2023 ANNUAL DATA REPORT

PRAMP
PEACE RIVER AREA MONITORING PROGRAM

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Prepared by: Michael Bisaga & Lily Lin
PRAMP Technical Program Managers

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Executive Summary

The Peace River Area Monitoring Program was established to address air quality monitoring and modeling recommendations from the Alberta Energy Regulator following its 2014 proceeding. The resulting report called for regulatory changes, regional air monitoring, and ongoing stakeholder engagement in the Peace River Area.

In 2023, the Peace River Area Monitoring Program monitored concentrations of methane, non-methane hydrocarbons, total reduced sulphurs, and sulphur dioxide at Stations 986-C, 842-B, Reno-B, and the Peace River Complex. Additionally, the Air Quality Health Index station in Grimshaw monitored ozone, nitrogen dioxide, nitric oxide, and fine particulate matter. Hydrogen sulphide was also measured at the Peace River Complex station. This report presents the collected data through various visualizations and summary statistics, including wind speed and direction, to better understand the potential sources of these substances. Triggered volatile organic compound sampling events provided additional data for various hydrocarbon species.

The 2022 third-party Network Assessment emphasized the importance of comprehensive coverage, influencing PRAMP's monitoring strategy for 2023. This guidance helped maintain the robustness of the network as the year's data revealed unique air quality patterns.

The summer of 2023 was marked by widespread wildfire smoke, which significantly impacted air quality and altered typical pollutant patterns in the region. The Peace River Area Monitoring Program detected 687 exceedances of the 1-hour Alberta Ambient Air Quality Guideline and 71 exceedances of the 24-hour Alberta Ambient Air Quality Objective for fine particulate matter during the wildfire season. The Air Quality Health Index station in Grimshaw recorded some of the highest particulate matter concentrations in Alberta due to the location of wildfires and the pattern of smoke dispersion.

Methane and non-methane hydrocarbons concentrations across the network showed slight increases, likely influenced by wildfire events. Despite these increases, PRAMP's stations recorded the low overall methane concentrations, with few isolated elevated events. Elevated total reduced sulphur concentrations were observed during the hot and dry summer months, primarily attributed to natural sources such as decaying vegetation in wetlands.

The passive monitoring network continued to operate in 2023, providing monthly average concentrations of sulphur dioxide and hydrogen sulphide. As in previous years, the passive monitoring stations reported pollutant levels well below the Alberta Ambient Air Quality Objectives where applicable.

Volatile organic compound sampling was triggered nine times in 2023, with seven of these events linked to high concentrations during wildfire smoke episodes. Acrolein, a byproduct of organic material combustion, exceeded the 1-hour Alberta Ambient Air Quality Objective in all wildfire-related samples.

In 2023, there were no odour complaints recorded by the Alberta Energy Regulator within the Peace River Area Monitoring Program network, maintaining the low complaint levels seen in previous years.

Acronyms

AAAQG - Alberta Ambient Air Quality Guideline

AAAQO - Alberta Ambient Air Quality Objective

AEPA - Alberta Environment and Protected Areas

AER - Alberta Energy Regulator

AQHI - Air Quality Health Index

CH_4 - methane

H_2S - hydrogen sulphide

NMHC - non-methane hydrocarbons

NO - nitric oxide

NO_2 - nitrogen dioxide

O_3 - ozone

OSM - Oil Sands Monitoring

PAZA - Peace Airshed Zone Association

$PM_{2.5}$ - fine pariculate matter

PPB - parts per billion

PPM - parts per million

PRAMP - Peace River Area Monitoring Program

PRC - Peace River Complex

SO_2 - sulphur dioxide

TRS - total reduced sulphurs

ug/m^3 - micrograms per cubic meter

VOC - volatile organic compound

1 - Introduction

1.1 Historical Context

The Peace River Area Monitoring Program (PRAMP) was established to meet air quality monitoring and modeling recommendations from the Alberta Energy Regulator (AER). The AER initiated this proceeding to address odour and emissions issues caused by heavy oil operations in the Peace River Area of Alberta (AER 2014a). The oral proceeding took place from January 21 to January 31, 2014, in Peace River, Alberta. On March 31, 2014, the panel published its *Report of Recommendations on Odours and Emissions in the Peace River Area*. The report recommended regulatory changes, regional air monitoring, and continued stakeholder engagement in the Peace River Area.

1.2 Monitoring Program Overview

PRAMP operates a well-established monitoring program essential for understanding air quality in the Peace River Area. The continuous monitoring program has been active at Station 986 since 2010, Station 842 since 2012, Reno Station since 2014, and the Peace River Complex (PRC) Station since 2022. In 2019, PRAMP deployed its Air Quality Health Index (AQHI) station in the community of Cadotte Lake for the first time. This station, designed as a portable monitoring unit, resembles other PRAMP continuous air monitoring stations in construction and layout. However, it is moved regularly, approximately every 18 to 24 months, to address emerging needs and issues. In late 2021, the AQHI station was relocated to the Town of Grimshaw, where it remained throughout 2023. Section 3 of this report provides more details about the AQHI.

Station 986 has been relocated twice, while Station 842 and Reno Station have each been relocated once during their deployment. With each move, PRAMP preserved a consistent naming convention by adding an alphabetic identifier: Station 986 is now 986-C, Station 842 is 842-B, and Reno Station is Reno-B. Despite the relocations, the new monitoring sites remain close to their original locations, ensuring they continue to represent their initial deployment areas.

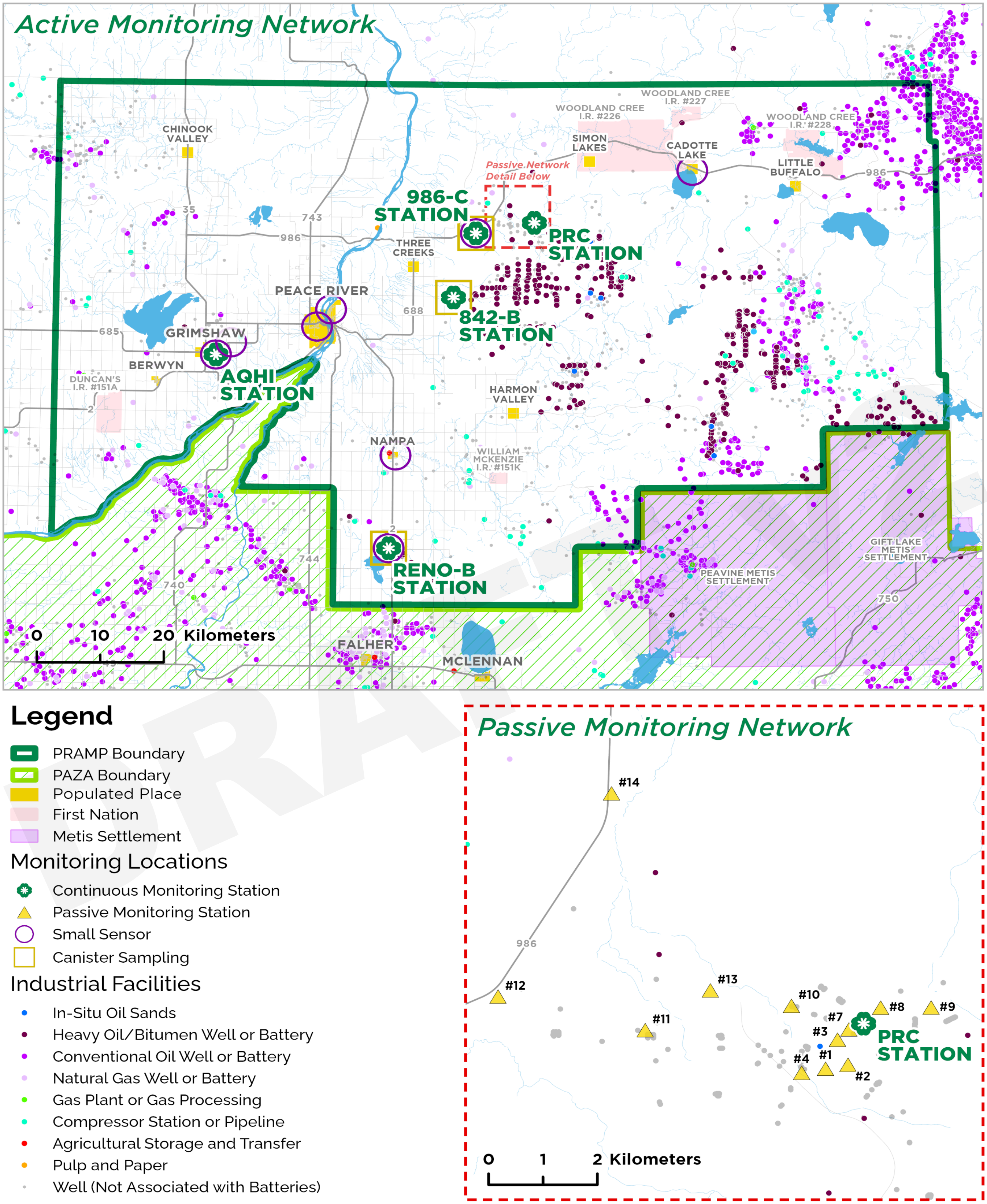


Figure 1: Map of the PRAMP Area

PRAMP continuously monitors concentrations of sulfur dioxide (SO_2), total reduced sulfur (TRS), methane (CH_4), and non-methane hydrocarbons (NMHC) at stations 986-C, 842-B, Reno-B, AQHI, and PRC. Additionally, the PRC station monitors hydrogen sulfide (H_2S), while the AQHI station also measures particulate matter ($PM_{2.5}$), nitrogen oxides (NO_2, NO), and ozone (O_3). Canisters are periodically collected at stations 986-C, 842-B, and Reno-B for detailed laboratory analysis of volatile organic compounds (VOCs).

PRAMP also operates a network of network of small senors for $PM_{2.5}$ however, data from these sensors is not summarized in this report.

PRAMP's continuous monitoring stations are located at:

- Station 842 (or 842-B)
  at 16-7-84-19 W5M
- Station 986 (or 986-C)
  at 5-15-85-19 W5M
- Reno Station (or Reno-B)
  at 01-28-79-20 W5M
- AQHI Station (located in Grimshaw) at 13-8-83-23 W5M
- Peace River Complex (or PRC)
  at 8-21-85-18 W5M

1.3 Air Quality Monitoring Goals

In 2021, PRAMP held strategic planning sessions and, as a result, established a new set of goals. The goals that are directly related to delivery of the air quality monitoring program are as follows:

GOAL 1: Evidence-driven verification that air quality in the Peace River area is at acceptable levels and that emissions are being minimized.

GOAL 2: Residents and stakeholders have timely access to air quality data and information in a manner that is readily understood.

GOAL 3: Educators, community groups, and citizens can access resources to increase understanding of and to promote healthy air quality.

GOAL 4: Recognized as an independent not-for-profit organization and Airshed that is focused on continuous improvement and responsible leadership in air quality monitoring.

There are several strategies associated with achieving these goals including:

- Maintain operation of all PRAMP air monitoring stations to achieve the objectives of the Oil Sands Monitoring (OSM) contract and to be in compliance with the Air Monitoring Directive.
- Data reporting meets or exceeds provincial requirements and regulatory compliance commitments.
- Data is analyzed to confirm that results do not exceed Alberta Ambient Air Quality Objectives and Guidelines and Canadian Ambient Air Quality Standards where applicable.
- Deliver timely, relevant, and accessible air quality data so that residents can make informed choices in support of human health and the environment.

PRAMP monitors air quality in the Peace River Area through continuous and passive measurements, as well as triggered canister samples. Continuous monitoring stations use substance-specific technology to detect concentrations in ambient air samples taken at regular intervals. These stations also collect wind speed and direction data. Most of PRAMP's continuous monitoring instruments record data every second, while 1-minute averages are used for quality assurance and control. After validating the data, PRAMP calculates 1-hour averages and submits them to the AEPA data warehouse system. By analyzing concentration and wind data together, PRAMP can identify potential sources of substances affecting local air quality. This report uses various data visualizations to help understand the spatial and temporal patterns and distribution of the data.

Stations 986-C, 842-B, and Reno-B automatically collect discrete 1-hour canister samples when NMHC concentrations exceed a predetermined threshold of 0.3 ppm, based on a five-minute real-time average. After collecting the 1-hour sample, PRAMP notifies a field technician, who then sends the canister to a laboratory for speciated hydrocarbon analysis.

In 2023, PRAMP continued to operate the 12-station PRC passive monitoring network, which tracks hydrogen sulphide and sulphur dioxide concentrations. Passive sampling devices, with their simple design, low operating costs, and ease of use, are ideal for remote areas as they require no power to collect samples. These devices provide long-term average concentrations and reveal spatial variations in air quality, though they are not suited for detecting maximums or short-term elevated pollutant levels. The passive monitoring network produces monthly averages for hydrogen sulphide and sulphur dioxide through laboratory analysis.

The Alberta government develops the Alberta Ambient Air Quality Objectives and Guidelines (AAAQO/AAAQG; AEP 2019) to protect the environment and human health. Led by Alberta Environment and Protected Areas under Section 14 of the Environmental Protection and Enhancement Act, a multi-stakeholder process establishes these objectives and guidelines. PRAMP uses these threshold values to compare substance concentrations over appropriate averaging periods and assess potential impacts.

1.4 Network Assessment

In 2022, PRAMP initiated its first formal Network Assessment to evaluate whether the existing monitoring strategy effectively covers the right parameters, utilizes appropriate technology, and is situated at optimal locations. To ensure an impartial and thorough review, PRAMP engaged AECOM Canada Ltd. as a neutral, independent contractor to conduct the assessment in collaboration with PRAMP stakeholders. This comprehensive study included an in-depth analysis of air monitoring and meteorological data from PRAMP's air monitoring stations, as well as the two Mercer Peace River pulp mill's air monitoring stations.

The findings of the assessment were significant. It was recommended that no monitoring stations be moved or removed, as each station was found to provide unique and essential data needed to understanding the air quality dynamics in the region. The assessment also highlighted the potential benefits of integrating lower-cost air monitoring sensors into areas within PRAMP's boundaries that currently lack sufficient coverage. Additionally, the study suggested considering these lower-cost sensors as viable alternatives when it becomes necessary to replace existing continuous monitoring equipment.

The final report from this assessment was accepted by PRAMP's Board of Directors in December 2022. These findings have since played a key role in shaping PRAMP's monitoring strategy, influencing the approach to data collection and analysis in 2023. Moving forward, PRAMP staff, together with the Technical Working Group, will focus on implementing the Assessment's prioritized recommendations, ensuring that the network remains robust, adaptive to emerging challenges, and aligned with the latest technological advancements.

2 - Continuous Monitoring Results

2.1 Interpretation Key

This section provides guidance for interpreting the standalone charts and dashboard-style layouts of data presented later in the report. In 2023, Alberta's Airsheds collectively operated over 80 continuous monitoring stations across the province (Figure 2), each monitoring a variety of pollutants and meteorological parameters. Every Airshed operates a monitoring program tailored to local objectives, including long-term trend analysis, air quality health index reporting, and compliance assurance.

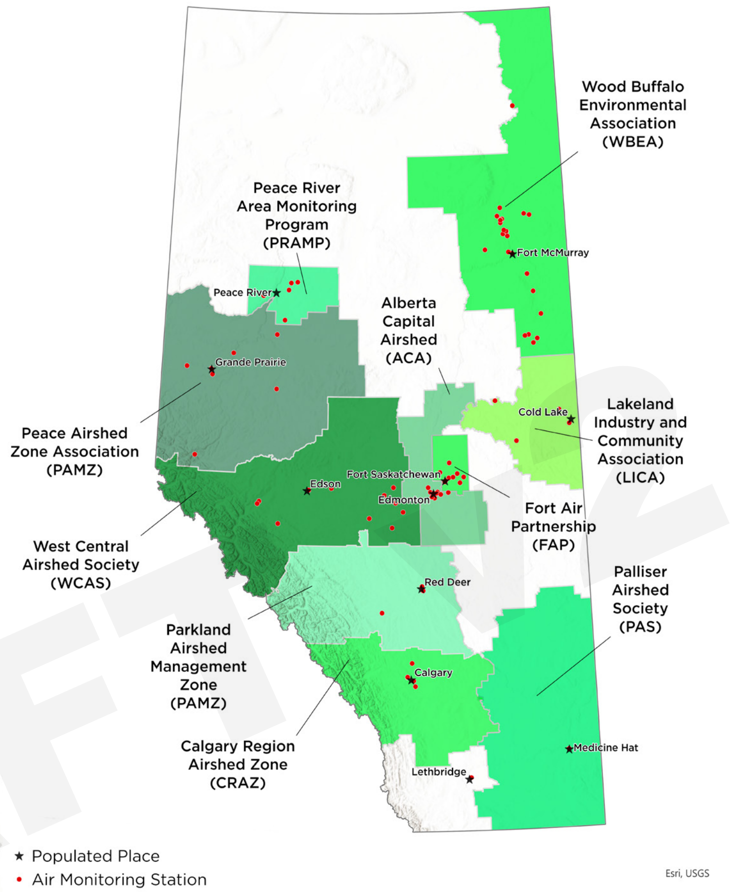


Figure 2: Alberta's Airshed Zones

Box plots summarize the 2023 continuous monitoring data collected by Alberta's Airsheds. Each monitoring location is labeled with an acronym representing the Airshed that operates the station. Airshed acronyms and their geographic locations can be found on the map included in this section (Figure 2). In some cases, Alberta Environment and Protected Areas (AEPA) also operates monitoring stations.

For each continuous monitoring location in Alberta, two concentrations are presented in a simplified box plot: the 'bar' represents the annual average of one-hour concentrations, and the 'whiskers' indicate the 95th percentile; bars representing PRAMP monitoring stations are highighted in yellow. A box plot chart interpretation key is provided in Figure 3. In statistics, a percentile is the value below which a certain percentage of scores fall. For example, the 95th percentile is the value below which 95% of the concentrations fall. This method highlights the central tendency using the average while excluding potential outliers, such as data collected during extreme events like forest fires, facility upsets, and unusual weather phenomena (data above the 95th percentile are considered outliers). If available, the relevant provincial or federal guideline or standard threshold for each pollutant is is included in the summary.

across the network. Each column in the dashboard represents a monitoring station in the PRAMP network. Figure 4 provides an interpretation key for the dashboard-style figures contained in this section.

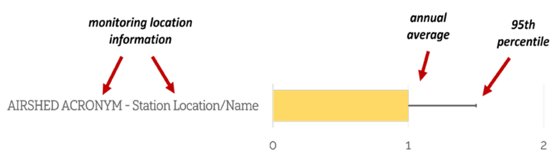


Figure 3: Box plot interpretation key

This section also introduces wind roses formatted to present pollutant concentrations, known as pollution roses or concentration roses. These diagrams show the frequency of contaminant concentrations associated with winds blowing from specific directions over a given period. The length of each 'spoke' around the circle corresponds to the frequency of that concentration occurring. While concentration roses typically resemble wind roses, their focus is on identifying the directions from which higher concentrations originate.

Each continuously monitored parameter in the following sections is summarized in a dashboard-style presentation. These dashboards contain up to 25 smaller charts, with each row representing different summary statistics or frequency distributions to highlight patterns and observations in the monitoring data

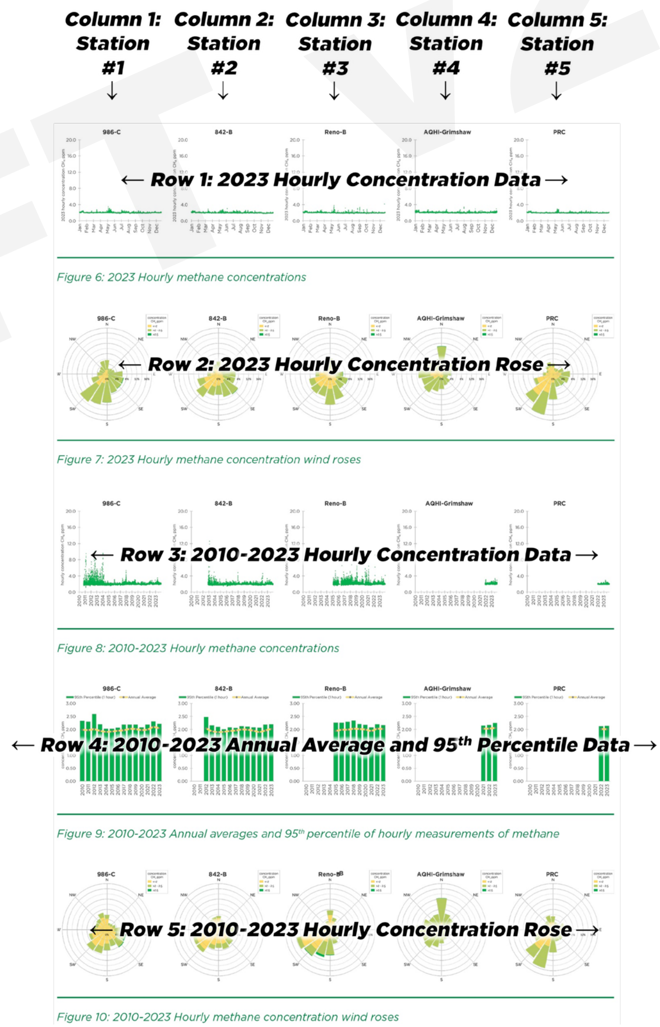


Figure 4: Dashboard Report interpretation key

2.2 Methane

Methane is a colourless and odourless gas commonly emitted during the production and transport of coal, natural gas, and oil. It also results from livestock, other agricultural practices, land use, and the decay of organic waste in municipal solid waste landfills. Although there is no Alberta Ambient Air Quality Objective (AAAQO) for methane, background levels typically hover around 1.8 ppm.

The frequency of elevated methane events at Stations 986-C, 842-B, and Reno-B has generally decreased, especially when compared to earlier monitoring records at these sites. In 2023, all stations reported similar annual averages, with a slight increase compared to recent years. This rise may be due to widespread wildfires, which likely contributed to the uptick in concentrations.

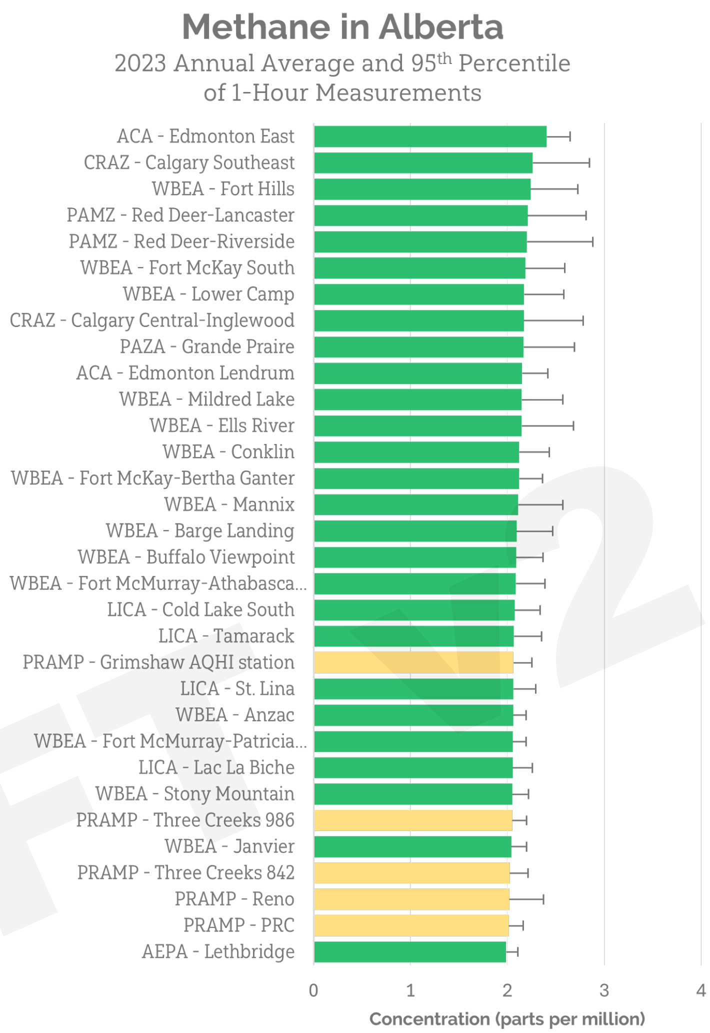


Figure 5: 2023 Methane in Alberta

In 2023, the highest methane concentrations were measured near industrial complexes and in Alberta's large cities, particularly those east of Edmonton and in the oilsands mining areas north of Fort McMurray. PRAMP's monitoring stations recorded concentrations that are very close to the natural background levels for rural Alberta, with the AQHI, PRC, Reno-B, and 842-B stations ranking among the lowest in the province (see Figure 5).

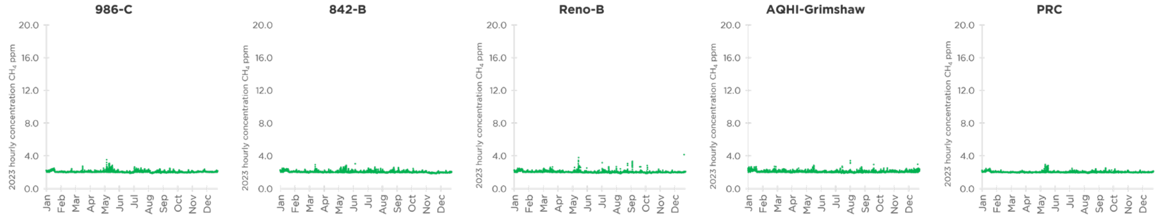


Figure 6: 2023 Hourly methane concentrations

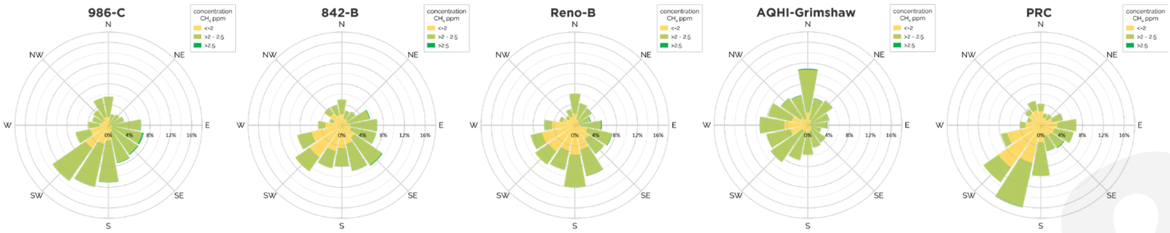


Figure 7: 2023 Hourly methane concentration wind roses

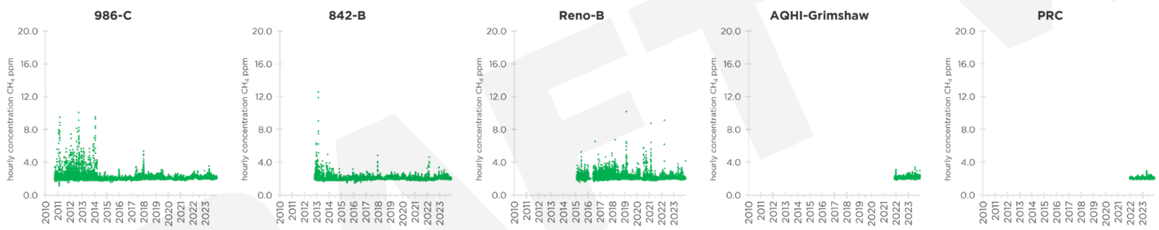


Figure 8: 2010-2023 Hourly methane concentrations

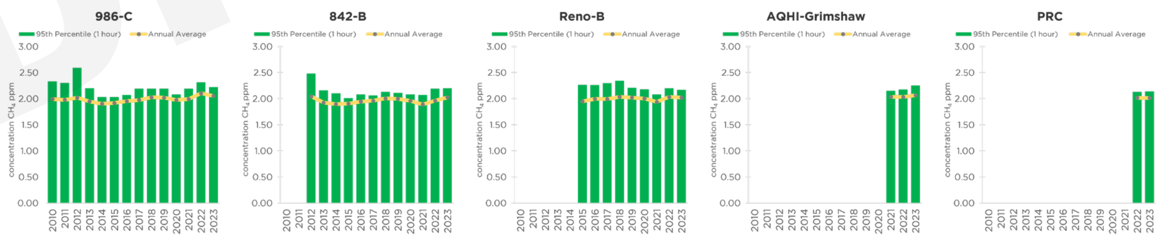


Figure 9: 2010-2023 Annual averages and 95th percentile of hourly measurements of methane

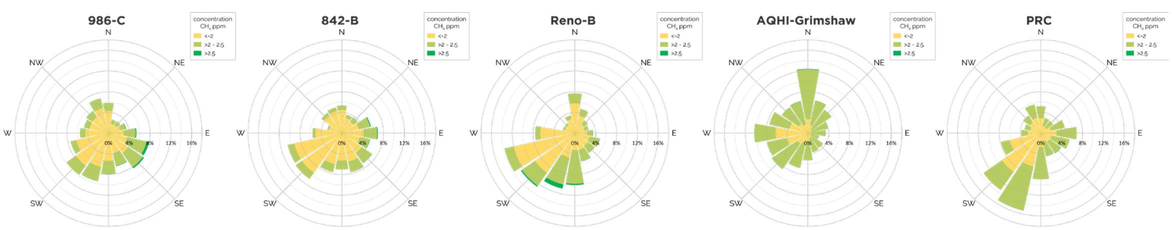


Figure 10: 2010-2023 Hourly methane concentration wind roses

2.3 Non-Methane Hydrocarbons

Non-methane hydrocarbons (NMHCs) are organic compounds that are typically photochemically reactive in the atmosphere. As the name implies, this group of hydrocarbons excludes methane. NMHCs are formed by a wide range of natural sources, such as vegetation and forest fires, as well as anthropogenic sources, including traffic, industrial complexes, and manufacturing.

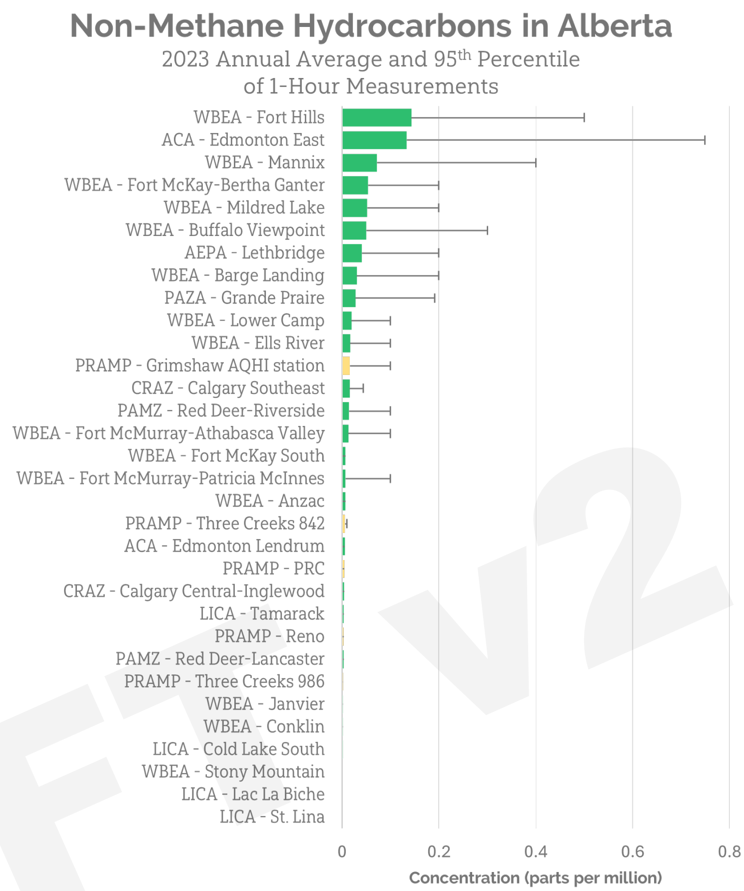


Figure 11: 2023 Non-methane hydrocarbons in Alberta

All stations in the PRAMP network measured elevated NMHC values during the protracted wildfire seasons of 2023. Wildfires are a significant source of various non-methane hydrocarbons. Some of these elevated measurements were directly linked to wildfire smoke episodes during the summer, while stagnant meteorological conditions in the winter also contributed. The AQHI-Grimshaw station consistently recorded higher concentrations throughout the year compared to PRAMP's other monitoring stations. Local factors, including vehicle use, home heating, and commercial activity in Grimshaw, further contributed to these elevated concentrations. Stations 986-C, 842-B, and Reno-B have seen a decrease in both the magnitude and frequency of elevated NMHC levels since monitoring began in the PRAMP area.

Across Alberta, most annual average NMHC concentrations are very close to zero parts per million at nearly all monitoring locations. Despite these low levels, some patterns emerge in the provincial data, including elevated concentrations at stations in the Fort McMurray oil sands area and stations in or near large urban areas and industrial complexes. PRAMP's stations—986-C, 842-B, Reno-B, and PRC—are all in the lower 50% of annual averages among monitoring stations in Alberta (see Figure 11).

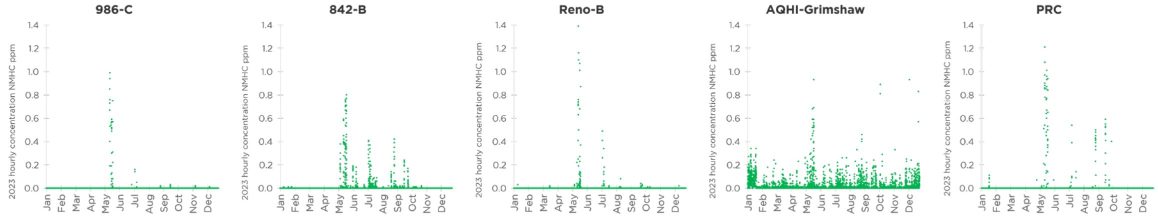


Figure 12: 2023 Hourly non-methane hydrocarbon concentrations

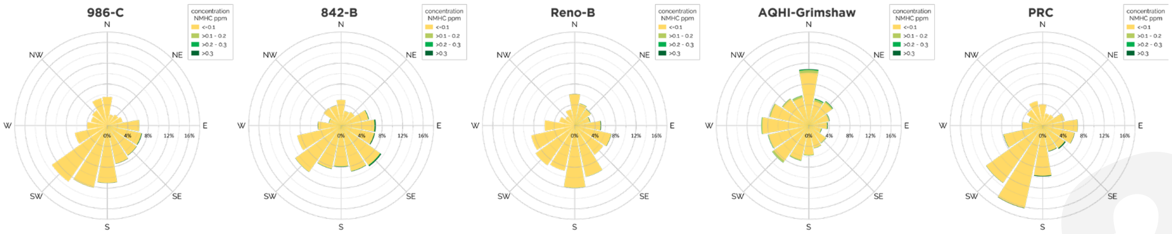


Figure 13: 2023 Hourly non-methane hydrocarbon concentration wind roses

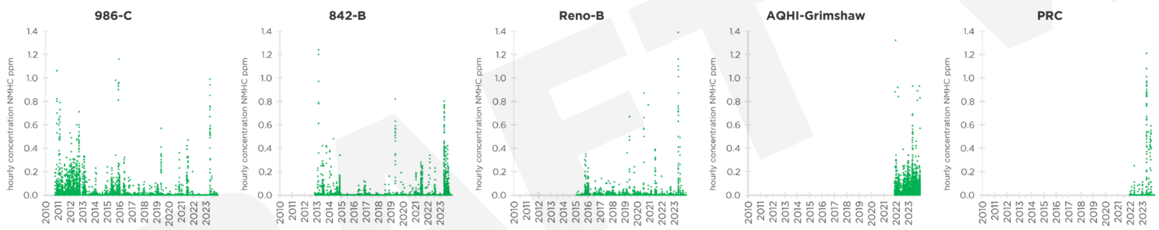


Figure 14: 2010-2023 Hourly non-methane hydrocarbon concentrations

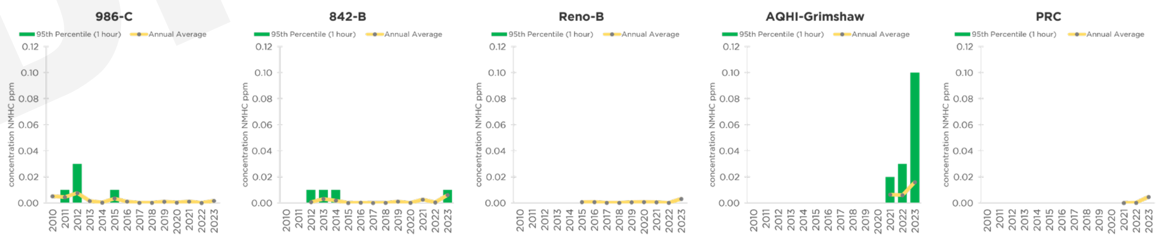


Figure 15: 2010-2023 Annual averages and 95th percentile of hourly measurements of non-methane hydrocarbons

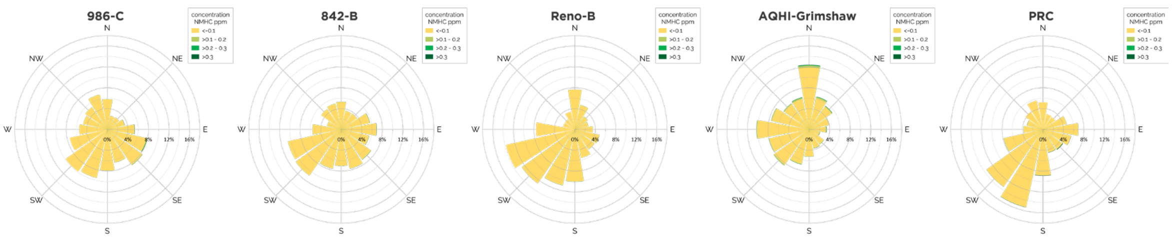


Figure 16: 2010-2023 Hourly non-methane hydrocarbon concentration wind roses

2.4 Sulphur Dioxide

Sulphur dioxide forms during the combustion of sulfur compounds in fuel and flared or incinerated gas. In Alberta, oil and gas operations produce sulfur dioxide emissions that vary in scale, from relatively small at distributed well sites to very large at oilsands operations and sour gas processing facilities. These operations often cluster together, leading to higher localized concentrations of sulphur dioxide. This pattern of elevated concentrations near major sources or facility clusters is evident in the monitoring data. In 2023, the highest annual sulphur dioxide concentrations were recorded north of Fort McMurray near oilsands mines, east of Edmonton near refineries, and around Fort Saskatchewan's petrochemical operations.

Alberta's Ambient Air Quality Objectives (AAAQOs) for sulphur dioxide are 172 parts per billion (ppb) for a 1-hour average and 8.0 ppb for an annual average. PRAMP's monitoring stations consistently reported sulfur dioxide levels well below these thresholds, with no discernible trends in the data. In 2023, all of PRAMP's monitoring locations had annual average sulfur dioxide concentrations in the lowest 15% of all stations across Alberta.

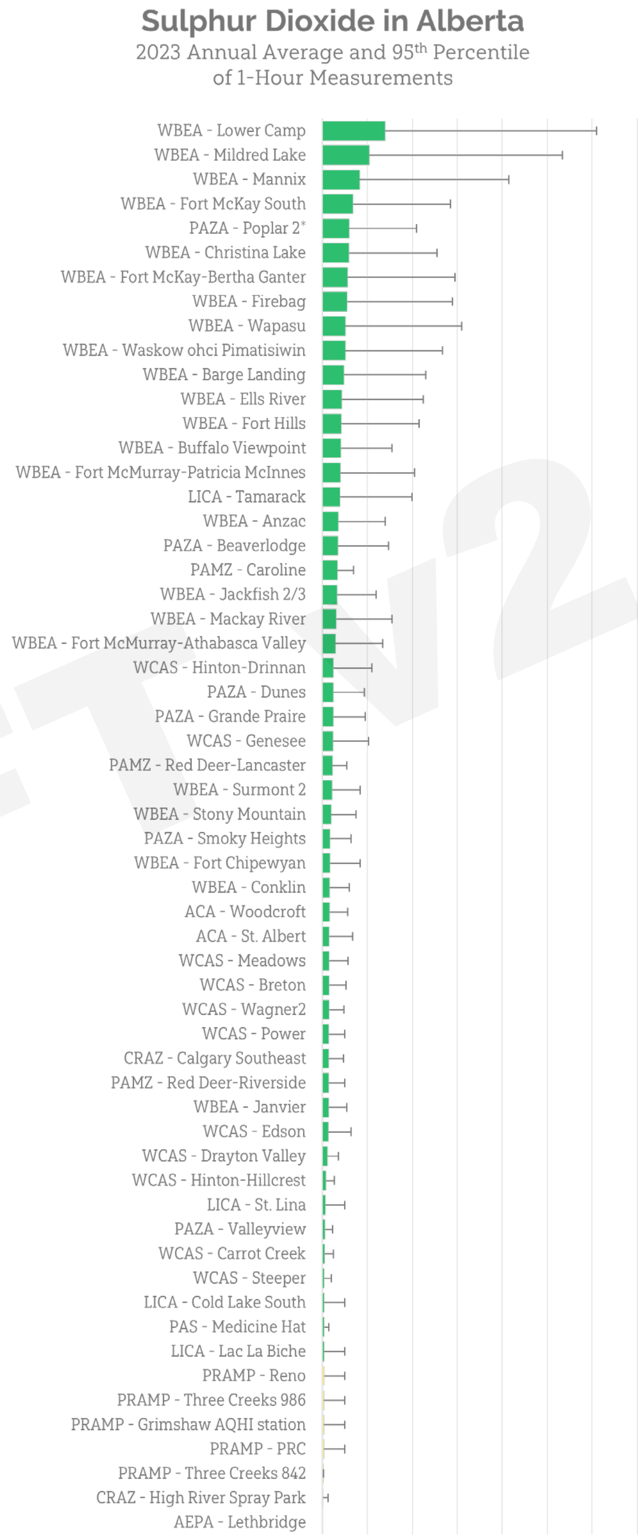


Figure 17: 2023 Sulphur dioxide in Alberta

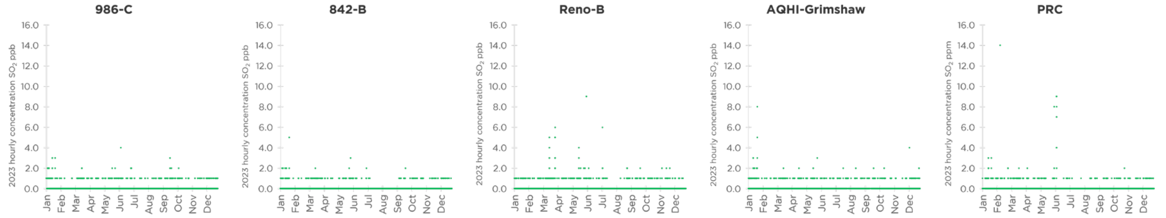


Figure 18: 2023 Hourly sulphur dioxide concentrations

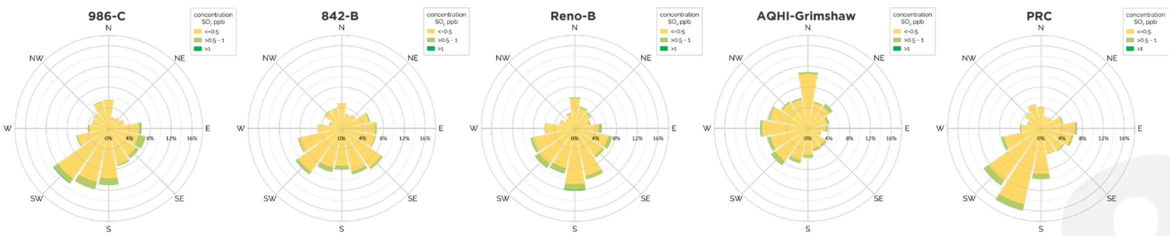


Figure 19: 2023 Hourly sulphur dioxide concentration wind roses

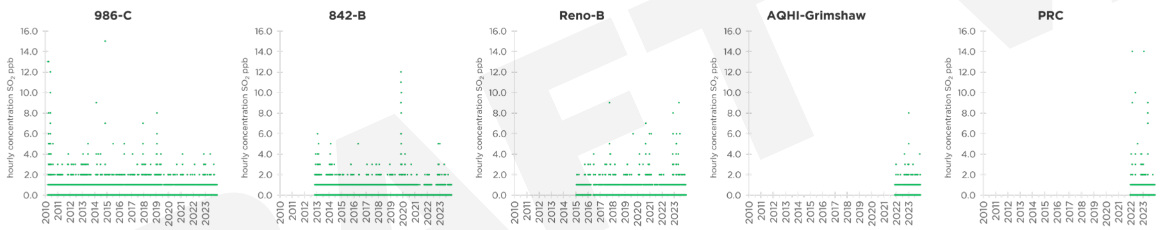


Figure 20: 2010-2023 Hourly sulphur dioxide concentrations

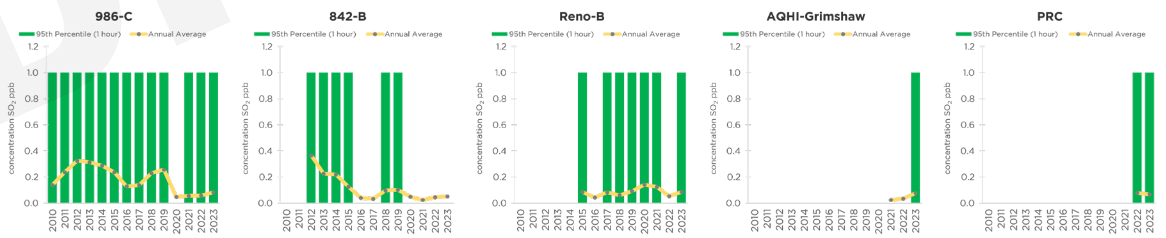


Figure 21: 2010-2023 Annual averages and 95th percentile of hourly measurements of sulphur dioxide

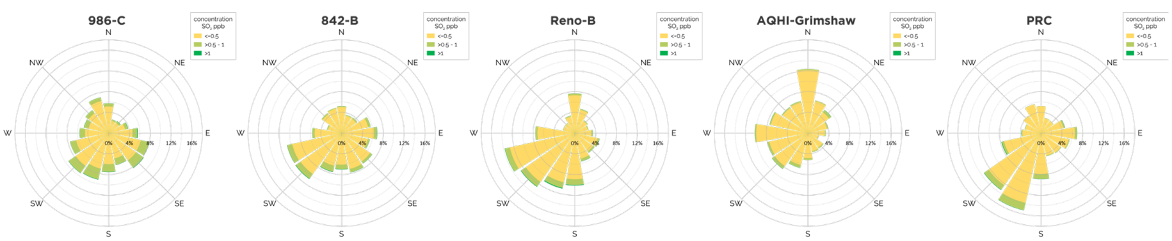


Figure 22: 2010-2023 Hourly sulphur dioxide concentration wind roses

2.5 Total Reduced Sulphur Compounds

Total reduced sulphur (TRS) compounds are a gaseous mixture of pollutants containing sulphur in its reduced state. While there is no specific AAAQO for TRS, the AAAQOs for hydrogen sulphide and carbon disulphide, both part of the TRS group, are set at 10 ppb.

TRS concentrations tend to elevate during the summer months across all stations in the PRAMP network. The summer of 2023 was particularly hot and dry, likely exacerbating the production of TRS from natural features such as swamps and other wetlands. These elevated levels begin to decrease as cooler fall weather sets in. This seasonal pattern may result from sulphur compounds released by decaying vegetation in shallow sloughs and wetlands, as well as from asphalt paving during the summer construction season.

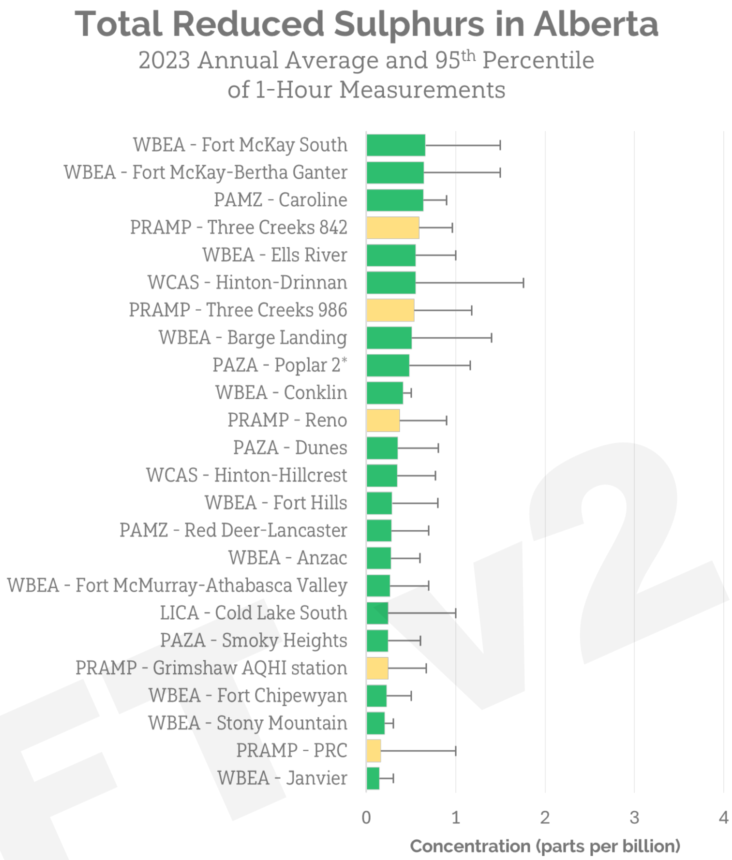


Figure 23: 2023 Total reduced sulphur compounds in Alberta

In Alberta, elevated TRS concentrations were observed in Hinton (due to pulp mill operations), Caroline (due to sour gas facilities), and the oil sands mining area north of Fort McMurray.

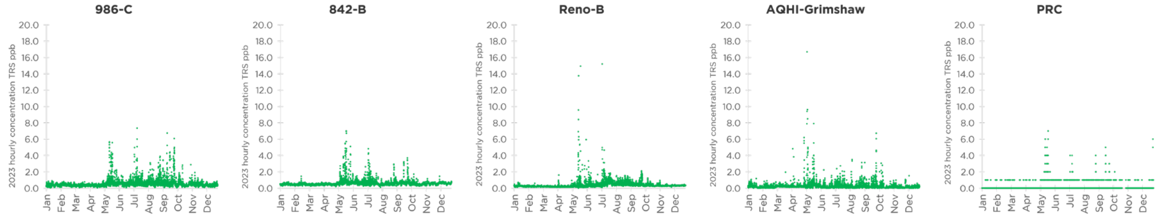


Figure 24: 2023 Hourly total reduced sulphur compounds concentrations

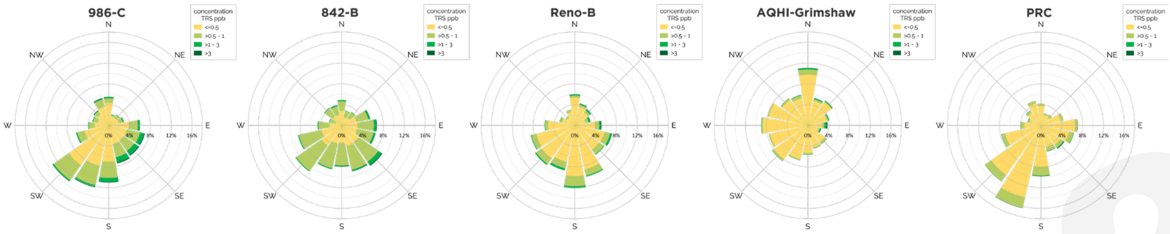


Figure 25: 2023 Hourly total reduced sulphur compounds concentration wind roses

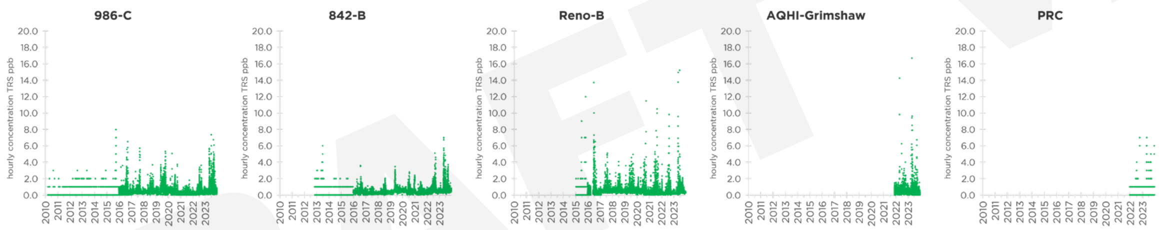


Figure 26: 2010-2023 Hourly total reduced sulphur compounds concentrations

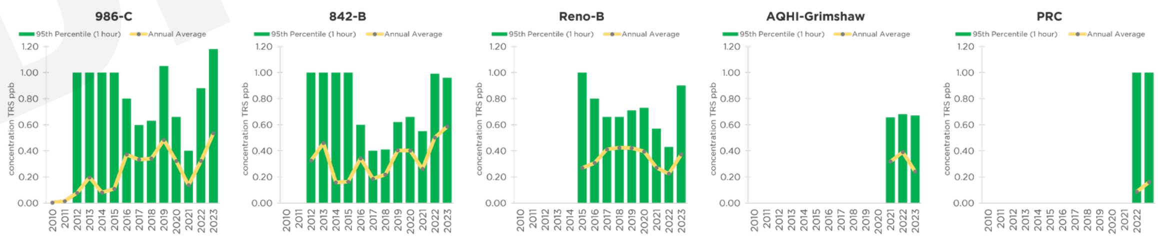


Figure 27: 2010-2023 Annual averages and 95th percentile of hourly measurements of total reduced sulphur compounds

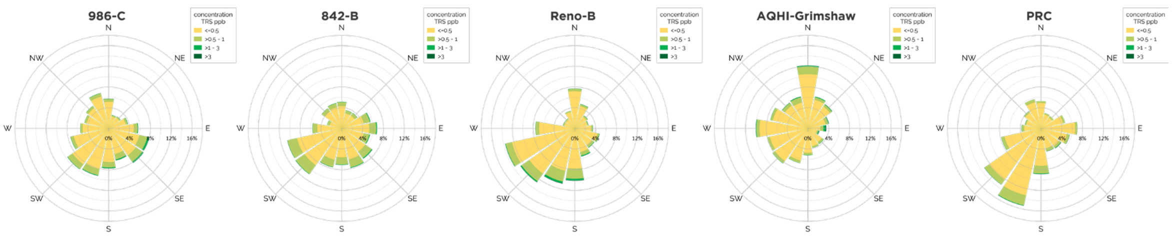


Figure 28: 2010-2023 Hourly total reduced sulphur compounds concentration wind roses

2.6 Hydrogen Sulphide

Hydrogen sulphide is considered an odour nuisance at low levels and can cause symptoms like headaches and nausea. Under most weather conditions, air movement dilutes hydrogen sulphide and total reduced sulphurs released from various sources, reducing the likelihood of health problems. However, odours may still be noticeable, as humans can detect sulphur-based chemicals, such as reduced sulphur compounds, at extremely low concentrations. The 1-hour Alberta Ambient Air Quality Objective (AAAQO) for hydrogen sulphide is 10 ppb.

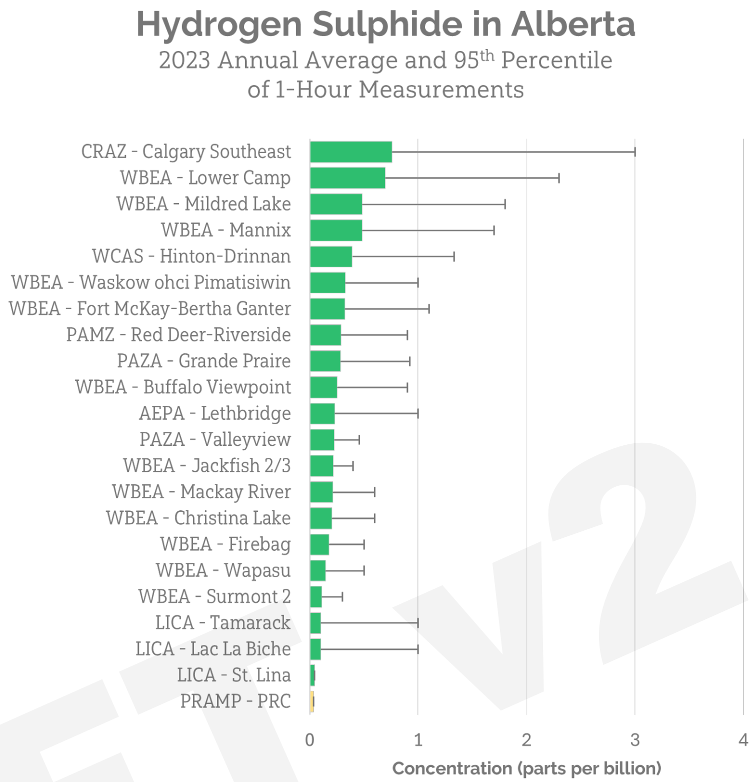


Figure 29: 2023 Hydrogen Sulphide in Alberta

In the PRAMP network, hydrogen sulphide is monitored only at the PRC station. Since PRAMP added the PRC station to the network in 2023, long-term data comparisons are not yet available for this site. However, in 2023, PRC recorded the lowest annual average hydrogen sulphide concentration in Alberta.

Across Alberta, elevated hydrogen sulphide concentrations were recorded in Hinton (due to pulp mill operations), the oil sands mining area north of Fort McMurray, Redwater (due to sour gas production), and Calgary Southeast, which is located close to a wastewater treatment plant.

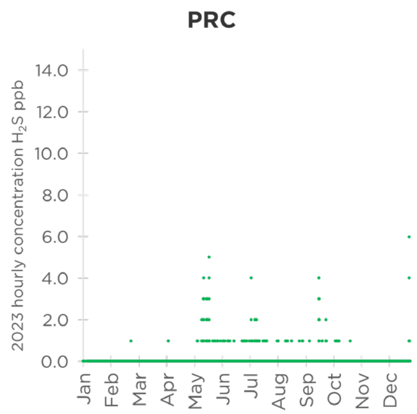


Figure 30: 2023 Hourly hydrogen sulphide concentrations

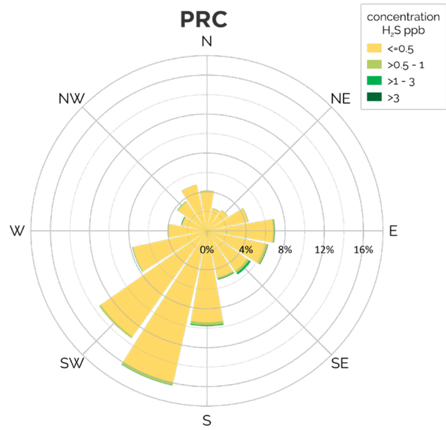


Figure 31: 2023 Hourly hydrogen sulphide concentration wind rose

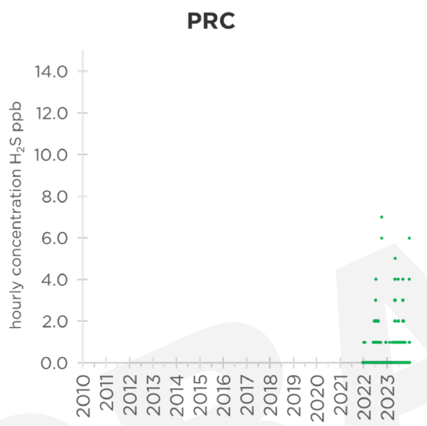


Figure 32: 2010-2023 Hourly hydrogen sulphide concentrations

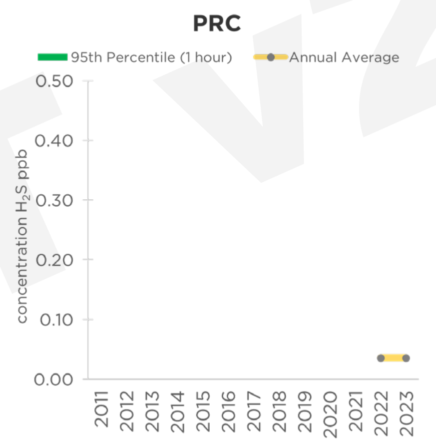


Figure 33: 2010-2023 Annual averages and 95th percentile of hourly measurements of Hydrogen Sulphide

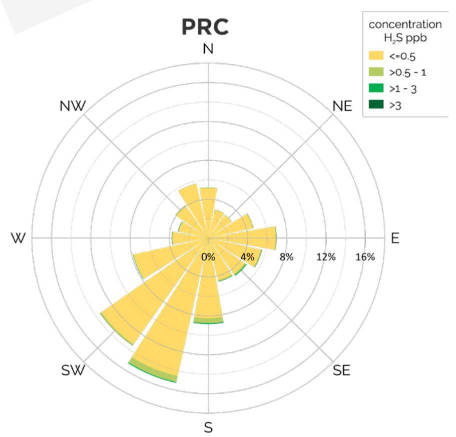


Figure 34: 2010-2023 Hourly hydrogen sulphide concentration wind rose

2.7 Nitrogen Dioxide

Nitrogen dioxide is a reddish-brown gas with a pungent, acrid odour. It belongs to the family of nitrogen oxides, pollutants formed from the reaction of nitrogen and oxygen gases in the air during combustion, particularly at high temperatures. Nitrogen dioxide is emitted from fuel combustion in both mobile sources, such as automobiles, and stationary sources, including power plants, refineries, and pulp mills. The 1-hour AAAQO for nitrogen dioxide is 159 ppb, and the annual AAAQO is 24 ppb.

In 2023, PRAMP monitored nitrogen dioxide at the AQHI-Grimshaw station. The data revealed a distinct seasonal pattern, with higher concentrations occurring in the winter due to emissions from home heating and vehicles. These pollutants tend to accumulate at ground level during the winter because of cold, stagnant meteorological conditions.

In Alberta, the highest annual average concentrations of nitrogen dioxide are found primarily in large cities, including Edmonton, Calgary, St. Albert, Red Deer, and Grande Prairie. Elevated concentrations are also generally observed in smaller urban centers and at monitoring stations near large industrial operations. At the AQHI-Grimshaw station, nitrogen dioxide concentrations measured by PRAMP are comparable to those in similarly-sized population centers.

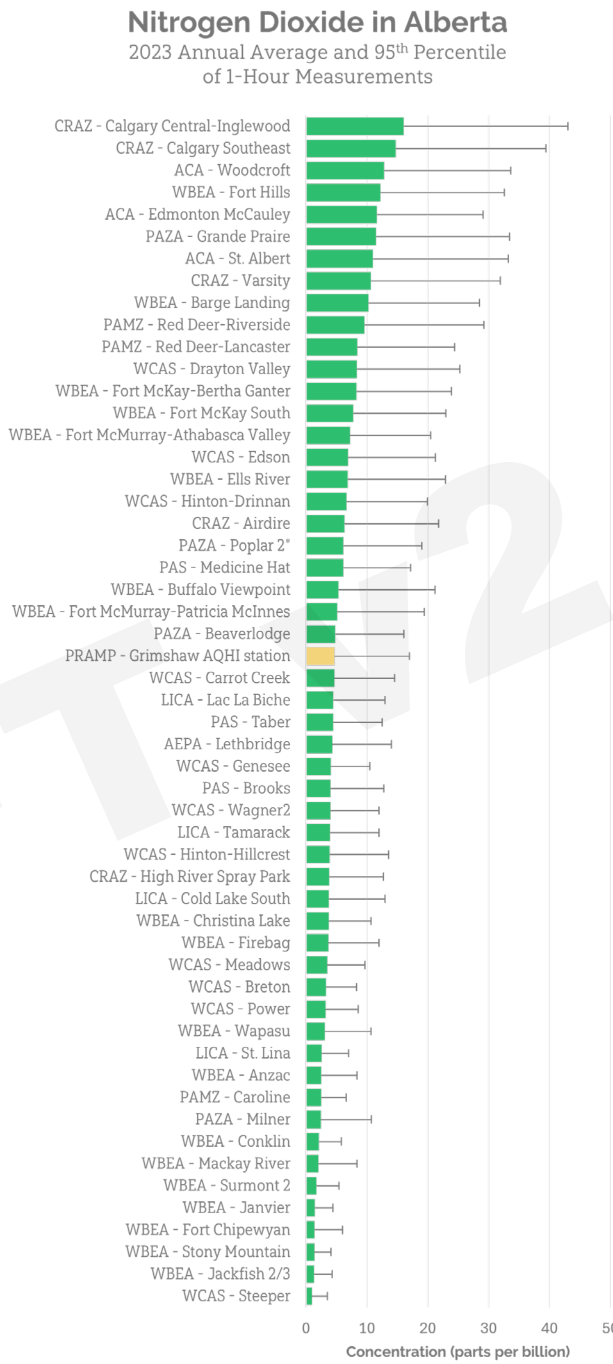


Figure 35: 2023 Nitrogen Dioxide in Alberta

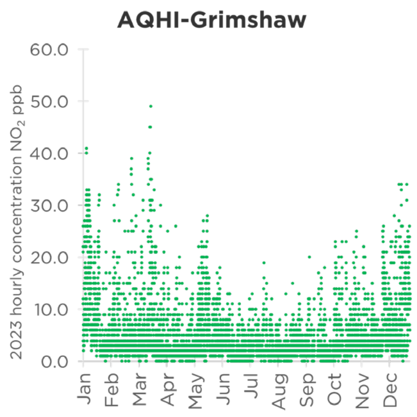


Figure 36: 2023 Hourly nitrogen dioxide concentrations

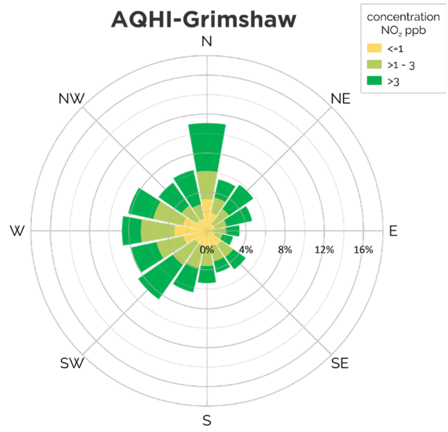


Figure 37: 2023 Hourly nitrogen dioxide concentration wind rose

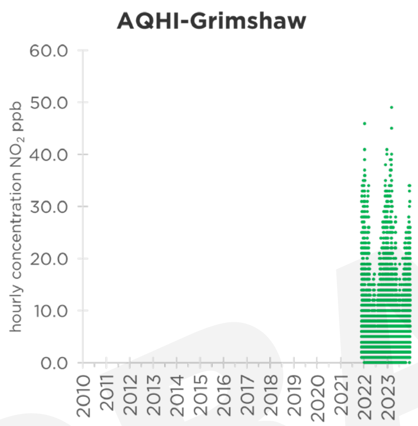


Figure 38: 2010-2023 Hourly nitrogen dioxide concentrations

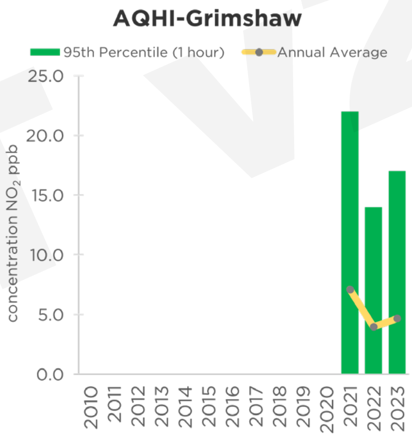


Figure 39: 2010-2023 Annual averages and 95th percentile of hourly measurements of nitrogen dioxide

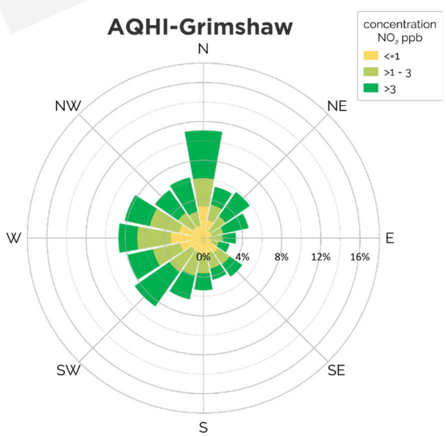


Figure 40: 2010-2023 Hourly nitrogen dioxide concentration wind rose

2.8 Ozone

Ozone is a colourless, odourless gas at ambient concentrations and a major component of smog. While ozone in the upper atmosphere (the ozone layer) plays a crucial role in protecting life on Earth from harmful ultraviolet radiation, ground-level ozone has significant environmental, health, and economic impacts. The 1-hour Alberta Ambient Air Quality Objective (AAAQO) for ozone is 76 parts per billion.

Ground-level ozone is a secondary pollutant, meaning it is not directly emitted by industry or vehicles. Instead, it forms and degrades through complex atmospheric processes. Ozone is created when nitrogen oxides and volatile organic compounds (the "precursor" chemicals) react in the presence of sunlight. However, under certain conditions, some of these compounds can also degrade ozone. This degradation occurs more frequently in cities than in rural areas due to the higher presence of precursor compounds, especially nitric oxide. As a result, rural areas in Alberta often experience higher ozone concentrations than urban areas because ozone levels are generally elevated downwind of precursor sources (such as cities), sometimes at distances of hundreds or even thousands of kilometers.

In 2023, data from PRAMP's AQHI-Grimshaw station revealed a seasonal pattern with an elevated period in the spring, when meteorological processes cause atmospheric mixing, bringing ozone from higher altitudes down to ground level. *Note: Data for June and July 2023 are missing in the following charts because the analyzer calibration failed, leading to the discarding of data.*

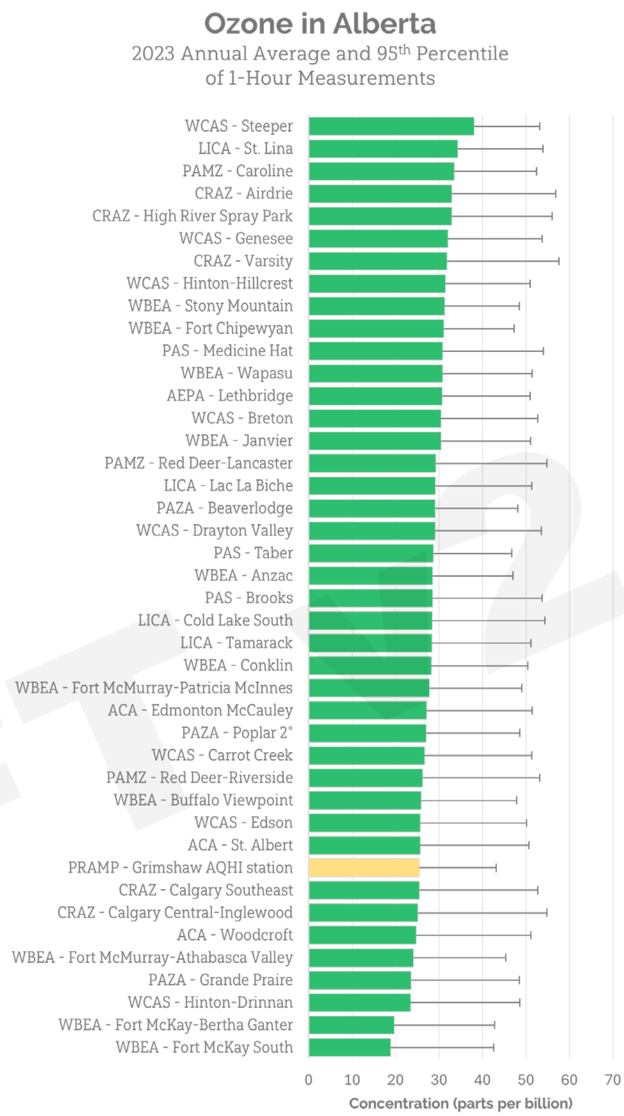


Figure 41: 2023 Ozone in Alberta

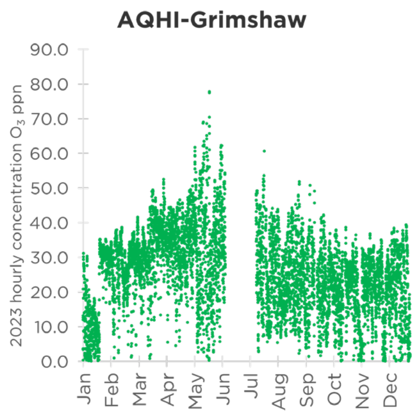


Figure 42: 2023 Hourly ozone concentrations

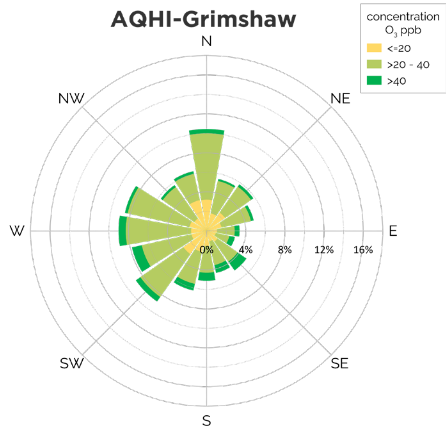


Figure 43: 2023 Hourly ozone concentration wind rose

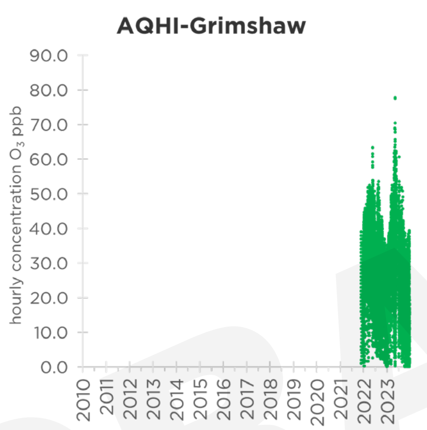


Figure 44: 2010-2023 Hourly ozone concentrations

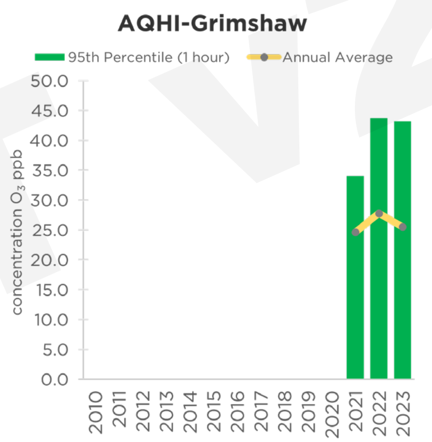


Figure 45: 2010-2023 Annual averages and 95th percentile of hourly measurements of ozone

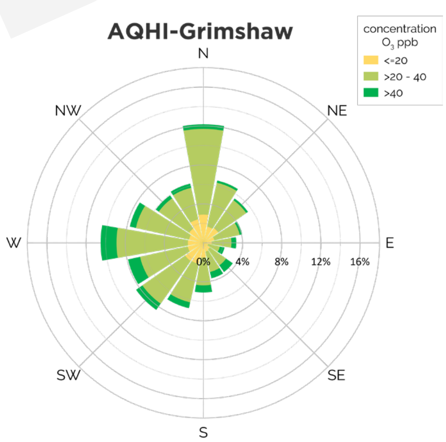


Figure 46: 2010-2023 Hourly ozone concentration wind rose

2.9 Particulate Matter

Particulate matter is classified by size due to the different health effects associated with particles of varying diameters. The term "particulate matter" refers to a mixture of solid particles and liquid droplets in the air, including smoke, dust, ash, and pollen. The composition of particulate matter varies depending on location, season, and weather conditions. By comparison, a human hair is about 70 microns in diameter. Fine particulate matter, also known as $PM_{2.5}$ or "respirable particles," can penetrate deeper into the respiratory system than larger particles. It is primarily formed from chemical reactions in the atmosphere and through fuel combustion. Major sources of fine particulate matter in Alberta include forest fires, vehicles, power plants, oil and gas facilities, residential fireplaces and wood stoves, and agricultural burning. The 1-hour Ambient Air Quality Guideline (AAAQG) for $PM_{2.5}$ is 80 ug/m^3, and the 24-hour Ambient Air Quality Objective (AAAQO) is 29 ug/m^3.

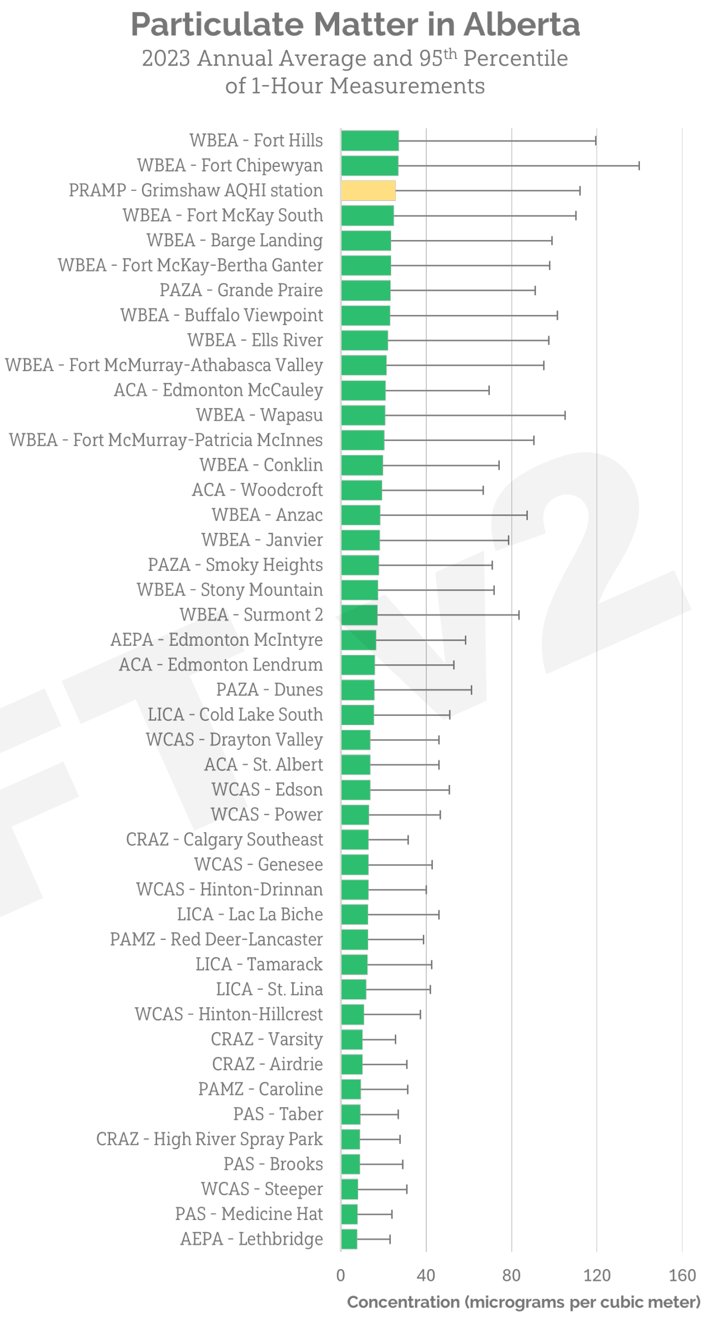


Figure 47: 2023 Particulate Matter in Alberta

Typically, the highest concentrations of fine particulate matter are observed in Alberta's large cities and urban centers, such as Edmonton, Calgary, Fort Saskatchewan, and Red Deer, as well as in areas downwind of these locations, like Gibbons and Lamont County. These patterns are often driven by secondary fine particulate matter formation and weather conditions like calm winds and temperature inversions, particularly in the winter months. The oil sands mining region north of Fort McMurray also typically experiences elevated particulate matter concentrations, likely due to dust from mining operations.

However, 2023 was an exceptional year due to the widespread occurrence of wildfire smoke, which significantly altered these usual patterns. The location of wildfires and the pattern of smoke dispersion placed PRAMP's AQHI-Grimshaw station among the sites with the highest overall concentrations of particulate matter in 2023. During the 2023 wildfire season, PRAMP detected 687 exceedances of the 1-hour Alberta Ambient Air Quality Guideline and 71 exceedances of the 24-hour Alberta Ambient Air Quality Objective for $PM_{2.5}$.

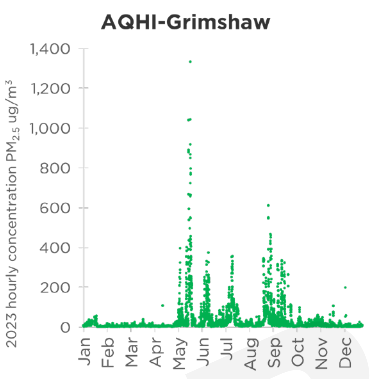


Figure 48: 2023 Hourly particulate matter concentrations

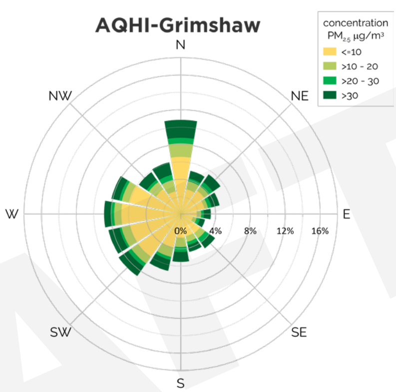


Figure 49: 2023 Hourly particulate matter concentration wind rose

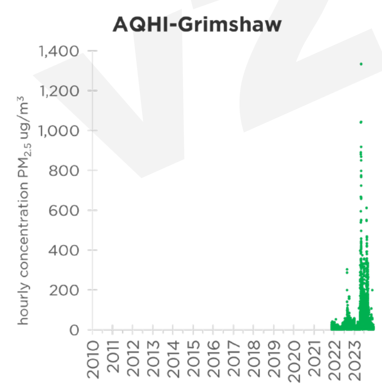


Figure 50: 2010-2023 Hourly particulate matter concentrations

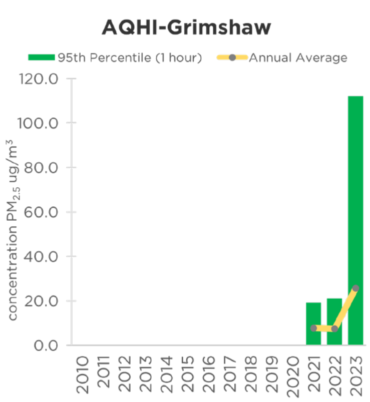


Figure 51: 2010-2023 Annual averages and 95th percentile of hourly measurements of particulate matter

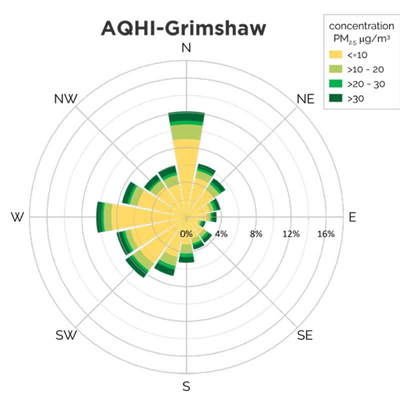


Figure 52: 2010-2023 Hourly particulate matter concentration wind rose

3 - Volatile Organic Compound Sampling

The volatile organic compound (VOC) canister sampling program captures a 1-hour air sample whenever the continuously measured non-methane hydrocarbons concentration reaches a specified trigger point, currently set at 0.3 ppm. This trigger point is based on real-time monitoring data averaged over a five-minute period. Canister sampling systems are installed at Stations 986-C, 842-B, and Reno-B; however, the AQHI-Grimshaw Station does not have a canister sampling system as part of its current suite of instruments

After collection, all canister samples are sent to a laboratory for analysis, which tests for over 130 VOC compounds and total reduced sulphur compounds. The time and date of each canister sampling are recorded to cross-reference the sample with monitored data, allowing retrieval of associated wind direction and speed.

In 2023, the PRAMP network collected nine triggered samples (Table 1), but seven of these were due to high VOC concentrations during wildfire smoke events. Excluding these wildfire-related samples, this marks one of the lowest total numbers of canisters collected since the program began. While this is not a direct measurement of air quality, the low number of triggered canisters suggests a significant reduction in the frequency of elevated hydrocarbon events since the inception of the sampling program.

A high-level summary of the 2023 triggered canister VOC sampling results is presented in the table below, highlighting compounds commonly found above the method detection limit. A complete list of species for each sample is provided in Appendix 1. Acrolein was very high or exceeded the 1-hour AAAQO in all samples triggered during the 2023 wildfire season. Acrolein is commonly found in wildfire smoke because it is a byproduct of the combustion of organic materials, such as wood and vegetation

		Station	Reno-B	842-B	986-C	842-B	Reno-B	986-C	Reno-B	842-B	Reno-B
		Sampled Date in 2023	Jan-09	May-08	Jun-30	Jul-07	Jul-07	Jul-07	Jul-11	Sep-20	Sep-29
		Sampled Time	06:45	06:35	13:45	03:25	04:20	06:45	04:15	14:40	19:40
		Triggered Concentration (ppm)	0.39	0.30	0.34	0.30	0.43	0.32	0.33	0.31	0.32
Parameter	**Unit**	**AAAQO**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
Acetone	**ppbv**	**2400**	1.5	14.6	13.1	15.3	18.2	18.2	11.9	17.2	5.6
Acrolein	**ppbv**	**1.9**	< 0.5	1.0	**3.5**	**2.4**	**2.8**	**2.8**	0.8	**2.2**	< 0.5
Benzene	**ppbv**	**9.0**	0.44	6.87	1.71	4.41	7.95	7.95	3.89	4.8	1.6
Ethanol	**ppbv**	**none**	2.7	2.1	3.2	3.0	2.1	2.1	10.2	2.8	2.9
Ethylbenzene	**ppbv**	**460**	0.05	0.43	0.08	0.2	0.47	0.47	0.17	0.1	< 0.05
Freon-113	**ppbv**	**none**	0.07	< 0.03	0.05	0.06	0.07	0.07	0.04	0.05	0.05
Isobutane	**ppbv**	**none**	2.35	3.69	0.09	0.75	0.72	0.72	0.6	1.22	0.16
Isopentane	**ppbv**	**none**	1.38	0.59	0.09	0.76	0.92	0.92	0.76	0.77	0.44
m,p-Xylene	**ppbv**	**530**	0.13	0.67	0.15	0.29	0.93	0.93	0.26	0.2	0.11
o-Xylene	**ppbv**	**530**	0.06	0.36	0.06	0.18	0.48	0.48	0.15	0.09	< 0.05
Methane	**ppmv**	**none**	2.6	2.6	2	2.6	3.2	3.2	3.3	2.5	1.9
n-Butane	**ppbv**	**none**	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
n-Pentane	**ppbv**	**none**	1.3	1.04	0.1	0.68	0.87	0.87	0.53	0.71	0.23
Toluene	**ppbv**	**499**	0.39	3.29	0.6	1.93	4.4	4.4	1.48	2.01	0.65

Table 1: Summary of 2023 VOC Sample Results for PRAMP Stations (842-B, 986-C, and Reno-B)

4 - Air Quality Health Index Summary

Monitoring data can be used to determine the Air Quality Health Index. The Air Quality Health Index (AQHI) provides a rating to indicate the level of relative health risk associated with local air quality using a colour-coded scale with associated values from 1 to 10. The index describes the level of health risk associated with each number as low (1 to 3), moderate (4 to 6), high (7 to 10) or very high (10+) and suggests exposure mitigation steps for each risk level.

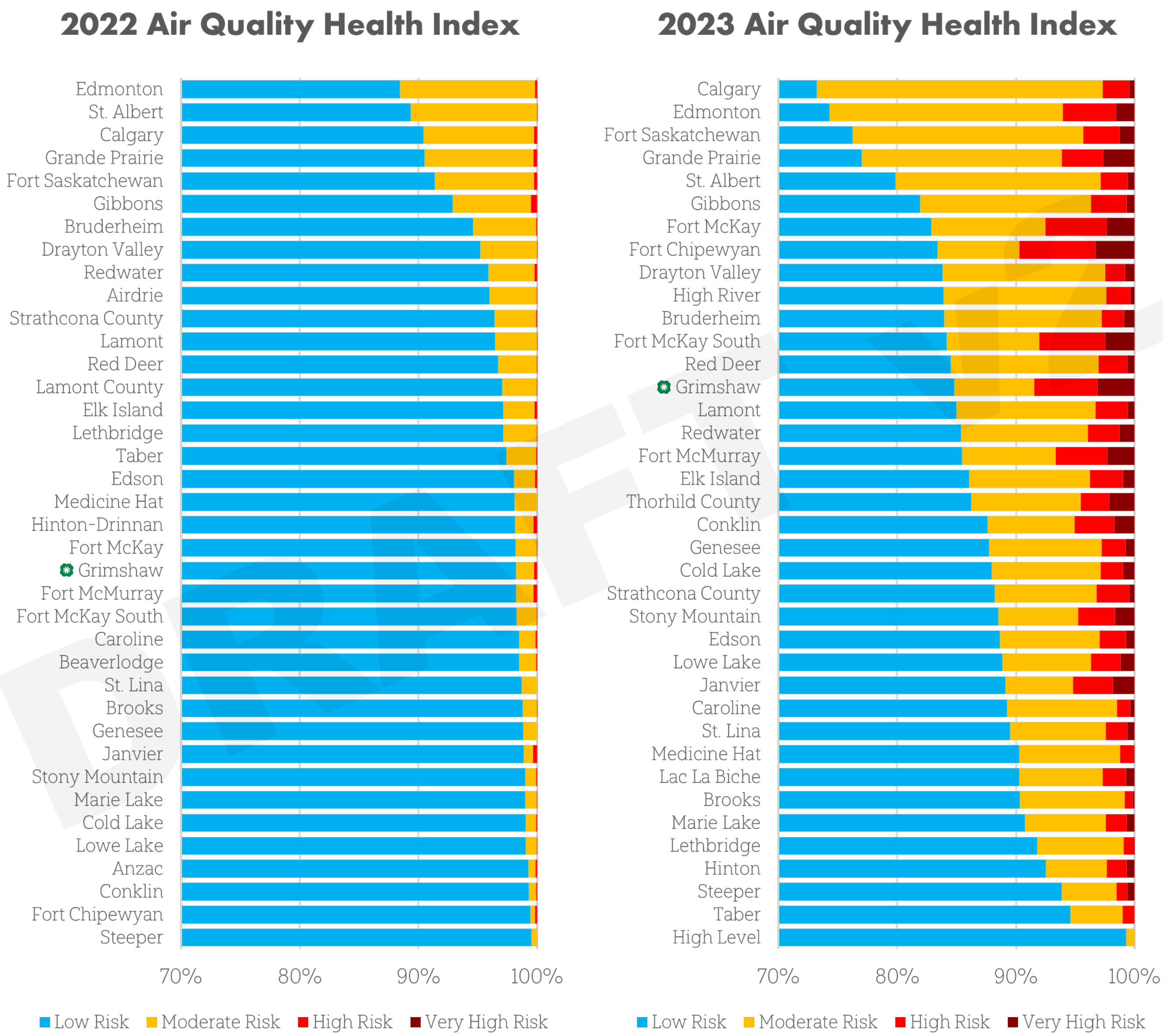
The AQHI communicates four key pieces of information:

- The air quality in relation health on a scale from 1 to 10. The higher the number, the greater the health risk associated with the air quality. When the amount of air pollution is very high, the number will be reported as 10+.
- A category that describes the level of health risk associated with the index reading (e.g. Low, Moderate, High, or Very High Health Risk).
- Health messages customized to each category for both the general population and the ‘at risk’ population.
- Current hourly AQHI readings. (and at some locations, maximum forecast values for ‘today’, ‘tonight’, and ‘tomorrow.’)

The AQHI is designed to give the above information along with some suggestions on how to adjust activity levels depending on individual health risk from air pollution. The AQHI is calculated based on the relative risks of a combination of common air pollutants that are known to harm human health. These pollutants are:

- Ozone at ground level
- Particulate Matter ($PM_{2.5}$)
- Nitrogen Dioxide

The Alberta AQHI data for 2022 and 2023 presented here are sorted by the percentage of low-risk days, which means the order of monitoring locations differs between the years. In the PRAMP network, the AQHI is determined in Grimshaw. The significant observation is the substantial increase in the frequency of moderate health risk and above in 2023, highlighting the widespread impact of wildfire smoke on air quality. The 2023 wildfire season was exceptional, with record-setting fires affecting all Canadian provinces and territories, burning over 184,961 square kilometers by October, surpassing previous records. Smoke from these fires caused air quality alerts and evacuations in Canada and the United States and reached Europe by late June. While many fires were controlled by July, significant fires persisted into the fall.



Health Risk	Low	Moderate	High	Very High
Colour Code	(blue)	(yellow)	(red)	(dark red)
Risk Value	1 - 3	4 - 6	7 - 10	10+

Figure 53: Comparison between 2022 and 2023 Air Quality Health Index values in Alberta

5 - Odour Complaints

Albertans are encouraged to contact the AER's Emergency 24-Hour Response Line with energy and environmental concerns including odour complaints.

Each year, PRAMP tracks the number of odour complaints that have been recorded by the AER for the Peace River Cold Heavy Oil Production areas (Three Creeks, Reno, Seal, Walrus). Odour complaints related to any industrial, agricultural, or commercial operations may be received by a range of other government departments or agencies. PRAMP has access only to data about complaints recorded by the AER. It should be noted that with the current network design, it is not possible to monitor all areas of the airshed at all times; however, it is possible for area residents to detect odours at any place at any time.

In 2023, there were no odour complaints recorded by the AER for the Peace River Cold Heavy Production areas; this is the same number of complaints as in 2022 and is the lowest number of complaints to the AER since PRAMP began compiling these data.

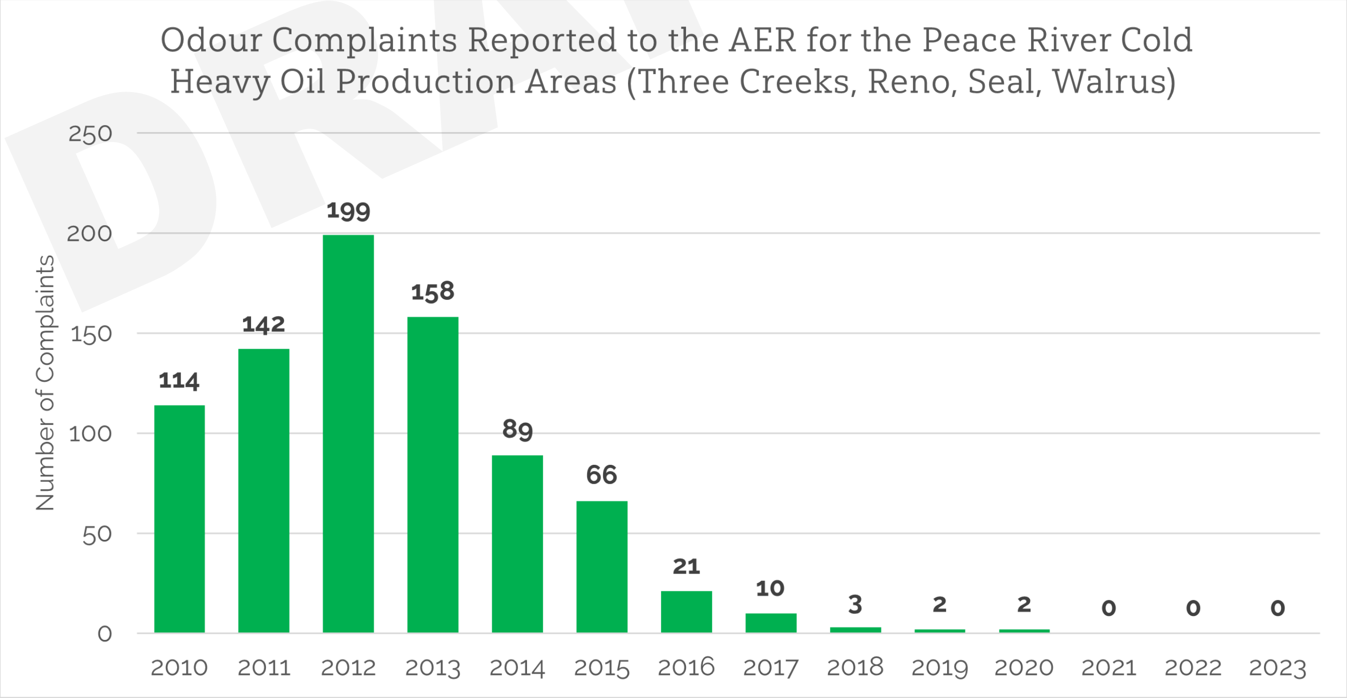


Figure 54: 2010-2023 Odour Complaints in the Peace River Cold Heavy Oil Production Area

6 - Passive Monitoring

PRAMP's passive stations are distributed in a small network around the Peace River Complex (PRC), east of Three Creeks. The following maps show the spatial pattern of monitoring results for 2023. On each map, the diameter of the bubble is representative of concentration (larger diameter = higher concentration).

6.1 Hydrogen Sulphide

Annual average concentrations of hydrogen sulphide in the PRAMP network, which usually show higher levels on the east side of nearby industrial sources, were likely influenced by wildfire smoke in 2023. Typically, elevated values result from hydrogen sulphide released by decaying plant material in nearby waterbodies and wetlands, along with emissions from oil sands operations. However, the extensive wildfire smoke likely altered these patterns. Despite this variability, emissions from facility processes and natural sources such as wetlands remain key contributors. Notably, there is currently no annual Alberta Ambient Air Quality Objective for hydrogen sulphide.

Figure 55: 2023 annual average hydrogen sulphide measured by PRAMP's passive monitoring network (in parts per billion).

6.2 Sulphur Dioxide

Annual average sulphur dioxide measurements in 2023 from PRAMP's passive monitoring network continue to show a consistent spatial pattern, with concentrations dropping off to background levels rapidly as the distance from nearby sources increases. The highest annual average concentration measured was 0.8 ppb, which remains well below the annual Alberta Ambient Air Quality Objective of 8 ppb.

Figure 56: 2023 Annual average sulphur dioxide measured by PRAMP's passive monitoring network (in parts per billion).

Appendix

VOC Canister Data

Station		Reno-B	842-B	986-C	842-B	Reno-B	986-C	Reno-B	842-B	Reno-B
Sampled Date		2023-01-09	2023-05-08	2023-06-30	2023-07-07	2023-07-07	2023-07-07	2023-07-11	2023-09-20	2023-09-29
Sampled Time		06:45	06:35	13:45	03:25	04:20	06:45	04:15	14:40	19:40
Triggered Concentration (ppm)		0.39	0.30	0.34	0.30	0.43	0.32	0.33	0.31	0.32
Parameter	Unit									
1-Butene	ppm	< 0.16	< 0.15	< 0.13	< 0.14	< 0.15	< 0.15	< 0.16	< 0.13	< 0.16
Acetylene	ppm	< 0.12	< 0.12	< 0.10	< 0.12	< 0.12	< 0.12	< 0.13	< 0.11	< 0.13
cis-2-Butene	ppm	< 0.06	< 0.06	< 0.05	< 0.06	< 0.06	< 0.06	< 0.07	< 0.05	< 0.07
Ethane	ppm	< 0.2	0.5	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.2
Ethylacetylene	ppm	< 0.09	< 0.09	< 0.08	< 0.09	< 0.09	< 0.09	< 0.10	< 0.08	< 0.10
Ethylene	ppm	< 0.11	< 0.10	< 0.09	< 0.10	< 0.11	< 0.11	< 0.11	< 0.09	< 0.11
Isobutane	ppm	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.2
Isobutylene	ppm	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.2
Methane	ppm	2.6	2.6	2	2.6	3.2	3.2	3.3	2.5	1.9
n-Butane	ppm	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
n-Propane	ppm	< 0.11	< 0.10	< 0.09	< 0.10	< 0.11	< 0.11	< 0.11	< 0.09	< 0.11
Propylene	ppm	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.2
Propyne	ppm	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.2
trans-2-Butene	ppm	< 0.14	< 0.13	< 0.12	< 0.13	< 0.14	< 0.14	< 0.15	< 0.12	< 0.15
2,5-Dimethylthiophene	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
2-Ethylthiophene	ppb	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
2-Methylthiophene	ppb	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
3-Methylthiophene	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
Butyl mercaptan	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5

Station		Reno-B	842-B	986-C	842-B	Reno-B	986-C	Reno-B	842-B	Reno-B
Sampled Date		2023-01-09	2023-05-08	2023-06-30	2023-07-07	2023-07-07	2023-07-07	2023-07-11	2023-09-20	2023-09-29
Sampled Time		06:45	06:35	13:45	03:25	04:20	06:45	04:15	14:40	19:40
Triggered Concentration (ppm)		0.39	0.30	0.34	0.30	0.43	0.32	0.33	0.31	0.32
Parameter	Unit									
Carbon disulphide	ppb	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Carbonyl sulphide	ppb	0.7	< 0.4	2.2	< 0.4	2.9	2.9	< 0.5	< 0.4	< 0.5
Dimethyl disulphide	ppb	< 0.3	< 0.3	< 0.3	< 0.3	2.3	2.3	< 0.3	< 0.3	< 0.3
Dimethyl sulphide	ppb	4.3	< 0.3	< 0.3	< 0.3	2.3	2.3	< 0.3	< 0.3	< 0.3
Ethyl mercaptan	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
Ethyl sulphide	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
Hydrogen sulphide	ppb	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.2
Isobutyl mercaptan	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
Isopropyl mercaptan	ppb	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2	< 0.1	< 0.2
Methyl mercaptan	ppb	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Pentyl mercaptan	ppb	< 0.6	< 0.6	< 0.5	< 0.6	< 0.6	< 0.6	< 0.7	< 0.5	< 0.7
Propyl mercaptan	ppb	< 0.6	< 0.6	< 0.5	< 0.6	< 0.6	< 0.6	< 0.7	< 0.5	< 0.7
tert-Butyl mercaptan	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
Thiophene	ppb	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
1,1,1-Trichloroethane	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
1,1,2,2-Tetrachloroethane	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
1,1,2-Trichloroethane	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
1,1-Dichloroethane	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
1,1-Dichloroethylene	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03

Station		Reno-B	842-B	986-C	842-B	Reno-B	986-C	Reno-B	842-B	Reno-B
Sampled Date		2023-01-09	2023-05-08	2023-06-30	2023-07-07	2023-07-07	2023-07-07	2023-07-11	2023-09-20	2023-09-29
Sampled Time		06:45	06:35	13:45	03:25	04:20	06:45	04:15	14:40	19:40
Triggered Concentration (ppm)		0.39	0.30	0.34	0.30	0.43	0.32	0.33	0.31	0.32
Parameter	Unit									
1,2,3-Trimethylbenzene	ppb	< 0.08	0.53	0.07	0.35	0.56	0.56	0.29	< 0.07	< 0.08
1,2,4-Trichlorobenzene	ppb	< 0.5	< 0.4	0.6	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
1,2,4-Trimethylbenzene	ppb	< 0.05	0.33	0.07	0.2	0.58	0.58	0.18	0.11	< 0.05
1,2-Dibromoethane	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
1,2-Dichlorobenzene	ppb	< 0.05	< 0.04	0.04	0.05	< 0.05	< 0.05	0.05	< 0.04	< 0.05
1,2-Dichloroethane	ppb	< 0.05	< 0.04	< 0.04	< 0.04	< 0.05	< 0.05	< 0.05	< 0.04	< 0.05
1,2-Dichloropropane	ppb	< 0.05	< 0.04	< 0.04	< 0.04	< 0.05	< 0.05	< 0.05	< 0.04	< 0.05
1,3,5-Trimethylbenzene	ppb	< 0.05	0.16	< 0.04	0.07	0.13	0.13	0.07	< 0.04	< 0.05
1,3-Butadiene	ppb	< 0.05	0.57	0.76	0.55	0.85	0.85	0.35	0.36	< 0.05
1,3-Dichlorobenzene	ppb	< 0.6	< 0.6	< 0.5	< 0.6	< 0.6	< 0.6	< 0.7	< 0.5	< 0.7
1,4-Dichlorobenzene	ppb	< 0.6	< 0.6	< 0.5	< 0.6	< 0.6	< 0.6	< 0.7	< 0.5	< 0.7
1,4-Dioxane	ppb	< 0.8	< 0.7	< 0.7	< 0.7	< 0.8	< 0.8	< 0.8	< 0.7	< 0.8
1-Butene	ppb	0.12	3.82	2.25	3.88	4.71	4.71	2.8	2.39	0.17
1-Hexene	ppb	< 0.11	0.4	0.23	0.34	0.51	0.51	0.25	0.19	< 0.11
1-Pentene	ppb	< 0.05	< 0.04	0.48	0.34	0.7	0.7	0.38	0.29	< 0.05
2,2,4-Trimethylpentane	ppb	0.05	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.04
2,2-Dimethylbutane	ppb	0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
2,3,4-Trimethylpentane	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
2,3-Dimethylbutane	ppb	< 0.14	< 0.13	< 0.12	< 0.13	< 0.14	< 0.14	< 0.15	< 0.12	< 0.15

Station		Reno-B	842-B	986-C	842-B	Reno-B	986-C	Reno-B	842-B	Reno-B
Sampled Date		2023-01-09	2023-05-08	2023-06-30	2023-07-07	2023-07-07	2023-07-07	2023-07-11	2023-09-20	2023-09-29
Sampled Time		06:45	06:35	13:45	03:25	04:20	06:45	04:15	14:40	19:40
Triggered Concentration (ppm)		0.39	0.30	0.34	0.30	0.43	0.32	0.33	0.31	0.32
Parameter	**Unit**									
2,3-Dimethylpentane	ppb	0.07	0.06	< 0.03	0.03	0.06	0.06	0.03	< 0.03	0.12
2,4-Dimethylpentane	ppb	< 0.05	< 0.04	< 0.04	< 0.04	< 0.05	< 0.05	< 0.05	< 0.04	< 0.05
2-Methylheptane	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
2-Methylhexane	ppb	0.11	0.07	< 0.04	< 0.04	< 0.05	< 0.05	< 0.05	< 0.04	0.06
2-Methylpentane	ppb	0.21	< 0.03	0.34	< 0.03	< 0.03	< 0.03	< 0.03	0.13	0.08
3-Methylheptane	ppb	< 0.05	0.05	< 0.04	< 0.04	< 0.05	< 0.05	< 0.05	< 0.04	< 0.05
3-Methylhexane	ppb	0.12	0.07	< 0.03	0.04	0.03	0.03	0.05	< 0.03	< 0.03
3-Methylpentane	ppb	0.22	0.12	< 0.03	0.04	0.05	0.05	0.04	0.09	0.06
Acetone	ppb	1.5	14.6	13.1	15.3	18.2	18.2	11.9	17.2	5.6
Acrolein	ppb	< 0.5	1	3.5	2.4	2.8	2.8	0.8	2.2	< 0.5
Benzene	ppb	0.44	6.87	1.71	4.41	7.95	7.95	3.89	4.8	1.6
Benzyl chloride	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
Bromodichloromethane	ppb	< 0.05	< 0.04	< 0.04	< 0.04	< 0.05	< 0.05	< 0.05	< 0.04	< 0.05
Bromoform	ppb	< 0.03	0.04	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Bromomethane	ppb	< 0.03	< 0.03	< 0.03	< 0.03	0.04	0.04	< 0.03	< 0.03	< 0.03
Carbon disulfide	ppb	< 0.03	< 0.03	0.11	< 0.03	0.07	0.07	< 0.03	< 0.03	< 0.03
Carbon tetrachloride	ppb	0.11	< 0.03	0.06	0.08	0.14	0.14	0.06	0.04	0.05
Chlorobenzene	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Chloroethane	ppb	< 0.03	< 0.03	0.28	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03

Station		Reno-B	842-B	986-C	842-B	Reno-B	986-C	Reno-B	842-B	Reno-B
Sampled Date		2023-01-09	2023-05-08	2023-06-30	2023-07-07	2023-07-07	2023-07-07	2023-07-11	2023-09-20	2023-09-29
Sampled Time		06:45	06:35	13:45	03:25	04:20	06:45	04:15	14:40	19:40
Triggered Concentration (ppm)		0.39	0.30	0.34	0.30	0.43	0.32	0.33	0.31	0.32
Parameter	Unit									
Chloroform	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Chloromethane	ppb	0.5	0.8	1.75	1.05	0.89	0.89	0.81	0.85	0.48
cis-1,2-Dichloroethene	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
cis-1,3-Dichloropropene	ppb	< 0.05	< 0.04	< 0.04	< 0.04	< 0.05	< 0.05	< 0.05	< 0.04	< 0.05
cis-2-Butene	ppb	< 0.05	0.4	0.11	0.28	0.46	0.46	0.31	0.06	< 0.05
cis-2-Pentene	ppb	< 0.03	0.2	0.13	0.07	0.11	0.11	0.05	0.03	< 0.03
Cyclohexane	ppb	0.18	0.12	< 0.05	0.06	< 0.06	< 0.06	0.07	< 0.05	< 0.07
Cyclopentane	ppb	0.15	0.24	0.17	0.18	< 0.03	< 0.03	1.4	0.26	0.04
Dibromochloromethane	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Ethanol	ppb	2.7	2.1	3.2	3	2.1	2.1	10.2	2.8	2.9
Ethyl acetate	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
Ethylbenzene	ppb	0.05	0.43	0.08	0.2	0.47	0.47	0.17	0.1	< 0.05
Freon-11	ppb	0.23	0.16	0.18	0.24	0.27	0.27	0.19	0.26	0.19
Freon-113	ppb	0.07	< 0.03	0.05	0.06	0.07	0.07	0.04	0.05	0.05
Freon-114	ppb	< 0.05	< 0.04	< 0.04	< 0.04	< 0.05	< 0.05	< 0.05	< 0.04	< 0.05
Freon-12	ppb	0.46	0.49	0.45	0.51	0.49	0.49	0.49	0.36	0.47
Hexachloro-1,3-butadiene	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
Isobutane	ppb	2.35	3.69	0.09	0.75	0.72	0.72	0.6	1.22	0.16
Isopentane	ppb	1.38	0.59	0.09	0.76	0.92	0.92	0.76	0.77	0.44

Station		Reno-B	842-B	986-C	842-B	Reno-B	986-C	Reno-B	842-B	Reno-B
Sampled Date		2023-01-09	2023-05-08	2023-06-30	2023-07-07	2023-07-07	2023-07-07	2023-07-11	2023-09-20	2023-09-29
Sampled Time		06:45	06:35	13:45	03:25	04:20	06:45	04:15	14:40	19:40
Triggered Concentration (ppm)		0.39	0.30	0.34	0.30	0.43	0.32	0.33	0.31	0.32
Parameter	Unit									
Isoprene	ppb	< 0.03	0.4	1.04	2.09	1.76	1.76	1.08	0.56	0.04
Isopropyl alcohol	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	1.2	< 0.5
Isopropylbenzene	ppb	< 0.06	0.08	< 0.05	< 0.06	< 0.06	< 0.06	< 0.07	< 0.05	< 0.07
m,p-Xylene	ppb	0.13	0.67	0.15	0.29	0.93	0.93	0.26	0.2	0.11
m-Diethylbenzene	ppb	< 0.03	1.29	< 0.03	< 0.03	< 0.03	< 0.03	0.14	< 0.03	< 0.03
m-Ethyltoluene	ppb	< 0.05	0.33	0.07	0.21	0.23	0.23	0.19	< 0.04	< 0.05
Methyl butyl ketone	ppb	< 0.6	< 0.6	< 0.5	< 0.6	< 0.6	< 0.6	< 0.7	< 0.5	< 0.7
Methyl ethyl ketone	ppb	< 0.5	1.5	0.8	1.6	2.9	2.9	1.1	1.5	< 0.5
Methyl isobutyl ketone	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
Methyl methacrylate	ppb	< 0.12	< 0.12	< 0.10	0.14	< 0.12	< 0.12	0.13	< 0.11	< 0.13
Methyl tert butyl ether	ppb	< 0.05	< 0.04	< 0.04	< 0.04	< 0.05	< 0.05	< 0.05	< 0.04	< 0.05
Methylcyclohexane	ppb	0.22	0.13	< 0.03	0.04	0.06	0.06	0.05	< 0.03	< 0.03
Methylcyclopentane	ppb	0.23	0.14	< 0.07	< 0.07	< 0.08	< 0.08	< 0.08	0.07	< 0.08
Methylene chloride	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
n-Butane	ppb	4.25	2.43	0.26	2.21	2.14	2.14	1.7	1.49	0.74
n-Decane	ppb	< 0.09	0.23	< 0.08	0.17	0.15	0.15	0.16	< 0.08	< 0.10
n-Dodecane	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
n-Heptane	ppb	0.15	0.36	0.06	0.16	0.35	0.35	0.12	0.11	0.09
n-Hexane	ppb	0.43	0.53	0.05	0.27	0.5	0.5	0.21	0.23	0.1

Station		Reno-B	842-B	986-C	842-B	Reno-B	986-C	Reno-B	842-B	Reno-B
Sampled Date		2023-01-09	2023-05-08	2023-06-30	2023-07-07	2023-07-07	2023-07-07	2023-07-11	2023-09-20	2023-09-29
Sampled Time		06:45	06:35	13:45	03:25	04:20	06:45	04:15	14:40	19:40
Triggered Concentration (ppm)		0.39	0.30	0.34	0.30	0.43	0.32	0.33	0.31	0.32
Parameter	Unit									
n-Nonane	ppb	< 0.06	0.25	0.06	0.1	0.17	0.17	0.08	< 0.05	< 0.07
n-Octane	ppb	0.06	0.33	0.13	0.14	0.24	0.24	0.1	0.1	< 0.03
n-Pentane	ppb	1.3	1.04	0.1	0.68	0.87	0.87	0.53	0.71	0.23
n-Propylbenzene	ppb	< 0.09	0.2	< 0.08	0.15	0.14	0.14	0.14	< 0.08	< 0.10
n-Undecane	ppb	< 0.8	< 0.7	< 0.7	< 0.7	< 0.8	< 0.8	< 0.8	< 0.7	< 0.8
Naphthalene	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
o-Ethyltoluene	ppb	< 0.03	0.26	0.03	0.12	0.28	0.28	0.11	0.03	< 0.03
o-Xylene	ppb	0.06	0.36	0.06	0.18	0.48	0.48	0.15	0.09	< 0.05
p-Diethylbenzene	ppb	< 0.03	0.18	< 0.03	0.17	0.15	0.15	0.16	< 0.03	0.06
p-Ethyltoluene	ppb	< 0.06	< 0.06	< 0.05	0.07	< 0.06	< 0.06	0.07	< 0.05	< 0.07
Styrene	ppb	< 0.06	0.38	0.17	0.22	0.46	0.46	0.22	< 0.05	< 0.07
Tetrachloroethylene	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Tetrahydrofuran	ppb	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
Toluene	ppb	0.39	3.29	0.6	1.93	4.4	4.4	1.48	2.01	0.65
trans-1,2-Dichloroethylene	ppb	< 0.09	0.57	0.12	2.18	< 0.09	< 0.09	< 0.10	3.8	< 0.10
trans-1,3-Dichloropropylene	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
trans-2-Butene	ppb	< 0.05	0.49	0.16	0.3	0.54	0.54	0.38	< 0.04	< 0.05
trans-2-Pentene	ppb	< 0.03	0.15	0.04	0.08	0.18	0.18	0.08	< 0.03	< 0.03
Trichloroethylene	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03

Station		Reno-B	842-B	986-C	842-B	Reno-B	986-C	Reno-B	842-B	Reno-B
Sampled Date		2023-01-09	2023-05-08	2023-06-30	2023-07-07	2023-07-07	2023-07-07	2023-07-11	2023-09-20	2023-09-29
Sampled Time		06:45	06:35	13:45	03:25	04:20	06:45	04:15	14:40	19:40
Triggered Concentration (ppm)		0.39	0.30	0.34	0.30	0.43	0.32	0.33	0.31	0.32
Parameter	Unit									
Vinyl acetate	ppb	< 0.5	270	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5
Vinyl chloride	ppb	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03

References

Alberta Energy Regulator (AER). 2014a. Report of Recommendations on Odours and Emissions in the Peace River Area - AER Response. Calgary, Alberta. March 31, 2014. https://www.aer.ca/documents/decisions/2014/2014-ABAER-005.pdf

Alberta Energy Regulator (AER). 2014b. Evaluating Stakeholder Engagement Peace River https://static.aer.ca/prd/documents/about-us/Peace-River/PR_EvaluatingEngagement_20141017.pdf

Alberta Energy Regulator (AER). 2017. Directive 084: Requirements for Hydrocarbon Emission Controls and Gas Conservation in the Peace River Area. February 23, 2017. 28pp. https://static.aer.ca/prd/documents/directives/Directive084.pdf

Alberta Environment and Parks (AEP). 2015. Study of Ambient Hydrocarbon Concentrations in Three Creeks, Alberta. Air and Climate Change Policy Branch. August 2016. ISBN No. 978-1-4601-2379-9. https://open.alberta.ca/dataset/0ef15c67-844b-4914-8b3d-fc90af2de67e/resource/d63c081d-e0f8-46d7-887b-de39a30969bb/download/2015-ambienthydrocarbonthreecreeks-aug2015.pdf

Alberta Environment and Parks (AEP). 2019. Alberta Ambient Air Quality Objectives and Guidelines Summary. Air Policy Branch. July 2017. ISBN: 978-1-4601-3485-6. 6 pp. https://open.alberta.ca/dataset/0d2ad470-117e-410f-ba4f-aa352cb02d4d/resource/4ddd8097-6787-43f3-bb4a-908e20f5e8f1/download/aaqo-summary-jan2019.pdf