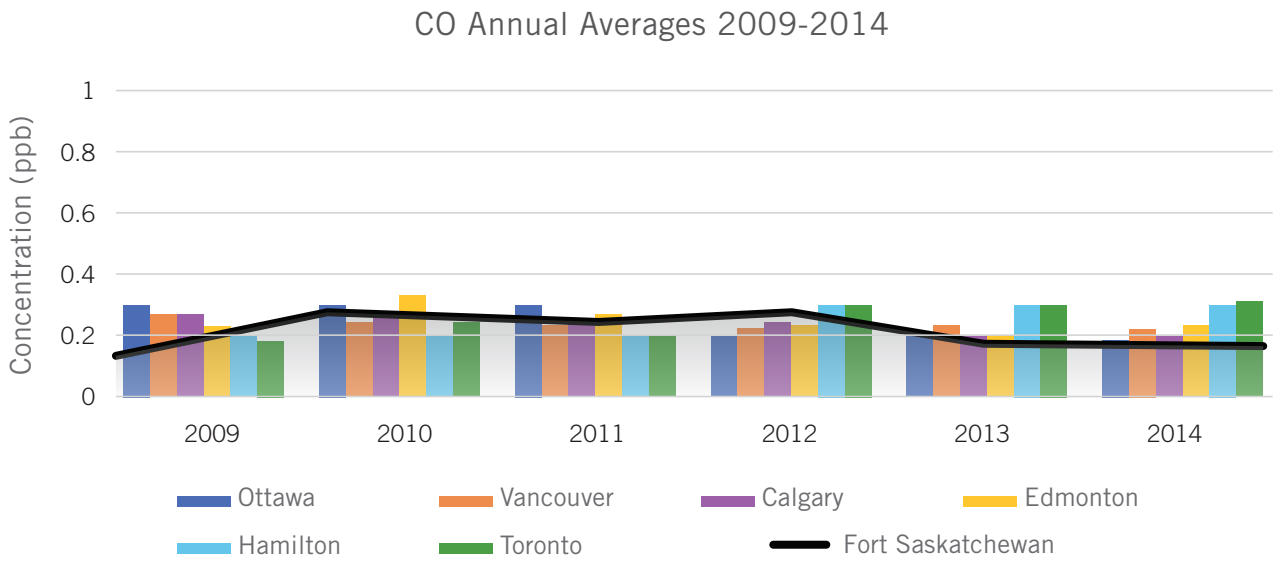


FIGURE 16: CARBON MONOXIDE AT FORT SASKATCHEWAN AND SELECT CANADIAN CITIES

FAP was not able to source sufficient data to provide an international comparison for carbon monoxide. Figure 16 shows a comparison of Fort Saskatchewan to select Canadian cities. Fort Saskatchewan is comparable to other locations in Canada.



Note: cities displayed in the bar chart left to right, follow the order of the cities listed in the legend as read from left to right.

REFERENCES

Alberta Energy Regulator, *Directive 60, Upstream Petroleum Industry Flaring, Incinerating and Venting.* March 12, 2018.

Alberta Environment and Parks.

Alberta Air Data Warehouse.

Fraser Institute, *Canada's Air Quality since 1970. An Environmental Success Story.* April 2017.

Clean Air Strategic Alliance, *Gas Flaring and Venting in Alberta: Report and Recommendations for the Upstream Petroleum Industry by the Flaring/Venting Project Team.* June 2002.

Environment and Climate Change Canada
National Air Pollution Surveillance Program. 2016.

Environmental Protection Department of Hong Kong
Air Quality Data. 2016.

European Environment Agency
Airbase - The European Air Quality Database and Air Quality e-Reporting. 2016.

United States Environmental Protection Agency, *Guideline on Data Handling Conventions for the PM NAAQS.* April 1999.

Office of Environment and Heritage of New South Wales
Air Quality Data Search. 2016.

United States Environmental Protection Agency
Air Data Download Data Files. 2016.

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