Peace River Area Monitoring Program

2018-2019

Annual Data Review

pramp

PEACE RIVER AREA MONITORING PROGRAM

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Cover Photo: Michael Bisaga
Canola Reno, Alberta

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1. HISTORICAL CONTEXT

The Peace River Area Monitoring Program (PRAMP) was created to satisfy air quality monitoring and modelling recommendations released following a proceeding called by the Alberta Energy Regulator (AER).

The proceeding was called to address odour and emissions generated by heavy oil operations in the Peace River Area of Alberta (AER 2014a). The oral proceeding started on January 21 and ended on January 31, 2014, in Peace River, Alberta. On March 31, 2014, the panel released its report titled Report of Recommendations on Odours and Emissions in the Peace River Area. The recommendations in the report included calls for regulatory change, regional air monitoring, and ongoing stakeholder engagement in the Peace River Area. In particular, the monitoring requirements in Paragraph 178(1) of the report recommendations state, "The AER accepts this recommendation and will immediately engage with industry, residents and stakeholders to establish a regional air quality monitoring program for the Peace River Area" (AER 2014b).

This report is the fifth annual data review and compares 2018 to 2019 monitoring results; the previous data reviews are available on the PRAMP website.

1.1. Emissions

In the region, there are many industrial facilities and installations including heavy oil operations, gas plants, flare stacks, wells, storage facilities, and pipeline infrastructure; these all have the potential to emit hydrocarbons. Heavy oil operators in the Peace River area (Three Creeks, Reno, Walrus, Seal) with Cold Heavy Oil Production (CHOP) facilities are required to have emission control devices in place to mitigate or eliminate potential releases of hydrocarbons (AER 2017). Typical hydrocarbon emissions result from fugitive and combustion sources and tend to occur on a continuous basis. Emissions also occur on an episodic basis from truck filling and tank cleaning operations. While emission sources are not characterized at all locations, the impacts on air quality at PRAMP's monitoring stations are presented for review.

1.2. Meteorology

This report outlines data collected during 2018-2019 at three monitoring locations (Figure 1). The measurements collected at the monitoring sites confirm that temporal and spatial meteorological variations occur in the Peace River Area.

1.3. Station Data and Trends

PRAMP has a well-established monitoring program that is critical to understanding the state of air quality in the Peace River Area. The monitoring program has been active at Station 986 since 2010, Station 842 since 2012, and the Reno Station since 2014.

Station 986 and 842 have been relocated 3 and 2 times (respectively), during their deployment in the region. With each relocation event, PRAMP maintained a consistent naming convention by annotating an alphabetic identifier; Station 986 is currently 986c and Station 842 is currently 842b. Despite moving the stations, the new monitoring sites are reasonably close to their original locations and are therefore considered to be representative of their earliest deployment locale.

This is PRAMP's fifth annual data review and data analysis was completed on the two most recent annual datasets (2018 – 2019). Three types of data are presented: continuous monitoring, meteorological measurements, and discrete canister samples.

Sulphur dioxide (SO_2), total reduced sulphur (TRS), total hydrocarbon (THC), methane (CH_4), and non-methane hydrocarbons (NMHC) concentrations are monitored continuously at Station 986c, Station 842b, Reno Station, and the Air Quality Health Index (AQHI) Station. The AQHI Station also measures particulate matter ($PM_{2.5}$ and PM_{10}), oxides of nitrogen (NO_2, NO, NO_x), and ozone (O_3). The AQHI Station (currently deployed near the Cadotte Lake community) was added towards the end of 2019 and only two months of monitoring data are available; therefore, these data are presented *for information* with minimal analysis as historical context is not available.

Meteorological parameters (wind speed, wind direction, temperature, pressure, and relative humidity) were also monitored at PRAMP's continuous air quality monitoring stations.

The canister sampling program collects a 1-hour sample of air when the continuously measured methane and/or non-methane hydrocarbon concentration reaches a specified trigger point (in 2019, the methane trigger was added to the program and prior to 2019, only non-methane triggered canisters were collected). Trigger points are 5.5 ppm for methane and 0.3 ppm for non-methane hydrocarbons and both trigger points are based on real-time monitoring data that are averaged over a 5-minute period. Canisters sample collection systems are in place at Station 986c, 842b, and the Reno Station; a canister sample collection system is not part of the suite of instruments currently deployed at the AQHI Station.

Canisters are analyzed for over 140 volatile organic compounds (VOC). In 2018, 6 NMHC canister events were triggered however only 3 of these events were 'real' with the remaining 3 being false triggers caused by station operations and maintenance. In 2019, 9 NMHC canister events were triggered however 3 of these events were caused by the Chuckegg Creek wildfire. In 2019, 10 CH_4 canister events were also triggered.

AER complaints were collected and analyzed for the correlations to monitored data.

The monitoring and sampling data are presented using the following visualization methods.

Continuous sampling:

- continuous measured meteorology parameters (wind speed and wind direction) are presented in wind roses
- continuous measured ambient SO_2, TRS, THC, CH_4, and NMHC concentrations are present in vertical bar charts, line plots, and concentration roses
- continuous measured ambient SO_2, TRS, THC, CH_4, and NMHC concentrations (maximum, 99th percentile, and average by month) are presented in vertical bar charts with statistical analysis

Triggered sampling canister events:

- 3 NMHC triggered canister events in 2018, 9 NMHC triggered canister events in 2019, and 10 CH_4 triggered canister events in 2019 were analyzed for over 140 volatile organic compounds (VOC). These data are presented in tables.

AER complaints:

- AER complaints are presented in a timeline with THC concentrations (continuous)

Based on hourly data THC, NMHC, SO_2, and CH_4 generally show that ambient concentrations remain low compared to historic measurements. Observations of increased THC and methane concentrations at Station 986 in 2018 and 2019 are likely due to cattle in the vicinity of the station; these elevated concentrations subsided after the station was moved in August 2019. TRS data at Stations 986c, 842b, and Reno show seasonal variation with higher concentration occurring in warmer summer months; similar to previous years, these elevated measurements may be influenced by shallow sloughs and asphalt paving in the area. Examination of monthly summary statistics showed that most parameters are either decreasing or have stayed the same over the last two years.

Stations 986c and 842b monitoring results showed that the 99th percentile concentrations of THC were similar to other areas of the Province. The Reno station concentrations are higher than the 986 and 842 stations, however they are at about the same as concentrations measured at other stations in the province.

Data for Three Creeks suggests that PRAMP is meeting the goal of verifying that air quality has improved and odours have been minimized as a result of operational and regulatory improvements; this is particularly evident when the full record of monitoring from Station 986c and 842b are considered. Recent spatial analysis of wells and their associated infrastructure suggests the close proximity of CHOP facilities may be influencing hydrocarbon concentrations more at the Reno Station than at Stations 986c and 842b.

1.4. Complaints

The AER recorded odour complaints from residents and assigned the location of the complaint to each of the three stations. AER complaints were collected and analyzed as follows:

- Station 986 showed a decrease in the number of complaints; there were 4 in 2018 and 2 in 2019 (down from a historical maximum of 33 in 2014)
- Station 842 showed no change in the number of complaints; there were 0 in 2018 and 0 in 2019 (down from a historical maximum of 44 in 2014)
- The Reno Station showed no change in the number of complaints; there were 0 in 2018 and 0 in 2019 (down from a historical maximum of 11 in 2015)

In 2019, there were only 2 odour complaints across the entire network; this is the lowest number of complaints since PRAMP began compiling these data.

2. BACKGROUND

The area that the PRAMP air monitoring network serves in Figure 1. The air quality monitoring program operated by PRAMP is designed to operate collaboratively and transparently including representation from industry, the AER, government agencies, residents of Three Creeks and Reno areas, and environmental non-governmental organizations (AER 2014b).

PRAMP's vision is that the "Peace River Area heavy oil and bitumen operations' emissions will not cause odours that affect human health" (PRAMP 2016). The mission statement maintained by PRAMP is the "Peace River Area will have an air quality monitoring program that provides credible and comprehensive data to permit the identification and appropriate response to odour and emission-related issues" (PRAMP 2016). An overview of PRAMP's goals and objectives are listed below. PRAMP defines odours and emissions as the following:

- odours: detected in the ambient air by the people in the area
- emissions: at a source are defined by the concentration and flow rate of each compound released; upon release from the source the emissions disperse downwind and may be measured as a concentration in the ambient air by a monitoring device

PRAMP's goals are to:

- assist in verifying that air quality is improving and odours are being minimized as a result of operational and regulatory improvements
- operate transparently and give residents and stakeholders timely access to data and information in a manner that is readily understood
- demonstrate that oil and gas operators have effective control mechanisms
- verify that air quality is at acceptable levels and that emissions residents are exposed to are below toxic thresholds (PRAMP 2016)
- maintain its status as an independent Not-for-Profit Organization and Airshed that is focused

on continuous improvement and responsible growth

To accomplish the goals the program would:

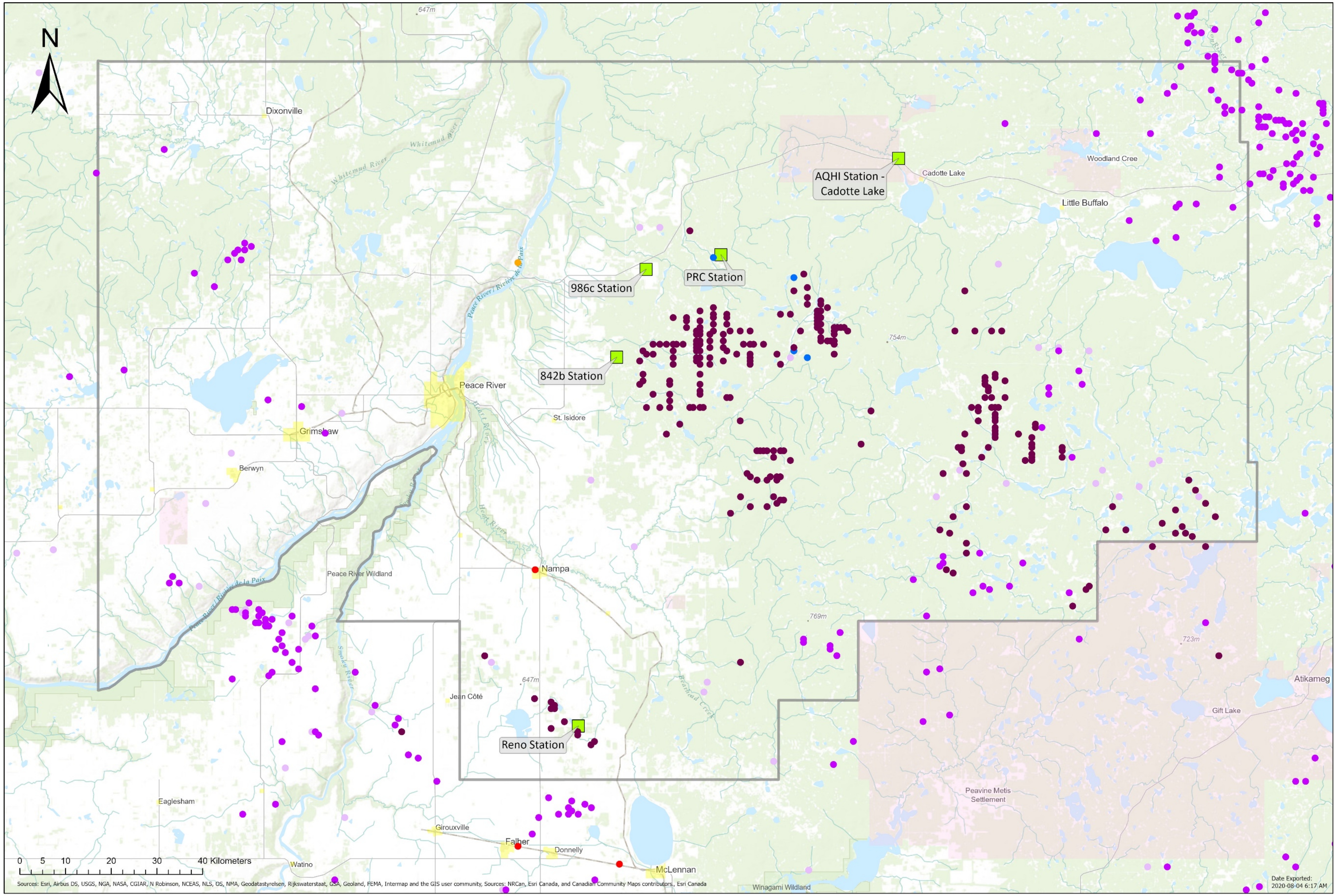
- characterize emissions and odours associated with industrial activity, with a focus on oil and gas operations
- identify and measure dominant sources of emissions in the area
- give timely, real-time data on ambient emissions and odours in the area (PRAMP 2017)

A review and analysis of the 2018 - 2019 annual air monitoring data collected by PRAMP is included in this report. The data includes the continuous monitoring of the 1-hour averaged TRS, CH_4, NMHC, THC, and SO_2 concentrations. Additionally, VOCs monitored using 1-hour event canisters triggered by elevated methane and NMHC concentrations were also assessed.

All monitoring was conducted at the four community stations located in PRAMP's monitoring network:

- Station 842b is located at 16-07-084-19 W5M
- Station 986b was relocated from 14-16-085-19 W5M to 5-15-085-19 W5M in August 2019
- Reno Station is located at 01-28-079-20 W5M
- AQHI Station is located at 16-27-86- 16 W5M (deployed October 2019)

The locations of the four monitoring stations are shown on Figure 1, which also shows nearby industrial activities in the Peace River Area and surrounding regions including compressor stations, oil batteries, gas gathering and processing facilities, terminals, pulp mills, and waste facilities (industrial and domestic). This figure assists in the identification of the emission sources around each station as well as the potential influence of nearby sources to the monitoring data. Figure 1 also shows the location of the Peace River Complex (PRC) monitoring station which is not yet part of the PRAMP network however, plans are underway to incorporate this into the regional network.



Facilities in the PRAMP Area

Location Data Sources: Petrinex 2019 & National Pollutant Release Inventory 2017

Legend

- Heavy Oil/Bitumen Wells and Batteries
- In-Situ Oil Sands Facilites
- Conventional Oil Wells and Batteries
- Natural Gas Wells and Batteries
- Pulp and Paper
- Agricultural Storage and Transfer
- Towns, Villages, and other Settlements
- First Nations Reservations and Metis Settlements
- PRAMP Airshed Zone Boundary
- PRAMP Continuous Air Monitoring Station

Figure 1: Facilities in the Peace River and Surrounding Area

2.1. Air Quality Monitoring Overview

To accomplish PRAMP's goals and to be in alignment with its mission statement, air quality in the Peace River Area was monitored through continuous and triggered canister samples.

Continuous monitoring stations use substance-specific technology to detect concentrations in a sample stream of ambient air that is taken by the instrument at a set time interval. Wind speed and direction data are also collected at the continuous monitoring stations. Assessing concentration and wind data together allows investigation into the potential sources of substances affecting the local air quality. Statistical analyses also assist in understanding the distribution of the data.

Discrete canister sampling events were triggered when continuous monitored data exceeded set thresholds. Triggered sampling events were completed using canisters to capture ambient air samples. The samples are then sent to a laboratory for analysis.

PRAMP's objectives include the comparison of monitored data to different thresholds (PRAMP 2016). The provincial government developed the Alberta Ambient Air Quality Objectives and Guidelines Summary (AAAQO; AEP 2019) to protect the environment and human health. The AAAQOs are used as threshold values for comparing substance concentrations (at appropriate averaging periods) to assess impacts.

3. CONTINUOUS MONITORING STATION DATA AND TRENDS

The following subsections describe the results of the monitoring, analysis, and methods used to complete this report.

3.1. Station Data and Trends Methodology

All hourly data collected at the three stations was compiled and interpreted. Hourly data for meteorology, THC, NMHC, TRS, SO_2, and CH_4 concentrations have been presented as follows:

- wind roses displaying the wind speed and direction for each year and at each station
- hourly data with maximum values identified for each year and station
- monthly measurement trends for the 100th (maximum) and 99th percentiles by month for each station for all time periods
- time series results for the maximum, 99th, 90th, and 50th percentiles and minimum readings collected at each station and year

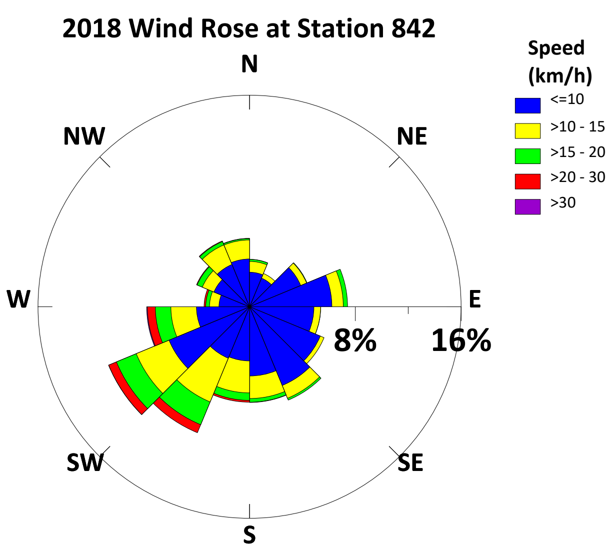
This data and statistical analysis have been presented with interpretation in Sections 3.2 to 3.5.

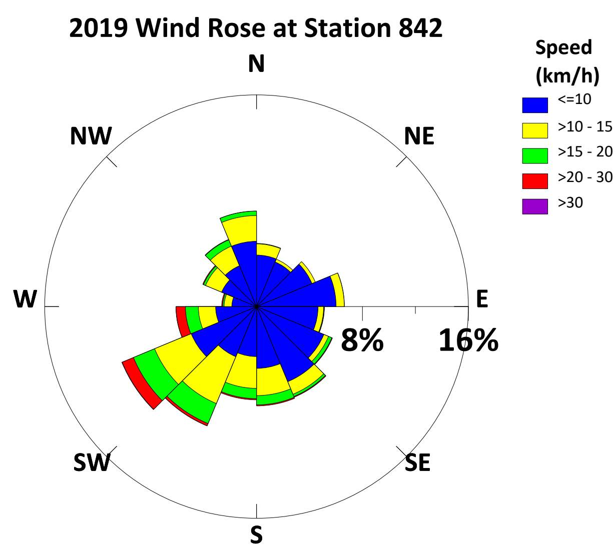
3.2. Wind Roses

Presented in a circular format, wind roses show the frequency of winds blowing from particular directions over a specified period. The length of each 'spoke' around the circle is related to the frequency that the wind blows from a particular direction per unit time. Each concentric circle represents a different frequency, emanating from zero at the center to increasing frequency at the outer circles. Each spoke is broken down into colour-coded bands to show the range of wind speeds that occurred in that particular direction.

Wind roses created from meteorological measurement data for each station and year are presented to understand the predominant wind conditions at each of the three station locations (Figure 2). Trends for each station are noted as follows:

- Station 842: Winds are primarily from the southwest. Wind speeds range from less than 10 to 30 km/hour with minimal wind speeds over 30 km/hour in both 2018 and 2019.
- Station 986: Wind direction varies, with a higher frequency of winds coming from the southeast and southwest and minimal winds coming from the northeast. Overall windspeeds were higher in 2019 due to the station's relocation to a more open, tree-free site; wind was less impeded at the new site compared to the previous location.
- Reno Station: Winds were primarily from the southwest. Wind speeds range from less than 10 to 20 km/hour with minimal wind speeds over 20 km/hour.





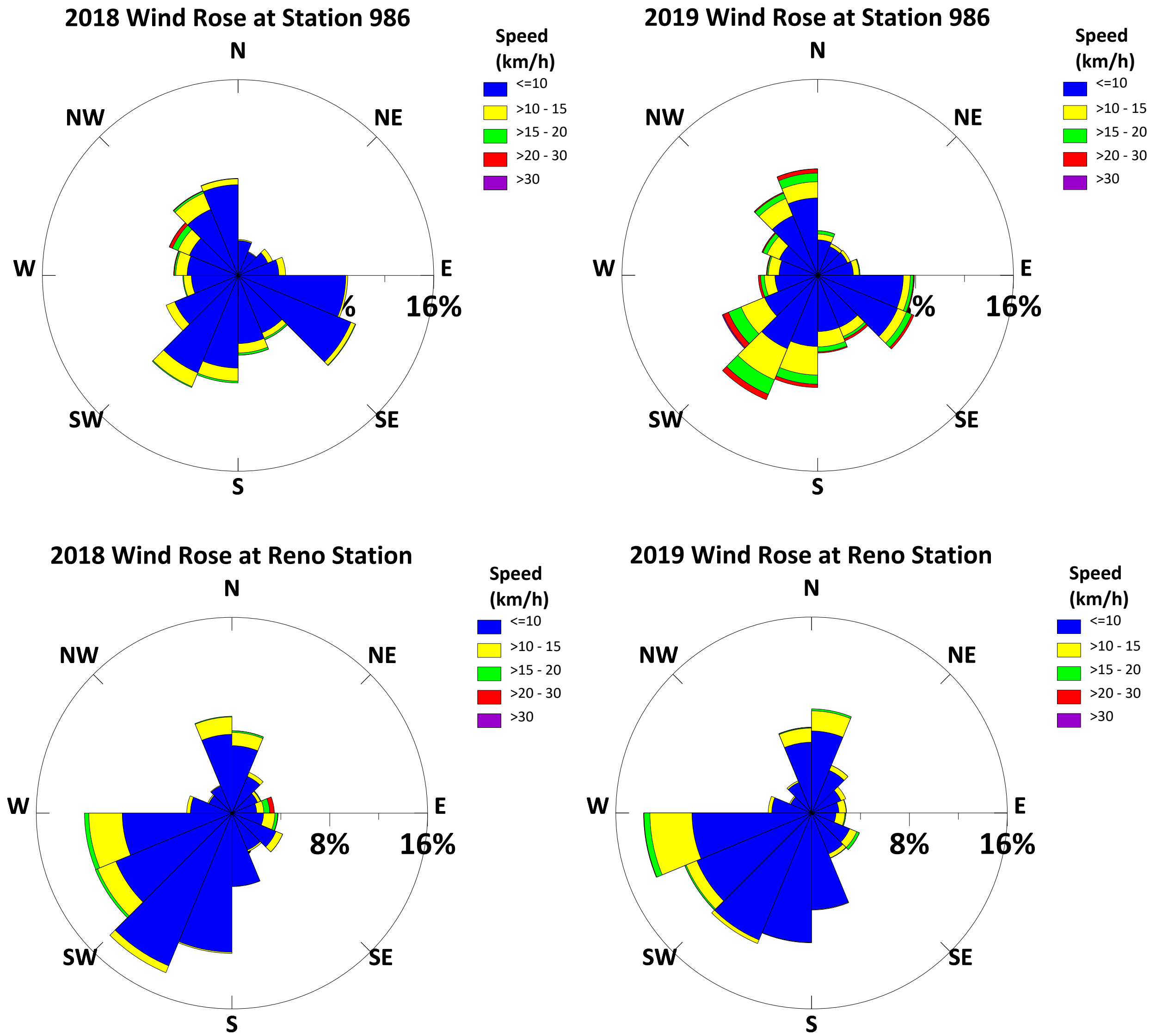


Figure 2: Wind Roses at Stations 842, 986 and Reno

3.3. Hourly Concentration Data

Hourly concentration data is presented to show all data collected at the 986c, 842b, and Reno stations for 2018 and 2019. Hourly concentrations are presented for total hydrocarbon (THC), non-methane hydrocarbons (NMHC), total reduced sulphur (TRS), sulphur dioxide (SO_2) and methane (CH_4) in this section.

THCs are the sum of CH_4 and NMHC. NMHC may be emitted with methane from the man-made sources and are likely to have an odour. NMHC measurements include volatile organic compounds (VOC).

TRS compounds include hydrogen sulphide, carbonyl sulphide, carbon disulphide, and other hydrocarbon-sulphur compounds such as mercaptans and thiophenes. Some TRS compounds may have a strong offensive odour at concentrations below 1 ppbv. There are natural sources of TRS but they can also be emitted from bitumen facilities.

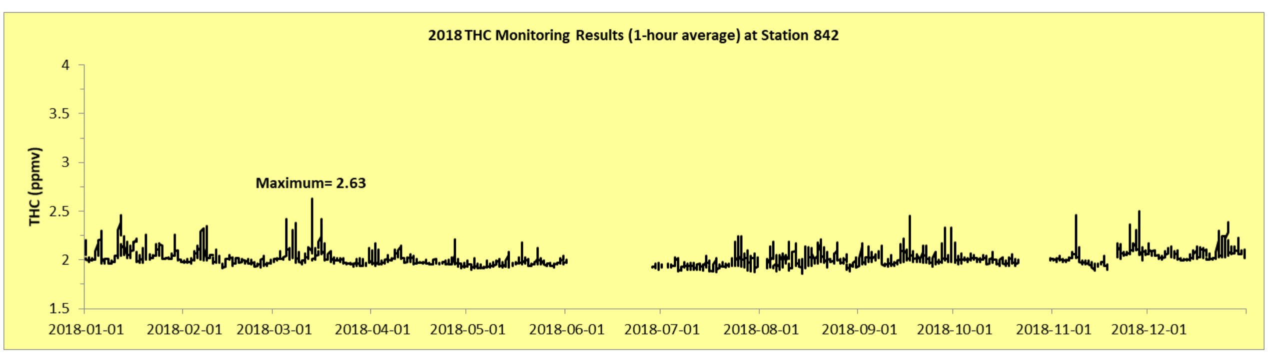
SO_2 results from the combustion of sulphur compounds in fuel and flared/incinerated gas. CH_4 comes from natural and man-made sources and has a background concentration of typically less than 2 ppmv, depending on season and time of day. CH_4 does not have an odour or health effects at these low concentrations.

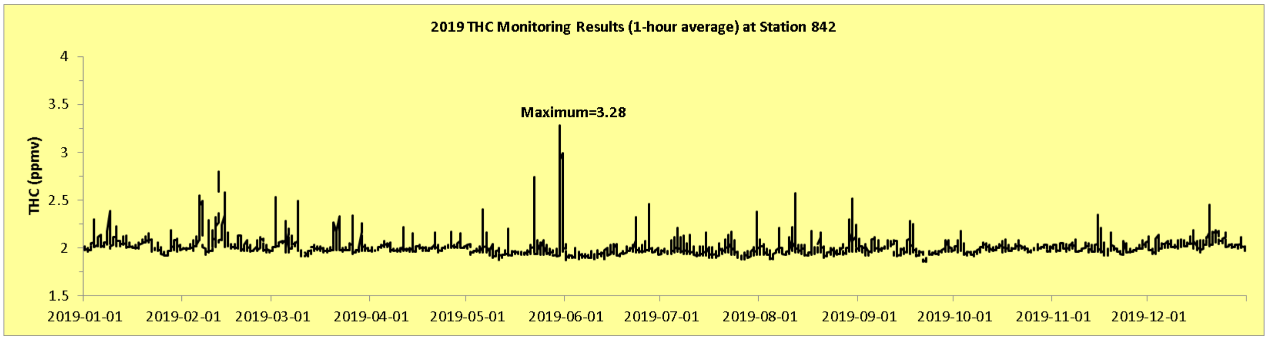
Some of the AQHI – Cadotte Lake station data are presented in a separate section as there is only 3 months of monitoring data available and the monitoring station is considered 'complementary' to the permanent fixed-location PRAMP network.

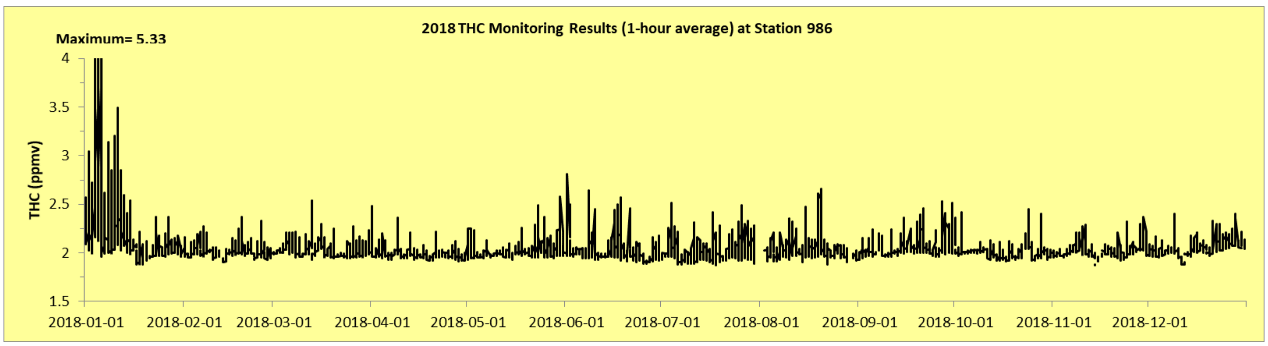
3.3.1. Total Hydrocarbons

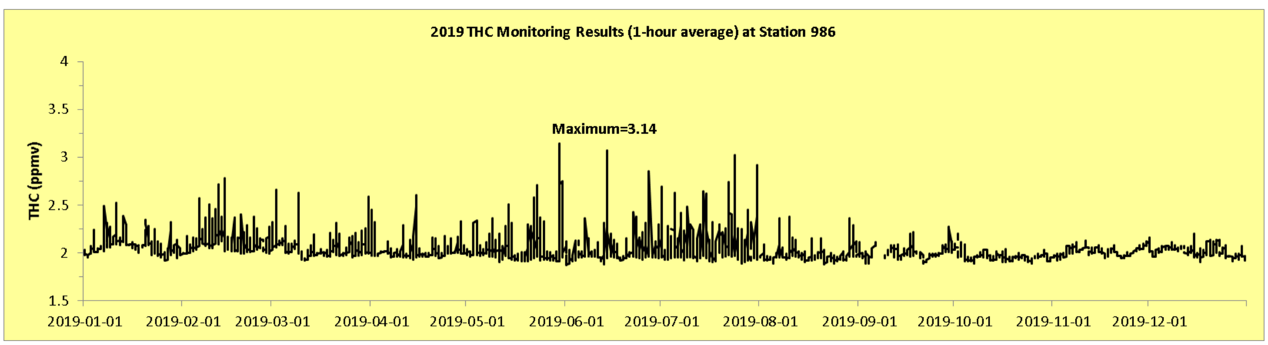
THC concentrations include all NMHC and methane concentrations. There is no AAAQO for THC. Hourly data for THC from the three stations is presented in the charts below (Figure 3).

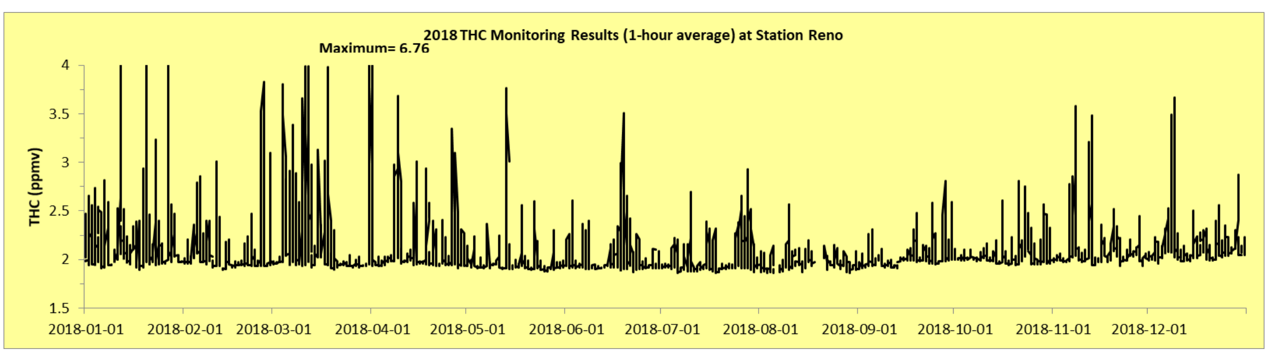
The maximum hourly THC data for the Reno Station was higher in 2019 than in 2018 however the overall frequency and magnitude of elevated concentrations both decreased. The maximum hourly THC concentration at Station 986 was lower in 2019 than in 2018 and concentrations decreased overall starting in August 2019 after the station was relocated. The maximum concentration at Station 842 was higher in 2019 than in 2018 however concentrations remained low compared to historical measurements.




2019 THC Monitoring Results (1-hour average) at Station 842
Maximum=3.28
THC (ppmv)
4
3.5
3
2.5
2
1.5
2019-01-01 2019-02-01 2019-03-01 2019-04-01 2019-05-01 2019-06-01 2019-07-01 2019-08-01 2019-09-01 2019-10-01 2019-11-01 2019-12-01


2018 THC Monitoring Results (1-hour average) at Station 986
Maximum= 5.33
THC (ppmv)
4
3.5
3
2.5
2
1.5
2018-01-01 2018-02-01 2018-03-01 2018-04-01 2018-05-01 2018-06-01 2018-07-01 2018-08-01 2018-09-01 2018-10-01 2018-11-01 2018-12-01


2019 THC Monitoring Results (1-hour average) at Station 986
Maximum=3.14
THC (ppmv)
4
3.5
3
2.5
2
1.5
2019-01-01 2019-02-01 2019-03-01 2019-04-01 2019-05-01 2019-06-01 2019-07-01 2019-08-01 2019-09-01 2019-10-01 2019-11-01 2019-12-01


2018 THC Monitoring Results (1-hour average) at Station Reno
Maximum= 6.76
THC (ppmv)
4
3.5
3
2.5
2
1.5
2018-01-01 2018-02-01 2018-03-01 2018-04-01 2018-05-01 2018-06-01 2018-07-01 2018-08-01 2018-09-01 2018-10-01 2018-11-01 2018-12-01

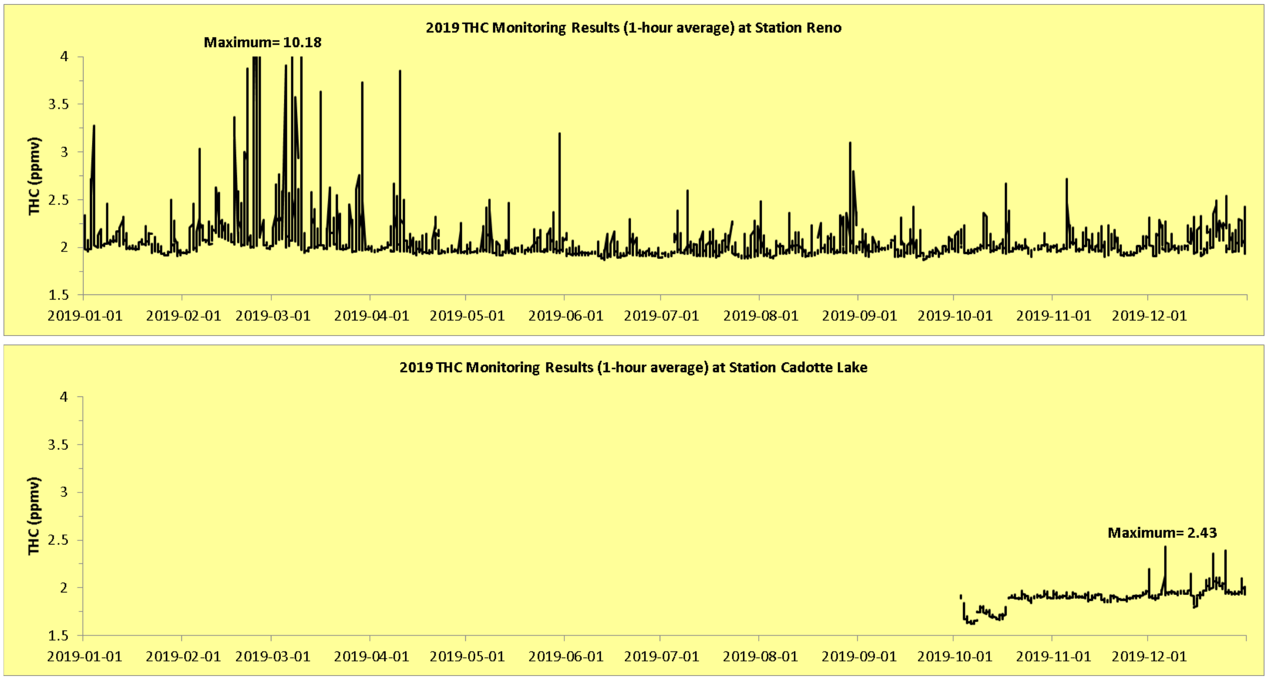
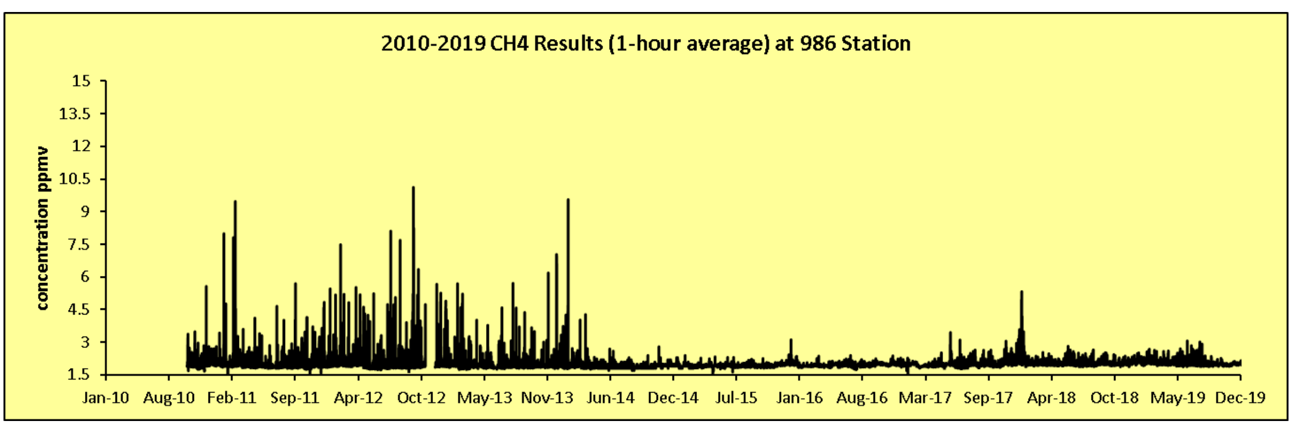
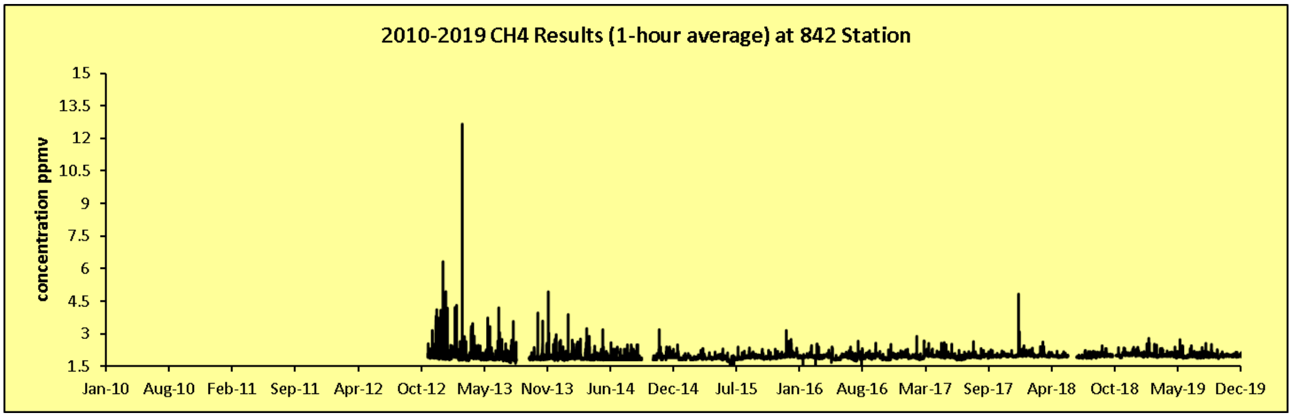
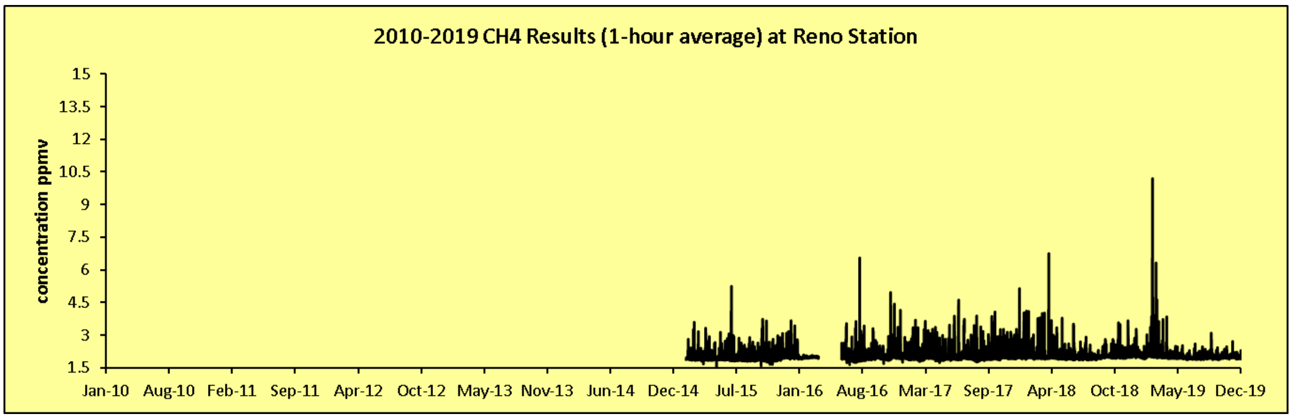


Figure 3: Hourly Monitored Total Hydrocarbons Data

For historical comparison purposes, Figure 4 shows the complete record of monitoring for THC at all stations. There is a clear decrease in ambient THC concentrations at Stations 986 and 842; the presence of cattle and their associated hydrocarbon emissions is noted in the 'up-tick' in concentrations towards the end of 2018 and the beginning of 2018. Note that the scale of these charts is different than the previous series because the historical concentrations of THC have been higher than measured in 2018-2019. Reno continues to show elevated THC relative to present-day measurements at the other stations however the concentrations are not as high as historical values measured at Stations 986 and 842 or historical concentrations at the Reno location itself.







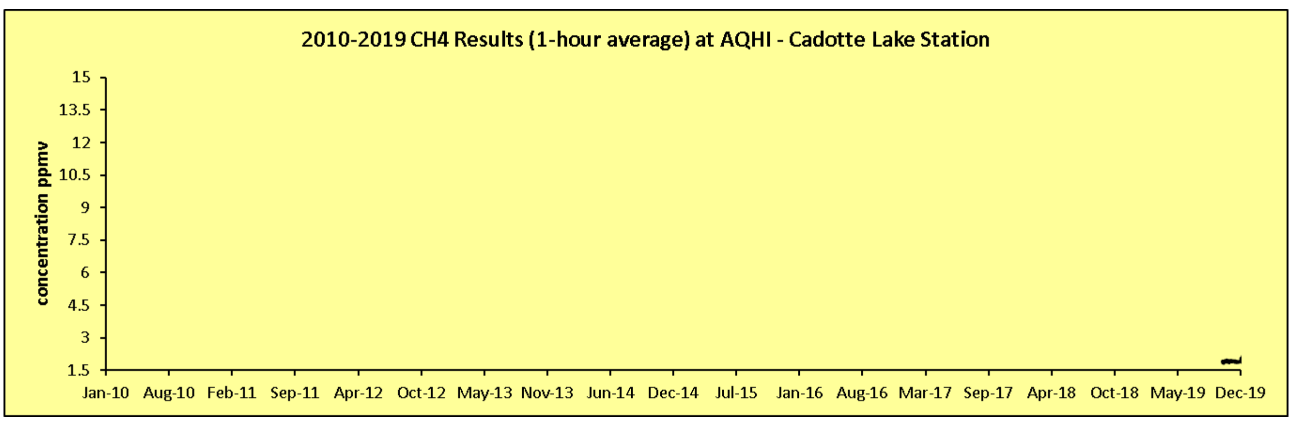
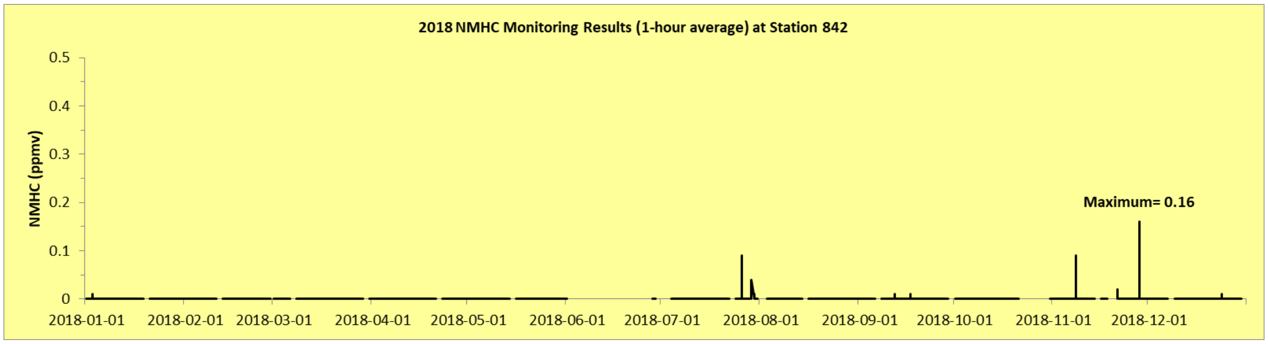
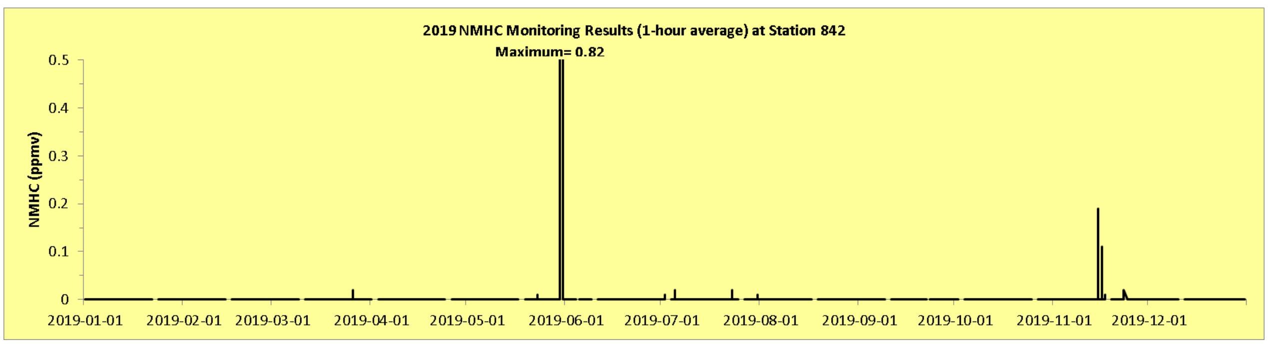


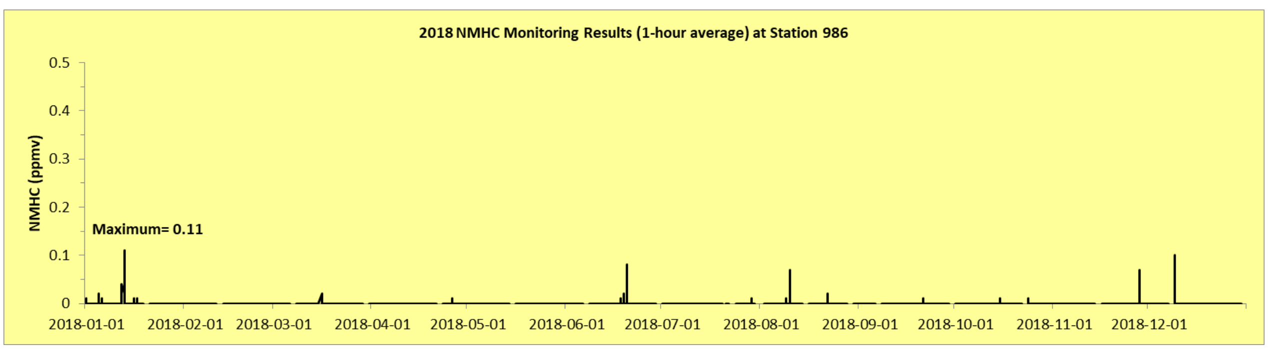
Figure 4: Hourly Monitored Total Hydrocarbon Data from 2010-2018

3.3.2. Non-methane Hydrocarbons

Hourly NMHC data for the three stations is shown in the charts below (Figure 5). There is no AAAQO for NMHC. All monitoring stations showed a 'spike' on May 29, 2019 due to the heavy smoke event caused by the Chuckegg Creek Fire. Outside of the May 2019 spike, the maximum hourly NMHC data for Station 986c, 842b and Reno remained comparable to 2018. Instrument malfunction resulted in data loss in June 2018 at Station 842b. During the short period of time that monitoring occurred at the AQHI station in 2019, a number of elevated NMHC concentrations were noted; this is likely due to the station's proximity to the Highway 986 and Haig Lake Road intersection.







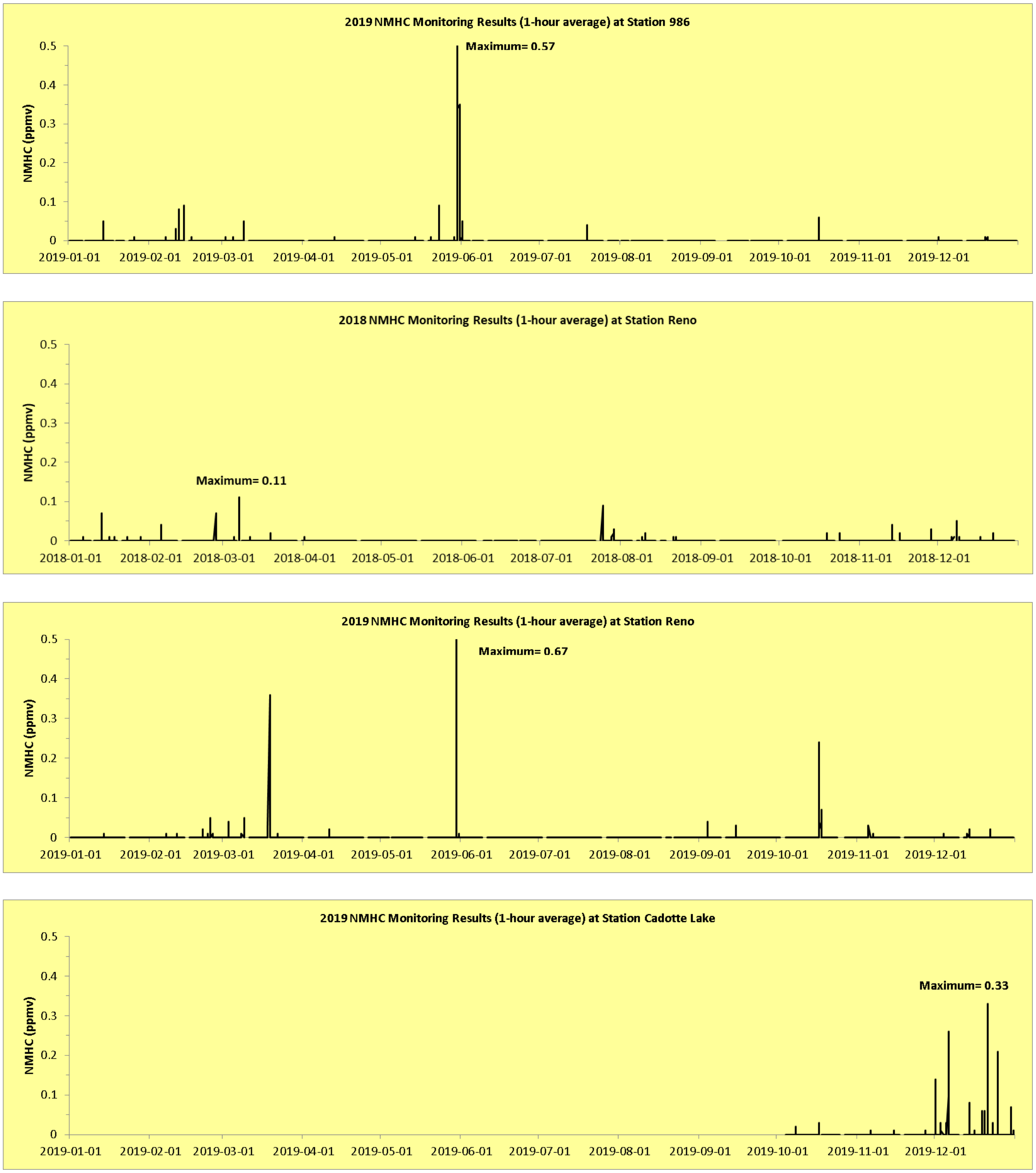
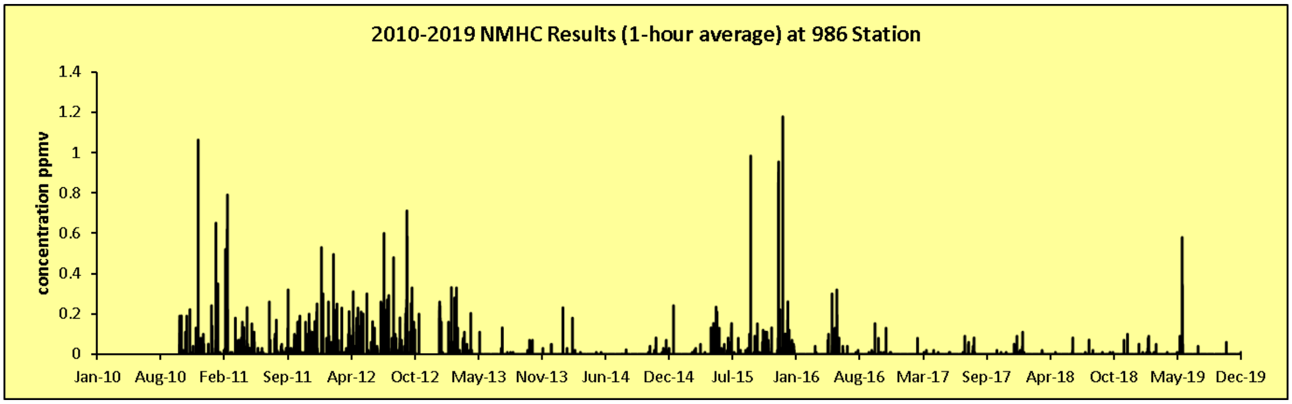
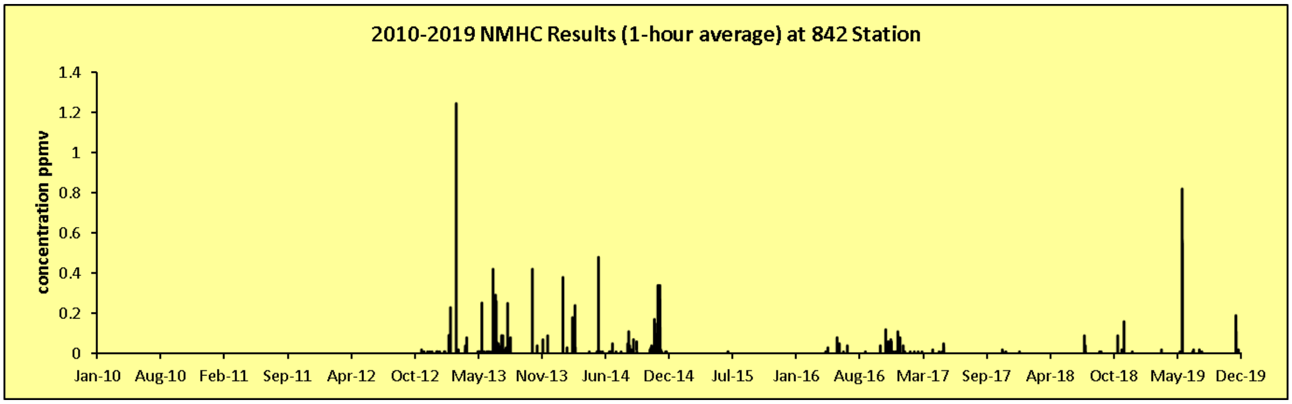


Figure 5: Hourly Monitored Non-methane Hydrocarbons Data

For historical comparison purposes, Figure 6 shows the complete record of monitoring for NMHC at all stations. There is a decrease in frequency of elevated NMHC events at Stations 986c and 842b, especially when compared to the early monitoring record at both sites. Reno shows a decrease in the magnitude and frequency of elevated NMHC since monitoring began at that site in 2014. The network-wide spike cause by forest fire smoke in May 2019 in clearly evident.





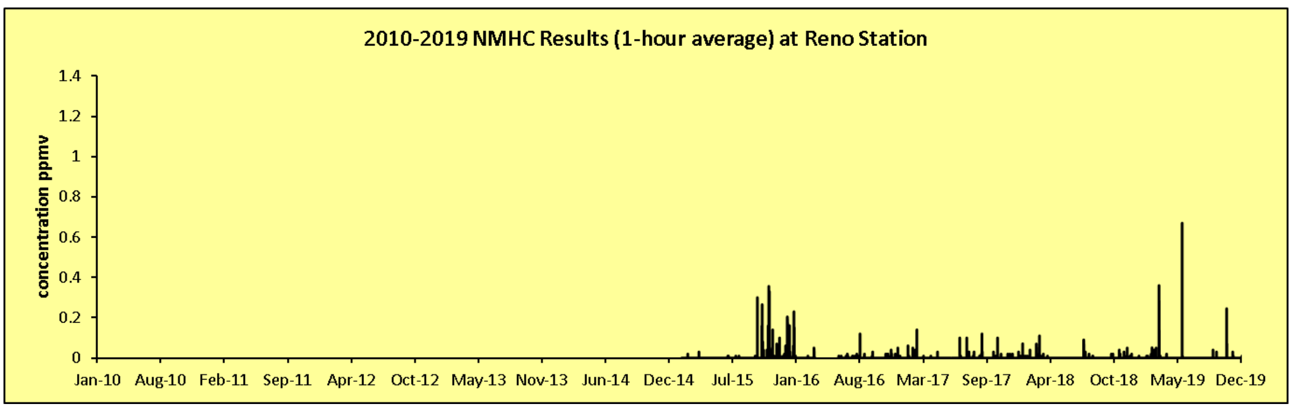
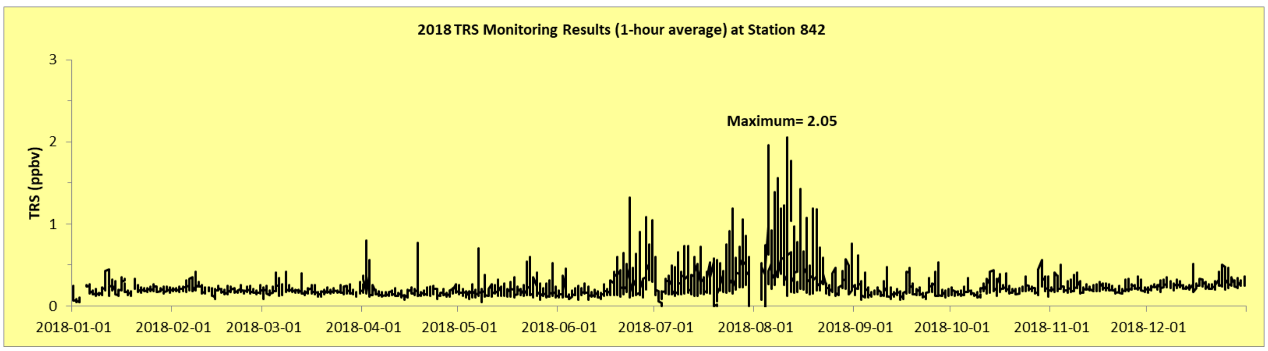


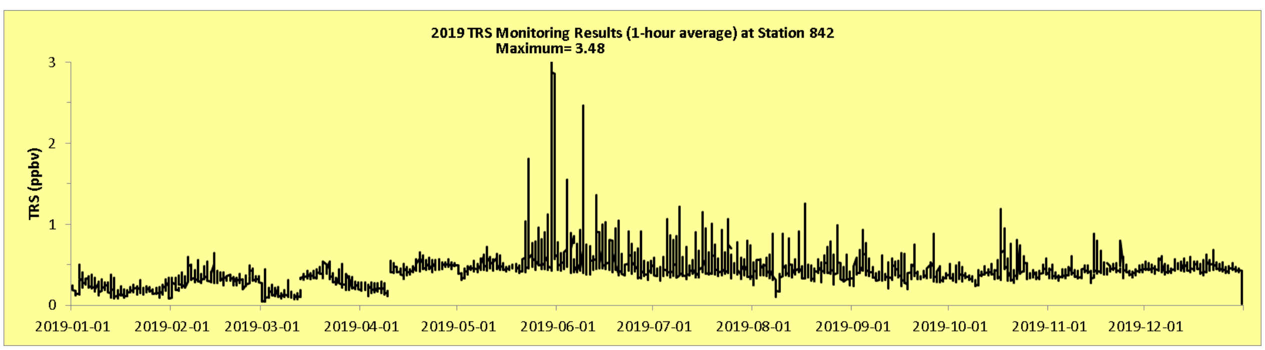
Figure 6: Hourly Monitored Non-Methane Hydrocarbons from 2010-2019

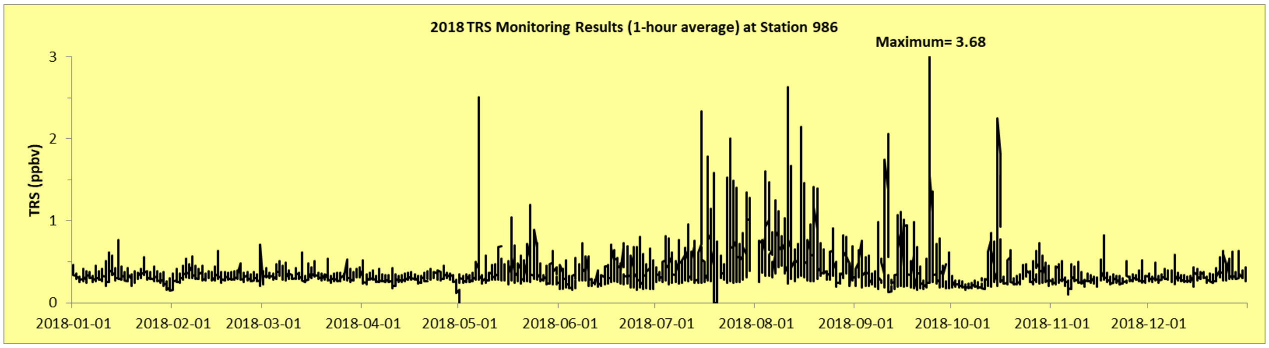
3.3.3. Total Reduced Sulphur

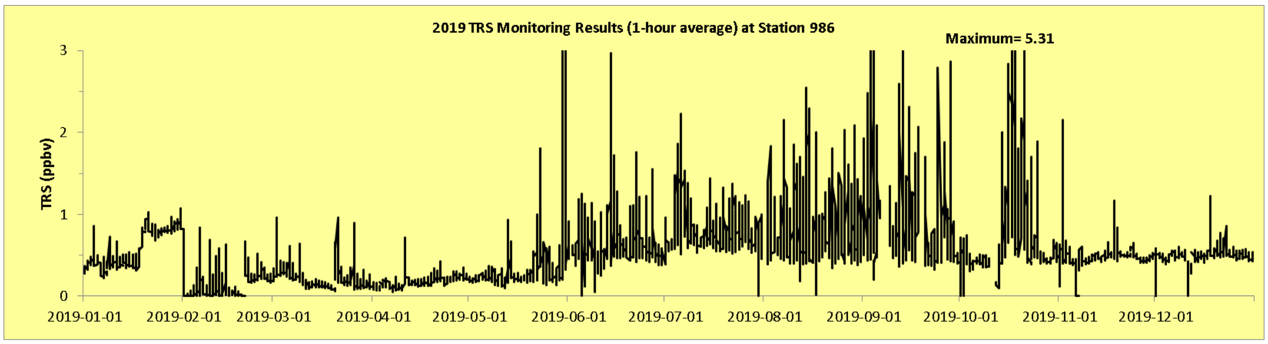
Hourly data for TRS for the four stations is shown in the charts below (Figure 11). There is no AAAQO for TRS but the AAAQO for hydrogen sulphide and carbon disulphide are both 10 ppbv; both of these substances are members of the total reduced sulphur group of compounds.

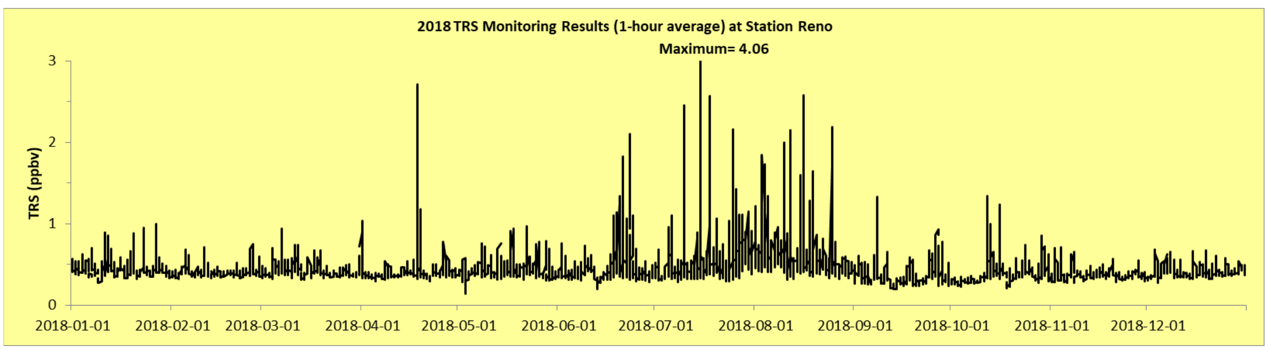
From 2018 to 2019 there is a slight increase in the maximum hourly TRS concentration at all stations. Elevated measurements of TRS may be caused by local industrial sources but other sources may include agriculture and natural features such as shallow lakes and sloughs. All monitoring stations show an increasing pattern of concentrations in the summer months which begin to decrease as cooler, fall weather arrives. This observation may be attributed to a few factors including sulphur compounds being released by shallow sloughs and wetlands that contain decaying vegetation and/or sulphur compounds released by asphalt paving during the summer construction period.

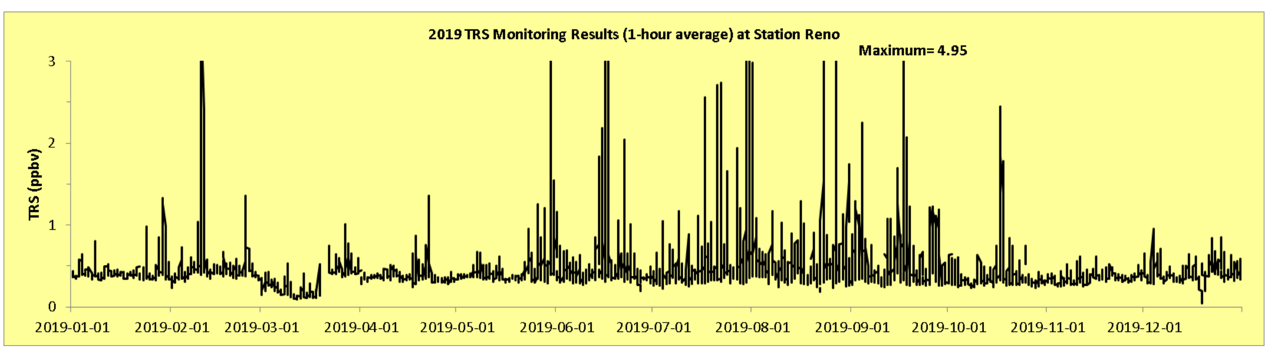





2018 TRS Monitoring Results (1-hour average) at Station 986
Maximum= 3.68
TRS (ppbv)
0
1
2
3
2018-01-01
2018-02-01
2018-03-01
2018-04-01
2018-05-01
2018-06-01
2018-07-01
2018-08-01
2018-09-01
2018-10-01
2018-11-01
2018-12-01


2019 TRS Monitoring Results (1-hour average) at Station 986
Maximum= 5.31
TRS (ppbv)
0
1
2
3
2019-01-01
2019-02-01
2019-03-01
2019-04-01
2019-05-01
2019-06-01
2019-07-01
2019-08-01
2019-09-01
2019-10-01
2019-11-01
2019-12-01


2018 TRS Monitoring Results (1-hour average) at Station Reno
Maximum= 4.06
TRS (ppbv)
0
1
2
3
2018-01-01
2018-02-01
2018-03-01
2018-04-01
2018-05-01
2018-06-01
2018-07-01
2018-08-01
2018-09-01
2018-10-01
2018-11-01
2018-12-01


2019 TRS Monitoring Results (1-hour average) at Station Reno
Maximum= 4.95
TRS (ppbv)
0
1
2
3
2019-01-01
2019-02-01
2019-03-01
2019-04-01
2019-05-01
2019-06-01
2019-07-01
2019-08-01
2019-09-01
2019-10-01
2019-11-01
2019-12-01

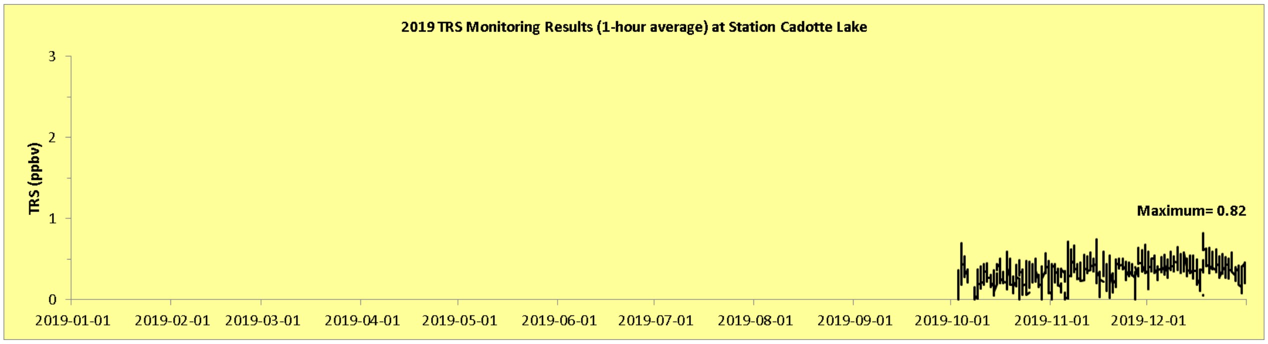
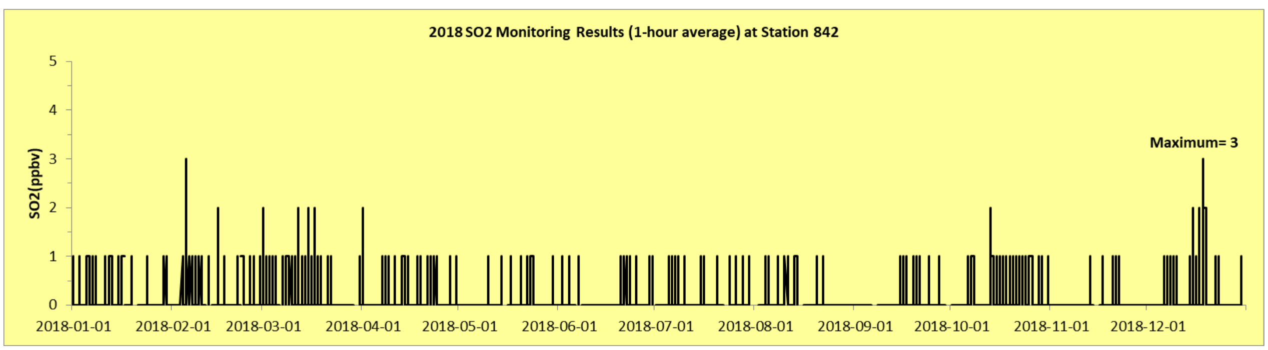


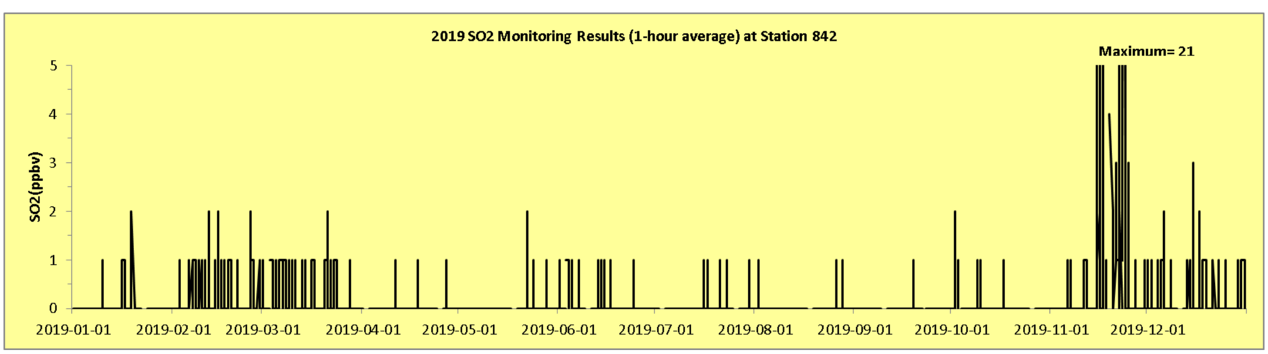
Figure 7: Hourly Monitored Total Reduced Sulphur Data

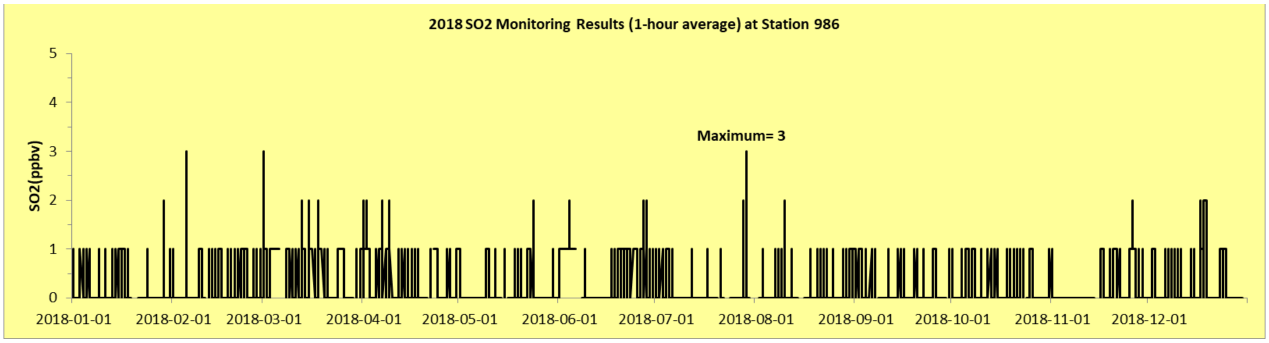
3.3.4. Sulphur Dioxide

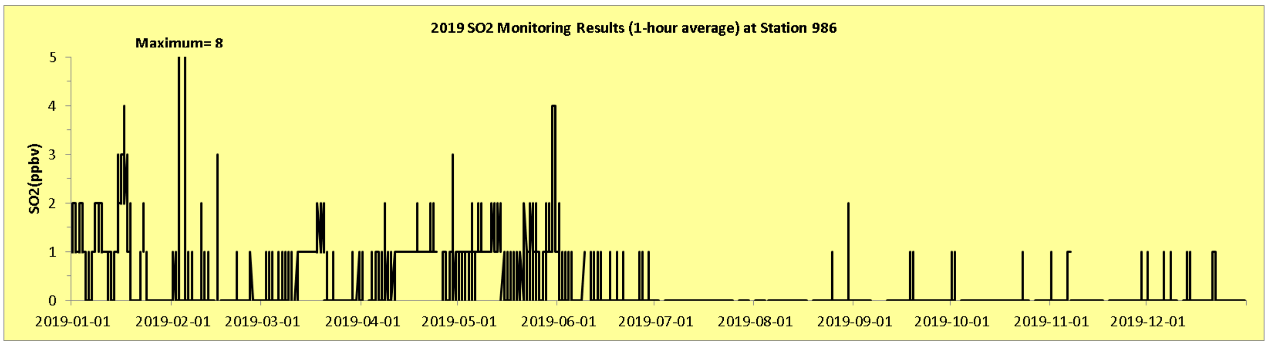
Hourly data for SO_2 for PRAMP's stations is shown in the charts below (Figure 12). The AAAQO for SO_2 is 172 ppbv.

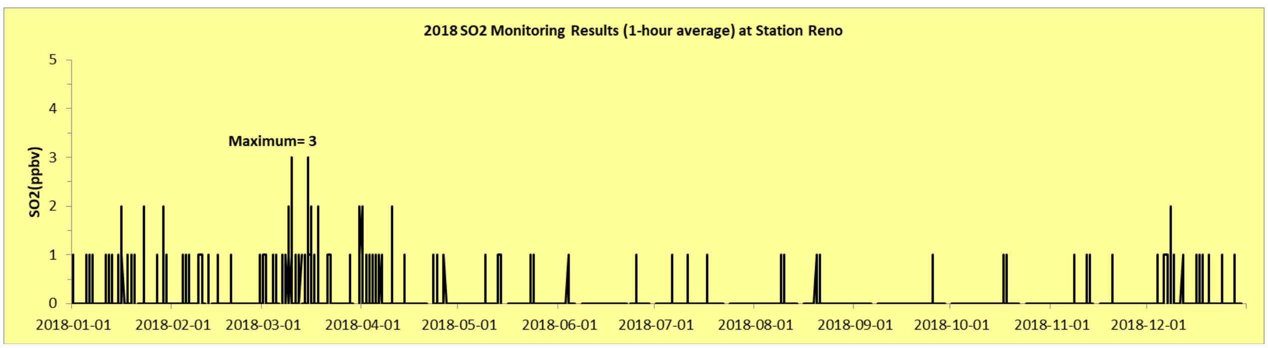
The maximum hourly SO_2 data for Station 842b, 986c, and Reno increased between 2018 and 2019. Although there was a increase in the maximum hourly measurement, elevated concentrations at all stations and years were nearly an order of magnitude lower than the Alberta Ambient Air Quality Objective.

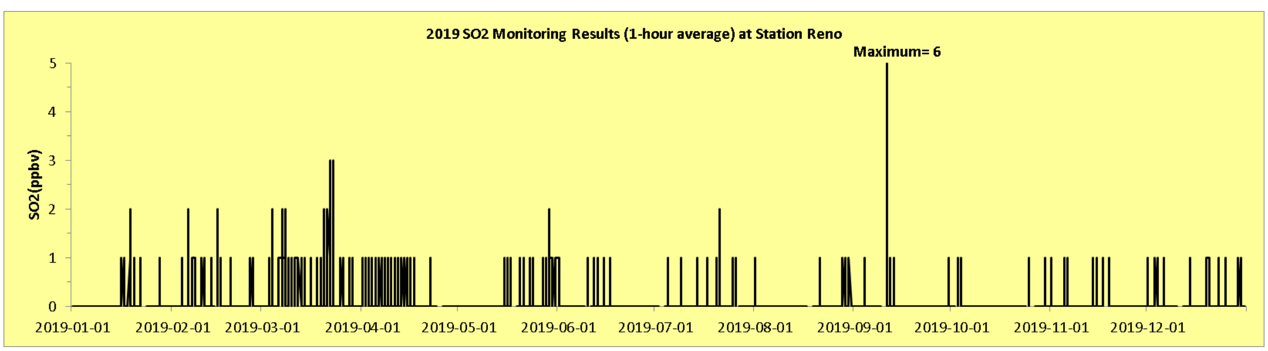





2018 SO2 Monitoring Results (1-hour average) at Station 986
SO2(ppbv)
Maximum= 3
0
1
2
3
4
5
2018-01-01
2018-02-01
2018-03-01
2018-04-01
2018-05-01
2018-06-01
2018-07-01
2018-08-01
2018-09-01
2018-10-01
2018-11-01
2018-12-01


2019 SO2 Monitoring Results (1-hour average) at Station 986
SO2(ppbv)
Maximum= 8
0
1
2
3
4
5
2019-01-01
2019-02-01
2019-03-01
2019-04-01
2019-05-01
2019-06-01
2019-07-01
2019-08-01
2019-09-01
2019-10-01
2019-11-01
2019-12-01


2018 SO2 Monitoring Results (1-hour average) at Station Reno
SO2(ppbv)
Maximum= 3
0
1
2
3
4
5
2018-01-01
2018-02-01
2018-03-01
2018-04-01
2018-05-01
2018-06-01
2018-07-01
2018-08-01
2018-09-01
2018-10-01
2018-11-01
2018-12-01


2019 SO2 Monitoring Results (1-hour average) at Station Reno
SO2(ppbv)
Maximum= 6
0
1
2
3
4
5
2019-01-01
2019-02-01
2019-03-01
2019-04-01
2019-05-01
2019-06-01
2019-07-01
2019-08-01
2019-09-01
2019-10-01
2019-11-01
2019-12-01

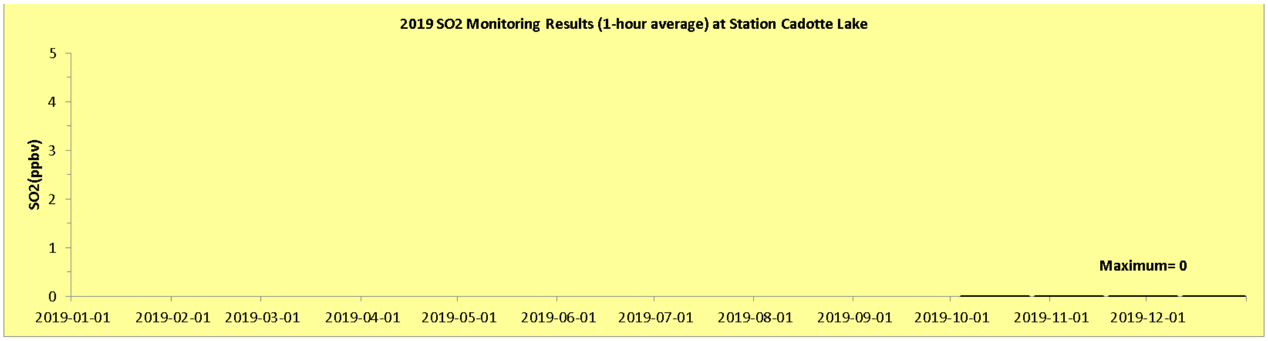
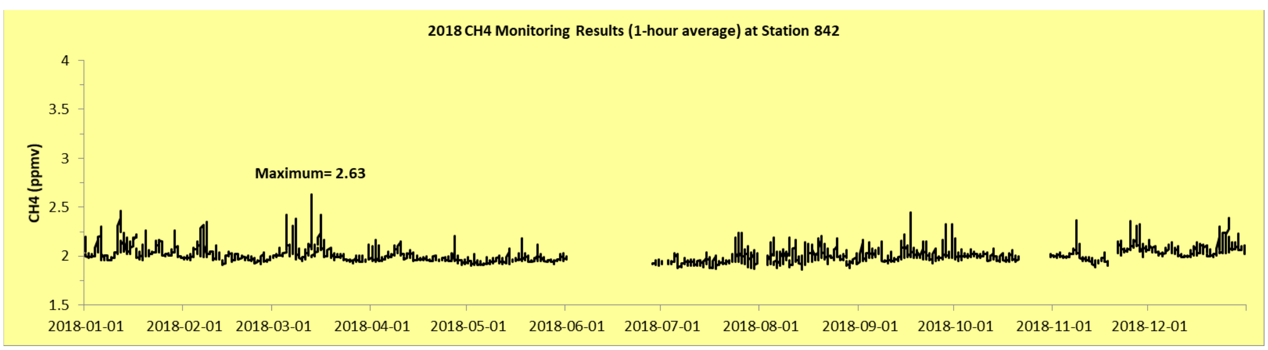


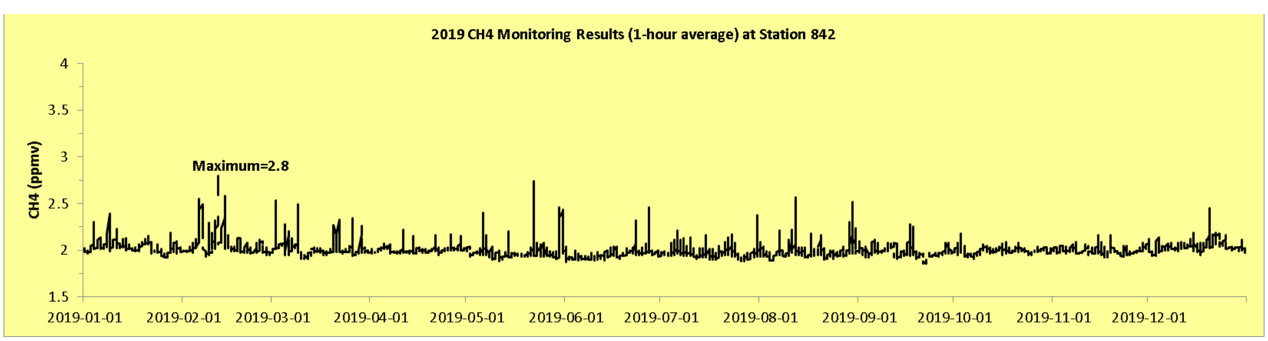
Figure 8: Hourly Monitored Sulphur Dioxide Data

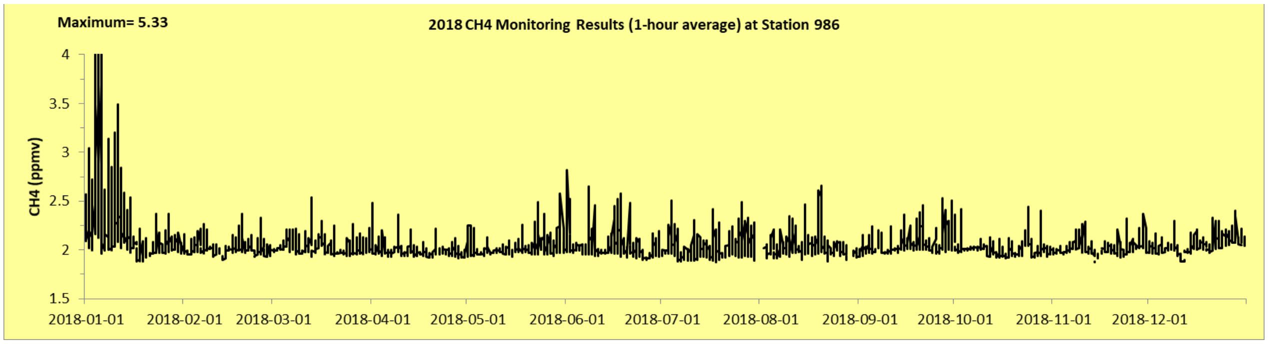
3.3.5. Methane

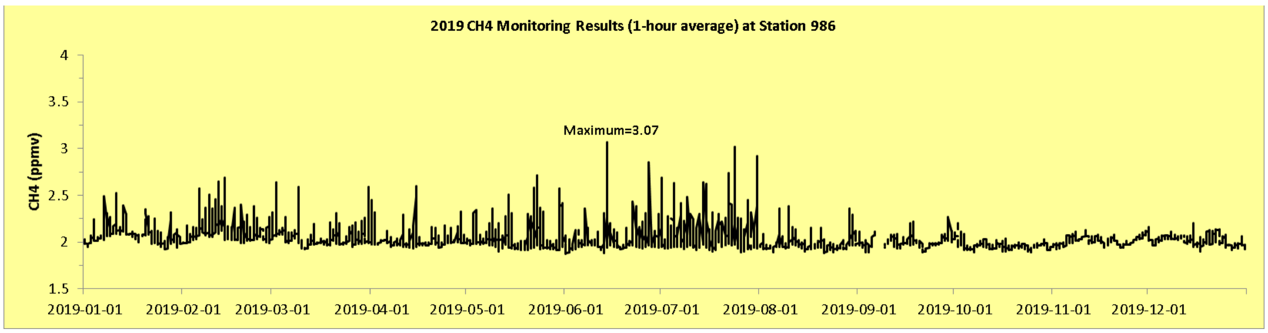
Hourly data for methane (CH_4) for the three stations is shown in the charts below (Figure 13). There is no AAAQO for CH_4. Instrument malfunction resulted in data loss in June 2018 at Station 842.

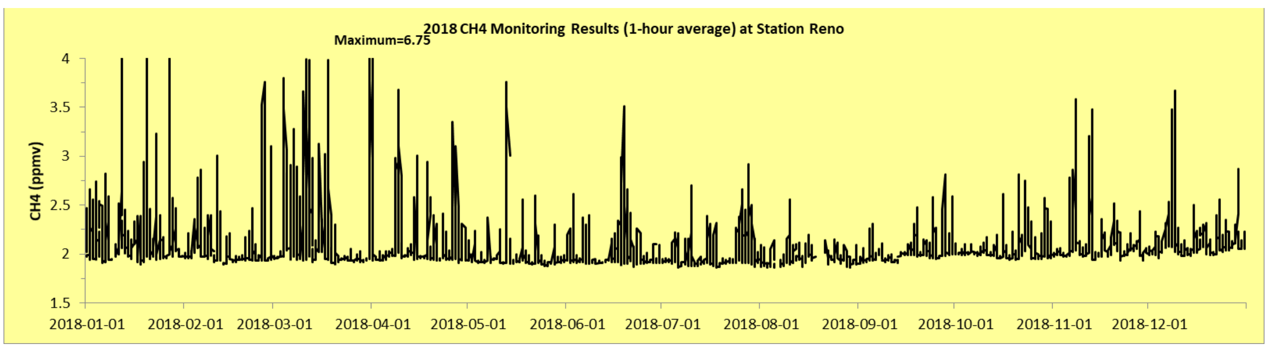
The maximum hourly CH_4 data for Station 842 increased slightly from 2018 to 2019. The maximum hourly CH_4 data for Station 986 decreased slightly from 2018 to 2019 due to station being moved away from grazing cattle. The Reno station shows a decrease in the number of elevated measurements of CH_4 between 2018 and 2019 however there was a slight increase in the maximum measured concentration.

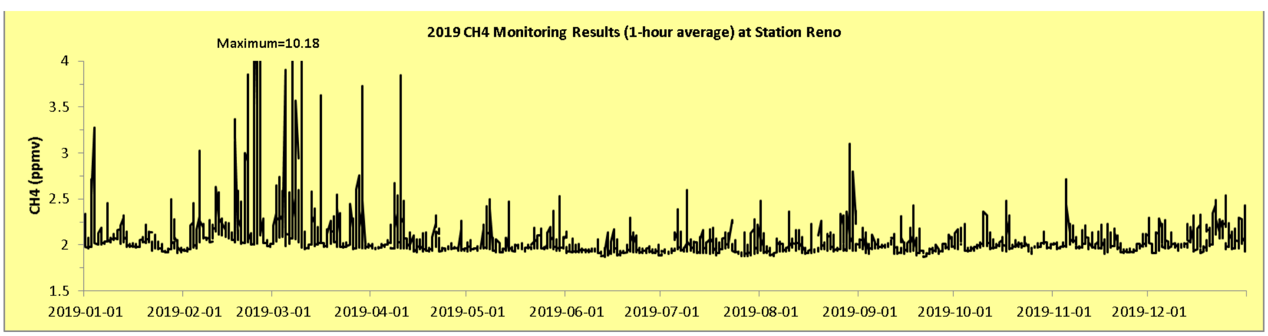





Maximum= 5.33
2018 CH4 Monitoring Results (1-hour average) at Station 986
CH4 (ppmv)
4
3.5
3
2.5
2
1.5
2018-01-01
2018-02-01
2018-03-01
2018-04-01
2018-05-01
2018-06-01
2018-07-01
2018-08-01
2018-09-01
2018-10-01
2018-11-01
2018-12-01


2019 CH4 Monitoring Results (1-hour average) at Station 986
Maximum=3.07
CH4 (ppmv)
4
3.5
3
2.5
2
1.5
2019-01-01
2019-02-01
2019-03-01
2019-04-01
2019-05-01
2019-06-01
2019-07-01
2019-08-01
2019-09-01
2019-10-01
2019-11-01
2019-12-01


2018 CH4 Monitoring Results (1-hour average) at Station Reno
Maximum=6.75
CH4 (ppmv)
4
3.5
3
2.5
2
1.5
2018-01-01
2018-02-01
2018-03-01
2018-04-01
2018-05-01
2018-06-01
2018-07-01
2018-08-01
2018-09-01
2018-10-01
2018-11-01
2018-12-01


2019 CH4 Monitoring Results (1-hour average) at Station Reno
Maximum=10.18
CH4 (ppmv)
4
3.5
3
2.5
2
1.5
2019-01-01
2019-02-01
2019-03-01
2019-04-01
2019-05-01
2019-06-01
2019-07-01
2019-08-01
2019-09-01
2019-10-01
2019-11-01
2019-12-01

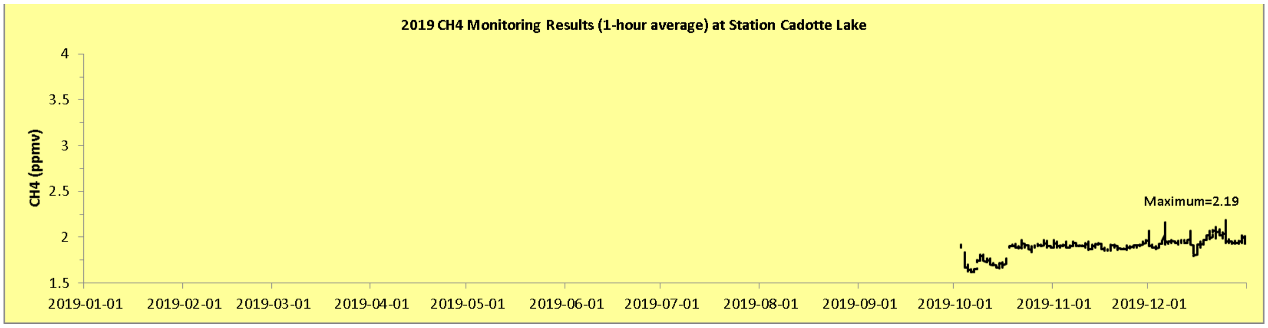


Figure 9: Hourly Monitored Methane Data

3.4. Monthly Data Analysis

The hourly data presented in this section were analyzed to determine the maximum, 99th percentile, and average of hourly concentrations for each month of data. Calculating percentiles allows data to be grouped based on the percentage of values that fall below a specific value. Arranging the data into percentile ranks can provide insight to the distribution of data and is helpful for understanding outlying values. For example, the 99th percentile value represents the value at which 99% of the data falls below.

Analyses are often carried out using a higher percentile instead of the true maximum as it is a more representative value of the full dataset and is less likely to be impacted by extreme data points. Trend lines of the non-zero series are presented to examine if the series have an increasing or decreasing behavior from January 2018 to December 2019 for all stations. Variation between the seasons is expected due to the impacts of climate on ambient concentration.

3.4.1. Total Hydrocarbons

The THC trends for the maximum, 99th percentile and average by month for each site are shown on the following figures. Table 1 presents the minimum and maximum monthly 99th percentile THC for each year. Reno shows the most noticeable decreasing trend of maximum and 99th percentile metrics.

Table 1: Minimum and Maximum of 99th Percentile in Each Month of THC Concentrations (2018 and 2019)

Station	2018		2019	
	Minimum (ppmv)	Maximum (ppmv)	Minimum (ppmv)	Maximum (ppmv)
842	2.09*	2.42*	1.86	3.28
986	2.22	4.04	1.87	3.14
Reno	2.38	3.76	1.87	10.23

** 842 Station 99th Percentile for June 2018 was excluded from the calculation. Due to equipment failure, only 9.2% of valid data were collected in June 2018.*

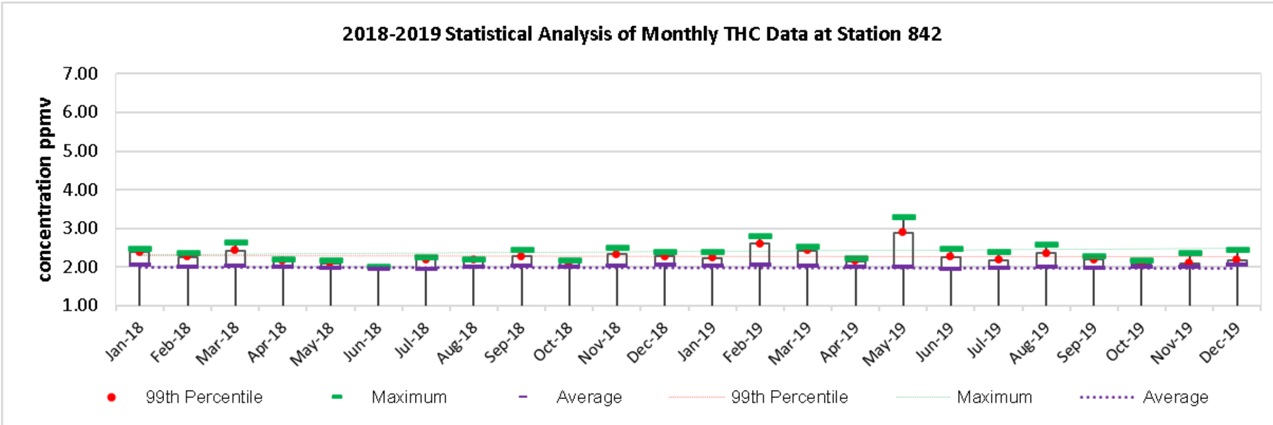


Figure 10: Total Hydrocarbons Data and Trends at Station 842

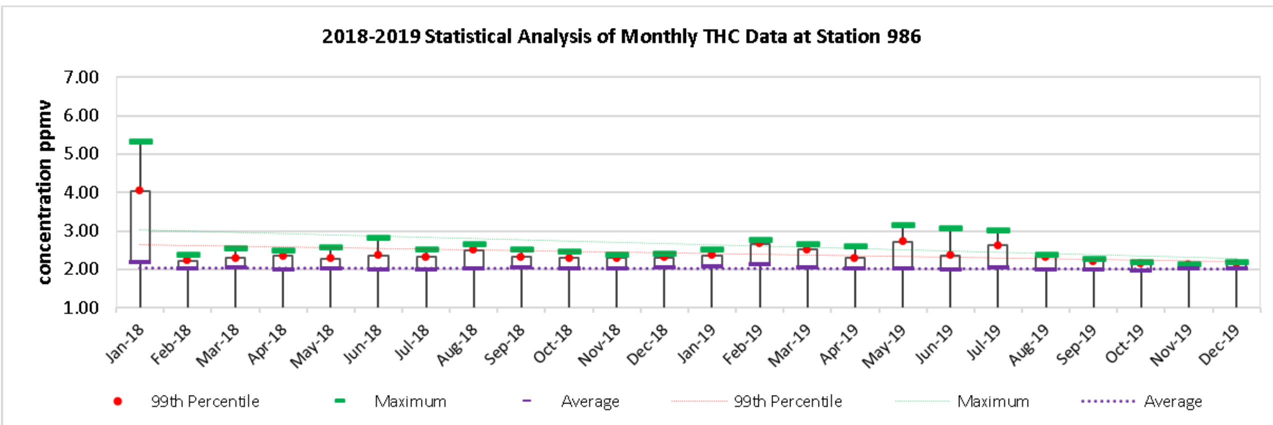


Figure 11: Total Hydrocarbons Data and Trends at Station 896

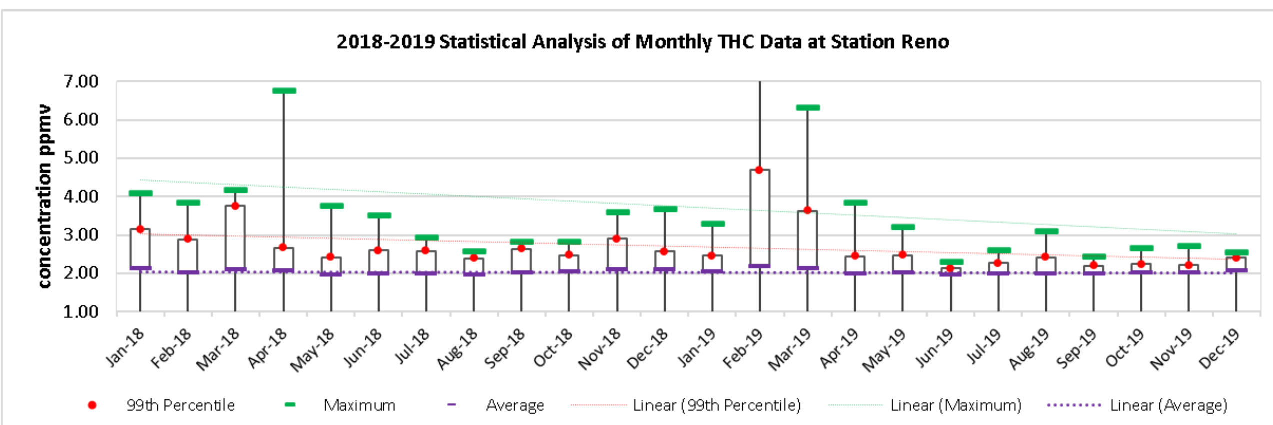


Figure 12: Total Hydrocarbons Data and Trends at Reno Station

3.4.2. Non-Methane Hydrocarbons

The NMHC trends for the maximum, 99th percentile, and average by month for each site are shown on the following figures. Although there appears to be a slight increasing trend at all stations for the 99th percentile, every station in the network affected by the extreme NMHC values that the Chuckegg Creek fire caused in 2019.

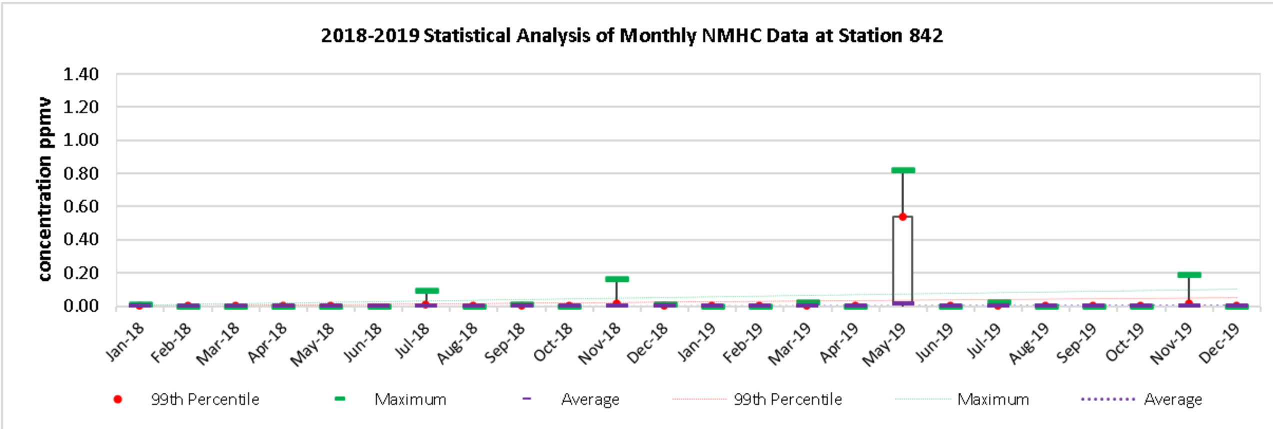


Figure 13: Non-methane Hydrocarbon Data and Trends at Station 842

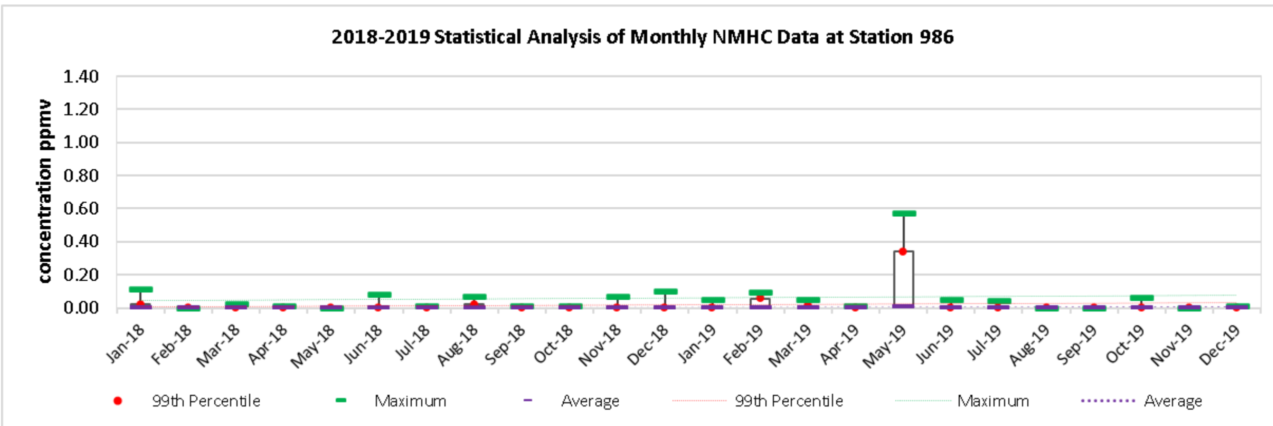


Figure 14: Non-methane Hydrocarbon Data and Trends at Station 986

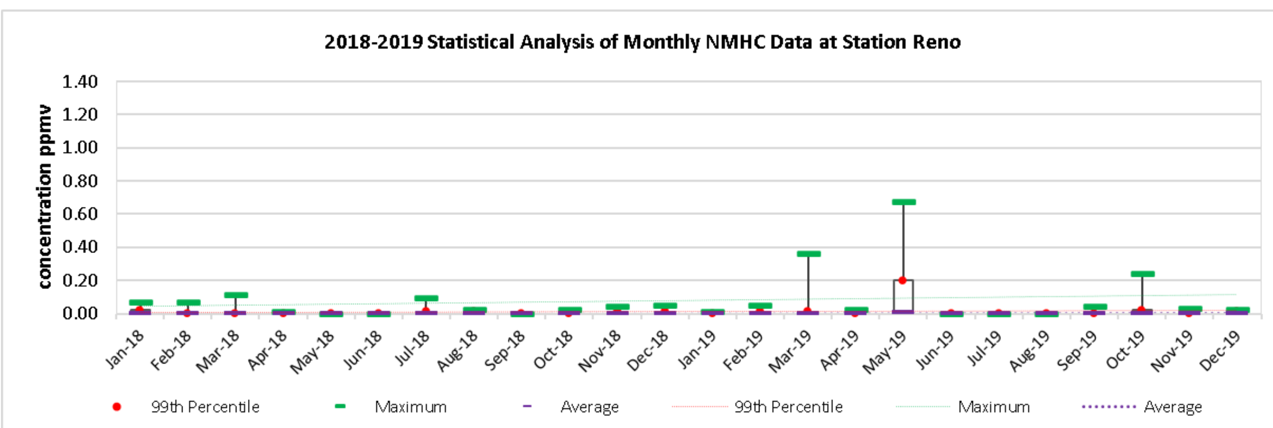


Figure 15: Non-methane Hydrocarbon Data and Trends at Reno Station

3.4.3. Total Reduced Sulphur

The TRS trends for the maximum, 99th percentile and average by month for each site are shown on the following figures. While the TRS average appears to remain unchanged, the maximum and 99th percentile values are being influenced by elevated summertime concentrations (likely sloughs and other natural phenomenon).

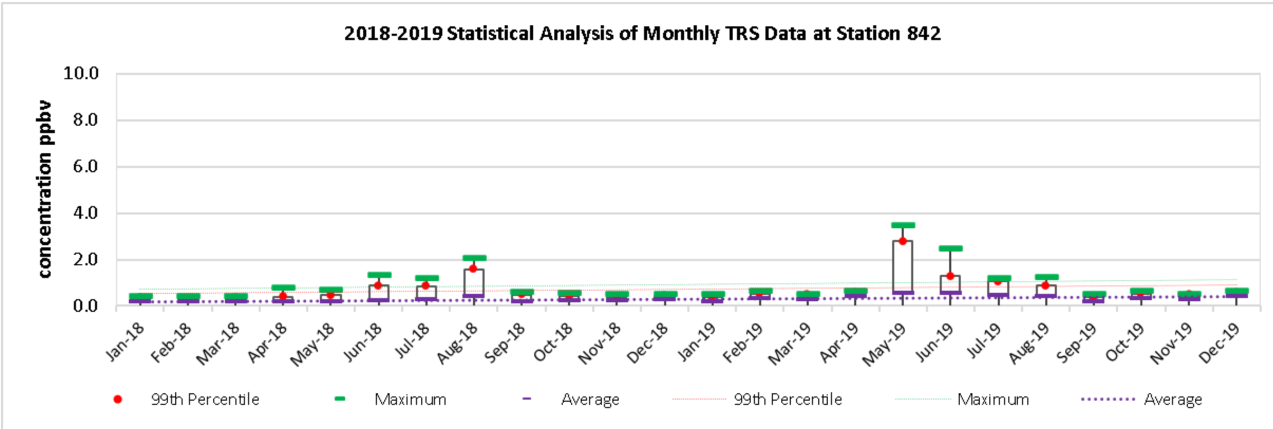


Figure 16: Total Reduced Sulphur Data and Trends at Station 842

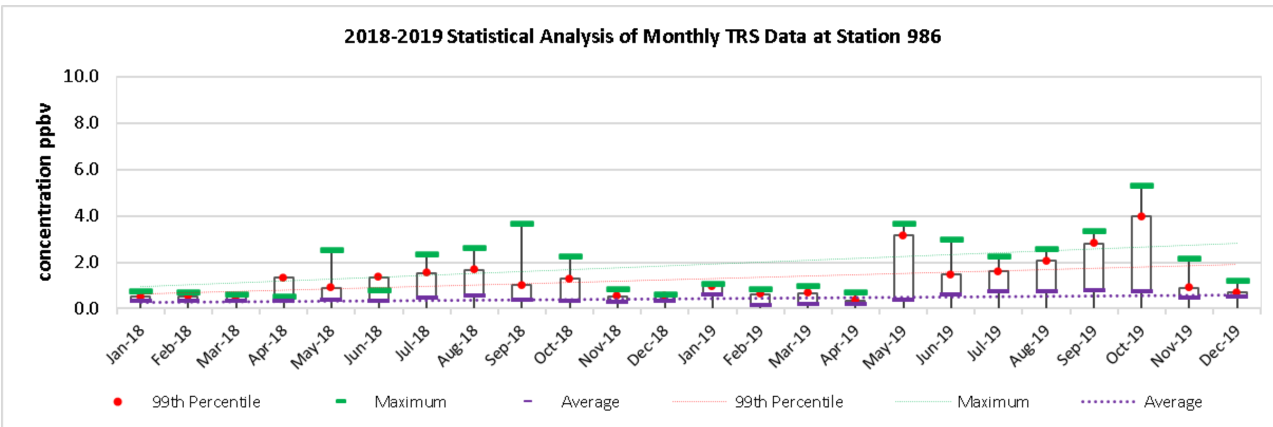


Figure 17: Total Reduced Sulphur Data and Trends at Station 986

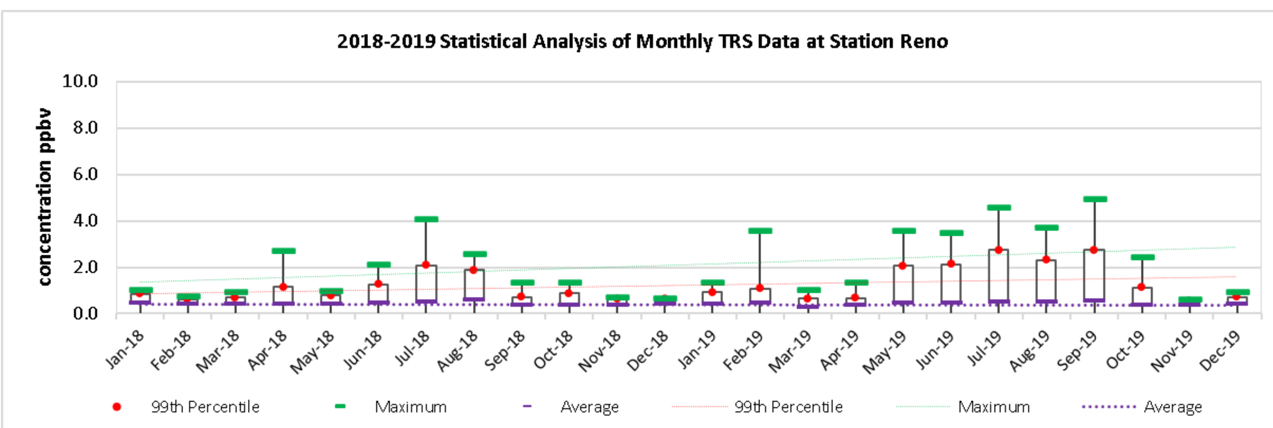


Figure 18: Total Reduced Sulphur Data and Trends at Reno Station

3.4.4. Sulphur Dioxide

The SO_2 trends for the maximum, 99th percentile and average by month for each site are shown on the following figures.

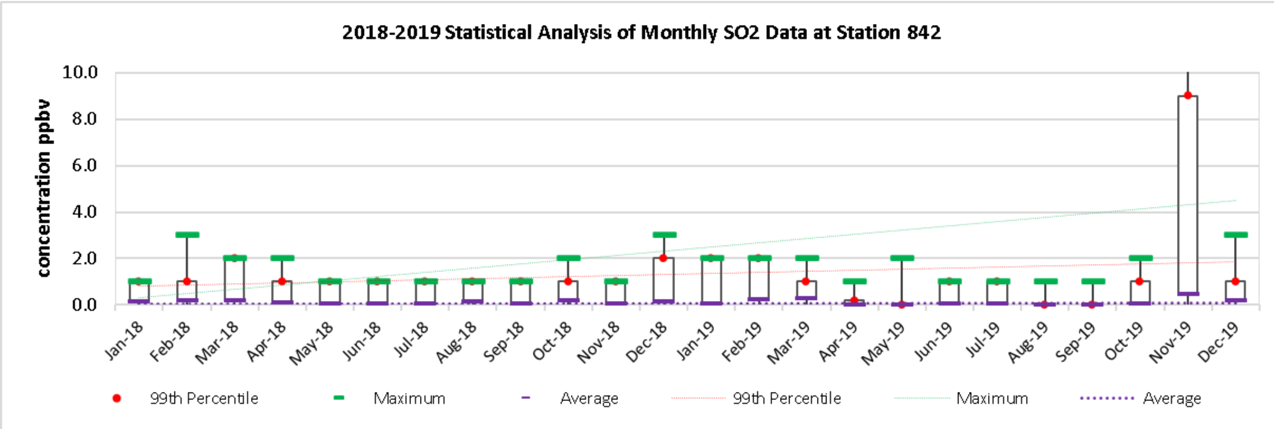


Figure 19: Sulphur Dioxide Data and Trends at Station 842

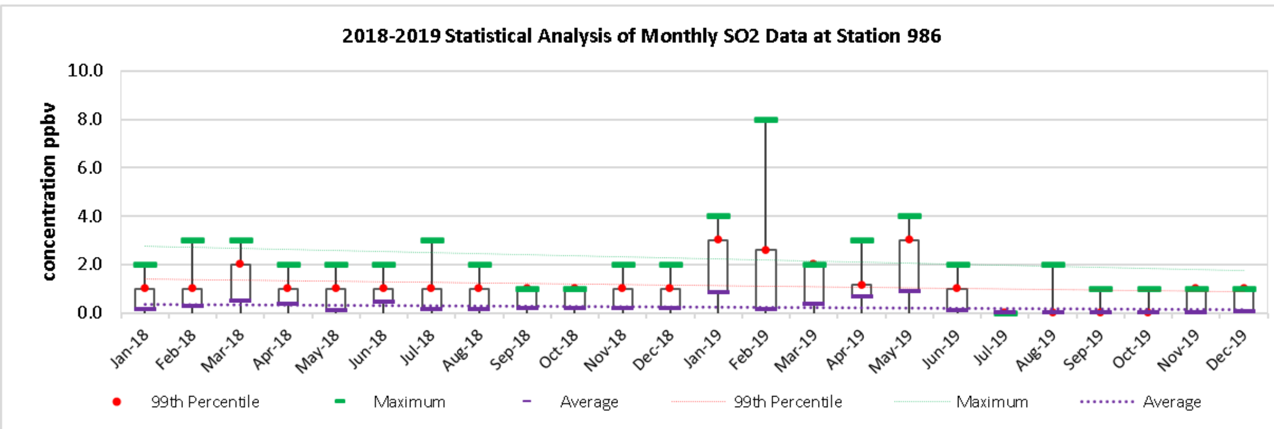


Figure 20: Sulphur Dioxide Data and Trends at Station 986

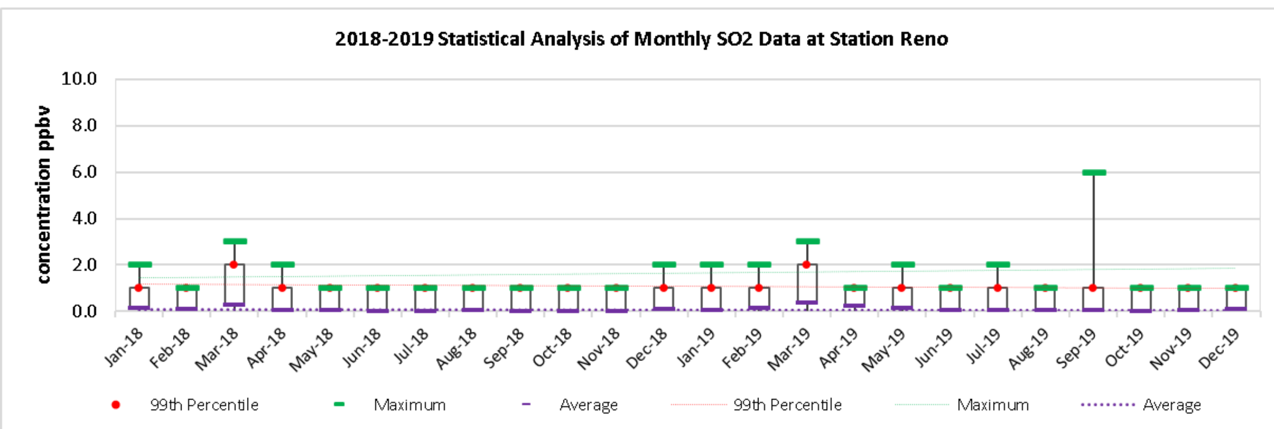


Figure 21: Sulphur Dioxide Data and Trends at Reno Station

3.4.5. Methane

The CH4 trends for the maximum, 99th percentile and average by month for each site are shown on the following figures.

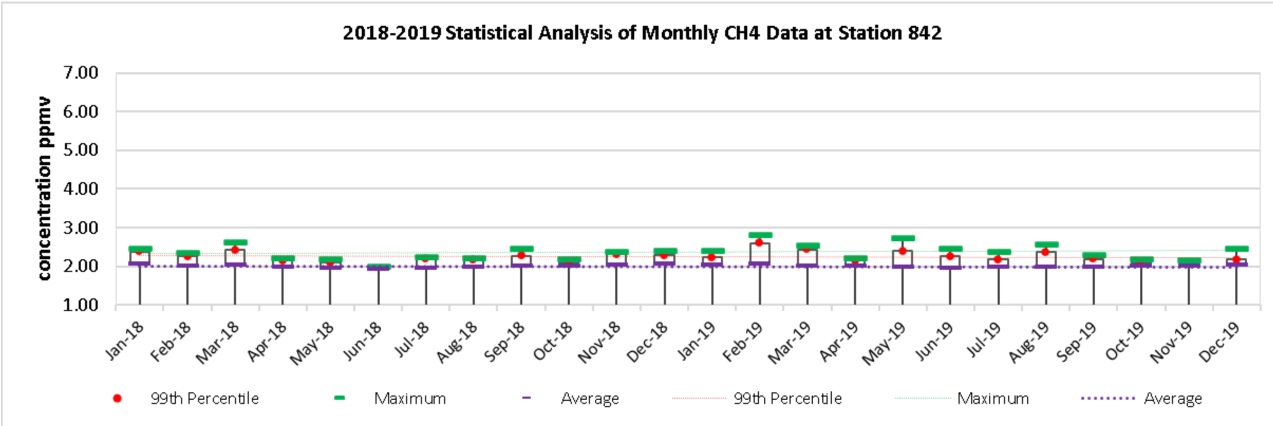


Figure 22: Methane Data and Trends at Station 842

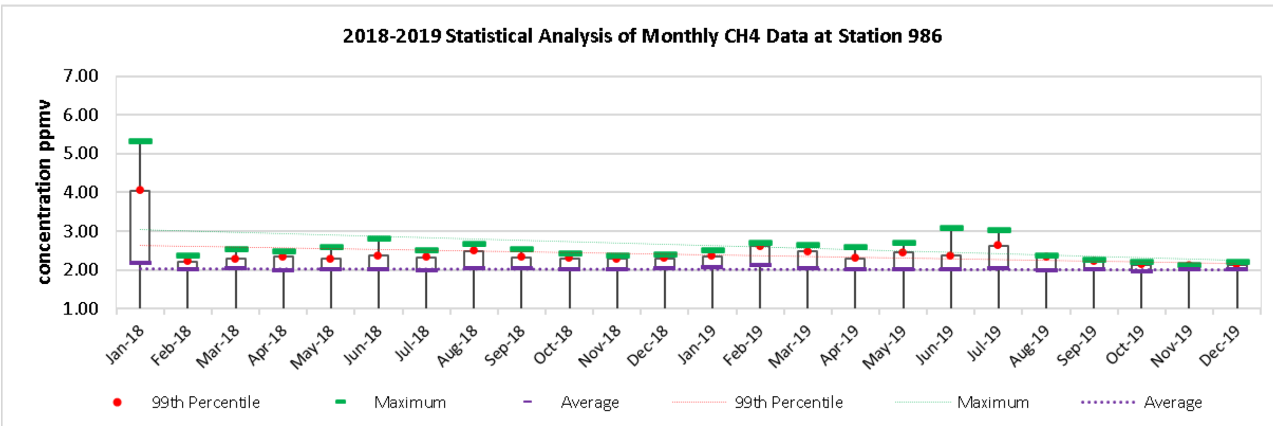


Figure 23: Methane Data and Trends at Station 986

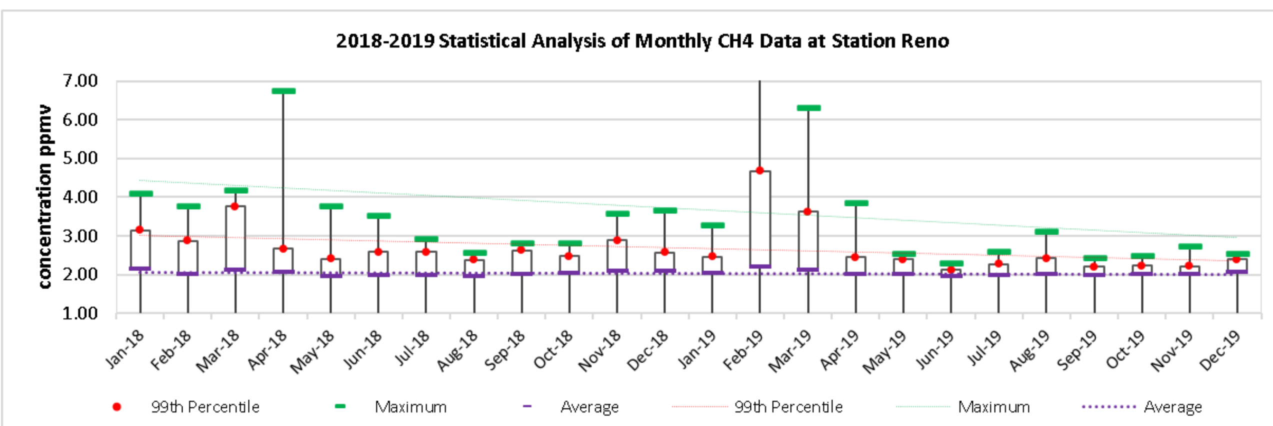


Figure 24: Methane Data and Trends at the Reno Station

3.4.6. Summary

In general, maximum and average values provide useful statistics but are often an over-simplified and inadequate representation of a dataset. For the measured results, the maximum values tend to fluctuate greatly and the average concentrations stay relatively stable and close to 0 ppm or ppb, for NMHC, and TRS and SO_2, respectively. However, as the 99th percentile is influenced by the distribution of the data, it provides a useful statistic for analyzing trends in a dataset.

The monthly data analysis for all stations shows that the 99th percentile data for most substances that PRAMP has historically been concerned about, namely hydrocarbons, have decreased or stayed the same over the reporting periods. The forest fire smoke event in May 2019 that caused elevated NMHC concentrations had and upward influence on the summary statistics and these data may be considered outliers. TRS concentrations appear to be increasing however the pattern is limited to the warmer months which suggests that there may be natural sources influencing these changes such as shallow sloughs and wetlands.

The correlation between values and wind directions are presented in the concentration roses (Section 3.6), which will assist in identifying from where predominant winds are carrying pollutants.

3.5. Annual Data Analysis

Analysis was completed for each station for 2018 and 2019 by calculating the maximum, 99th, 90th, 50th percentiles and minimum value of the 1-hour concentrations for each year for THC, NMHC, TRS, SO_2, and CH_4. Similar to the 99th percentile, 90th percentile and 50th percentile metrics indicate that 90% and 50% of data fall below that value respectively. Calculating percentiles allow data to be grouped based on the percentage of values that fall below a specific value. Arranging the data into percentile ranks can provide insight to the distribution of data and is helpful for understanding outlying values. By definition, the 50th percentile represents the median of the dataset. The results of this analysis are shown in Tables 2 and 3. The annual 99th percentile concentrations for Stations 986c, 842b, and Reno were generally lower or stayed about the same in in 2019 compared to 2018.

Table 2: 2018 Monitoring Data Percentiles

Location	Rank	THC (ppmv)	NMHC (ppmv)	TRS (ppbv)	SO2 (ppbv)	CH4 (ppmv)
Station 842 [1]	**Average**	2.00	0.00	0.22	0	2.00
	Maximum	2.63	0.16	2.05	3	2.63
	99th percentile	2.24	0.00	0.58	1	2.24
	90th percentile	2.07	0.00	0.32	1	2.07
	50th percentile	1.99	0.00	0.20	0	1.99
	Minimum	1.86	0.00	0.00	0	1.86
Station 986	**Average**	2.02	0.00	0.34	0	2.02
	Maximum	5.33	0.11	3.68	3	5.33
	99th percentile	2.46	0.00	0.98	1	2.46
	90th percentile	2.13	0.00	0.52	1	2.13
	50th percentile	2.00	0.00	0.32	0	2.00
	Minimum	1.87	0.00	0.00	0	1.87
Reno	**Average**	2.03	0.00	0.42	0	2.03
	Maximum	6.76	0.11	4.06	3	6.75
	99th percentile	2.75	0.01	1.02	1	2.75
	90th percentile	2.18	0.00	0.57	0	2.18
	50th percentile	1.97	0.00	0.41	0	1.95
	Minimum	1.86	0.00	0.14	0	1.86
AAAQO*	**1-hour**	-	-	-	172	-

[1] 842 Station 99 Percentile for June 2018 was excluded from the calculation. Due to equipment failure, only 9.2% of valid data were collected in June 2018.
* Source: Alberta Ambient Air Quality Objectives and Guidelines Summary (AEP 2019)

Table 3: 2019 Monitoring Data Percentiles

Location	Rank	THC (ppmv)	NMHC (ppmv)	TRS (ppbv)	SO2 (ppbv)	CH4 (ppmv)
Station 842	Average	2.00	0.09	0.36	0	2.00
	Maximum	3.28	0.82	3.48	21	2.80
	99th percentile	2.30	0.05	0.83	2	2.26
	90th percentile	2.05	0.00	0.49	0	2.05
	50th percentile	1.98	0.00	0.35	0	1.98
	Minimum	1.86	0.00	0.05	0	1.86
Station 986	Average	2.02	0.00	0.49	0	2.02
	Maximum	3.14	0.57	5.31	8	3.07
	99th percentile	2.37	0.03	1.60	1	2.34
	90th percentile	2.11	0.00	0.75	0	2.10
	50th percentile	2.00	0.00	0.40	0	2.00
	Minimum	1.87	0.00	0.00	0	1.87
Reno	Average	2.02	0.00	0.42	0	2.02
	Maximum	10.23	0.67	4.95	6	10.18
	99th percentile	2.63	0.02	1.47	1	2.62
	90th percentile	2.11	0.00	0.58	0	2.11
	50th percentile	1.99	0.00	0.36	0	1.99
	Minimum	1.87	0.00	0.04	0	1.87
AQHI - Cadotte Lake[1]	Average	1.92	0.00	0.34	0	1.92
	Maximum	2.43	0.33	0.82	0	2.19
	99th percentile	2.08	0.07	0.61	0	2.01
	90th percentile	1.98	0.00	0.46	0	1.97
	50th percentile	1.92	0.00	0.34	0	1.92
	Minimum	1.79	0.00	0.00	0	1.79
AAAQO*	1-hour	-	-	-	172	-

* Source: Alberta Ambient Air Quality Objectives and Guidelines Summary (AEP 2019)

[1] : Station was installed in October 2019. Metrics are calculated based on the valid data from October to December.

3.6. Concentration Roses for Continuous Monitoring Data

Much the same as wind roses, concentration roses show the frequency of contaminant concentrations travelling with winds blowing from a particular direction over a specified period. The length of each 'spoke' around the circle is related to the frequency of that concentration of the contaminant occurring.

Concentration roses will have the same shape as wind roses. The focus is on which direction the higher concentrations come from.

3.6.1. Total Hydrocarbons

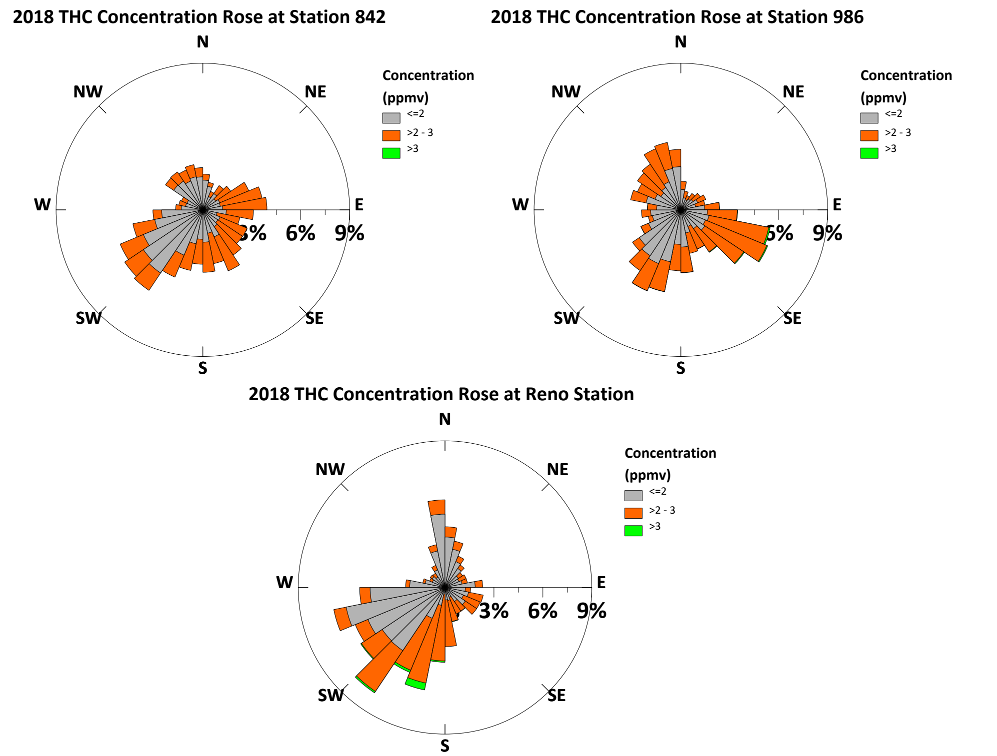


Figure 25: Total Hydrocarbons Concentration Roses for 2018 at Station 842, Station 986, and Reno Station

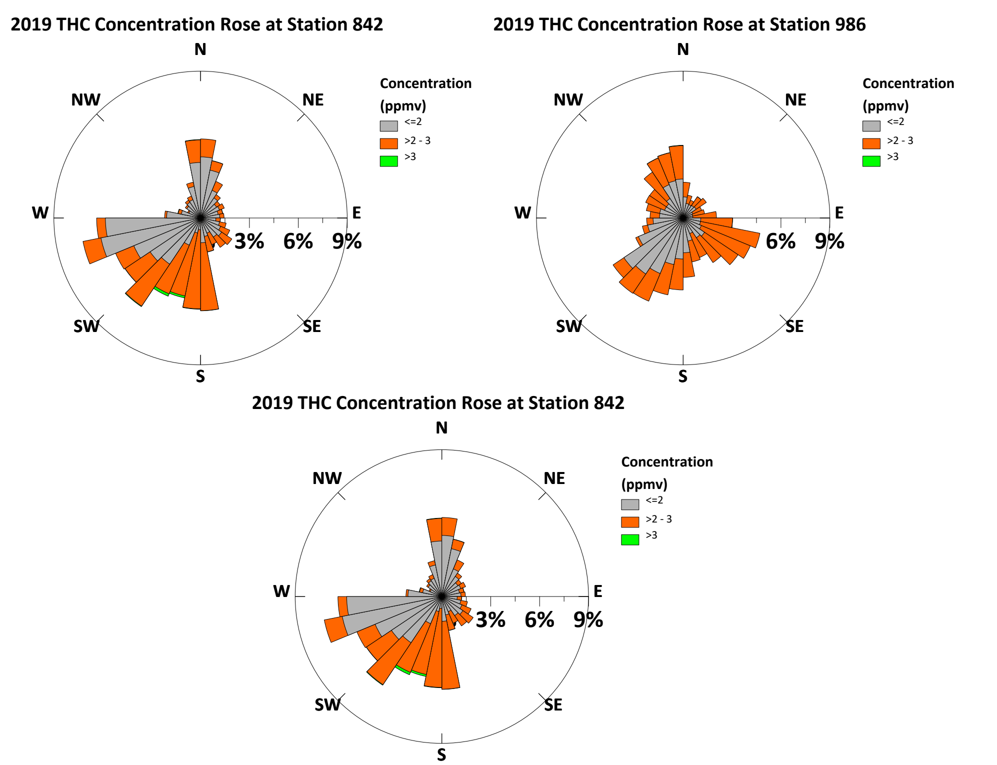


Figure 26: Total Hydrocarbons Concentration Roses for 2019 at Station 842, Station 986, and Reno Station

3.6.2. Non-methane Hydrocarbons

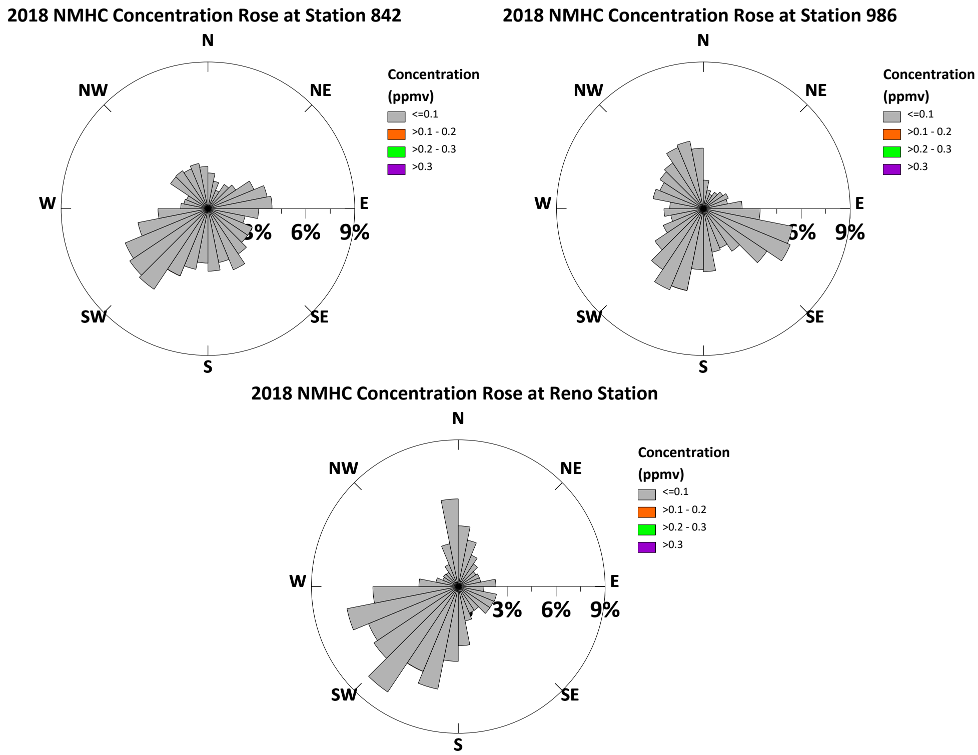


Figure 27: Non-methane Hydrocarbons Concentration Roses for 2018 at Station 842, Station 986, and Reno Station

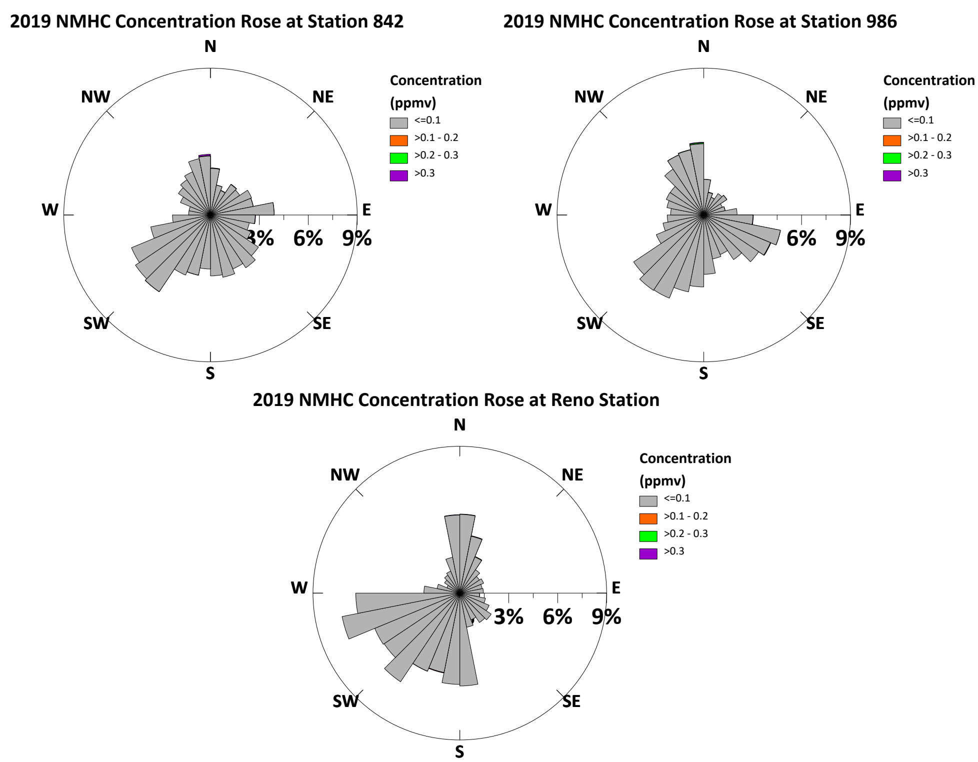


Figure 28: Non-methane Hydrocarbons Concentration Roses for 2019 at Station 842, Station 986, and Reno Station

3.6.3. Total Reduced Sulphur

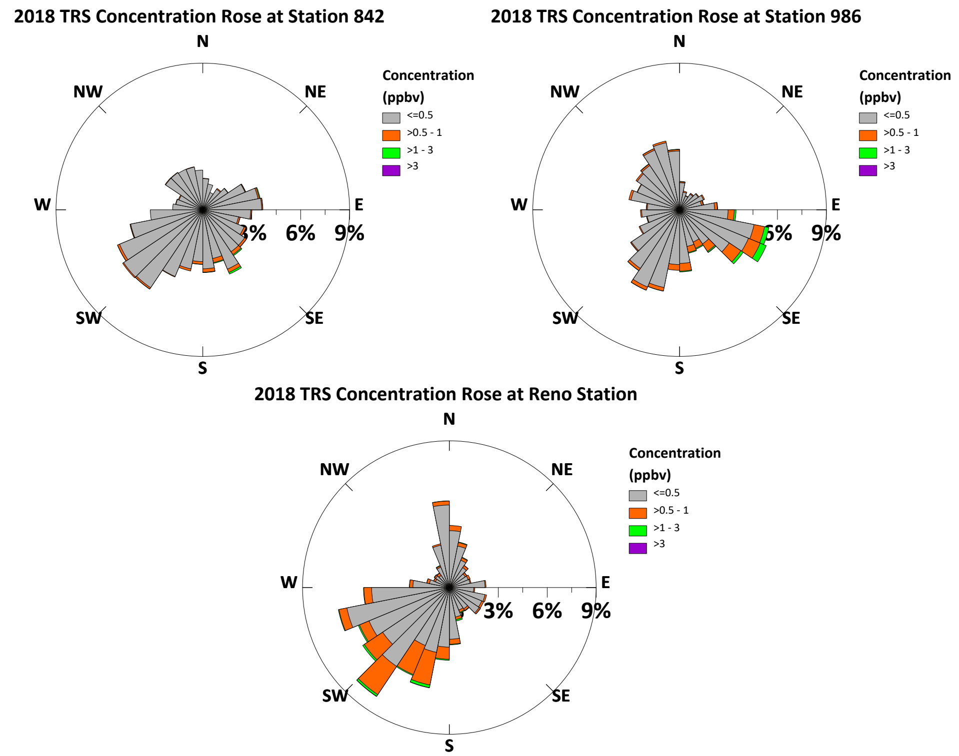


Figure 29: Total Reduced Sulphur Concentration Roses for 2018 at Station 842, Station 986, and Reno Station

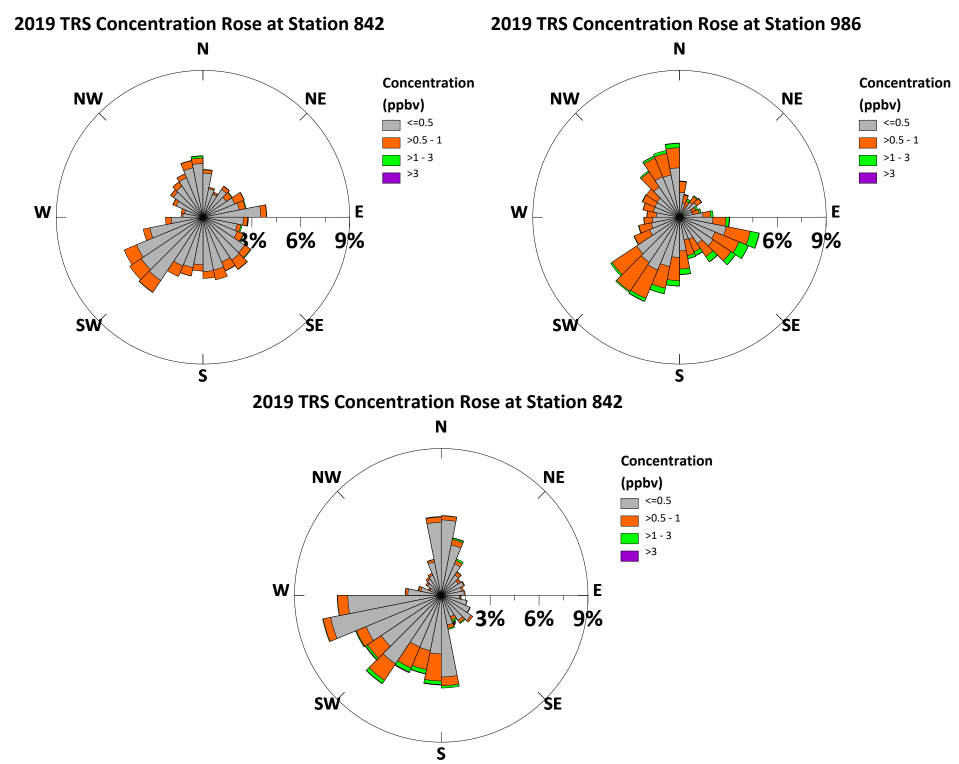


Figure 30: Total Reduced Sulphur Concentration Roses for 2019 at Station 842, Station 986, and Reno Station

3.6.4. Sulphur Dioxide

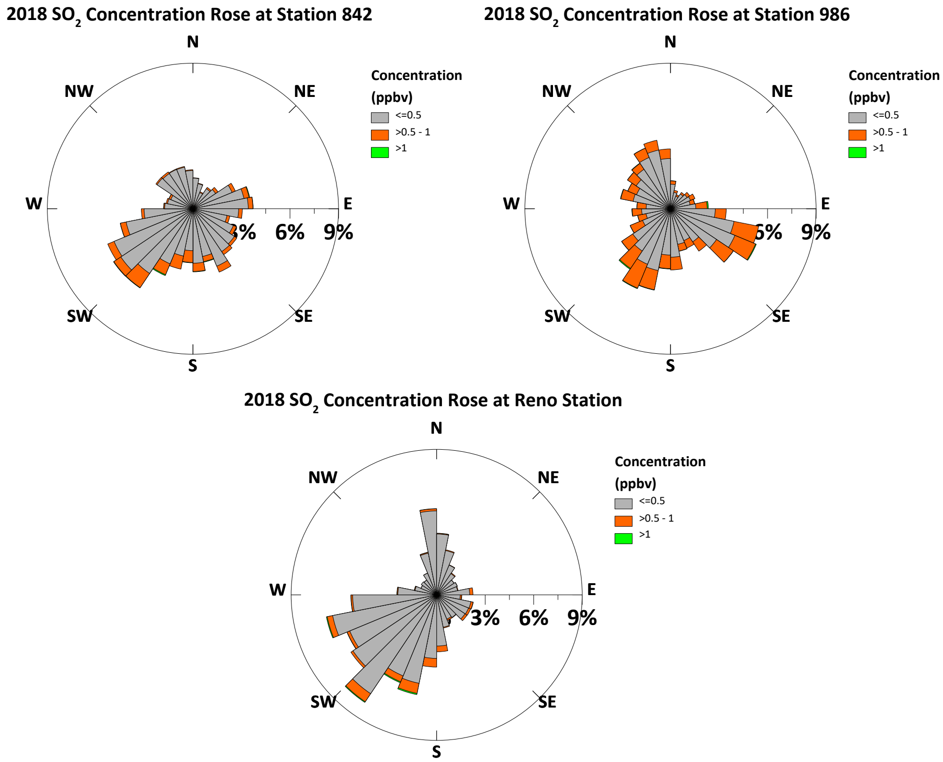


Figure 31: Sulphur Dioxide Concentration Roses for 2018 at Station 842, Station 986, and Reno Station

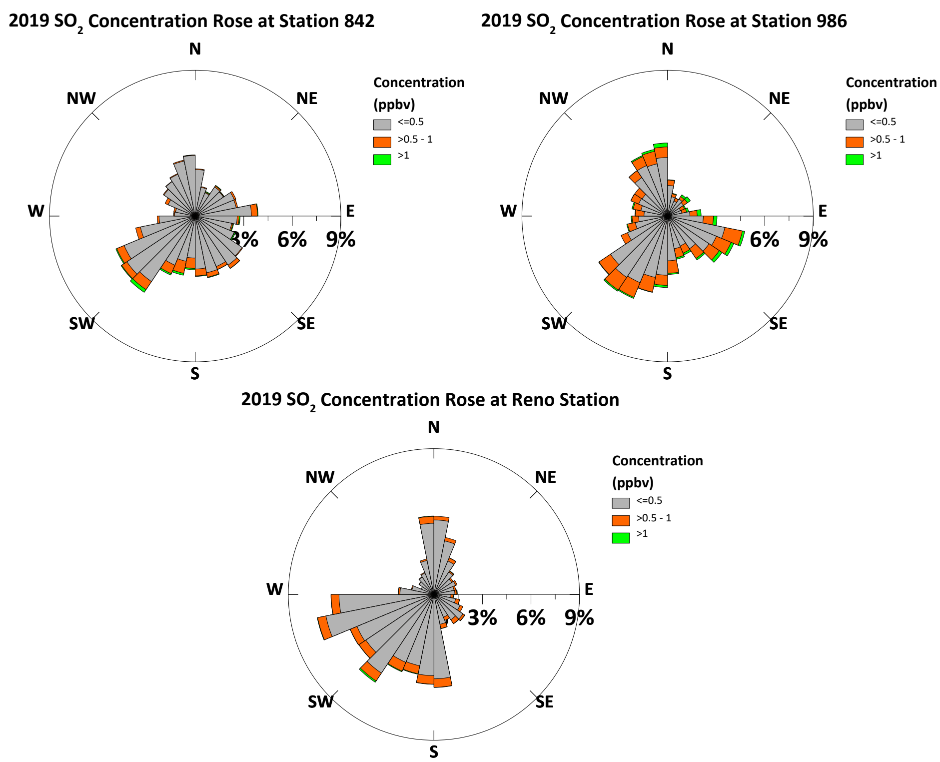


Figure 32: Sulphur Dioxide Concentration Roses for 2019 at Station 842, Station 986, and Reno Station

3.6.5. Methane

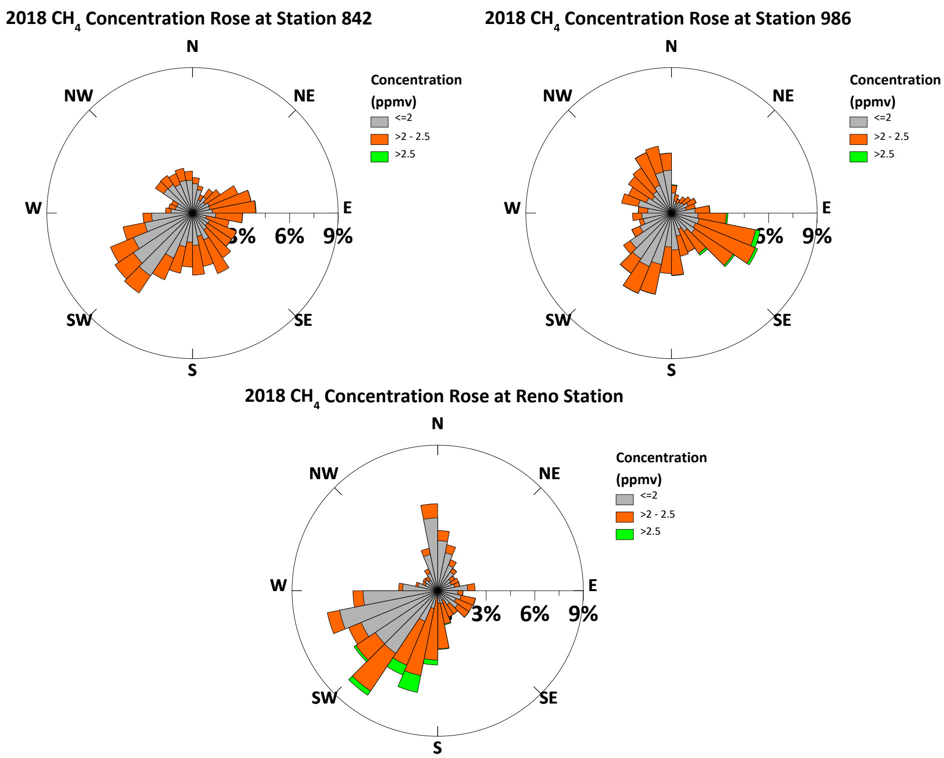


Figure 33: Methane Concentration Roses for 2018 at Station 842, Station 986, and Reno Station

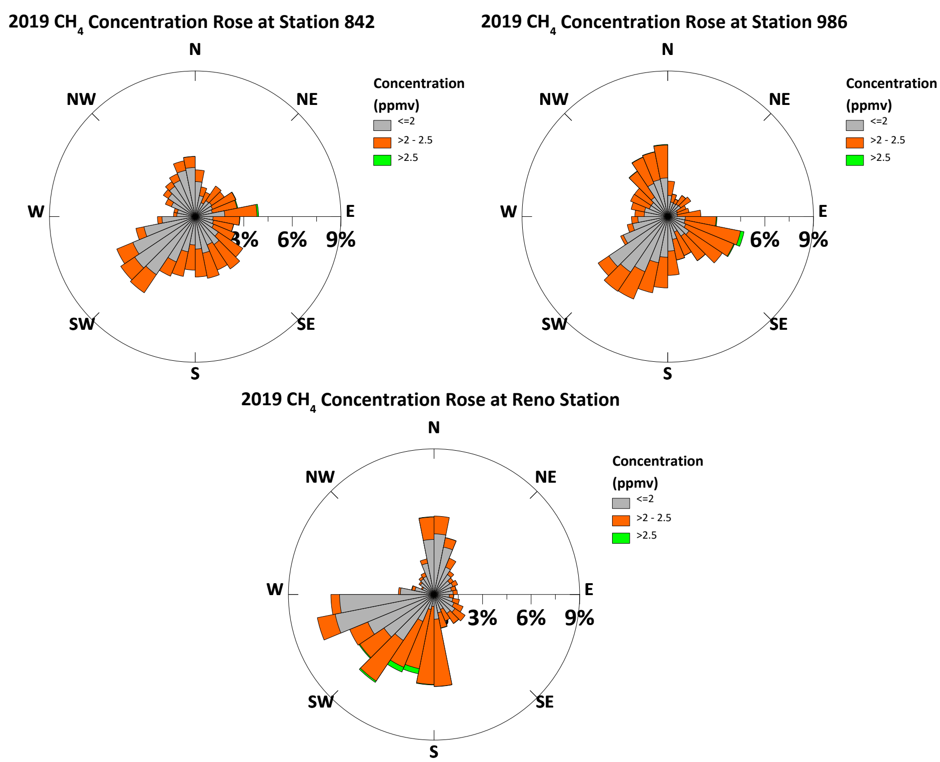


Figure 34: Methane Concentration Roses for 2019 at Station 842, Station 986, and Reno Station

3.6.6. Summary

Elevated concentrations of methane and non-methane hydrocarbons at the Reno Station indicate that elevated values are likely due to the heavy oil wells and batteries are near the station. Heavy oil wells and batteries are south-southwest and southwest of the Reno station and the elevated hydrocarbon concentrations are predominantly coming from these directions. As noted in previous Annual Data Reviews, oil field infrastructure near the Reno Station is much closer compared to Station 986 and 842. The facilities nearest Station 986 and 842 are approximately 6km and 4km away, however at the Reno Station, similar facilities are 300 - 500m away which represents an order of magnitude difference. Over time, hydrocarbon concentrations have decreased in the Reno area and there was a lower frequency of elevated hydrocarbon concentrations in 2019 compared to 2018.

At Station 986 and 842, other sources not related to heavy oil operations are likely contributing to elevated readings of other pollutants including SO_2; other industry in the vicinity includes non-heavy oil facilities, land fill stations, agricultural operations and a relatively close pulp mill operation. Cattle grazing south of Station 986 are the likely source of methane when wind is coming from that direction.

4. TRIGGERED VOLATILE ORGANIC COMPOUND SAMPLING

The canister sampling program collects a 1-hour sample of air when the continuously measured methane and/or non-methane hydrocarbon concentration reaches a specified trigger point. The current trigger points are 5.5 ppm for methane and 0.3 ppm for non-methane hydrocarbons. Both trigger points are based on real-time monitoring data that are averaged over a 5-minute period. Canisters sample collection systems are in place at Station 986c, 842b, and the Reno Station; a canister sample collection system is not part of the suite of instruments currently deployed at the AQHI-Cadotte Lake Station.

All canister samples were taken to a laboratory for analysis of over 140 VOC compounds and total reduced sulphur compounds. Time and date of the canister sampling was recorded and used to cross reference the sample to the monitored data and retrieve the associated wind direction and speed.

In early 2019, the methane trigger was added to the network; prior to this, canister samples were only triggered on non-methane hydrocarbon concentrations. The methane-based samples were added to the program to help differentiate potential sources of elevated methane using isotopic analysis; work on isotopic analysis is expected to be complete in 2021.

The 2018 and 2019 non-methane triggered canister VOC sampling results are presented in Table 4 and 5, respectively; the top twelve compounds, of the 100+ compounds that the samples were analyzed for at the laboratory (based on highest concentrations) are summarized. Table 6 presents the methane triggered canister VOC sampling results for 2019. A comparison of the data to available AAAQO (AEP 2019) was conducted. A complete list of species for each of the samples is provided in Appendix 1, Table A-1 and A-2.

Three non-methane triggered samples were collected across the entire PRAMP network in 2018 while 8 canisters were collected in 2019; this represents the lowest number of triggered canisters collected in the network since this program began.

4.1. Volatile Organic Compound Results Compared to AAAQO

There were no exceedances of the AAAQOs in 2019 however it should be noted that there are few hydrocarbon species that have an associated AAAQO.

Table 4: 2018 NMHC – Triggered Volatile Organic Compound Canister Sample 1-hour Average Concentrations (ppbv)

Station ID	Sampled Date (YYYY/MM/DD)	Sampled Time (MST)	WS (km/hr)	WD	NMHC triggered concentration (ppmv)	CH4	Acetone	Acrolein	Benzene	Ethanol	Freon-113	Isobutane	Isopentane	Butane	n-Butane	n-Pentane	Toluene	Pentane
AAAQO*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	9	n/a	n/a	n/a	n/a	n/a	n/a	n/a	499	n/a
842 [1]	2018-02-16	10:35	8.4	4	0	2500	5.6	<0.4	<0.01	1.7	<0.01	<100	0.93	n/a	<300	2.7	<0.01	n/a
842 [2]	2018-03-01	1:25	9.6	66	0.33	<100	3.1	<0.4	0.1	1.5	0.03	<100	0.75	n/a	<300	0.3	<0.01	n/a
Reno	2018-03-07	21:45	2.5	202	0.42	4500	0.9	<0.4	0.13	0.5	0.07	<100	1.36	n/a	<300	0.9	0.26	n/a
Reno [3]	2018-07-02	8:10	12.1	5	2.1	1700	4.5	0.5	0.08	6.3	<0.01	<100	0.11	n/a	<300	<0.1	0.18	n/a
842	2018-07-26	7:30	2.3	181	0.31	2100	8.3	0.6	0.6	5.5	<0.02	<100	0.54	n/a	<300	0.3	0.37	n/a
986	2018-12-09	20:25	4.8	294	0.63	2000	25.6	1.7	1.95	9.1	0.12	<100	0.48	n/a	<300	0.7	1.33	n/a

* Alberta Ambient Air Quality Objectives and Guidelines Summary (bolded values exceed)
(a) Data Source: Alberta Ambient Air Quality Objectives and Guidelines Summary (AEP 2017)
n/a – data not available
1. Canister collected on February 16 is not a valid event. The sample was collected during the canister system check.
2. Canister collected on March 1 is not a valid event. The sample was a blank sample.
3. Canister collected on July 2 is not considered a valid event. The canister system was triggerd while the carrier gas was being replaced.

Table 5: 2019 NMHC – Triggered Volatile Organic Compound Canister Sample 1-hour Average Concentrations (ppbv)

Station ID	Sampled Date (YYYY/MM/DD)	Sampled Time (MST)	WS (km/hr)	WD	NMHC triggered concentration (ppmv)	CH4 (ppmv)	Acetone	Acrolein	Benzene	Ethanol	Freon-113	Isobutane	Isopentane	Butane	n-Butane	n-Pentane	Toluene	Pentane
AAAQO*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Reno	2019-03-18	21:55	3.2	212(SSW)	0.32	1.9	5.6	<0.4	0.43	2.8	0.04	1.88	0.54	n/a	2.13	0.9	1.85	n/a
Reno	2019-03-19	18:30	2.6	197(SSW)	0.67	2.1	3.8	<0.5	<0.02	< 0.5	< 0.02	0.9	1.03	n/a	1.13	0.4	0.1	n/a
986b	2019-05-30	5:55	8.5	347(NNW)	0.62	2.2	27.3	12.1	11.9	7.2	0.06	3.8	0.51	n/a	2.87	1.1	5.8	n/a
842b	2019-05-30	6:05	13.0	354(N)	0.39	2.0	19.7	5.4	6.43	5.2	< 0.01	2.58	0.35	n/a	1.94	0.8	4.85	n/a
Reno	2019-05-30	7:15	10.0	6(N)	0.37	2.1	21.6	7.2	8.29	3.9	< 0.01	0.74	0.3	n/a	2.19	0.9	5.35	n/a
Reno	2019-10-17	20:45	1.0	210(SSW)	0.73	2.2	30.7	5.5	6.99	8.1	< 0.02	2.57	1.53	n/a	2.88	1.7	3.46	n/a
Reno	2019-11-05	22:15	0.9	191(S)	0.34	1.9	1.4	<0.5	0.23	1.4	< 0.02	0.64	0.5	n/a	0.4	0.3	0.52	n/a
842b	2019-11-15	14:15	12.1	215(SSW)	0.36	1.9	7.6	1.9	4.17	9.5	< 0.02	1.84	0.53	n/a	2.46	0.6	1.74	n/a

* Alberta Ambient Air Quality Objectives and Guidelines Summary (bolded values exceed)
(a) Data Source: Alberta Ambient Air Quality Objectives and Guidelines Summary (AEP 2017)
n/a – data not available

Table 6: 2019 Methane – Triggered Volatile Organic Compound Canister Sample 1-hour Average Concentrations (ppbv)

Station ID	Sampled Date (YYYY/MM/DD)	Sampled Time (MST)	WS (km/hr)	WD	CH4 triggered concentration (ppmv)	CH4 (ppmv)	Acetone	Acrolein	Benzene	Ethanol	Freon-113	Isobutane	Isopentane	Butane	n-Butane	n-Pentane	Toluene	Pentane
AAAQO*	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Reno	2019-02-17	19:25	2.9	197(SSW)	5.95	3.0	3.3	< 0.5	0.26	2.2	0.03	2.3	0.94	n/a	2.89	0.6	0.32	n/a
Reno	2019-02-20	22:05	6.4	213(SSW)	5.50	2.3	< 0.6	< 0.5	< 0.02	< 0.5	< 0.02	0.31	0.3	n/a	0.49	0.2	< 0.02	n/a
Reno	2019-02-23	20:15	1.6	203(SSW)	17.24	6.1	0.7	< 0.5	0.02	< 0.5	< 0.02	0.85	1.2	n/a	0.83	0.4	< 0.02	n/a
Reno	2019-02-24	19:35	1.4	209(SSW)	11.33	4.1	< 0.6	< 0.5	0.02	< 0.5	< 0.02	0.83	0.87	n/a	0.89	0.3	< 0.02	n/a
Reno	2019-03-08	22:20	0.6	288(WNW)	9.92	2.8	2.1	< 0.4	0.08	2.2	< 0.01	1.42	0.95	n/a	2.12	0.8	0.12	n/a
Reno	2019-03-10	8:25	4.4	187(S)	5.93	14.4	2.4	< 0.5	0.69	2.1	0.33	20.8	5.21	n/a	23.9	3.5	0.62	n/a
Reno	2019-03-16	15:35	5.2	177(S)	6.05	2.4	3.0	< 0.5	0.07	< 0.5	< 0.02	0.36	0.3	n/a	0.56	0.2	< 0.02	n/a
Reno	2019-03-29	1:55	n/a	n/a	6.56	2.3	2.6	< 0.5	0.2	1.9	< 0.02	0.4	0.69	n/a	0.65	0.3	1.74	n/a
Reno**	2019-04-10	21:20	1.6	205(SSW)	5.86	2.9	12.6	0.5	< 0.02	2.5	< 0.02	0.24	0.28	n/a	0.25	< 0.2	0.85	n/a
986b	2019-06-14	1:10	1.6	340(NNW)	7.75	2.6	17.3	< 0.5	0.8	6.2	< 0.02	2.81	0.19	n/a	0.52	0.2	0.75	n/a

* Alberta Ambient Air Quality Objectives and Guidelines Summary (bolded values exceed)
(a) Data Source: Alberta Ambient Air Quality Objectives and Guidelines Summary (AEP 2017)
n/a – data not available

5. BACKGROUND CONCENTRATIONS OF METHANE

A background concentration is the combination of naturally occurring chemical substances and ambient concentrations of man-made chemical substances in the environment that is representative of the surrounding area. The statistical analysis of the 1-hour concentrations for each year is presented in Tables 2 and 3.

Similar to previous years, the 50th percentile reading from each station was found to be consistent from 2018 to 2019. This suggests that the 50th percentile represents the background concentration as it remains nearly unchanged regardless of year and location. It is reasonable to conclude that a suitable background methane (CH_4) concentration is approximately 1.9 ppm for the region.

6. COMPARISONS OF RESULTS ACROSS ALBERTA

This section summarizes all monitoring stations in Alberta (including Stations 842, 986, and Reno) that collect data for CH_4, NMHC, THC, and TRS during 2018 and 2019. The 99th percentile is often used as an indicator of elevated concentrations that are exceeded 1% of the time. A maximum value could be used but it occurs only once. Alberta air quality management frameworks often use the annual 99th percentile as an indicator of prolonged exposures or of multiple episodes to high concentrations. For example, the annual 99th percentile target for SO_2 for a regional plan is set by reviewing past monitoring data.

Using the one parameter at multiple stations reporting option, the station data was downloaded from the Alberta Environment and Parks air data site:

http://airdata.alberta.ca/aepContent/Reports/DataDownloadMain.aspx

Additional station information reports including the airshed, location, start date, status and parameters monitored are available on the Alberta Environment and Parks air data site:

http://airdata.alberta.ca/aepContent/Reports/StationInformationMain.aspx

The locations of many of the stations is shown on the air quality technical map:

http://maps.srd.alberta.ca/AQHI

The 99th percentile for each month was calculated along with the annual or data set 99th percentile and average for each station for the available data. For ease of viewing, only the maximum 99th percentile for each month and annual averages are presented on the figures. All of the calculated statistics are presented in the tables.

6.1. Methane

Figure 35 and Table 7 compare the CH_4 1-hour average measurements in Alberta in 2018 and 2019 for a number of stations.

CH_4 readings in the Three Creeks area are comparable to other locations in Alberta and notably lower than most urban and industrial areas. The highest concentrations were measured at the Calgary Southeast monitoring station.

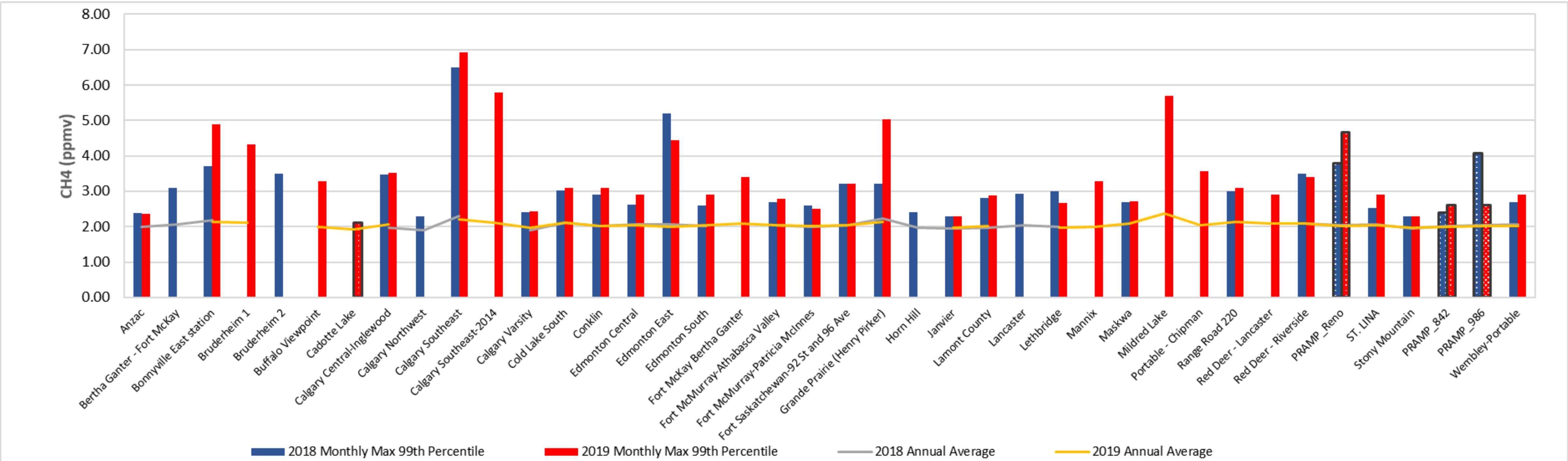


Figure 35: CH4 1-hour Average Measurements in Alberta in 2018 and 2019

Table 7: CH4 1-hour Average Measurements in Alberta for 2018 and 2019 (ppmv)

Sorted Results	Anzac	Bertha Ganter - Fort McKay	Bonnyville East station	Bruderheim 1	Bruderheim 2	Buffalo Viewpoint	Cadotte Lake	Calgary Central-Inglewood	Calgary Northwest	Calgary Southeast	Calgary Southeast-2014	Calgary Varsity	Cold Lake South	Conklin	Edmonton Central	Edmonton East	Edmonton South	Fort McKay Bertha Ganter	Fort McMurray-Athabasca Valley	Fort McMurray-Patricia McInnes	Fort Saskatchewan-92 St and 96 Ave	Grande Prairie (Henry Pirker)	Horn Hill	Janvier	Lamont County	Lancaster	Lethbridge	Mannix	Maskwa	Mildred Lake	Portable - Chipman	Range Road 220	Red Deer - Lancaster	Red Deer - Riverside	PRAMP_Reno	ST. LINA	Stony Mountain	PRAMP_842	PRAMP_986	Wembley-Portable
2018 Monthly Max 99th Percentile	2.39	3.10	3.70	n/a	3.49	n/a	n/a	3.47	2.30	6.50	n/a	2.40	3.02	2.90	2.61	5.20	2.60	n/a	2.70	2.60	3.20	3.20	2.40	2.30	2.80	2.92	3.00	n/a	2.69	n/a	n/a	3.00	n/a	3.50	3.79	2.53	2.30	2.40	4.08	2.70
2019 Monthly Max 99th Percentile	2.35	n/a	4.89	4.31	n/a	3.29	2.11	3.52	n/a	6.92	5.78	2.43	3.10	3.10	2.90	4.43	2.90	3.40	2.79	2.50	3.20	5.02	n/a	2.30	2.89	n/a	2.67	3.28	2.71	5.69	3.55	3.10	2.90	3.40	4.66	2.90	2.30	2.60	2.60	2.90
2018 Annual 99th Percentile	2.39	3.10	3.70	n/a	3.49	n/a	n/a	3.47	2.30	6.50	n/a	2.40	3.02	2.90	2.61	5.20	2.60	n/a	2.70	2.60	3.20	3.20	2.40	2.30	2.80	2.92	3.00	n/a	2.69	n/a	n/a	3.00	n/a	3.50	3.79	2.53	2.30	2.40	4.08	2.70
2019 Annual 99th Percentile	2.20	n/a	3.22	3.30	n/a	2.60	2.08	2.89	n/a	4.95	4.50	2.30	2.90	2.50	2.60	2.80	2.60	2.80	2.50	2.40	2.77	3.20	n/a	2.20	2.40	n/a	2.44	2.60	2.60	5.58	3.10	2.80	2.60	2.80	2.50	2.50	2.20	2.30	2.40	2.70
2018 Annual Average	2.00	2.06	2.18	n/a	2.06	n/a	n/a	1.98	1.89	2.31	n/a	1.90	2.11	2.01	2.06	2.07	2.03	n/a	2.05	2.00	2.05	2.23	1.97	1.94	1.98	2.03	2.00	n/a	2.09	n/a	n/a	2.09	n/a	2.09	2.04	2.08	1.95	2.01	2.03	2.07
2019 Annual Average	1.99	n/a	2.14	2.12	n/a	2.00	1.93	2.06	n/a	2.21	2.11	1.97	2.11	2.02	2.05	2.00	2.03	2.08	2.04	2.02	2.04	2.14	n/a	1.97	2.01	n/a	1.97	2.00	2.08	2.38	2.05	2.14	2.10	2.09	2.02	2.04	1.97	2.00	2.02	2.02

6.2. Non-methane Hydrocarbons

Figure 36 and Table 8 compare the NMHC 1-hour average measurements in Alberta in 2018 and 2019 for 33 stations.

NMHC readings in the Peace River Area remain amongst the lowest concentrations in the province; the increase observed in the Peace River Area between 2018 and 2019 can be fully explained by the extreme values measured during the Chuckegg Creek Wildfire. The highest concentrations were measured at the Edmonton East monitoring station.

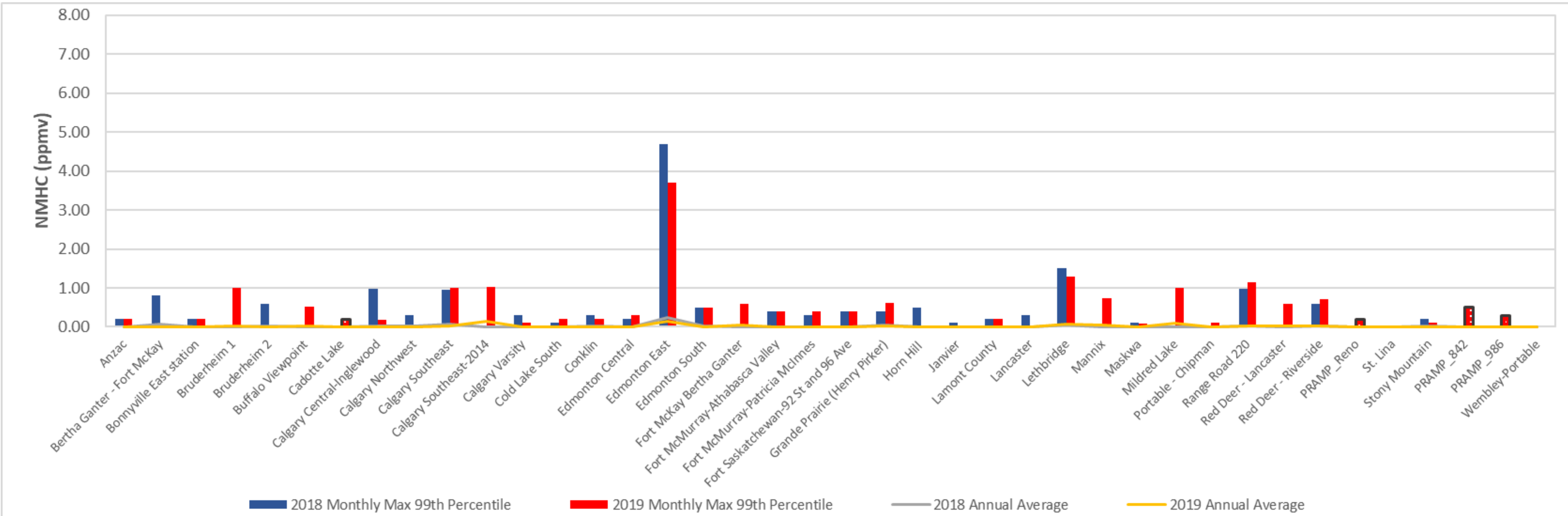


Figure 36: NMHC 1-hour Average Measurements in Alberta in 2018 and 2019

Table 8: NMHC 1-hour Average Measurements in Alberta for 2018 and 2019 (ppmv)

Sorted Results	Anzac	Bertha Ganter - Fort McKay	Bonnyville East station	Bruderheim 1	Bruderheim 2	Buffalo Viewpoint	Cadotte Lake	Calgary Central-Inglewood	Calgary Northwest	Calgary Southeast	Calgary Southeast-2014	Calgary Varsity	Cold Lake South	Conklin	Edmonton Central	Edmonton East	Edmonton South	Fort McKay Bertha Ganter	Fort McMurray-Athabasca Valley	Fort McMurray-Patricia McInnes	Fort Saskatchewan-92 St and 96 Ave	Grande Prairie (Henry Pirker)	Horn Hill	Janvier	Lamont County	Lancaster	Lethbridge	Mannix	Maskwa	Mildred Lake	Portable - Chipman	Range Road 220	Red Deer - Lancaster	Red Deer - Riverside	PRAMP_Reno	St. Lina	Stony Mountain	PRAMP_842	PRAMP_986	Wembley-Portable
2018 Monthly Max 99th Percentile	0.20	0.80	0.20	n/a	0.60	n/a	n/a	0.99	0.30	0.94	n/a	0.30	0.12	0.30	0.20	4.69	0.50	n/a	0.40	0.30	0.40	0.40	0.48	0.10	0.20	0.30	1.50	n/a	0.10	n/a	n/a	0.98	n/a	0.60	0.00	0.00	0.20	0.00	0.00	0.00
2019 Monthly Max 99th Percentile	0.20	n/a	0.20	1.00	n/a	0.51	0.20	0.19	n/a	1.00	1.03	0.11	0.20	0.20	0.31	3.69	0.49	0.60	0.39	0.40	0.40	0.62	n/a	0.00	0.20	n/a	1.30	0.74	0.10	0.99	0.10	1.14	0.59	0.70	0.20	0.00	0.10	0.50	0.30	0.01
2018 Annual 99th Percentile	0.10	0.50	0.10	n/a	0.40	n/a	n/a	0.40	0.20	0.80	n/a	0.10	0.00	0.20	0.10	2.30	0.30	n/a	0.20	0.10	0.20	0.40	0.05	0.00	0.00	0.10	1.00	n/a	0.10	n/a	n/a	0.40	n/a	0.30	0.00	0.00	0.20	0.00	0.00	0.00
2019 Annual 99th Percentile	0.10	n/a	0.10	0.50	n/a	0.26	0.10	0.01	n/a	0.40	0.60	0.06	0.10	0.10	0.10	1.60	0.10	0.40	0.20	0.20	0.20	0.40	n/a	0.00	0.13	n/a	0.80	0.30	0.00	0.90	0.10	0.70	0.10	0.40	0.00	0.00	0.10	0.00	0.00	0.00
2018 Annual Average	0.01	0.08	0.01	n/a	0.03	n/a	n/a	0.02	0.02	0.06	n/a	0.00	0.00	0.01	0.00	0.23	0.03	n/a	0.01	0.00	0.00	0.04	0.00	0.00	0.00	0.01	0.05	n/a	0.00	n/a	n/a	0.03	n/a	0.03	0.00	0.00	0.02	0.00	0.00	0.00
2019 Annual Average	0.00	n/a	0.00	0.03	n/a	0.01	0.00	0.00	n/a	0.01	0.15	0.00	0.00	0.00	0.00	0.14	0.00	0.06	0.01	0.01	0.01	0.02	n/a	0.00	0.01	n/a	0.07	0.04	0.00	0.09	0.00	0.03	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00

6.3. Total Hydrocarbons

Figure 37 and Table 9 compare the THC 1-hour average measurements in 2018 and 2019 for a number of stations in Alberta.

Similar to CH_4 readings, THC concentrations in the Three Creeks area are comparable to other locations in Alberta and notably lower than most urban and industrial areas. The highest overall concentrations were measured at the Horizon monitoring station (north of Fort McMurray).

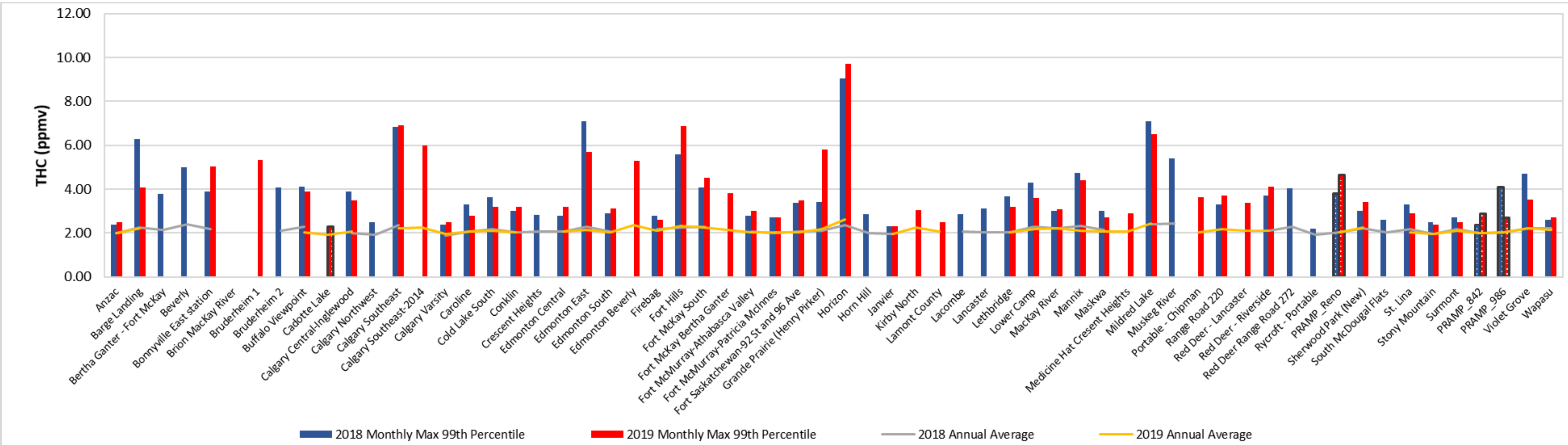


Figure 37: THC 1-hour Average Measurements in Alberta in 2018 and 2019

Table 9: THC 1-hour Average Measurements in Alberta in 2018 and 2019 (ppmv)

Sorted Results	Anzac	Barge Landing	Bertha Ganter - Fort McKay	Beverly	Bonnyville East station	Brion MacKay River	Bruderheim 1	Bruderheim 2	Buffalo Viewpoint	Cadotte Lake	Calgary Central-Inglewood	Calgary Northwest	Calgary Southeast	Calgary Southeast-2014	Calgary Varsity	Caroline
2018 Monthly Max 99th Percentile	2.40	6.28	3.78	4.99	3.89	n/a	n/a	4.08	4.10	n/a	3.90	2.50	6.83	n/a	2.40	3.31
2019 Monthly Max 99th Percentile	2.51	4.09	n/a	n/a	5.04	n/a	5.31	n/a	3.90	2.31	3.50	n/a	6.92	5.99	2.50	2.80
2018 Annual 99th Percentile	2.30	3.30	3.10	3.59	3.60	n/a	n/a	3.40	3.30	n/a	3.00	2.30	5.80	n/a	2.30	2.70
2019 Annual 99th Percentile	2.30	3.30	n/a	n/a	3.30	n/a	3.70	n/a	3.00	2.18	2.90	n/a	5.00	4.80	2.30	2.60
2018 Annual Average	2.01	2.25	2.14	2.38	2.19	n/a	n/a	2.09	2.29	n/a	2.00	1.91	2.37	n/a	1.90	2.08
2019 Annual Average	2.00	2.22	n/a	n/a	2.15	n/a	2.15	n/a	2.04	1.93	2.06	n/a	2.22	2.25	1.97	2.07

Sorted Results	Cold Lake South	Conklin	Crescent Heights	Edmonton Central	Edmonton East	Edmonton South	Edmonton Beverly	Firebag	Fort Hills	Fort McKay South	Fort McKay Bertha Ganter	Fort McMurray-Athabasca Valley	Fort McMurray-Patricia McInnes	Fort Saskatchewan-92 St and 96 Ave	Grande Prairie (Henry Pirker)	Horizon
2018 Monthly Max 99th Percentile	3.62	3.00	2.82	2.80	7.09	2.90	n/a	2.79	5.59	4.09	n/a	2.80	2.70	3.39	3.40	9.06
2019 Monthly Max 99th Percentile	3.19	3.19	n/a	3.20	5.70	3.10	5.30	2.60	6.87	4.50	3.80	3.00	2.70	3.50	5.80	9.70
2018 Annual 99th Percentile	3.00	2.60	2.80	2.50	5.20	2.60	n/a	2.50	4.00	3.40	n/a	2.60	2.40	2.90	3.00	4.70
2019 Annual 99th Percentile	2.90	2.60	n/a	2.70	4.20	2.60	3.71	2.50	4.80	3.30	3.10	2.60	2.50	2.90	3.46	6.79
2018 Annual Average	2.20	2.03	2.08	2.07	2.30	2.05	n/a	2.16	2.24	2.30	n/a	2.06	2.00	2.05	2.09	2.36
2019 Annual Average	2.11	2.02	n/a	2.06	2.14	2.04	2.37	2.11	2.31	2.26	2.14	2.05	2.03	2.05	2.16	2.62

Sorted Results	Horn Hill	Janvier	Kirby North	Lamont County	Lacombe	Lancaster	Lethbridge	Lower Camp	MacKay River	Mannix	Maskwa	Medicine Hat Crescent Heights	Mildred Lake	Muskeg River	Portable - Chipman	Range Road 220
2018 Monthly Max 99th Percentile	2.86	2.30	n/a	n/a	2.86	3.12	3.68	4.29	3.00	4.72	3.00	n/a	7.08	5.40	n/a	3.30
2019 Monthly Max 99th Percentile	n/a	2.30	3.04	2.50	n/a	n/a	3.20	3.60	3.09	4.39	2.71	2.89	6.50	n/a	3.63	3.69
2018 Annual 99th Percentile	2.46	2.20	n/a	n/a	2.80	2.80	3.20	3.40	2.70	3.90	2.80	n/a	4.30	4.20	n/a	2.90
2019 Annual 99th Percentile	n/a	2.20	2.60	2.40	n/a	n/a	2.90	3.20	2.60	3.30	2.60	2.60	4.20	n/a	3.10	3.20
2018 Annual Average	1.98	1.94	n/a	n/a	2.09	2.04	2.05	2.31	2.23	2.32	2.14	n/a	2.38	2.43	n/a	2.11
2019 Annual Average	n/a	1.97	2.25	2.05	n/a	n/a	2.04	2.18	2.20	2.10	2.09	2.08	2.43	n/a	2.05	2.17

Sorted Results	Red Deer - Lancaster	Red Deer - Riverside	Red Deer Range Road 272	Rycroft - Portable	PRAMP_Reno	Sherwood Park (New)	South McDougal Flats	St. Lina	Stony Mountain	Surmont	PRAMP_842	PRAMP_986	Violet Grove	Wapasu	Wembley-Portable
2018 Monthly Max 99th Percentile	n/a	3.70	4.03	2.20	3.79	2.99	2.60	3.30	2.49	2.70	2.40	4.08	4.70	2.60	2.70
2019 Monthly Max 99th Percentile	3.39	4.10	n/a	n/a	4.66	3.40	n/a	2.90	2.40	2.50	2.89	2.70	3.54	2.70	2.90
2018 Annual 99th Percentile	n/a	3.10	3.50	2.10	2.93	2.70	2.50	2.80	2.20	2.60	2.20	2.50	3.20	2.50	2.70
2019 Annual 99th Percentile	2.70	3.10	n/a	n/a	2.56	2.91	n/a	2.50	2.20	2.50	2.30	2.40	3.10	2.50	2.71
2018 Annual Average	n/a	2.12	2.31	1.94	2.04	2.22	2.03	2.19	1.97	2.18	2.01	2.03	2.23	2.20	2.08
2019 Annual Average	2.11	2.12	n/a	n/a	2.02	2.24	n/a	2.04	1.98	2.09	2.00	2.02	2.21	2.13	2.04

6.4. Total Reduced Sulphur

Figure 42 and Table 8 compare the TRS 1-hour average measurements in 2018 and 2019 for a number of stations in Alberta.

TRS concentrations in the Peace River area remain low compared to other monitoring stations in Alberta. The Hinton monitoring station shows the highest concentrations of TRS in the Province, likely being influence by pulp and paper operations in the area.

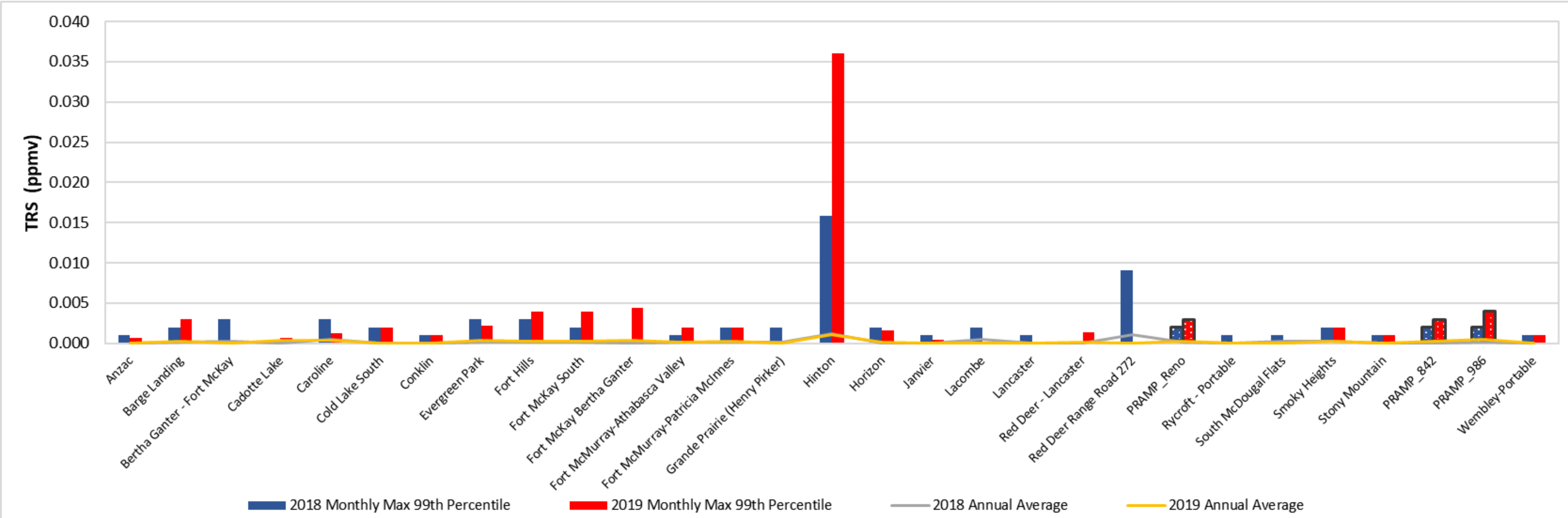


Figure 38: TRS 1-hour Average Measurements in Alberta in 2018 and 2019

Table 10: TRS 1-hour Average Measurements in Alberta in 2018 and 2019 (ppmv)

Sorted Results	Anzac	Barge Landing	Bertha Ganter - Fort McKay	Cadotte Lake	Caroline	Cold Lake South	Conklin	Evergreen Park	Fort Hills	Fort McKay South	Fort McKay Bertha Ganter	Fort McMurray-Athabasca Valley	Fort McMurray-Patricia McInnes	Grande Prairie (Henry Pirker)	Hinton	Horizon	Janvier	Lacombe	Lancaster	Red Deer - Lancaster	Red Deer Range Road 272	PRAMP_Reno	Rycroft - Portable	South McDougal Flats	Smoky Heights	Stony Mountain	PRAMP_842	PRAMP_986	Wembley-Portable	Wembley-Portable
2018 Monthly Max 99th Percentile	0.001	0.002	0.003	n/a	0.003	0.002	0.001	0.003	0.003	0.002	n/a	0.001	0.002	0.002	**0.016**	0.002	0.001	0.002	0.001	n/a	0.009	0.002	0.001	0.001	0.002	0.001	0.002	0.002	0.001	n/a
2019 Monthly Max 99th Percentile	0.001	0.003	n/a	0.001	0.001	0.002	0.001	0.002	0.004	0.004	0.004	0.002	0.002	n/a	**0.036**	0.002	0.000	n/a	n/a	0.001	n/a	0.003	n/a	n/a	0.002	0.001	0.003	0.004	0.001	0.001
2018 Annual 99th Percentile	0.000	0.002	0.002	n/a	0.001	0.001	0.001	0.001	0.002	0.001	n/a	0.001	0.001	0.001	**0.010**	0.001	0.000	0.001	0.001	n/a	0.007	0.001	0.001	0.001	0.001	0.000	0.001	0.001	0.001	n/a
2019 Annual 99th Percentile	0.000	0.002	n/a	0.001	0.001	0.001	0.001	0.002	0.002	0.002	0.002	0.001	0.001	n/a	**0.010**	0.001	0.000	n/a	n/a	0.001	n/a	0.002	n/a	n/a	0.001	0.000	0.001	0.002	0.001	0.001
2018 Annual Average	0.000	0.000	0.000	n/a	0.001	0.000	0.000	0.000	0.000	0.000	n/a	0.000	0.000	0.000	**0.001**	0.000	0.000	0.000	0.000	n/a	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	n/a
2019 Annual Average	0.000	0.000	n/a	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	n/a	**0.001**	0.000	0.000	n/a	n/a	0.000	n/a	0.000	n/a	n/a	0.000	0.000	0.000	0.000	0.000	0.000

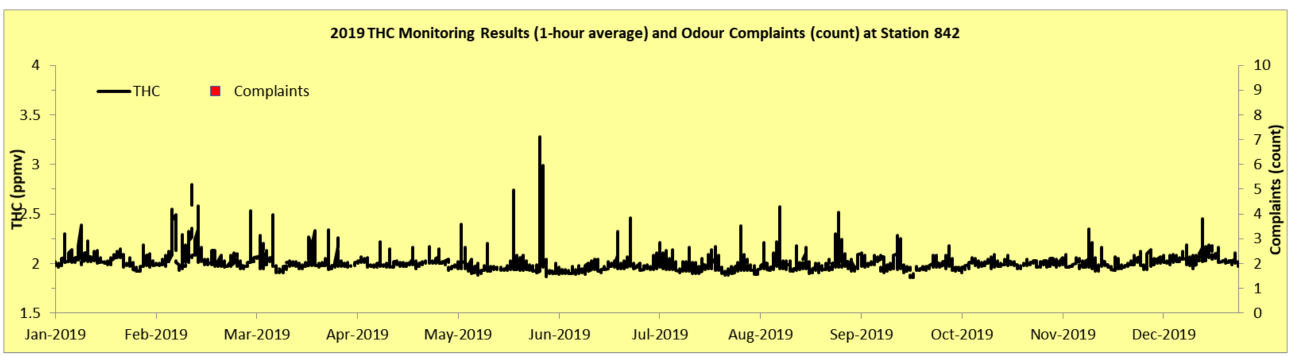
7. COMPLAINTS AND THC MONITORING RESULTS

The AER recorded complaints from residents and assigned the location of the complaint to each of the three stations. AER complaints were collected and analyzed as follows:

- Station 986 showed a decrease in the number of complaints; there were 4 in 2018 and 2 in 2019 (down from a historical maximum of 33 in 2014)
- Station 842 showed no change in the number of complaints; there were 0 in 2018 and 0 in 2019 (down from a historical maximum of 44 in 2014)
- The Reno Station showed no change in the number of complaints; there were 0 in 2018 and 0 in 2019 (down from a historical maximum of 11 in 2015)

Based on the latitude and longitude of the complaint, each complaint was assigned the station closest to where the complaint was logged. 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. Therefore, when a complaint is assigned to a monitoring station, it is considered to be reasonably close for correlation analysis of the complaint and wind speed, wind direction, THC concentrations, and other parameters; the complaint was not necessarily logged at the exact location of the monitoring station.

In 2019, there were only 2 odour complaints across the entire network; this is the lowest number of complaints since PRAMP began compiling these data. Over time, there have been fewer odour complaints. While fewer complaints is a likely outcome of the reduction in ambient hydrocarbon concentrations, PRAMP recognizes that there may be other factors involved including residents moving out of the area and 'complainant fatigue'.



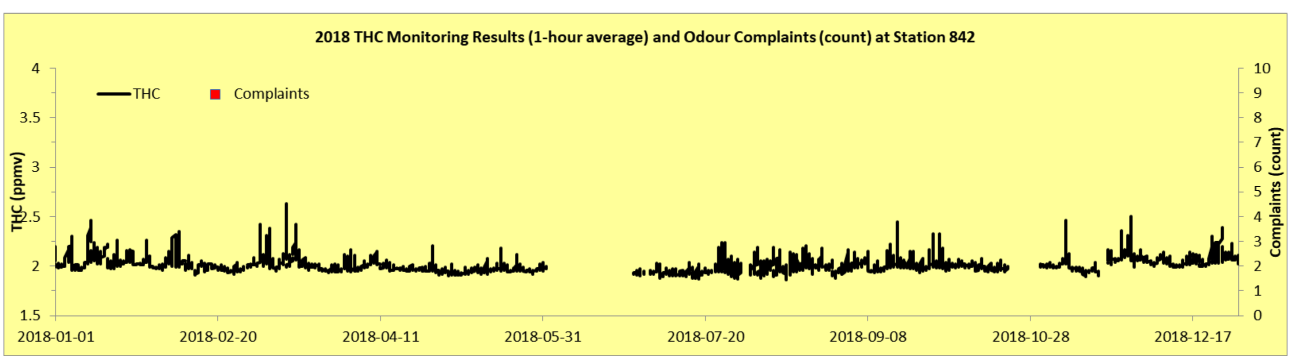
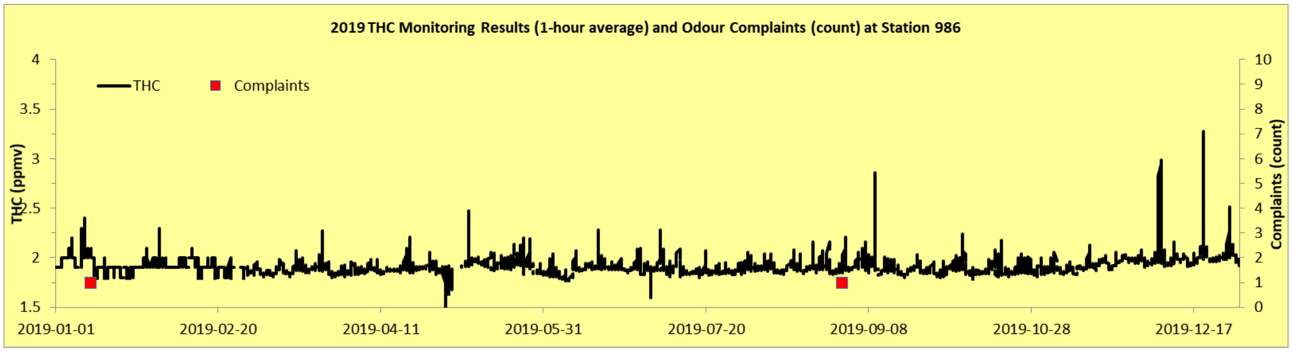


Figure 39: THC and Complaints Correlation at Station 986



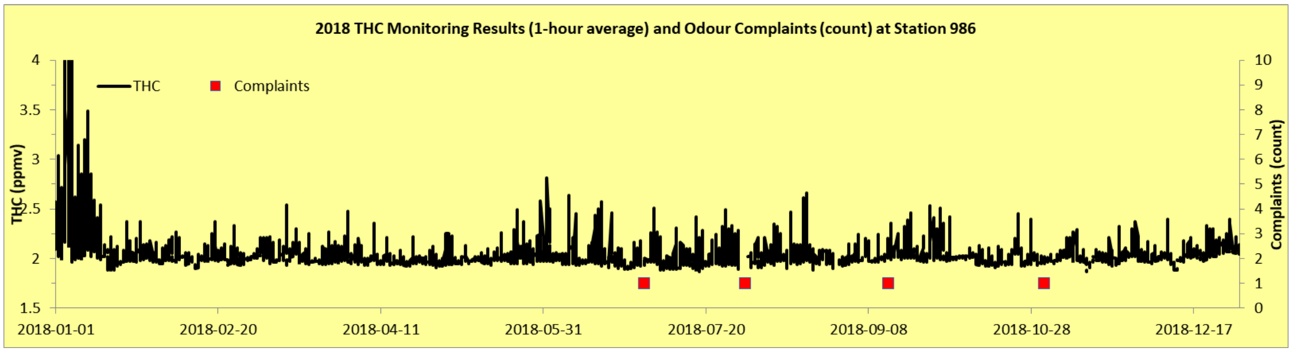
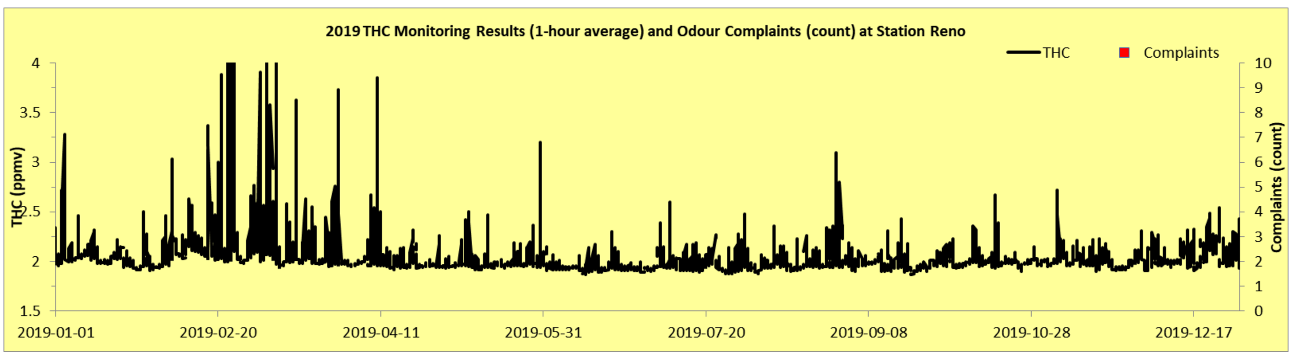


Figure 40: THC and Complaints Correlation for Station 842



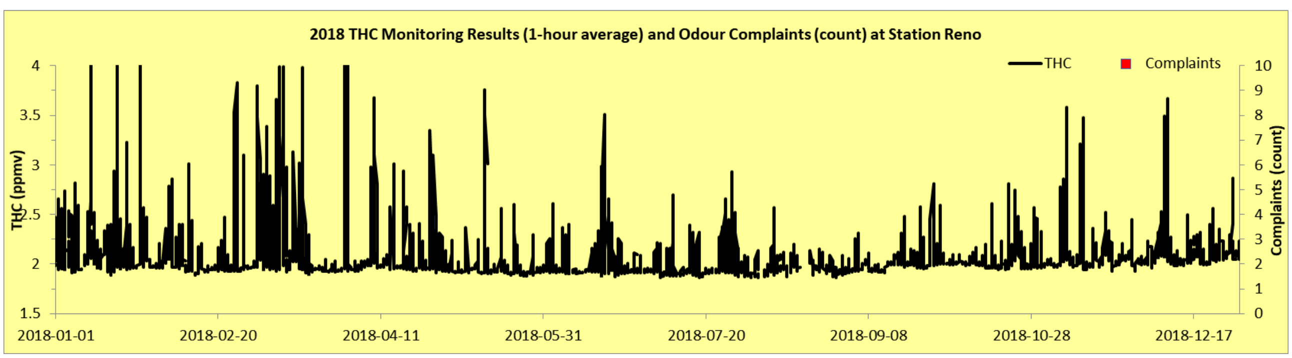


Figure 41: THC and Complaints Correlation for Reno Station

8. AQHI STATION: SPECIAL SECTION

In previous sections of this report, limited comparisons of hydrocarbon data collected at the AQHI – Cadotte Lake station were made to data collected at PRAMP's other monitoring stations. Since PRAMP's AQHI station was deployed in late 2019, there isn't enough data to make detailed year-over-year comparisons with other stations in the PRAMP network and stations in other Alberta Airsheds. In addition, the AQHI station also monitors for pollutants that are not part of the suite of parameters monitored at PRAMP's other monitoring stations. Therefore, in this section of the annual data review, a brief overview of limited data for the AQHI station is presented for the additional parameters; data from October 2019 – December 2019 are summarized.

8.1. Hourly Concentration Data

Hourly concentration data is presented to show all data collected at the AQHI – Cadotte Lake station for 2019 for nitrogen dioxide (NO2), nitric oxide (NO), ozone (O3), and particulate matter (PM2.5).

Nitrogen oxides (NOx) is a collective term used to refer to nitric oxide and nitrogen dioxide. Nitric oxide (NO) is a colourless gas and one of the principal oxides of nitrogen; nitrogen dioxide (NO2) is a reddish-brown gas with a pungent, acrid odour and one of the several oxides of nitrogen. Nitrogen oxides are produced from the reaction of nitrogen and oxygen gases in the air during combustion, especially at high temperatures. Nitrogen oxides are produced from fuel combustion in mobile and stationary sources. The combustion of gasoline in automobiles emit nitrogen oxides into the atmosphere (mobile source). Stationary emissions sources include power plants, refineries, and pulp mills. The 1-hour nitrogen dioxide AAAQO is 159 ppb. There is no AAAQO for NO.

Ozone occurs both in the Earth's upper atmosphere and at ground level. Ozone can be good or bad, depending on where it is found. Called stratospheric ozone, good ozone occurs naturally in the upper atmosphere, where it forms a protective layer that shields us from the sun's harmful ultraviolet rays. Ozone at ground level is a harmful air pollutant, because of its effects on people and the environment, and it is the main ingredient in "smog." Tropospheric, or ground level ozone, is not emitted directly into the air, but is created by chemical reactions between oxides of nitrogen (NOx) and volatile organic compounds (VOC). This happens when pollutants emitted by cars, power plants, industrial boilers, refineries, chemical plants, and other sources chemically react in the presence of sunlight. The 1-hour AAAQO is 76 ppb (daily maximum).

Particulate matter (PM) is the term for a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope. PRAMP monitors PM2.5, which are also known as fine inhalable particles that have a diameter that are generally 2.5 micrometers and smaller. The average human hair is about 70 micrometers in diameter – making it 30 times larger than the largest fine particle. The 1-hour AAAQG for PM2.5 is 80 µg m3.

8.1.1. Oxides of Nitrogen

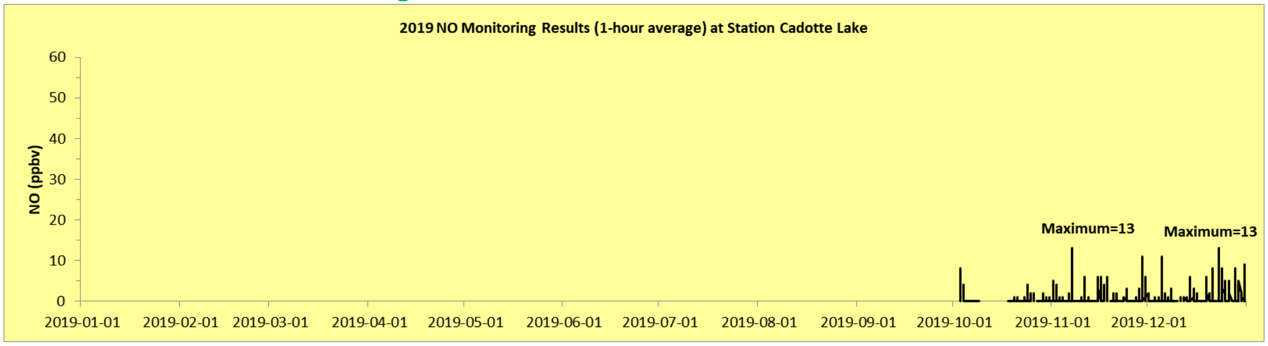


Figure 42: Hourly Monitored Nitric Oxide Data

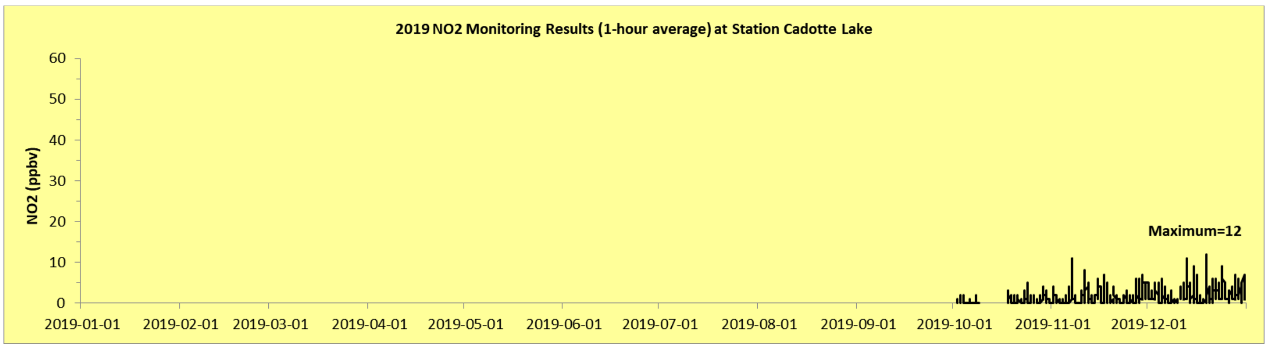


Figure 43: Hourly Monitored Nitrogen Dioxide Data

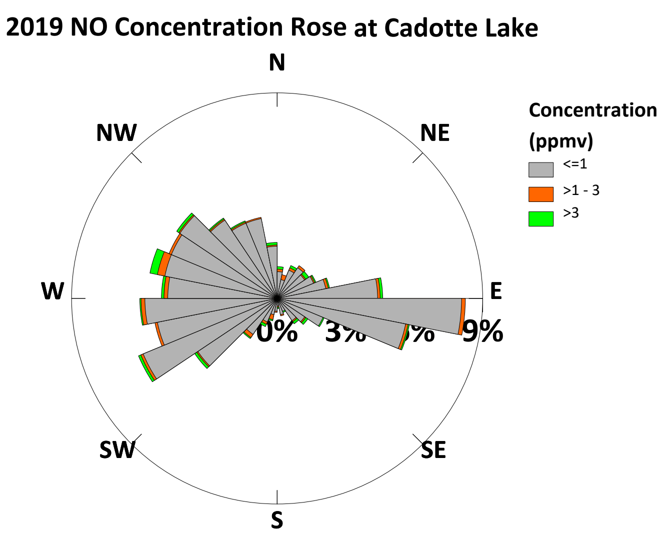


Figure 44: Nitric Oxide Concentration Rose for 2019 at the AQHI Station

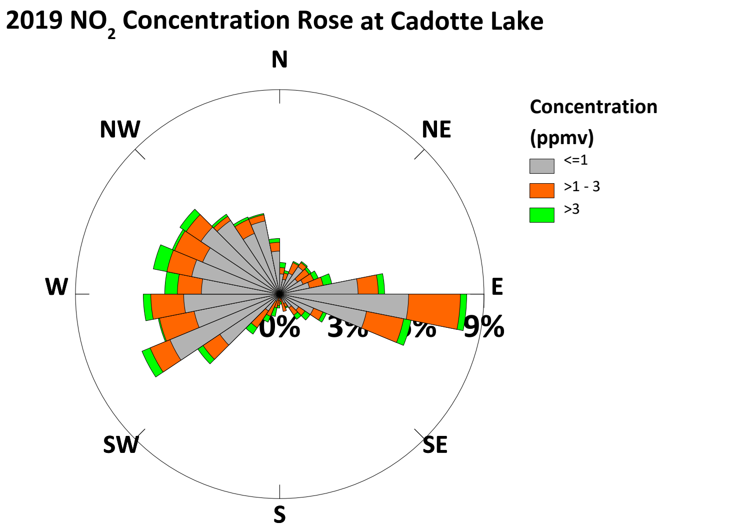


Figure 45: Nitrogen Dioxide Concentration Rose for 2019 at the AQHI Station

8.1.2. Ozone

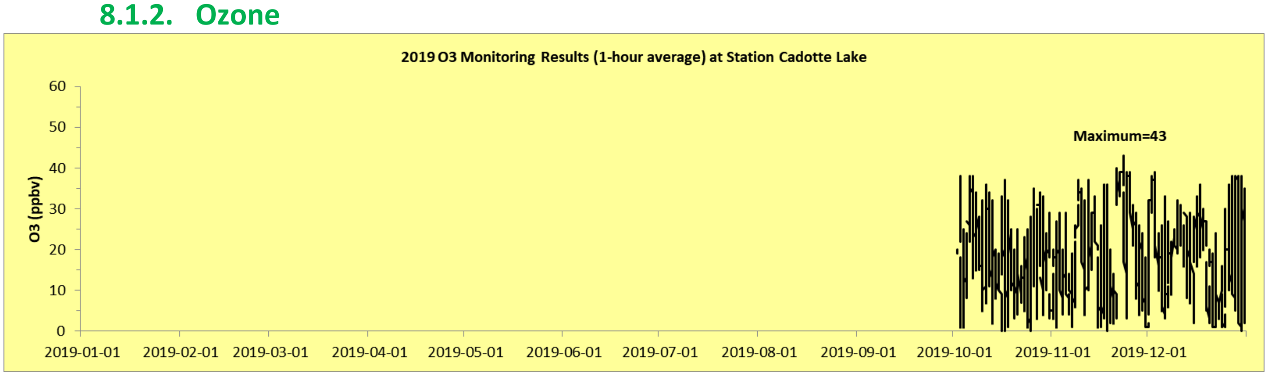


Figure 46: Hourly Monitored Ozone Data

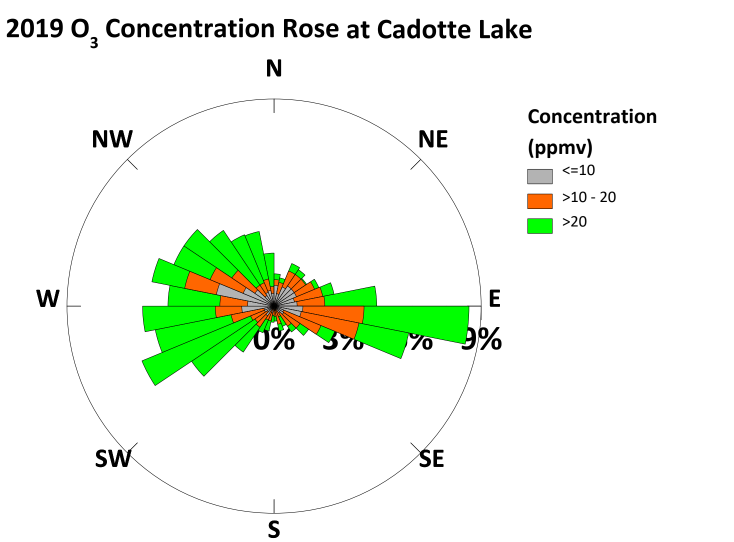


Figure 47: Ozone Concentration Rose for 2019 at the AQHI Station

8.1.3. Particulate Matter

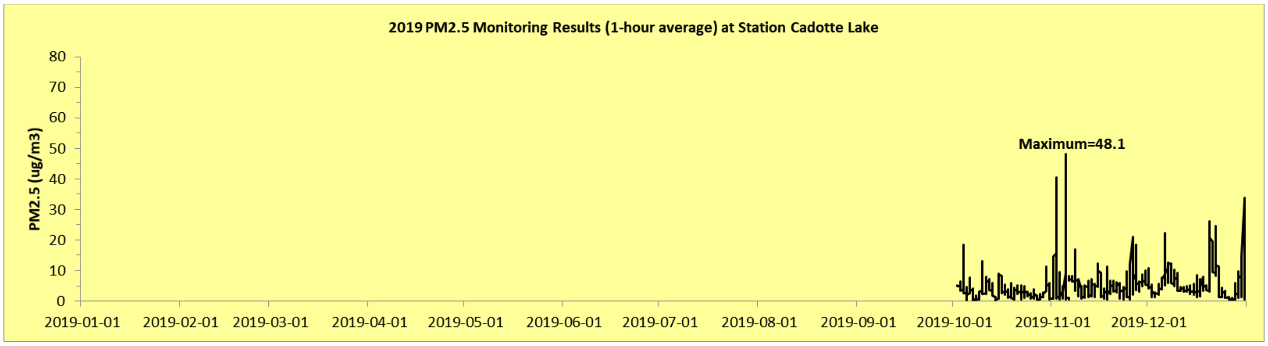


Figure 48: Hourly Monitored Particulate Matter Data

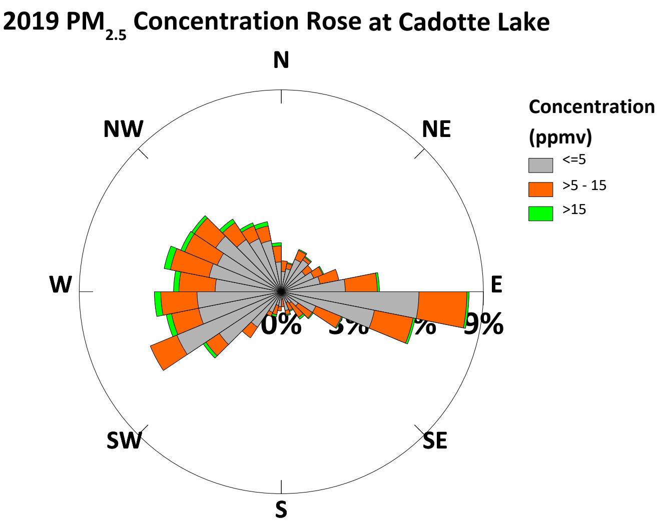


Figure 49: Particulate Matter Concentration Rose for 2019 at the AQHI Station

8.2. Summary

The AQHI Station was deployed to both fill a spatial gap in the PRAMP Airshed and respond to the Cadotte Lake community who expressed an interest in understanding their local air quality. With only three months of monitoring data available for 2019, only limited data analysis is possible for ozone, particulate matter, and oxides of nitrogen. Generally, all concentrations were very low with no AAAQOs or AAAQGs being exceeded during the monitoring period. Concentration roses for $PM_{2.5}$ and oxides of nitrogen show the strongest evidence of a relationship between elevated concentrations and wind direction. Most elevated concentrations at the AQHI station were coming from the northwest, north, and northeast directions suggesting that reclamation activities that involved diesel-powered heavy earth moving equipment were influencing air quality measurements.

9. CONCLUSIONS

PRAMP collected concentration data of THC, NMHC, TRS, SO_2, and CH_4 at Station 986, 842, and Reno continuous monitoring stations in the Peace River Area throughout 2018 and 2019; a limited dataset these parameters plus O_3, NOx, and $PM_{2.5}$ were also collected at the AQHI – Cadotte Lake station. The data was summarized and analyzed using statistical methods to quantify the air quality in the area. Wind speed and direction was also monitored to further understand the potential sources of substances detected by the monitoring. Triggered sampling events provided additional concentration data.

Based on year-over-year data, hourly measurements of THC, NMHC, SO_2, TRS, and CH_4 concentrations generally show decreasing trends or patterns between 2018 and 2019 using different summary statistics (average, 99th percentile, 90th percentile, etc.). Similar to previous years' analyses, it should be noted that all of the changes are incremental, particularly when considering the historically elevated concentrations of hydrocarbons at station 986 and 842. The existing monitoring program should continue with the same measurement parameters to continue to examine trends in concentrations and to evaluate the effectiveness of ongoing improvements to CHOP emissions management.

The 2019 Chuckegg Creek Wildfire had a relatively short but noticeable impact on local air quality and the patterns and observations in PRAMP's annual data analysis. The fire caused non-methane hydrocarbon concentrations to peak at levels not seen since the early days of PRAMP's monitoring efforts, prior to improvements made to emissions management for CHOP activities. The NMHC data collected by PRAMP during the fire may be considered "outlier" values.

Although the Reno monitoring station continues to show elevated hydrocarbon concentrations relative to current measurements at the other PRAMP sites, overall there has been a decrease in the magnitude and frequency of elevated concentration hydrocarbon events between 2018 and 2019; this is likely due to the ongoing emissions management efforts from CHOP operators. Wintertime hydrocarbon concentrations remain elevated in the Reno area (likely due to stagnant cold air), however, the pattern of decreasing concentrations is most evident in the summer months. As has been noted in previous annual data reviews, despite being elevated, measurements at Reno are lower than the historical maximums at 986 and 842. CHOP infrastructure is much closer to the Reno Station compared to Station 986 and 842 and is likely a strong influence on the elevated measurements at that site as is the predominant southwest wind direction (putting nearby potential sources upwind of the station). The CHOP facilities nearest Station 986 and 842 are approximately 6km and 4km away; however, at the Reno Station, the same types of facilities are 300-500m away which represents an order of magnitude difference.

In 2019, there were only 2 odour complaints across the entire network; this is the lowest number of complaints since PRAMP began compiling these data. Over time, there have been fewer odour complaints. While fewer complaints is a likely outcome of the reduction in ambient hydrocarbon concentrations, PRAMP recognizes that there may be other factors involved including residents moving out of the area and complainant fatigue.

In late 2018, PRAMP decided to implement a methane-based triggered canister collection program to supplement its existing canister sampling program. Implemented in 2019, these additional air samples will be used to more accurately assess the source(s) of the methane, and to better understand any non-methane compounds that may be present when methane levels are elevated. In addition to the usual speciated hydrocarbon analysis, isotopic analysis will help identify potential sources of methane. Analysis of the isotopic data will be complete in 2021.

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APPENDIX A
Triggered Sample Results

APPENDIX A-1 NMHC TRIGGERED SAMPLE RESULTS

Station		Reno	Reno	986b	842b	Reno	Reno	Reno	842b
Sampled Date (MM/DD/YYYY)		2019-03-18	2019-03-19	2019-05-30	2019-05-30	2019-05-30	2019-10-17	2019-11-05	2019-11-15
Sampled Time		21:55	18:30	5:55	6:05	7:15	20:45	22:15	14:15
Triggered Concentration (ppm)		0.32	0.67	0.62	0.39	0.37	0.73	0.34	0.36
Parameter	**Unit**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
1-Butene	ppmv	< 0.15	< 0.15	< 0.13	< 0.15	< 0.14	< 0.17	< 0.16	< 0.15
Acetylene	ppmv	< 0.12	< 0.12	< 0.10	< 0.12	< 0.12	< 0.13	< 0.12	< 0.12
cis-2-Butene	ppmv	< 0.06	< 0.06	< 0.05	< 0.06	< 0.06	< 0.07	< 0.06	< 0.06
Ethane	ppmv	< 0.1	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2
Ethylacetylene	ppmv	< 0.09	< 0.09	< 0.08	< 0.09	< 0.09	< 0.10	< 0.09	< 0.09
Ethylene	ppmv	< 0.10	< 0.11	< 0.09	< 0.10	< 0.10	< 0.12	< 0.11	< 0.11
Isobutane	ppmv	< 0.1	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2
Isobutylene	ppmv	< 0.1	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2
Methane	ppmv	1.90	2.10	2.20	2.00	2.10	2.20	1.90	1.90
n-Butane	ppmv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
n-Propane	ppmv	< 0.10	< 0.11	< 0.09	< 0.10	< 0.10	< 0.12	< 0.11	< 0.11
Propylene	ppmv	< 0.1	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2
Propyne	ppmv	< 0.1	< 0.2	< 0.1	< 0.1	< 0.1	< 0.2	< 0.2	< 0.2
trans-2-Butene	ppmv	< 0.13	< 0.14	< 0.12	< 0.13	< 0.13	< 0.15	< 0.14	< 0.14
2,5-Dimethylthiophene	ppbv	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5
2-Ethylthiophene	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
2-Methylthiophene	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
3-Methylthiophene	ppbv	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5
Butyl mercaptan	ppbv	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5
Carbon disulphide	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Carbonyl sulphide	ppbv	1.10	0.60	1.70	< 0.4	< 0.4	0.50	1.30	0.60
Dimethyl disulphide	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	0.50	< 0.3	< 0.3
Dimethyl sulphide	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	1.20	< 0.3	< 0.3

Station		Reno	Reno	986b	842b	Reno	Reno	Reno	842b
Sampled Date (MM/DD/YYYY)		2019-03-18	2019-03-19	2019-05-30	2019-05-30	2019-05-30	2019-10-17	2019-11-05	2019-11-15
Sampled Time		21:55	18:30	5:55	6:05	7:15	20:45	22:15	14:15
Triggered Concentration (ppm)		0.32	0.67	0.62	0.39	0.37	0.73	0.34	0.36
Ethyl mercaptan	ppbv	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5
Ethyl sulphide	ppbv	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5
Hydrogen sulphide	ppbv	1.60	1.90	1.10	1.50	1.00	1.50	< 0.2	1.40
Isobutyl mercaptan	ppbv	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5
Isopropyl mercaptan	ppbv	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5
Methyl mercaptan	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
Pentyl mercaptan	ppbv	< 0.6	< 0.6	< 0.5	< 0.6	< 0.6	< 0.7	< 0.6	< 0.6
Propyl mercaptan	ppbv	< 0.6	< 0.6	< 0.5	< 0.6	< 0.6	< 0.7	< 0.6	< 0.6
tert-Butyl mercaptan	ppbv	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5
Thiophene	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
1,1,1-Trichloroethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
1,1,2,2-Tetrachloroethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
1,1,2-Trichloroethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
1,1-Dichloroethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
1,1-Dichloroethylene	ppbv	< 0.06	< 0.06	< 0.05	< 0.06	< 0.06	< 0.07	< 0.06	< 0.06
1,2,3-Trimethylbenzene	ppbv	< 0.07	< 0.08	< 0.06	0.15	0.14	< 0.08	< 0.08	< 0.08
1,2,4-Trichlorobenzene	ppbv	< 1.2	< 1.2	< 1.0	< 1.2	< 1.2	< 1.3	< 1.2	< 1.2
1,2,4-Trimethylbenzene	ppbv	< 0.07	< 0.08	< 0.06	0.18	0.14	0.29	0.37	0.31
1,2-Dibromoethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
1,2-Dichlorobenzene	ppbv	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.05	< 0.05	< 0.05
1,2-Dichloroethane	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	< 0.02	0.02
1,2-Dichloropropane	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	< 0.02	0.08
1,3,5-Trimethylbenzene	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.13	0.14
1,3-Butadiene	ppbv	< 0.03	< 0.03	4.48	2.67	2.97	1.19	0.07	1.30
1,3-Dichlorobenzene	ppbv	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5

Station		Reno	Reno	986b	842b	Reno	Reno	Reno	842b
Sampled Date (MM/DD/YYYY)		2019-03-18	2019-03-19	2019-05-30	2019-05-30	2019-05-30	2019-10-17	2019-11-05	2019-11-15
Sampled Time		21:55	18:30	5:55	6:05	7:15	20:45	22:15	14:15
Triggered Concentration (ppm)		0.32	0.67	0.62	0.39	0.37	0.73	0.34	0.36
1,4-Dichlorobenzene	ppbv	< 0.6	< 0.6	< 0.5	< 0.6	< 0.6	< 0.7	< 0.6	< 0.6
1,4-Dioxane	ppbv	< 0.6	< 0.6	< 0.5	< 0.6	< 0.6	< 0.7	< 0.6	< 0.6
1-Butene	ppbv	1.23	< 0.03	8.73	7.93	6.02	5.70	0.96	3.20
1-Hexene	ppbv	< 0.03	< 0.03	< 0.03	0.92	1.01	0.48	0.27	0.44
1-Pentene	ppbv	< 0.01	< 0.02	1.35	1.45	1.60	< 0.02	< 0.02	0.30
2,2,4-Trimethylpentane	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	< 0.02	< 0.02
2,2-Dimethylbutane	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	0.10	0.11
2,3,4-Trimethylpentane	ppbv	< 0.01	< 0.02	0.09	< 0.01	< 0.01	< 0.02	0.14	0.10
2,3-Dimethylbutane	ppbv	< 0.03	0.06	0.52	< 0.03	< 0.03	0.29	0.20	0.15
2,3-Dimethylpentane	ppbv	< 0.03	0.17	0.12	< 0.03	< 0.03	0.09	0.05	0.06
2,4-Dimethylpentane	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	0.13	0.11
2-Methylheptane	ppbv	< 0.01	< 0.02	0.10	< 0.01	< 0.01	0.10	0.11	< 0.02
2-Methylhexane	ppbv	0.03	0.24	0.08	< 0.01	< 0.01	0.07	0.06	0.06
2-Methylpentane	ppbv	0.18	0.35	0.23	0.05	0.05	0.21	0.26	0.20
3-Methylheptane	ppbv	< 0.03	< 0.03	0.07	< 0.03	< 0.03	< 0.03	0.12	0.12
3-Methylhexane	ppbv	0.05	0.36	0.05	0.18	0.20	0.10	0.08	0.10
3-Methylpentane	ppbv	0.08	0.24	0.05	< 0.01	< 0.01	0.14	0.26	0.17
Acetone	ppbv	5.60	3.80	27.30	19.70	21.60	30.70	1.40	7.60
Acrolein	ppbv	< 0.4	< 0.5	12.10	5.40	7.20	5.50	< 0.5	1.90
Benzene	ppbv	0.43	< 0.02	11.90	6.43	8.29	6.99	0.23	4.17
Benzyl chloride	ppbv	< 0.6	< 0.6	< 0.5	< 0.6	< 0.6	< 0.7	< 0.6	< 0.6
Bromodichloromethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Bromoform	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Bromomethane	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	< 0.02	0.03
Carbon disulfide	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	0.11	< 0.02

Station		Reno	Reno	986b	842b	Reno	Reno	Reno	842b
Sampled Date (MM/DD/YYYY)		2019-03-18	2019-03-19	2019-05-30	2019-05-30	2019-05-30	2019-10-17	2019-11-05	2019-11-15
Sampled Time		21:55	18:30	5:55	6:05	7:15	20:45	22:15	14:15
Triggered Concentration (ppm)		0.32	0.67	0.62	0.39	0.37	0.73	0.34	0.36
Carbon tetrachloride	ppbv	0.11	0.05	0.06	0.05	< 0.01	0.14	0.05	0.11
Chlorobenzene	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.05
Chloroethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Chloroform	ppbv	< 0.03	< 0.03	0.04	< 0.03	< 0.03	< 0.03	< 0.03	0.03
Chloromethane	ppbv	0.81	0.64	1.62	1.03	1.06	0.91	0.50	0.73
cis-1,2-Dichloroethene	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	< 0.02	< 0.02
cis-1,3-Dichloropropene	ppbv	< 0.06	< 0.06	< 0.05	< 0.06	< 0.06	< 0.07	< 0.06	< 0.06
cis-2-Butene	ppbv	< 0.03	< 0.03	1.34	0.92	0.91	0.72	0.03	0.21
cis-2-Pentene	ppbv	< 0.03	< 0.03	1.33	0.21	0.18	0.48	0.19	0.19
Cyclohexane	ppbv	< 0.03	0.66	0.06	< 0.03	< 0.03	0.23	0.25	0.16
Cyclopentane	ppbv	< 0.01	2.18	0.87	1.76	< 0.01	1.06	0.58	0.53
Dibromochloromethane	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	< 0.02	< 0.02	< 0.02
Ethanol	ppbv	2.80	< 0.5	7.20	5.20	3.90	8.10	1.40	9.50
Ethyl acetate	ppbv	< 0.6	< 0.6	< 0.5	< 0.6	< 0.6	< 0.7	< 0.6	< 0.6
Ethylbenzene	ppbv	0.11	< 0.02	0.53	0.63	0.70	0.52	0.38	0.42
Freon-11	ppbv	0.32	0.21	0.24	0.26	0.18	0.55	0.11	0.20
Freon-113	ppbv	0.04	< 0.02	0.06	< 0.01	< 0.01	< 0.02	< 0.02	< 0.02
Freon-114	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03
Freon-12	ppbv	0.52	0.50	0.49	0.39	0.34	0.76	0.49	0.59
Hexachloro-1,3-butadiene	ppbv	< 0.73	< 0.76	< 0.64	< 0.74	< 0.72	< 0.83	< 0.78	< 0.76
Isobutane	ppbv	1.88	0.90	3.80	2.58	0.74	2.57	0.64	1.84
Isopentane	ppbv	0.54	1.03	0.51	0.35	0.30	1.53	0.50	0.53
Isoprene	ppbv	< 0.01	< 0.02	1.32	0.88	0.83	0.57	0.17	0.35
Isopropyl alcohol	ppbv	< 0.6	< 0.6	0.90	< 0.6	< 0.6	0.80	< 0.6	< 0.6
Isopropylbenzene	ppbv	< 0.01	< 0.02	< 0.01	< 0.01	< 0.01	0.03	< 0.02	< 0.02

Station		Reno	Reno	986b	842b	Reno	Reno	Reno	842b
Sampled Date (MM/DD/YYYY)		2019-03-18	2019-03-19	2019-05-30	2019-05-30	2019-05-30	2019-10-17	2019-11-05	2019-11-15
Sampled Time		21:55	18:30	5:55	6:05	7:15	20:45	22:15	14:15
Triggered Concentration (ppm)		0.32	0.67	0.62	0.39	0.37	0.73	0.34	0.36
m,p-Xylene	ppbv	0.45	< 0.05	0.93	1.23	1.27	0.79	0.65	0.50
m-Diethylbenzene	ppbv	< 0.06	< 0.06	0.09	< 0.06	< 0.06	< 0.07	0.28	< 0.06
m-Ethyltoluene	ppbv	< 0.12	< 0.12	0.18	0.20	0.18	0.26	0.21	0.24
Methyl butyl ketone	ppbv	< 0.73	< 0.76	< 0.64	< 0.74	< 0.72	< 0.83	< 0.78	< 0.76
Methyl ethyl ketone	ppbv	< 0.4	< 0.5	4.70	2.70	3.40	2.80	< 0.5	1.00
Methyl isobutyl ketone	ppbv	< 0.6	< 0.6	0.70	< 0.6	< 0.6	< 0.7	< 0.6	< 0.6
Methyl methacrylate	ppbv	< 0.10	< 0.11	< 0.09	< 0.10	< 0.10	< 0.12	< 0.11	0.23
Methyl tert butyl ether	ppbv	< 0.04	< 0.05	< 0.04	< 0.04	< 0.04	< 0.05	< 0.05	< 0.05
Methylcyclohexane	ppbv	0.15	1.01	0.08	< 0.01	< 0.01	0.14	0.25	0.12
Methylcyclopentane	ppbv	0.13	0.59	0.12	< 0.03	< 0.03	0.17	0.31	0.18
Methylene chloride	ppbv	< 0.4	< 0.5	< 0.4	< 0.4	< 0.4	< 0.5	< 0.5	< 0.5
n-Butane	ppbv	2.13	1.13	2.87	1.94	2.19	2.88	0.40	2.46
n-Decane	ppbv	< 0.09	< 0.09	0.15	0.15	0.22	0.22	0.25	0.23
n-Dodecane	ppbv	< 0.6	< 0.6	< 0.5	< 0.6	< 0.6	< 0.7	< 0.6	< 0.6
n-Heptane	ppbv	0.09	< 0.02	0.50	0.29	0.40	0.36	0.13	0.17
n-Hexane	ppbv	0.32	0.18	0.63	0.45	0.53	0.47	0.08	0.28
n-Nonane	ppbv	0.05	< 0.02	0.26	0.18	0.21	0.22	0.16	0.19
n-Octane	ppbv	0.08	< 0.03	0.45	0.24	0.30	0.25	0.17	0.21
n-Pentane	ppbv	0.90	0.40	1.10	0.80	0.90	1.70	0.30	0.60
n-Propylbenzene	ppbv	< 0.07	< 0.08	0.09	0.11	0.12	0.23	0.20	0.21
n-Undecane	ppbv	< 0.7	< 0.8	< 0.6	< 0.7	< 0.7	< 0.8	< 0.8	< 0.8
Naphthalene	ppbv	< 0.7	< 0.8	< 0.6	< 0.7	< 0.7	< 0.8	< 0.8	< 0.8
o-Ethyltoluene	ppbv	< 0.01	< 0.02	0.04	0.14	0.15	0.15	0.12	0.08
o-Xylene	ppbv	< 0.01	< 0.02	0.52	0.54	0.53	0.38	0.16	0.24
p-Diethylbenzene	ppbv	< 0.06	< 0.06	0.06	< 0.06	< 0.06	< 0.07	0.57	< 0.06

Station		Reno	Reno	986b	842b	Reno	Reno	Reno	842b
Sampled Date (MM/DD/YYYY)		2019-03-18	2019-03-19	2019-05-30	2019-05-30	2019-05-30	2019-10-17	2019-11-05	2019-11-15
Sampled Time		21:55	18:30	5:55	6:05	7:15	20:45	22:15	14:15
Triggered Concentration (ppm)		0.32	0.67	0.62	0.39	0.37	0.73	0.34	0.36
p-Ethyltoluene	ppbv	< 0.10	< 0.11	< 0.09	< 0.10	< 0.10	< 0.12	0.20	0.22
Styrene	ppbv	< 0.06	< 0.06	0.82	1.08	1.07	0.63	< 0.06	0.60
Tetrachloroethylene	ppbv	< 0.06	< 0.06	< 0.05	< 0.06	< 0.06	< 0.07	< 0.06	< 0.06
Tetrahydrofuran	ppbv	< 0.6	< 0.6	< 0.5	< 0.6	< 0.6	< 0.7	< 0.6	< 0.6
Toluene	ppbv	1.85	0.10	5.80	4.85	5.35	3.46	0.52	1.74
trans-1,2-Dichloroethylene	ppbv	< 0.01	< 0.02	0.14	3.40	< 0.01	< 0.02	< 0.02	2.37
trans-1,3-Dichloropropylene	ppbv	< 0.06	< 0.06	< 0.05	< 0.06	< 0.06	< 0.07	< 0.06	< 0.06
trans-2-Butene	ppbv	< 0.01	< 0.02	1.78	1.13	1.08	0.94	0.04	0.29
trans-2-Pentene	ppbv	< 0.03	< 0.03	0.47	0.37	0.34	0.47	< 0.03	0.18
Trichloroethylene	ppbv	< 0.06	< 0.06	< 0.05	< 0.06	< 0.06	< 0.07	< 0.06	< 0.06
Vinyl acetate	ppbv	< 0.6	< 0.6	2.20	< 0.6	< 0.6	< 0.7	< 0.6	< 0.6
Vinyl chloride	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03

APPENDIX A-2 CH_4 TRIGGERED SAMPLE RESULTS

Station		Reno	Reno	Reno	Reno	Reno	Reno	Reno	Reno	Reno**	986b
Sampled Date (MM/DD/YYYY)		2019-02-17	2019-02-20	2019-02-23	2019-02-24	2019-03-08	2019-03-10	2019-03-16	2019-03-29	2019-04-10	2019-06-14
Sampled Time		19:25	22:05	20:15	19:35	22:20	8:25	15:35	1:55	21:20	1:10
Triggered Concentration (ppm)		5.95	5.50	17.24	11.33	9.92	5.93	6.05	6.56	5.86	7.75
Parameter	**Unit**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**
1-Butene	ppmv	< 0.15	< 0.16	< 0.16	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15	< 0.15	< 0.16
Acetylene	ppmv	< 0.12	< 0.13	< 0.13	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.12	< 0.13
cis-2-Butene	ppmv	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	< 0.07
Ethane	ppmv	0.20	< 0.2	< 0.2	< 0.2	< 0.1	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Ethylacetylene	ppmv	< 0.09	< 0.09	< 0.10	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	< 0.09	< 0.10
Ethylene	ppmv	< 0.11	< 0.11	< 0.11	< 0.11	< 0.10	< 0.11	< 0.11	< 0.11	< 0.11	< 0.12
Isobutane	ppmv	< 0.2	< 0.2	< 0.2	< 0.2	< 0.1	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Isobutylene	ppmv	< 0.2	< 0.2	< 0.2	< 0.2	< 0.1	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Methane	ppmv	3.00	2.30	6.10	4.10	2.80	14.40	2.40	2.30	2.90	2.60
n-Butane	ppmv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3
n-Propane	ppmv	< 0.11	< 0.11	< 0.11	< 0.11	< 0.10	< 0.11	< 0.11	< 0.11	< 0.11	< 0.12
Propylene	ppmv	< 0.2	< 0.2	< 0.2	< 0.2	< 0.1	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
Propyne	ppmv	< 0.2	< 0.2	< 0.2	< 0.2	< 0.1	< 0.2	< 0.2	< 0.2	< 0.2	< 0.2
trans-2-Butene	ppmv	< 0.14	< 0.14	< 0.15	< 0.14	< 0.13	< 0.14	< 0.14	< 0.14	< 0.14	< 0.15
2,5-Dimethylthiophene	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5	< 0.5	< 0.5	n/a	< 0.5
2-Ethylthiophene	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	n/a	< 0.3
2-Methylthiophene	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	n/a	< 0.3
3-Methylthiophene	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5	< 0.5	< 0.5	n/a	< 0.5
Butyl mercaptan	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5	< 0.5	< 0.5	n/a	< 0.5
Carbon disulphide	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	n/a	< 0.3
Carbonyl sulphide	ppbv	2.60	3.00	< 0.5	< 0.5	1.60	1.80	1.20	1.20	n/a	1.00
Dimethyl disulphide	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	n/a	< 0.3

Dimethyl sulphide	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	n/a	< 0.3
Ethyl mercaptan	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5	< 0.5	< 0.5	n/a	< 0.5
Ethyl sulphide	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5	< 0.5	< 0.5	n/a	< 0.5
Hydrogen sulphide	ppbv	2.50	3.30	< 0.2	< 0.2	3.30	3.50	3.50	2.20	n/a	3.40
Isobutyl mercaptan	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5	< 0.5	< 0.5	n/a	< 0.5
Isopropyl mercaptan	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5	< 0.5	< 0.5	n/a	< 0.5
Methyl mercaptan	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	n/a	< 0.3
Pentyl mercaptan	ppbv	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	n/a	< 0.7
Propyl mercaptan	ppbv	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	n/a	< 0.7
tert-Butyl mercaptan	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5	< 0.5	< 0.5	n/a	< 0.5
Thiophene	ppbv	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	< 0.3	n/a	< 0.3
1,1,1-Trichloroethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.17	< 0.03	< 0.02	< 0.03	< 0.03
1,1,2,2-Tetrachloroethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.20	< 0.03	< 0.02	< 0.03	< 0.03
1,1,2-Trichloroethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.21	< 0.03	< 0.03	< 0.03	< 0.03
1,1-Dichloroethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.22	< 0.03	< 0.03	< 0.03	< 0.03
1,1-Dichloroethylene	ppbv	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	0.23	< 0.06	< 0.06	< 0.06	< 0.07
1,2,3-Trimethylbenzene	ppbv	< 0.08	< 0.08	< 0.08	< 0.08	< 0.07	0.22	< 0.08	< 0.08	< 0.08	< 0.08
1,2,4-Trichlorobenzene	ppbv	< 1.2	< 1.3	< 1.3	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.2	< 1.3
1,2,4-Trimethylbenzene	ppbv	< 0.08	< 0.08	< 0.08	< 0.08	< 0.07	0.49	< 0.08	< 0.08	< 0.08	< 0.08
1,2-Dibromoethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.17	< 0.03	< 0.03	< 0.03	< 0.03
1,2-Dichlorobenzene	ppbv	< 0.05	< 0.05	< 0.05	< 0.05	< 0.04	0.18	< 0.05	< 0.05	< 0.05	< 0.05
1,2-Dichloroethane	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.28	< 0.02	< 0.02	< 0.02	< 0.02
1,2-Dichloropropane	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.22	< 0.02	< 0.02	< 0.02	< 0.02
1,3,5-Trimethylbenzene	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.50	< 0.03	< 0.03	< 0.03	< 0.03
1,3-Butadiene	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.24	< 0.03	< 0.03	< 0.03	< 0.03
1,3-Dichlorobenzene	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
1,4-Dichlorobenzene	ppbv	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.7
1,4-Dioxane	ppbv	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.7
1-Butene	ppbv	0.79	< 0.03	0.04	< 0.03	< 0.03	0.64	0.17	0.48	< 0.03	4.15
1-Hexene	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.43	< 0.03	< 0.03	< 0.03	< 0.03

1-Pentene	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.24	< 0.02	0.04	< 0.02	0.54
2,2,4-Trimethylpentane	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.25	< 0.02	0.03	< 0.02	< 0.02
2,2-Dimethylbutane	ppbv	< 0.02	< 0.02	0.06	< 0.02	< 0.01	0.29	< 0.02	0.02	< 0.02	< 0.02
2,3,4-Trimethylpentane	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.26	< 0.02	< 0.02	< 0.02	< 0.02
2,3-Dimethylbutane	ppbv	< 0.03	< 0.03	0.17	0.06	0.06	0.43	< 0.03	0.04	< 0.03	< 0.03
2,3-Dimethylpentane	ppbv	< 0.03	< 0.03	0.06	< 0.03	0.03	0.33	< 0.03	< 0.03	< 0.03	< 0.03
2,4-Dimethylpentane	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.27	< 0.02	< 0.02	< 0.02	< 0.02
2-Methylheptane	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.24	< 0.02	< 0.02	< 0.02	< 0.02
2-Methylhexane	ppbv	0.03	< 0.02	0.07	0.04	0.08	0.40	< 0.02	0.14	< 0.02	< 0.02
2-Methylpentane	ppbv	0.23	0.08	0.57	0.28	0.34	0.98	0.10	0.14	0.05	< 0.02
3-Methylheptane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.26	< 0.03	< 0.03	< 0.03	< 0.03
3-Methylhexane	ppbv	0.05	< 0.03	0.13	0.04	0.12	0.41	< 0.03	0.13	< 0.03	< 0.03
3-Methylpentane	ppbv	0.12	< 0.02	0.38	0.17	0.17	0.66	0.03	0.14	< 0.02	< 0.02
Acetone	ppbv	3.30	< 0.6	0.70	< 0.6	2.10	2.40	3.00	2.60	12.60	17.30
Acrolein	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5	< 0.5	< 0.5	0.50	< 0.5
Benzene	ppbv	0.26	< 0.02	0.02	0.02	0.08	0.69	0.07	0.20	< 0.02	0.80
Benzyl chloride	ppbv	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.7
Bromodichloromethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.16	< 0.03	< 0.03	< 0.03	< 0.03
Bromoform	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.12	< 0.03	< 0.03	< 0.03	0.05
Bromomethane	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.23	< 0.02	0.08	< 0.02	< 0.02
Carbon disulfide	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.11	< 0.02	< 0.02	0.12	0.22
Carbon tetrachloride	ppbv	0.03	< 0.02	< 0.02	< 0.02	< 0.01	0.22	0.07	0.23	< 0.02	0.05
Chlorobenzene	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.22	< 0.03	< 0.03	< 0.03	< 0.03
Chloroethane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.24	< 0.03	< 0.03	< 0.03	0.06
Chloroform	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.24	< 0.03	0.07	< 0.03	< 0.03
Chloromethane	ppbv	0.50	0.49	0.54	0.48	0.56	0.83	0.53	0.58	0.55	0.78
cis-1,2-Dichloroethene	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.23	< 0.02	< 0.02	< 0.02	< 0.02
cis-1,3-Dichloropropene	ppbv	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	0.11	< 0.06	< 0.06	< 0.06	< 0.07
cis-2-Butene	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.25	< 0.03	< 0.03	< 0.03	< 0.03
cis-2-Pentene	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.23	< 0.03	< 0.03	< 0.03	< 0.03

Cyclohexane	ppbv	0.11	< 0.03	0.79	0.29	0.19	0.92	< 0.03	0.14	< 0.03	< 0.03
Cyclopentane	ppbv	0.04	< 0.02	0.17	0.07	0.03	0.52	< 0.02	6.85	< 0.02	< 0.02
Dibromochloromethane	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.13	0.05	< 0.02	< 0.02	< 0.02
Ethanol	ppbv	2.20	< 0.5	< 0.5	< 0.5	2.20	2.10	< 0.5	1.90	2.50	6.20
Ethyl acetate	ppbv	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.7
Ethylbenzene	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.51	< 0.02	< 0.02	< 0.02	< 0.02
Freon-11	ppbv	0.22	0.19	0.19	0.20	0.21	0.49	0.20	< 0.03	0.15	0.16
Freon-113	ppbv	0.03	< 0.02	< 0.02	< 0.02	< 0.01	0.33	< 0.02	< 0.02	< 0.02	< 0.02
Freon-114	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.15	< 0.03	< 0.03	< 0.03	< 0.03
Freon-12	ppbv	0.46	0.46	0.47	0.47	0.48	0.67	0.44	0.25	0.43	0.36
Hexachloro-1,3-butadiene	ppbv	< 0.76	< 0.79	< 0.81	< 0.76	< 0.74	< 0.76	< 0.77	< 0.76	< 0.76	< 0.82
Isobutane	ppbv	2.30	0.31	0.85	0.83	1.42	20.80	0.36	0.40	0.24	2.81
Isopentane	ppbv	0.94	0.30	1.20	0.87	0.95	5.21	0.30	0.69	0.28	0.19
Isoprene	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.18	< 0.02	< 0.02	< 0.02	1.25
Isopropyl alcohol	ppbv	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	0.80
Isopropylbenzene	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.27	< 0.02	< 0.02	< 0.02	< 0.02
m,p-Xylene	ppbv	< 0.05	< 0.05	< 0.05	< 0.05	< 0.04	0.79	< 0.05	0.05	< 0.05	< 0.05
m-Diethylbenzene	ppbv	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	0.27	< 0.06	< 0.06	< 0.06	< 0.07
m-Ethyltoluene	ppbv	< 0.12	< 0.13	< 0.13	< 0.12	< 0.12	0.25	< 0.12	< 0.12	< 0.12	< 0.13
Methyl butyl ketone	ppbv	< 0.76	< 0.79	< 0.81	< 0.76	< 0.74	< 0.76	< 0.77	< 0.76	< 0.76	< 0.82
Methyl ethyl ketone	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Methyl isobutyl ketone	ppbv	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.7
Methyl methacrylate	ppbv	< 0.11	< 0.11	< 0.11	< 0.11	< 0.10	0.22	< 0.11	< 0.11	< 0.11	< 0.12
Methyl tert butyl ether	ppbv	< 0.05	< 0.05	< 0.05	< 0.05	< 0.04	0.22	< 0.05	< 0.05	< 0.05	< 0.05
Methylcyclohexane	ppbv	0.22	0.05	0.75	0.33	0.42	0.67	< 0.02	0.05	0.16	< 0.02
Methylcyclopentane	ppbv	0.23	0.07	0.62	0.33	0.37	0.73	< 0.03	0.20	0.11	< 0.03
Methylene chloride	ppbv	< 0.5	< 0.5	< 0.5	< 0.5	< 0.4	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
n-Butane	ppbv	2.89	0.49	0.83	0.89	2.12	23.90	0.56	0.65	0.25	0.52
n-Decane	ppbv	< 0.09	< 0.09	< 0.10	< 0.09	< 0.09	0.26	< 0.09	< 0.09	< 0.09	< 0.10
n-Dodecane	ppbv	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.7

n-Heptane	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	0.05	0.70	< 0.02	0.47	< 0.02	< 0.02
n-Hexane	ppbv	0.08	< 0.02	0.08	< 0.02	0.33	1.21	< 0.02	0.31	< 0.02	< 0.02
n-Nonane	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.30	0.03	< 0.02	< 0.02	0.16
n-Octane	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.33	< 0.03	0.09	< 0.03	0.11
n-Pentane	ppbv	0.60	0.20	0.40	0.30	0.80	3.50	0.20	0.30	< 0.2	0.20
n-Propylbenzene	ppbv	< 0.08	< 0.08	< 0.08	< 0.08	< 0.07	0.24	< 0.08	< 0.08	< 0.08	< 0.08
n-Undecane	ppbv	< 0.8	< 0.8	< 0.8	< 0.8	< 0.7	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
Naphthalene	ppbv	< 0.8	< 0.8	< 0.8	< 0.8	< 0.7	< 0.8	< 0.8	< 0.8	< 0.8	< 0.8
o-Ethyltoluene	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.24	< 0.02	< 0.02	< 0.02	0.02
o-Xylene	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.53	< 0.02	0.02	< 0.02	< 0.02
p-Diethylbenzene	ppbv	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	0.23	< 0.06	< 0.06	< 0.06	0.12
p-Ethyltoluene	ppbv	< 0.11	< 0.11	< 0.11	< 0.11	< 0.10	0.49	< 0.11	< 0.11	< 0.11	< 0.12
Styrene	ppbv	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	0.42	< 0.06	< 0.06	0.22	0.45
Tetrachloroethylene	ppbv	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	0.24	< 0.06	< 0.06	< 0.06	< 0.07
Tetrahydrofuran	ppbv	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.7
Toluene	ppbv	0.32	< 0.02	< 0.02	< 0.02	0.12	0.62	< 0.02	1.74	0.85	0.75
trans-1,2-Dichloroethylene	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.23	< 0.02	< 0.02	< 0.02	0.97
trans-1,3-Dichloropropylene	ppbv	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	0.09	< 0.06	< 0.06	< 0.06	0.07
trans-2-Butene	ppbv	< 0.02	< 0.02	< 0.02	< 0.02	< 0.01	0.27	< 0.02	< 0.02	< 0.02	< 0.02
trans-2-Pentene	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.21	< 0.03	< 0.03	< 0.03	< 0.03
Trichloroethylene	ppbv	< 0.06	< 0.06	< 0.06	< 0.06	< 0.06	0.21	< 0.06	< 0.06	< 0.06	< 0.07
Vinyl acetate	ppbv	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.6	< 0.7
Vinyl chloride	ppbv	< 0.03	< 0.03	< 0.03	< 0.03	< 0.03	0.18	< 0.03	< 0.03	< 0.03	< 0.03