Heartland
Air Monitoring
Partnership

We Monitor the Air You Breathe

Newbrook

Portable Monitoring Station Project

Air Quality
Monitoring Report
June 2024

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Executive Summary

Heartland Air Monitoring Partnership (HAMP), formerly known as Fort Air Partnership, is a not-for-profit organization formed in 1997 to monitor the air people breathe within a 4,500 square kilometer Airshed located immediately north and east of Edmonton, Alberta, Canada. HAMP operates a portable air quality monitoring station, the Keith Purves Portable (KPP) that can be sited throughout the HAMP region to monitor ambient air quality. The Keith Purves Portable was most recently located in Thorhild County near the community of Newbrook where it collected air quality measurements from February 1, 2023, to January 31, 2024. This site, although located in a rural area approximately six kilometers south of Newbrook, will be referred to throughout this report as Newbrook or KPP Newbrook site.

A significant factor in the selection of the area as a location for the Keith Purves Portable was the fact that no continuous ambient air monitoring at or near the northern HAMP border had previously been done.

Since the Air Quality Health Index (AQHI) is a measurement of air quality as it pertains to human health, the standard suite of monitoring equipment for a community AQHI station was installed in the KPP during this project. Monthly averages were charted for all parameters listed below, as well as histograms summarizing the distribution of one-hour averages during the 12 month project. Wind roses illustrating the proportion of time the wind was blowing from which direction were also developed for the KPP Newbrook site. The bulk of measurements at the KPP Newbrook site occurred with winds from either the west to northwest, or east to southeast directions. The wind blew from the southeast to southwest quadrant, toward the northern HAMP border, only 18 percent of the time. Accompanying pollutant roses have been included to compare concentrations of fine particulate matter, methane, nitrogen dioxide (NO_2) and sulphur dioxide (SO_2) with the wind direction. O_3 and H_2S were not included in wind rose plots since O_3 is not emitted directly by sources, while H_2S is generated primarily by localized sources (both natural and human-made) and not readily transported over any significant distance. Non-methane hydrocarbons (NMHCs) were not included in wind rose plots since levels recorded were very low and did not vary significantly throughout the project.

- **Fine Particulate Matter** – The highest one-hour average $PM_{2.5}$ measurement not due to wildfire smoke recorded at the KPP Newbrook site was 79.8 µg/m^3 in March 2023 due to regional meteorological conditions, while the highest one-hour average $PM_{2.5}$ measurement due to wildfire smoke was 416 µg/m^3 recorded in early September. There were 247 one-hour $PM_{2.5}$ exceedances during the time the KPP station was in operation at the Newbrook site. All but three of these exceedances were due to wildfire smoke, the remainder attributed to agricultural operations. There were also 40 24-hour $PM_{2.5}$ exceedances recorded during the same period. Three were due to wintertime inversions or meteorological conditions, the rest due to wildfire smoke.
- **Hydrogen Sulphide** – H_2S levels at Newbrook did not differ substantially from other stations where H_2S is monitored within HAMP's Airshed. All the monthly averages recorded at other stations varied less than 1 (one) parts per billion (ppb) from those recorded at the KPP Newbrook site. No measurements exceeded the 1-hour Alberta Ambient Air Quality Objective (AAAQO) of 10 ppb or the 24-hour AAAQO of 3 ppb. The highest measurements were 3.3 and 1.0 ppb respectively.
- **Hydrocarbons** - Total hydrocarbons (THC) is made up of NMHC and methane (CH_4). Methane at the KPP Newbrook site was on average almost 0.2 ppm higher than all other HAMP sites. Ranging from 0.1 ppm higher in November 2023 to 0.28 ppm higher in June 2023.

- **Nitrogen Dioxide** - The NO_2 levels at the KPP Newbrook site were lower than levels recorded at other sites within HAMP during the 12 month project, differing the most during the winter months. The NO_2 pollutant rose indicates most (62%) of the higher measurements (10 to 50 ppb) occurred when winds were from the east to southeast directions. No 1-hour average NO_2 measurements approached the AAAQO during the project, with the highest measurement reaching 36.1 ppb which is 22.7% of the AAAQO of 159 ppb.
- **Ozone** - O_3 levels at the KPP Newbrook site did not differ substantially from levels recorded at other stations within HAMP. Monthly averages during the summer months of May to September, were on average 3% higher than other HAMP stations. The spring and fall shoulder seasons were an average of 16% higher at the KPP Newbrook site. The winter months, February and December 2023 and January 2024 recorded an average of 34% higher O_3 at Newbrook. There were four instances of the O_3 exceeding the daily maximum AAAQO. The highest of these was 126% of the AAAQO of 76 ppb.
- **Sulphur Dioxide** - SO_2 levels at the KPP Newbrook site did not differ substantially from levels recorded at other stations within HAMP, with all monthly averages being within 1.5 ppb of the averages recorded at Newbrook. There was some variability from month to month as can be expected with such low concentrations. The SO_2 pollutant rose indicates that 1-hour concentrations above 1 ppb only occurred 148 times when winds were from the southeast to southwest quadrant. No one-hour SO_2 measurements approached the AAAQO, with the highest measurement only reaching 9.9 ppb which is 5.7% of the AAAQO.
- **AQHI** - The KPP Newbrook site, like all HAMP stations, recorded low risk to health AQHI ratings for the vast majority of the project. The KPP Newbrook site was in the low-risk category 87.8% of the time, slightly more of the time than all other HAMP stations. The station was in the High and Very High risk 4.2% of the hours monitored. This was on par with other HAMP stations and due to long range transport of wildfire smoke from outside of HAMP. The 139 high and 159 very high risk ratings occurred during the summer months. All but two of these were due to wildfire smoke.

There was a total of 244 1-hour average AAAQO exceedances from May to September that were due to wildfire smoke from fires outside of HAMP and even long range transport from outside of Alberta. There were also 37 24-hour $PM_{2.5}$ exceedances during the same period due to wildfire smoke.

Regional meteorological conditions in March 2023 where a stagnant air mass over a large area of the Edmonton Metropolitan Area accounted for one 1-hour AAAQO exceedance of ozone and one 24-hour exceedance of $PM_{2.5}$. There were three 1-hour exceedances of ozone in June as a byproduct of the wildfire smoke experienced in the HAMP region during those days. There were also three hourly $PM_{2.5}$ exceedances recorded on three separate days in September 2023 that were attributed to agricultural operations in the region at the time.

There were two 24-hour $PM_{2.5}$ exceedances in January 2024 due to wintertime inversion weather condition that occurred in the Edmonton Metropolitan Area and surrounding areas for several days.

HAMP wishes to thank TLC Farms for accommodating the KPP on site for the 12-month project.

1.0 About Heartland Air Monitoring Partnership

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

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

Figure 1: Exterior Photo of the KPP Station

2.0 Portable Station Program Description

HAMP operates a portable station that can be sited throughout the region to monitor ambient air quality. HAMP has developed a documented process to select sites for the Keith Purves Portable.

The Keith Purves Portable is equipped with the parameters required to calculate the Air Quality Health Index (AQHI) including oxides of nitrogen (NO/NOx/NO_2), ozone (O_3), fine particulate matter ($PM_{2.5)}$, sulphur dioxide (SO_2) and hydrogen sulphide (H_2S), along with meteorological parameters including wind speed, wind direction, ambient temperature and relative humidity. The station also measured non-methane hydrocarbons (NMHCs) during this project.

Equipment to measure other substances can also be added to the monitoring suite depending on the project objectives. All parameters, with the exception of fine particulate matter which is measured in micrograms per cubic meter ($\mu g/m^3$), are measured in parts per billion (ppb). A pinch of salt in a 10-ton bag of potato chips or one drop of ink in a large gasoline tanker truck would approximately equal one ppb.

The Keith Purves Portable station is operated by HAMP according to the Alberta Government Air Monitoring Directive and is subject to the same rigorous quality assurance measures as the rest of the air monitoring network. Details on these measures are available in the 2023 Annual Technical Report available on the HAMP website library.

3.0 Project Description

3.1 Project Objectives

The objectives of the Newbrook ambient air monitoring project listed at the outset, were to monitor and record air quality data to:

- Characterize the air quality the hamlet residents experience.
- Determine possible influence from sources near the hamlet.
- Determine possible effects of regional air quality events such as inversions, wildfires, and summertime smog.
- Compare air quality in the hamlet of Newbrook with other communities in HAMP.

A secondary objective, and one of the criteria used in the selection process discussed below was to consider this site as a trans-boundary station on HAMP's northern boundary.

Figure 2: Interior photo of the KPP Station

3.2 Station Location

In March 2022, a sub-committee of the HAMP Technical Working Group (TWG) followed a documented site selection process to assess Newbrook among several candidate locations as the next site for the portable station. This recommendation was subject to finding a suitable site to place the shelter.

The community of Newbrook ranked as the highest priority for the following reasons:

- There has been no continuous monitoring done historically in the community of Newbrook.
- The nearest continuous air quality monitoring station is Redwater, which is 42 kilometers away from the community. While the nearest SO_2 & H_2S passive samplers are located nine kilometers away.
- There is a new Class II landfill within seven kilometers of the community.
- The community of Newbrook is on the northern representation of the air quality leaving the HAMP Airshed when there is a northerly airflow.

3.3 KPP Newbrook Site Information

- The community of Newbrook is on the northern border of HAMP. It lies directly north of the developed Industrial Heartland Area.
- The population of the community of Newbrook is 63 (2021).
- The selected site was located on the property of TLC Farms at northwest quarter of Section 9, Township 61, Range 20, West of the 4th meridian. Approximately 6 kilometers south of the community of Newbrook.
- The continuous monitoring station nearest the selected site is also operated by HAMP approximately 36 kilometers to the south-southwest in the Town of Redwater.

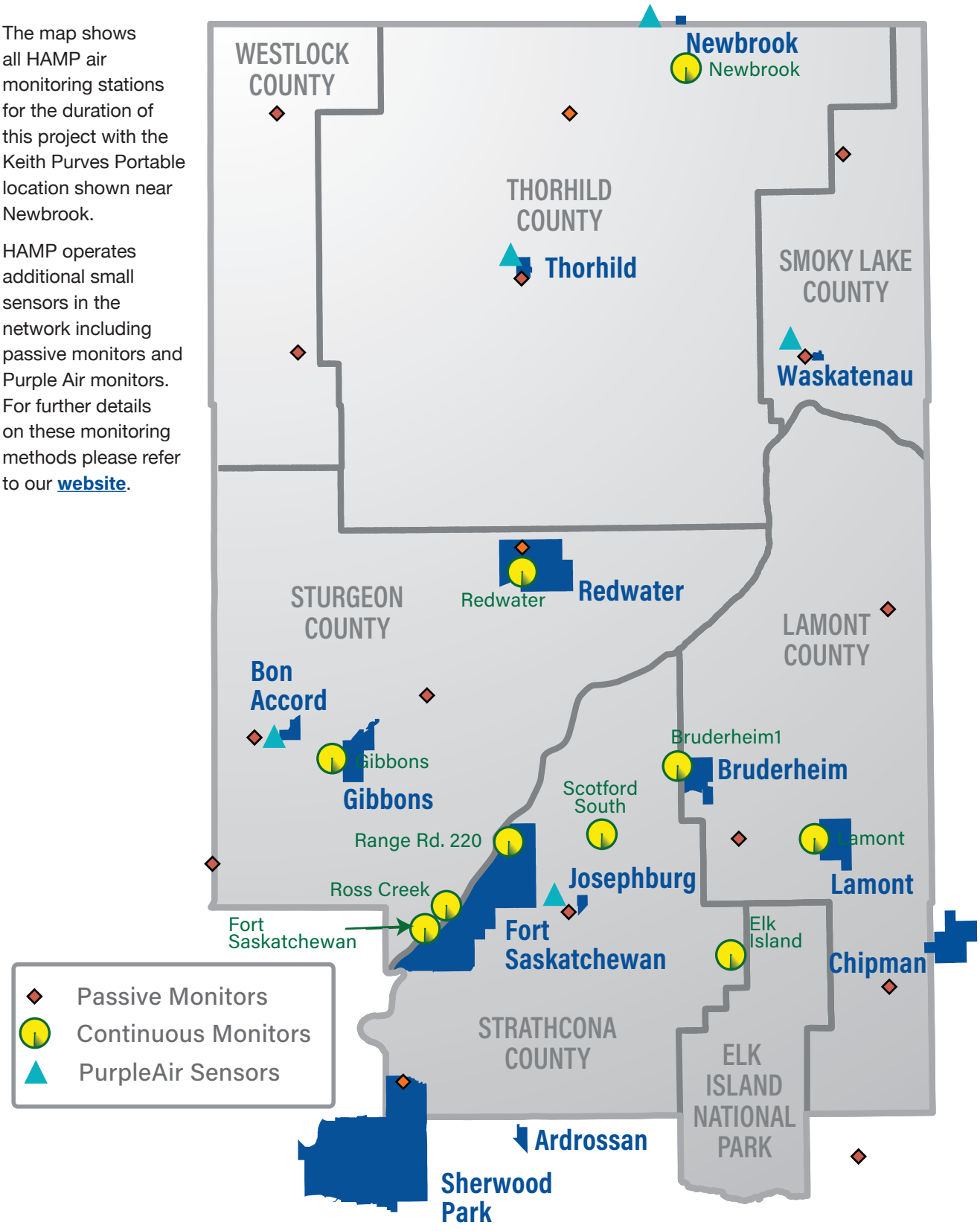
Site Chosen

The community of Newbrook was scouted for appropriate sites. However, the few possible locations presented challenges to placing the station since they did not meet the Alberta Government requirements for locating an ambient air monitoring station. A rural property approximately six kilometers south of the hamlet was available for the project. The landowners, TLC Farms, allowed the placement of the Keith Purves Portable on their property.

Figure 3: HAMP Monitoring Locations

The map shows all HAMP air monitoring stations for the duration of this project with the Keith Purves Portable location shown near Newbrook.

HAMP operates additional small sensors in the network including passive monitors and Purple Air monitors. For further details on these monitoring methods please refer to our **website**.



4.0 Project Monitoring Results

4.1 Results Compared to Alberta Ambient Air Quality Objectives

Alberta Ambient Air Quality Objectives (AAAQOs) are regulatory tools established by the Government of Alberta, under the Alberta Environmental Protection and Enhancement Act. Alberta Environment and Protected Areas (AEPA) works with a variety of stakeholders, including other government departments, the scientific community, environmental organizations, industry and the public to develop and review objectives. AAAQOs provide environmental and human health protection to an extent technically and economically feasible, as well as consider what is socially and politically acceptable. AAAQOs are set well below what are considered emergency levels. Not all substances measured at HAMP monitoring stations have corresponding AAAQOs. HAMP's Exceedance Fact Sheet, available on the HAMP website, provides more information about AAAQOs.

Table 1 provides details of the AAAQO exceedances measured and reported at the KPP Newbrook site including the dates, the number of exceedances of each type and the attribution assigned by HAMP and submitted to Alberta Environment and Protected Areas.

Table 1: Detail of Exceedances Measured at the KPP Newbrook Site

Date	Substance	One hour	24 hours	Attribution
March 20	O_3	1	–	Regional meteorological conditions
	$PM_{2.5}$	–	1	
May 16,19 21-23	$PM_{2.5}$	37	4	Wildfire smoke
June 2, 8-13	O_3	3	–	Wildfire smoke
	$PM_{2.5}$	13	7	
July 8-16	$PM_{2.5}$	84	6	Wildfire smoke
July 20-22	$PM_{2.5}$	–	3	
August 24-31	$PM_{2.5}$	16	7	Wildfire smoke
September 1-4, 13, 14, 16-18	$PM_{2.5}$	94	10	Wildfire smoke
September 19, 24, 25	$PM_{2.5}$	3	–	Agriculture operations
January 24, 25	$PM_{2.5}$	–	2	Wintertime inversion
Total O_3		**4**	**0**	
Total $PM_{2.5}$		**247**	**40**	

Description of Exceedances at Newbrook

The March 20, 2023, O_3 and $PM_{2.5}$ exceedances were attributed to a meteorological condition known as a wintertime temperature inversion. This type of weather condition occurs during very low wind conditions, where a stable layer of cold air near the earth's surface is trapped by a layer of warmer air aloft, effectively trapping pollutants at ground level. This will often result in increased levels of $PM_{2.5}$ and other substances. All other stations in HAMP experienced elevated O_3 on March 20 with, as can be seen in Table 2 below, two other community stations registering O_3 exceedances.

As many remember, the HAMP area and much of Alberta were blanketed by prolonged and repeated episodes of wildfire smoke in 2023. These resulted in the multitude of exceedances registered during the project both at the Keith Purves Portable and all other HAMP stations that measure $PM_{2.5}$.

Table 2 below shows all the instances where an exceedance of an AAAQO occurred in communities across HAMP while the Keith Purves Portable was at the KPP Newbrook site.

Table 2: Exceedances in HAMP Communities (February 2023 to January 2024)

AIR QUALITY EVENT DATES	SUB-STANCE	Bruderheim		Fort Saskatchewan		Gibbons		Lamont		Redwater		Keith Purves Portable		AIR QUALITY EVENT CAUSE
		1 Hour	24 Hour	1 Hour	24 Hour	1 Hour	24 Hour	1 Hour	24 Hour	1 Hour	24 Hour	1 Hour	24 Hour	
March 2023	O_3		n/a		n/a		n/a	1	n/a		n/a		n/a	Regional meteorological conditions
	$PM_{2.5}$		1		1		1				1	1	1	
April 2023	$PM_{2.5}$				1		1							Regional meteorological conditions
	H_2S									1				Undetermined
May 2023	O_3	4	n/a	3	n/a	2	n/a	4	n/a		n/a		n/a	Wildfire smoke and summertime smog
	$PM_{2.5}$	43	4	87	8	49	4	33	3	73	6	37	4	Wildfire smoke
June 2023	O_3	5	n/a	3	n/a	4	n/a	8	n/a	3	n/a	3	n/a	Wildfire smoke and summertime smog
	$PM_{2.5}$	2	6	12	9	10	8	14	6	26	10	13	7	Wildfire smoke
July 2023	$PM_{2.5}$	59	6	80	10	77	8	80	11	83	11	84	9	Wildfire smoke
	H_2S										1			Natural due to wetlands
August 2023	O_3	1	n/a		n/a		n/a	1	n/a		n/a		n/a	Summertime Smog
	$PM_{2.5}$	5	4	18	7	20	6	5	5	21	7	16	7	Wildfire smoke
September 2023	$PM_{2.5}$	57	8	90	10	94	11	49	7	92	9	94	10	Wildfire smoke
	$PM_{2.5}$											3		Agriculture operations
January 2024	$PM_{2.5}$		4	1	4	1	3		2	3	3		2	Wintertime operations
TOTAL	H_2S									4				4
TOTAL	O_3	10	n/a	6	n/a	6	n/a	13	n/a	3	n/a	3	n/a	41
TOTAL	$PM_{2.5}$	166	33	288	50	251	42	181	34	298	47	247	40	1,677

n/a: There is no 24 hour AAAQO for ozone.

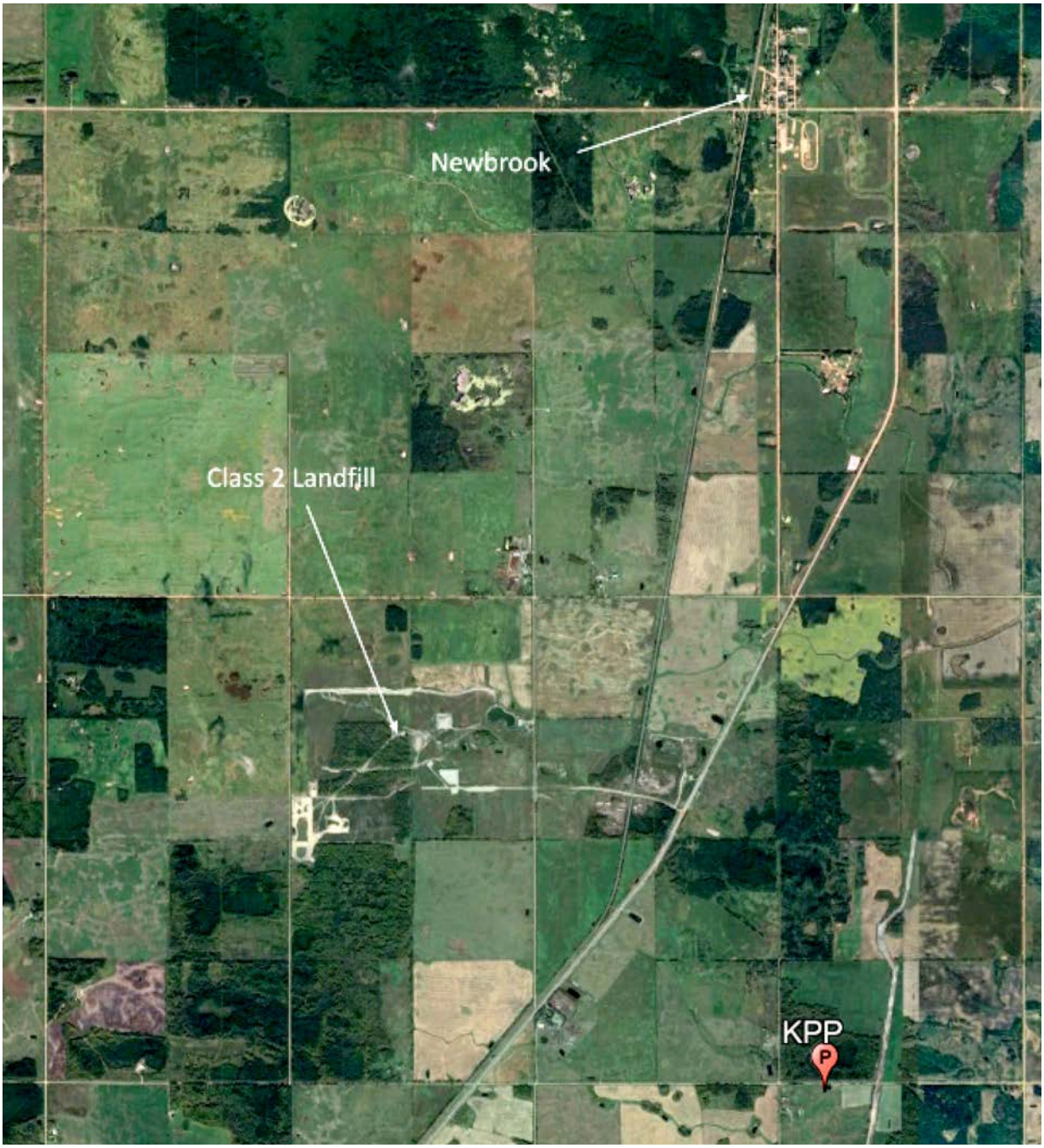
4.2 Results Compared Against the Project Objectives

Possible Influence of the Sources Near the Community

A source of interest in this project was the regional Class II landfill near Newbrook. A Class II landfill may only handle non-hazardous materials.

Figure 4 below shows the KPP (map pin) relative to Newbrook and the landfill nearby.

Figure 4: Location of KPP



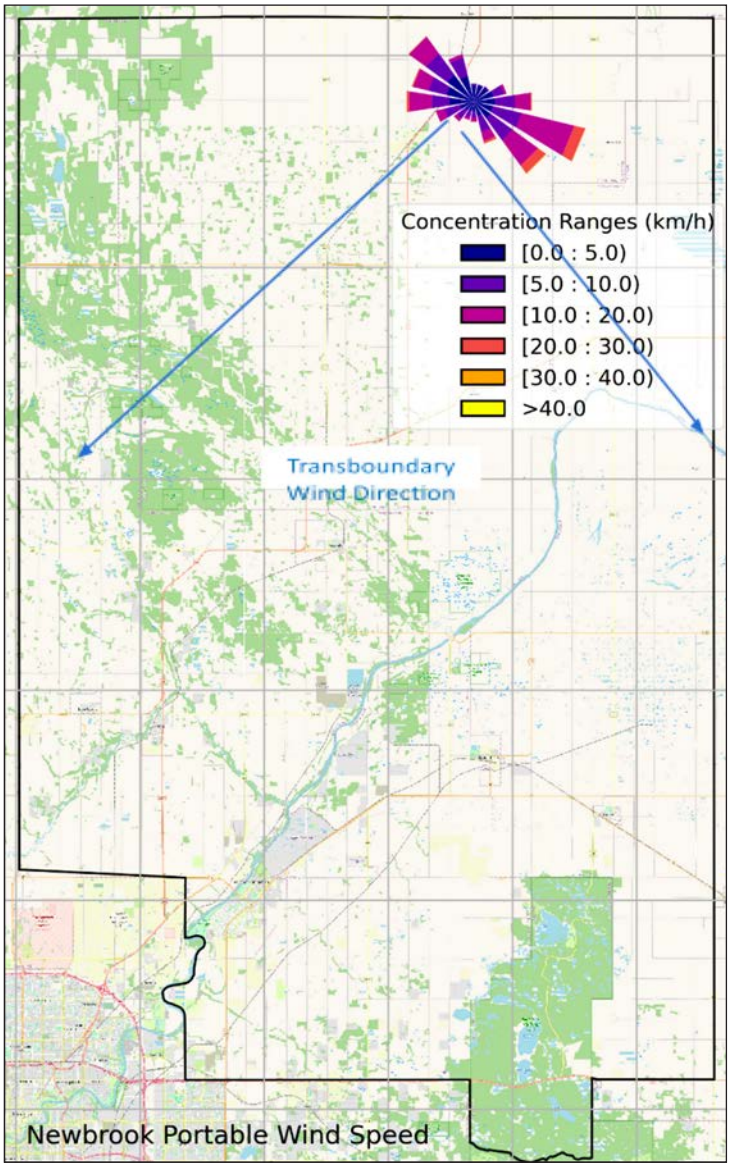
Rose plots are a useful tool to visually represent the scale and number of measurements for a given substance and the direction the wind was blowing from when those measurements were taken. In this report 1-hour average measurements are used in the rose plots.

Figure 5 shows a wind rose which depicts wind speeds in 5 or 10 kilometer per hour groupings and the direction was blowing from as measured at the KPP Newbrook site superimposed on a map of the HAMP Airshed. Figure 6 through Figure 10 show the results for $PM_{2.5}$, NO_2, SO_2 and THC, respectively, known as pollutant roses. All plots except for $PM_{2.5}$ summarize the measurements taken from February 1, 2023, to January 31, 2024. There are two pollutant roses shown for $PM_{2.5}$, one covering all 12 months and a second rose only for months with no wildfire smoke.

A Note on Reading Rose Plots: The colours break down the measurements into six categories, with blue representing the lowest concentration and red the highest concentration, or in the case of the wind rose, wind speeds. The concentrations shown in red on the pollutant roses are those that would exceed the applicable AAAQO. The length of each 'arm' represents the number of one-hour averages when the wind is coming from that direction. The longer the arm, the greater the number of measurements logged in that sector.

Figure 5: Wind Rose

Figure 5 below shows wind measurements at the KPP Newbrook site almost equally frequent in originating from the northwest and southeast quadrants during the 12 month project. The blue arrows to southeast and southwest of the station indicate what are considered transboundary winds. Measurements taken while winds were from anywhere in this 90 degree quadrant are broken down in Table 3 to Table 7.



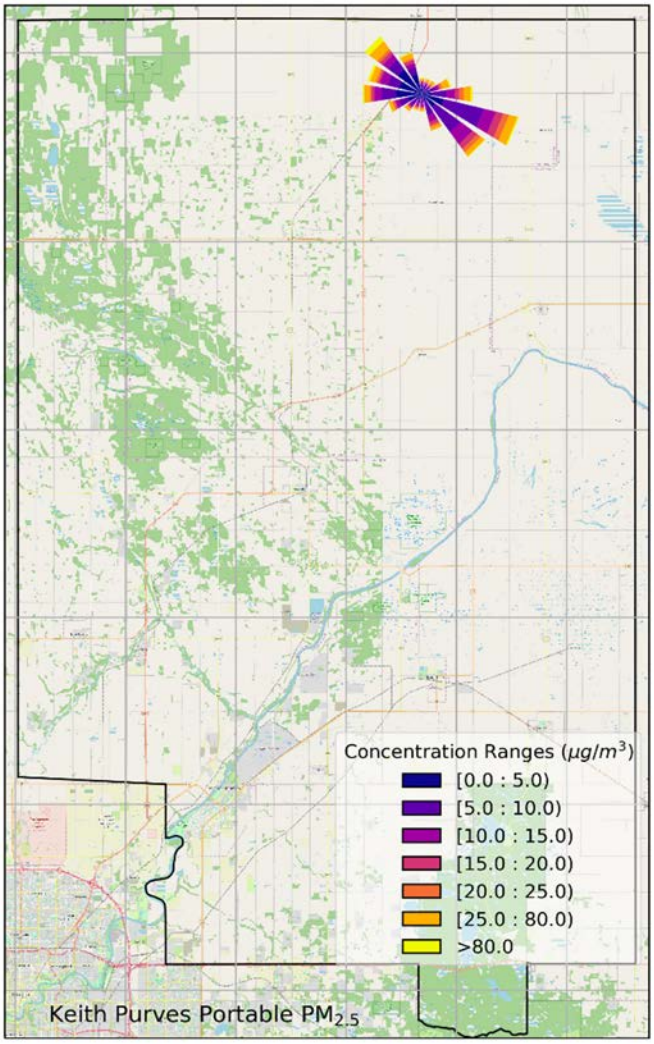


Figure 6: $PM_{2.5}$ Pollutant Rose (all Months)

Figure 6 shows the $PM_{2.5}$ pollutant rose for all 12 months of the project. The number of fine particulate matter readings above 25 µg/m³ tended to be distributed evenly from many wind directions while the majority of $PM_{2.5}$ readings above 80 µg/m³ occurred when the wind was coming from the northwest.

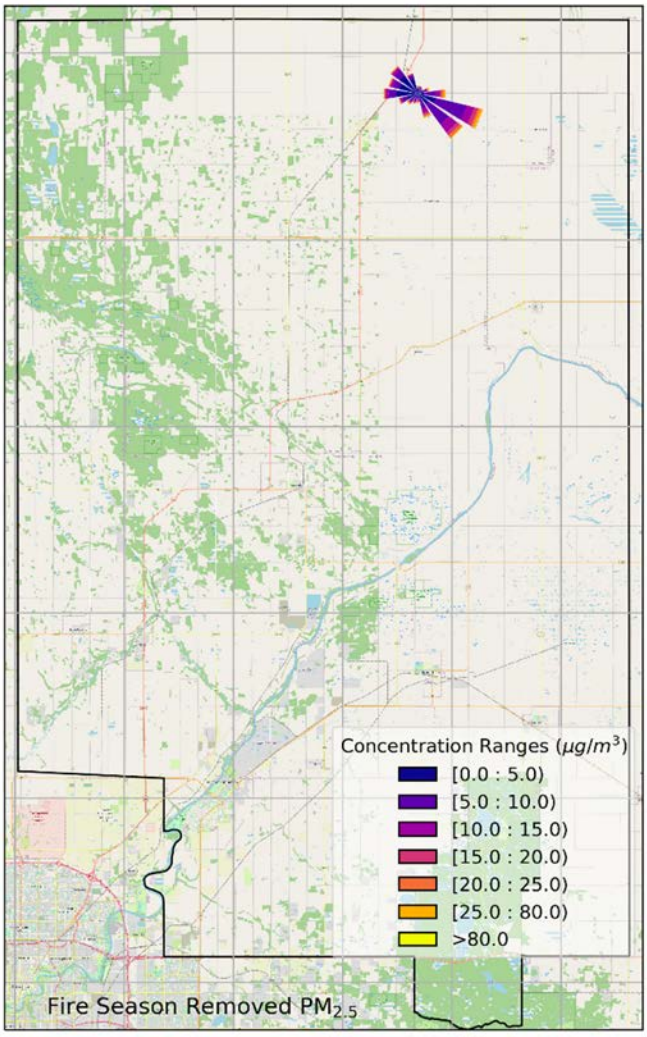
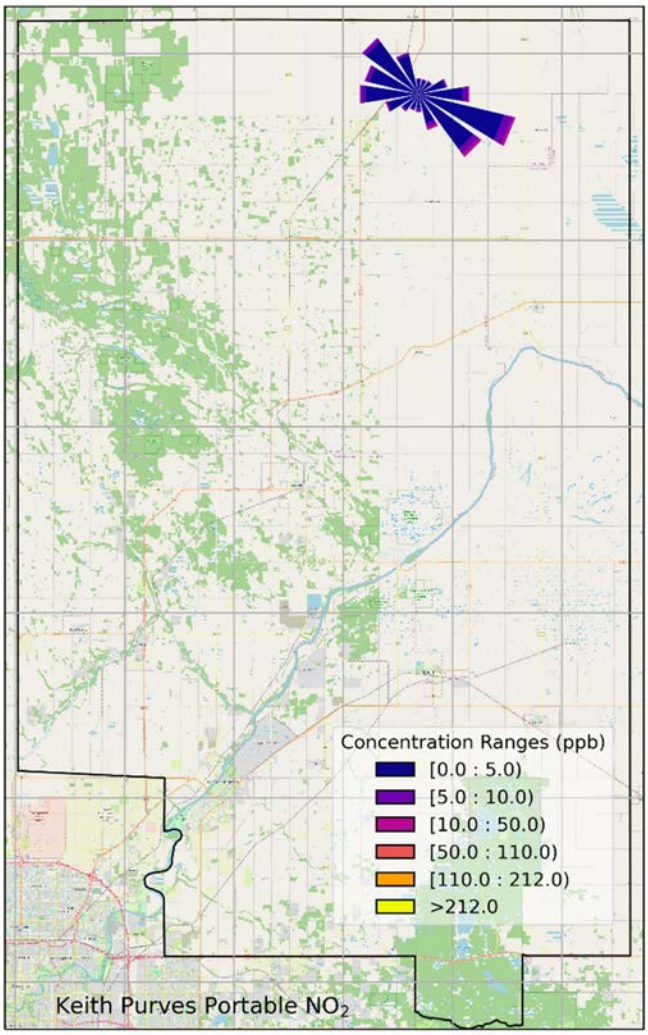


Figure 7: $PM_{2.5}$ Pollutant Rose (May – September Removed)

The months of May through September 2023 were frequently and heavily influenced by wildfire smoke from beyond HAMP borders. To avoid this confounding factor, **Figure 7** shows $PM_{2.5}$ data for February through April 2023 and October 2023 through January 2024. The figure however shows a more frequent occurrence of measurements in the 20 µg/m³ and above when the wind direction had southerly and easterly components, indicating multiple sources contributing to $PM_{2.5}$.

Figure 8: Nitrogen Dioxide (NO_2) Pollutant Rose

Figure 8 shows that 62% of the higher NO_2 measurements (10 to 50 ppb) occurred when winds were from the south-southeast to east directions. As shown in Table 15, the highest 1-hour average concentration measured during the project was 36.1 ppb.



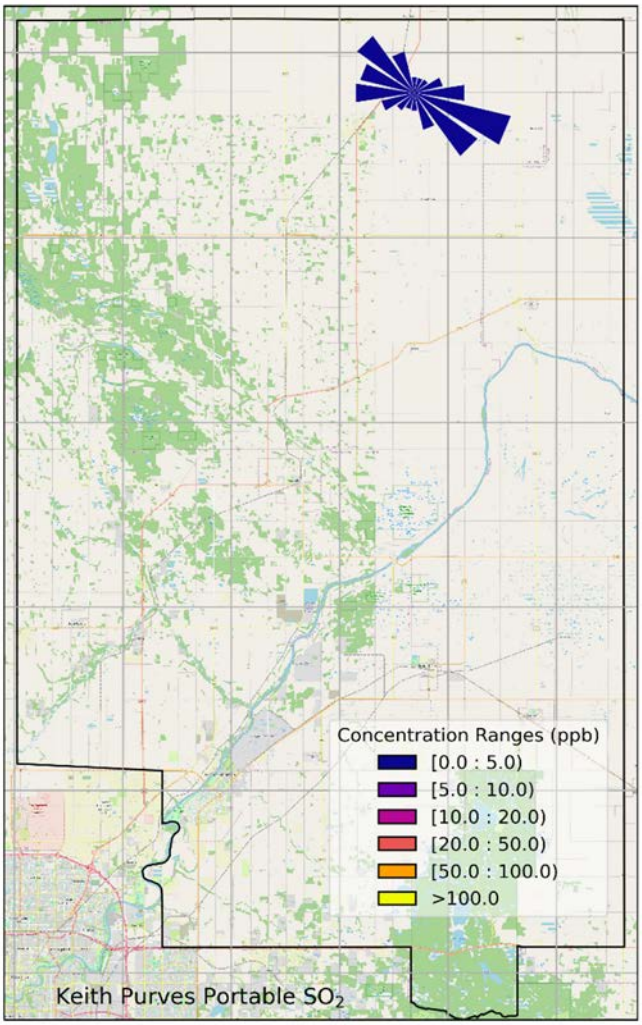


Figure 9: Sulphur Dioxide (SO_2) Pollutant Rose

Figure 9 shows that most SO_2 measurements were below 5 ppb. Measurements in the next concentration class of 5 to 10 ppb occurred from multiple wind directions, predominately east northeast to southeast and west northwest to northwest, matching the prevailing wind directions. There were no measurements above 10 ppb with wind in that direction according to the breakdown in Table 6. Refer to Table 19 and Table 20 later in this report for the maximum SO_2 measurements recorded during the KPP Newbrook project.

Table 3 to Table 7 below further break down the number of 1-hour average measurements at the KPP Newbrook site represented by the pollutant rose plots above. The table summarizes the measurements taken while the wind was coming from the south-east to south-west quadrant. The Industrial Heartland lies within these compass points from KPP Newbrook site. As can be seen on the tables, the wind blew from this direction only eighteen percent of the time during the 12 month project. Table 4 below further parses out the $PM_{2.5}$ measurements to only those months without wildfire smoke when winds were from the southeast to southwest quadrant.

Some notes on the findings:

- NO_2 measurements 38 ppb or below are under 25% of the 1-hour AAAQO.
- SO_2 measurements below 10 ppb are under 6% of the 1-hour AAAQO.
- There is no AAAQO set for THC.

Wind speeds measured under 0.1 kilometers per hour are described as calm and measurements during those periods are not included in the wind roses.

Table 3: Distribution of $PM_{2.5}$ Measurements with Southeast to Southwest Wind Directions

Total measurements	Measurements from SE to SW (% of Total Measurements)	Measurements at calm	Concentration range					
			0-1 µg/m³	1-10 µg/m³	10-15 µg/m³	15-30 µg/m³	30-80 µg/m³	>80 µg/m³
			% of AAAQO					
			<1%	1-12%	12-18%	18-38%	38-100%	>100%
8555	1546 (18%)	14	9	874	296	250	104	13

Table 4: Distribution of $PM_{2.5}$ Measurements with Southeast to Southwest Wind Directions (Only Months with No Wildfire Smoke)

Total measurements	Measurements from SE to SW (% of Total Measurements)	Measurements at calm	Concentration range					
			0-1 µg/m³	1-10 µg/m³	10-15 µg/m³	15-30 µg/m³	30-80 µg/m³	>80 µg/m³
			% of AAAQO					
			<1%	1-12%	12-18%	18-38%	38-100%	>100%
5003	1030 (21%)	9	9	660	175	151	35	0

Table 5: Distribution of NO_2 Measurements with Southeast to Southwest Wind Directions

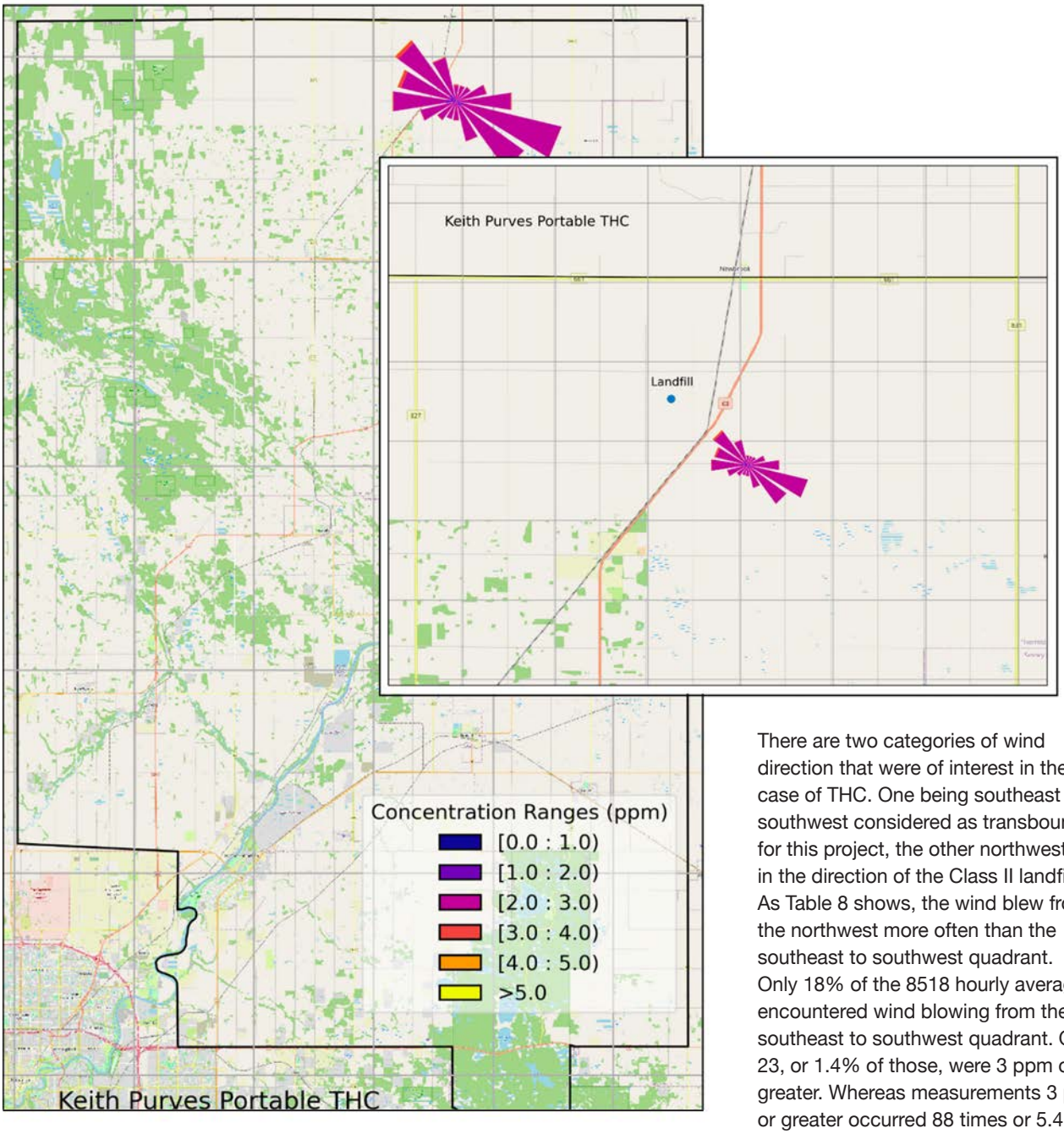
Total measurements	Measurements from SE to SW (% of Total Measurements)	Measurements at calm	Concentration range					
			0-5 ppb	5-15 ppb	15-24 ppb	24-100 ppb	100-159 ppb	>159 ppb
			% of AAAQO					
			<1%	1-12%	12-18%	18-38%	38-100%	>100%
8590	1549 (18%)	14	1307	224	15	3	0	0

Table 6: Distribution of SO_2 Measurements with Southeast to Southwest Wind Directions

Total measurements	Measurements from SE to SW (% of Total Measurements)	Measurements at calm	Concentration range					
			0-0.5 ppb	0.5-1 ppb	1-10 ppb	10-48 ppb	48-172 ppb	>172 ppb
			% of AAAQO					
			<0.3%	0.3-0.6%	0.6-6%	6-28%	28-100%	>100%
8637	1570 (18%)	14	1313	109	148	0	0	0

Total hydrocarbon (THC) measurements are comprised of methane (CH_4) and non-methane hydrocarbons (NMHC). Given the infrequent occurrence and very low concentration of NMHC measurements (see Table 12), THC measurements in this project were almost exclusively CH_4. CH_4 is a main component of gases emitted by landfills. The plot in Figure 10 shows a similar pattern to wind roses for other substances with largely equal numbers of measurements with winds from the northwest and southeast directions.

Figure 10: Total Hydrocarbons (THC) Pollutant Rose



There are two categories of wind direction that were of interest in the case of THC. One being southeast to southwest considered as transboundary for this project, the other northwest in the direction of the Class II landfill. As Table 8 shows, the wind blew from the northwest more often than the southeast to southwest quadrant. Only 18% of the 8518 hourly averages encountered wind blowing from the southeast to southwest quadrant. Only 23, or 1.4% of those, were 3 ppm or greater. Whereas measurements 3 ppm or greater occurred 88 times or 5.4% of the time when wind was in the direction of the landfill.

Table 7: Distribution of THC Measurements When Winds from the Southeast to Southwest

Total measurements	Measurements from SE to SW (% of Total Measurements)	Measurements at calm	Concentration range					
			0-1 ppm	1-2 ppm	2-3 ppm	3-4 ppm	4-5 ppm	>5 ppm
8515	1544 (18%)	14	0	74	1447	232	0	0

Table 8: Distribution of THC Measurements When Winds from the Northwest

Total measurements	Measurements from SE to SW (% of Total Measurements)	Measurements at calm	Concentration range					
			0-1 ppm	1-2 ppm	2-3 ppm	3-4 ppm	4-5 ppm	>5 ppm
8518	1630 (19%)	12	0	148	1349	76	10	2

Effects of Regional Air Quality Events on Newbrook Air Quality

This section focuses on those air quality episodes that resulted in measurements exceeding AAAQOs at the HAMP community stations. During the 12-month period of this project there were multiple episodes, some prolonged, of wildfire smoke impacts in HAMP and the Edmonton Metropolitan Area. In addition, there were five air quality events of note experienced in the HAMP Airshed and the broader Edmonton Metropolitan Area:

Meteorological conditions created a stagnant air mass that resulted in several measurements exceeding both O_3 and $PM_{2.5}$ AAAQOs on March 20, 2023.

A summertime smog episode with warm outdoor temperatures and low winds over four separate days in May coupled with wildfire smoke caused elevated O_3 and PM2. levels at multiple HAMP stations. Ozone is a known by product of wildfire smoke under these conditions. See Table 2 above.

A summertime smog episode with warm outdoor temperatures and a stable air mass (low winds) over four separate days in June coupled with wildfire smoke caused elevated O_3 and $PM_{2.5}$. levels at multiple HAMP stations. Ozone is a known by product of wildfire smoke under these conditions. See Table 2 above.

Two separate wintertime temperature inversion events occurred on January 5 and 23 to 25, 2024.

All HAMP stations were affected similarly by the wildfire smoke episodes. The effects of wintertime inversions or summertime smog episodes were not as severe at the KPP location since it was further removed from the large source, the Edmonton Metropolitan Area and surrounding communities, that contribute to these air quality events. Details on the exceedances during these events are provided in section 4.1 of this report.

Results by Substance

The following section describes the results of each compound measured at the Newbrook site. Plots are provided showing measurements recorded at continuous stations in the HAMP Airshed. Not all continuous stations measure the same set of compounds. For instance, other than at the KPP station, fine particulates (i.e. $PM_{2.5}$) are measured at six stations, while hydrocarbons (i.e. NMHC) are only measured at four. The data shown in each plot covers the period February 1, 2023, to January 31, 2024, the time the KPP Station was active at the Newbrook site.

Although Fort Saskatchewan is a much more highly populated area, data from the station is also shown in the plots in this report for comparison purposes.

Fine Particulate Matter Results

Fine particulate matter ($PM_{2.5}$) consists of tiny particles that are smaller than 2.5 microns. In comparison, a strand of human hair is about 70 microns in width, meaning that a $PM_{2.5}$ particle is approximately 1/40 the diameter of a human hair. Sources of $PM_{2.5}$ include soil, roads, agricultural dust, vehicles, industrial emissions, wildfire smoke, cigarettes, household heating, fireplaces, backyard fire pits and barbecues. Secondary particulate matter may also be produced in the atmosphere through several complex chemical processes involving other substances. Particulates can come from both solid matter and liquid aerosols.

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

Higher levels of $PM_{2.5}$ typically occur during wintertime temperature inversions when air movement is limited or in the summer months during periods of very warm weather with little or no wind. This is particularly problematic when coupled with smoke from wildfires as experienced in recent years.

$PM_{2.5}$ is measured and reported in micrograms per cubic meter (µg/m³) throughout this report.

- **Alberta has established a 24-hour AAAQO for $PM_{2.5}$ at 29 µg/m³.**
- **Alberta also has a one-hour average Guideline* in place for fine particulate at 80 µg/m³.** **Note: for the purposes of this report the guideline is also referred to as an AAAQO.*

The highest one-hour average $PM_{2.5}$ not due to wildfire smoke recorded at the KPP Newbrook site was 79.8 µg/m³ in March 2023 due to regional meteorological conditions while the highest due to wildfire smoke was 416 µg/m³ recorded in early September.

There were 247 one-hour $PM_{2.5}$ exceedances during the time the KPP station was in operation at the KPP Newbrook site. All but three of these exceedances were due to wildfire smoke, the remainder attributed to agricultural operations. There were also 40 24-hour $PM_{2.5}$ exceedances in the same time period. Three were due to wintertime inversions or the meteorological conditions, the rest due to wildfire smoke.

Figure 11: $PM_{2.5}$ Monthly Averages from February 2023 to January 2024

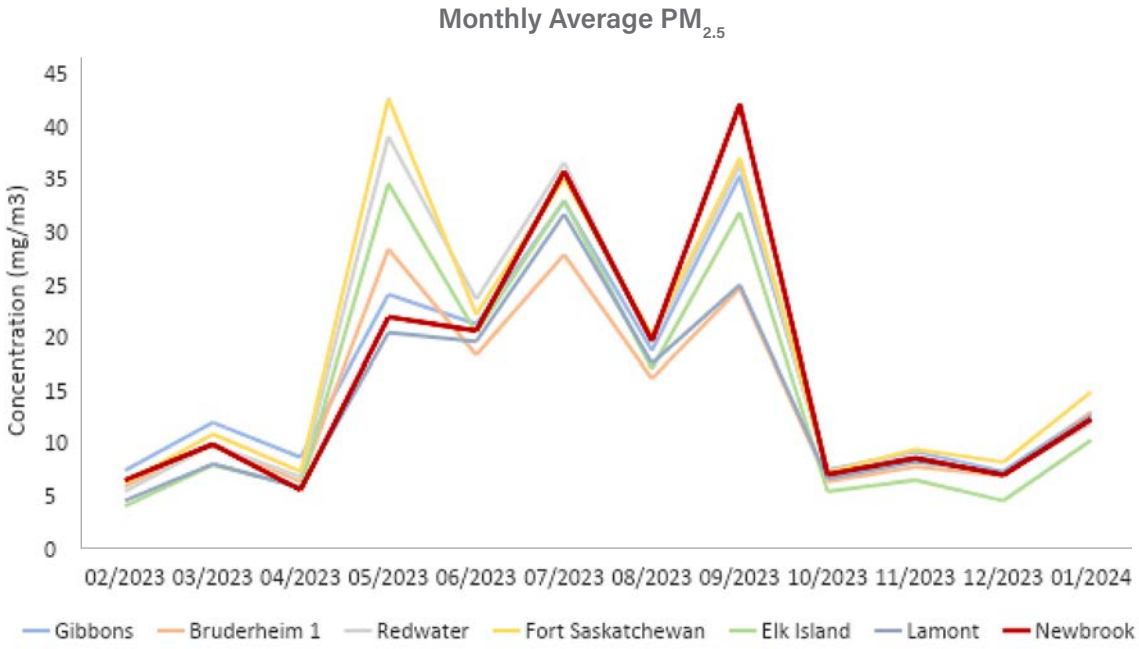


Figure 11 shows the monthly average concentrations of $PM_{2.5}$ at the KPP Newbrook site and other HAMP monitoring stations. Monthly averages at the KPP Newbrook site compared closely with those at other sites in HAMP and varied less than 4 µg/m³ from those recorded at all other HAMP stations in non-wildfire smoke months. The KPP Newbrook site was lower on average than other sites during wildfire season in May and differed on average less than 3 µg/m³ from June to August. The September monthly average was higher at the KPP Newbrook site than all other sites by an average of 10 µg/m³. Some of this difference may be due to agricultural activities in the vicinity of the KPP Newbrook site.

Figure 11 is a $PM_{2.5}$ histogram plot showing the distribution of 1-hour average measurements at the KPP Newbrook site during the 12-month project. As noted above there were 247 measurements exceeding the AAAQG of 80 µg/m³.

A Note on Reading Histogram Plots: The X axis is divided into 'bins' representing concentration ranges in the measurements. In this case, the measurements are split into 6 bins. For the $PM_{2.5}$ plot, the lowest bin is 0-1 µg/m³ with the highest including measurements greater than 80 µg/m³. The Y axis on the plot shows the number of hourly averages. The blue bars then represent the number (as noted above it) of 1-hour average readings in each bin. These are the same concentration classes as used in the rose plots earlier in the report.

Table 9: Maximum 1-Hour Average $PM_{2.5}$ Concentrations (µgr/m^3)

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
KPP	35.9	79.8	31.6	**379.3**	115.1	355.0	165.2	416.2	57.3	41.3	64.8	66.2
Bruderheim 1	32.1	47.4	40.1	**503.2**	96.1	262.8	105.4	165.2	23.4	36.0	32.3	61.9
Elk Island	16.9	46.7	30.5	**494.3**	111.6	389.5	135.8	279.4	21.4	38.0	22.7	60.4
Ft Saskatchewan	20.9	52.4	72.4	**588.8**	101.9	403.3	143.6	285.7	36.2	38.3	33.0	111.9
Gibbons	33.0	77.8	45.7	**320.5**	88.8	378.2	134.5	267.5	36.8	45.0	40.7	88.8
Lamont	36.9	49.9	59.4	**326.7**	167.1	284.0	110.7	190.6	34.3	47.9	38.1	52.6
Redwater	25.6	52.0	44.0	**614.3**	122.9	464.4	139.7	297.3	26.5	43.7	54.2	233.1

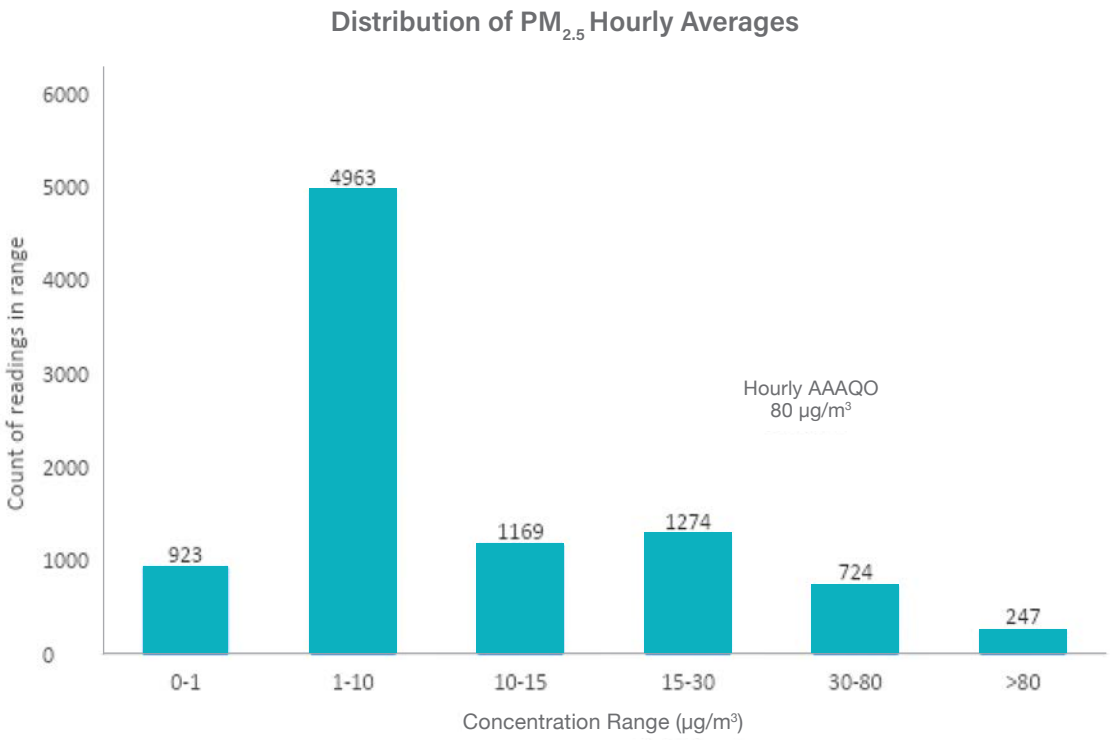
Table 9 below shows the maximum 1-hour average $PM_{2.5}$ concentrations recorded at the HAMP monitoring stations each month while Table 10 shows the maximum 24-hour averages.

For reference the 1-hour AAAQO is 80 µgr/m^3 while the 24-hour is 29 µgr/m^3.

Table 10: Maximum 24-Hour Average $PM_{2.5}$ Concentrations (µgr/m^3)

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
KPP	16.4	31.4	18.0	135.7	70.8	**202.9**	68.4	190.4	13.8	27.6	17.1	44.0
Bruderheim 1	11.5	33.7	23.8	**313.6**	53.4	99.3	41.7	104.3	11.1	21.0	16.1	61.9
Elk Island	8.5	25.2	20.9	**338.0**	58.2	201.5	50.1	167.1	9.5	21.9	12.1	42.5
Ft Saskatchewan	12.4	36.2	30.0	**334.4**	63.5	214.4	65.0	175.0	13.6	26.7	20.5	55.0
Gibbons	13.3	32.7	33.7	94.6	66.8	**219.4**	62.4	149.9	13.3	24.8	19.6	45.6
Lamont	10.9	23.0	18.3	66.5	57.6	**151.3**	44.8	120.8	11.5	22.0	14.0	38.3
Redwater	12.7	32.9	23.0	**385.2**	82.9	214.9	66.1	161.2	14.1	23.5	20.1	48.5

Figure 12: Fine Particulate Matter ($PM_{2.5}$) Distribution of One-Hour Averages at Newbrook



Hydrocarbon Results

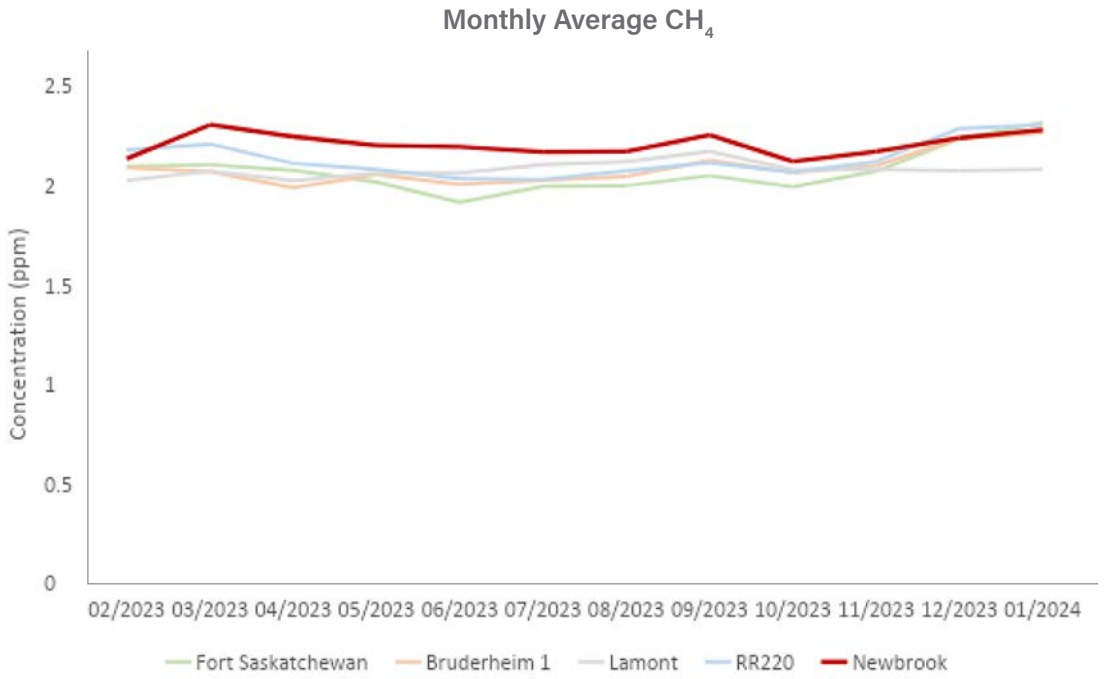
The **hydrocarbon** results in this project were of particular interest due to the potential influence of the landfill to the northwest of the KPP station. Landfill gas (LFG) is a mixture of several gases due to the action of microorganisms as the break down organic matter including paper. LFG is approximately 40% to 60% methane (CH_4), the rest predominately carbon dioxide (CO_2) with trace amounts of other reactive or non-methane hydrocarbons.

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

The major non-reactive hydrocarbon in the atmosphere is methane (CH_4). Major worldwide sources of atmospheric methane include wetlands, ruminants such as cattle, energy use, landfills and burning biomass such as wood. Methane is the primary component of natural gas.

Monthly average concentrations of methane at the KPP (Newbrook) site and other HAMP monitoring stations are illustrated in Figure 13. Methane at the KPP Newbrook site was on average almost 0.2 ppm higher than all other HAMP sites. Ranging from 0.1 ppm higher in November 2023 to 0.28 ppm higher in June 2023.

Figure 13: Methane Monthly Averages from February 2023 to January 2024



The reactive (or non-methane) hydrocarbons (NMHC) consist of many volatile organic compounds (VOCs), some of which react with oxides of nitrogen in the atmosphere to form ozone. Many of these non-methane hydrocarbons carry readily detectable odours. Alberta does not have ambient air quality objectives (AAAQO) for total hydrocarbons, methane or non-methane hydrocarbons as a group. The oxidation of hydrocarbons in the atmosphere contributes to an increased amount of nitrogen oxides and ozone, which do have AAAQOs.

Figure 14: Non-Methane Monthly Averages from February 2023 to January 2024

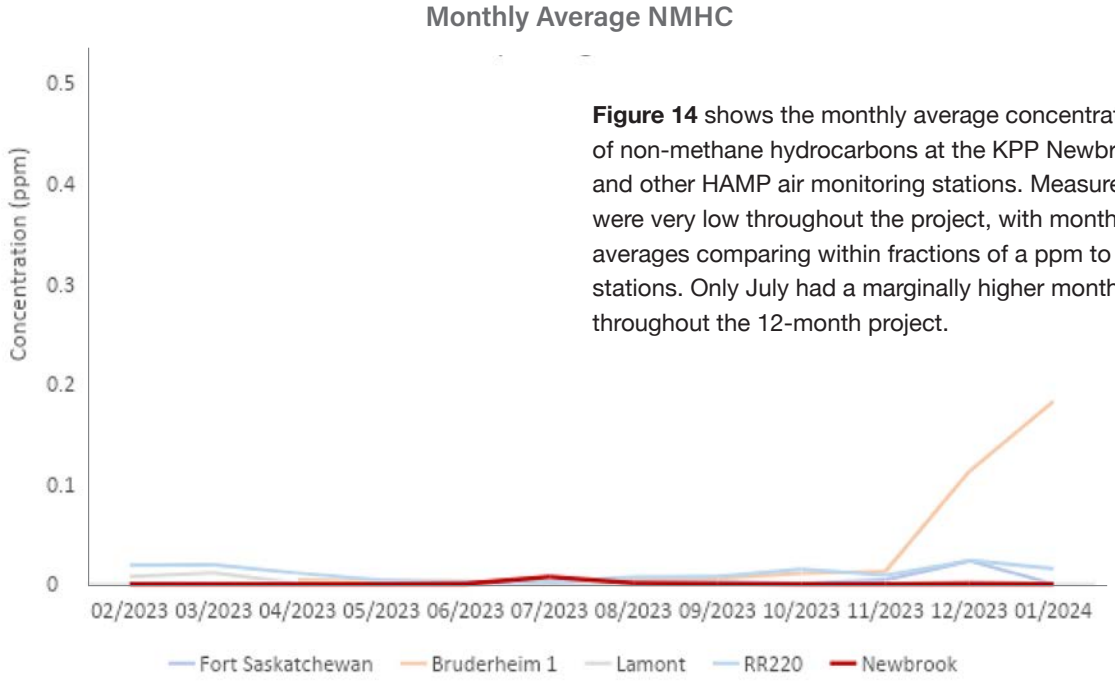


Figure 14 shows the monthly average concentrations of non-methane hydrocarbons at the KPP Newbrook site and other HAMP air monitoring stations. Measurements were very low throughout the project, with monthly averages comparing within fractions of a ppm to other stations. Only July had a marginally higher monthly average throughout the 12-month project.

Table 11: Maximum 1-hour Average Hydrocarbon Concentrations

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Total Hydrocarbons THC (ppm)												
KPP	3.66	4.26	3.42	3.47	4.63	5.26	4.43	**6.44**	3.70	4.31	3.98	5.02
Bruderheim 1	4.68	3.09	3.72	3.27	3.02	3.23	5.08	3.50	**6.75**	3.61	4.95	4.93
Ft Saskatchewan	**3.68**	2.72	2.36	2.66	2.58	2.58	2.75	3.48	2.59	2.72	3.44	3.13
Lamont	2.58	2.45	2.64	2.41	2.65	2.72	3.05	2.87	2.46	2.65	2.98	**3.20**
Range Road 220	3.06	3.96	2.61	3.70	3.30	3.29	3.57	**4.12**	4.00	4.18	4.03	4.01
Methane CH_4 (ppm)												
KPP	3.66	4.26	3.42	3.47	4.63	5.24	4.43	**6.43**	3.70	4.31	3.97	5.01
Bruderheim 1	**3.84**	3.00	2.91	2.99	2.56	2.96	3.44	3.39	2.87	3.01	3.81	3.73
Ft Saskatchewan	**3.67**	2.71	2.36	2.65	2.37	2.54	2.74	3.47	2.49	2.56	3.25	3.13
Lamont	2.58	2.43	2.36	2.41	2.65	2.72	3.05	2.87	2.45	2.65	2.98	**3.07**
Range Road 220	2.90	3.05	2.50	3.43	3.05	2.64	2.94	2.93	3.19	3.05	**3.60**	3.17
Non-Methane NMHC (ppm)												
KPP	0.00	0.00	0.00	0.00	0.08	**0.13**	0.07	0.04	0.01	0.00	0.05	0.01
Bruderheim 1	0.84	0.15	0.81	0.39	0.46	0.28	3.17	0.70	**4.55**	0.65	1.14	1.19
Ft Saskatchewan	0.35	0.02	0.02	0.61	0.43	0.22	0.62	0.39	0.40	**0.67**	0.59	0.00
Lamont	0.09	0.17	0.28	0.04	0.16	0.13	0.04	0.04	0.03	0.01	**0.77**	0.13
Range Road 220	0.65	1.42	0.50	0.30	0.45	1.18	1.00	**1.59**	1.62	1.45	1.41	1.54

Table 11 above shows the maximum 1-hour average hydrocarbon concentrations recorded at the HAMP monitoring stations each month while Table 12 shows the maximum 24-hour averages.

Table 12: Maximum 24-Hour Average Hydrocarbon Concentrations

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Total Hydrocarbons THC (ppm)												
KPP	2.37	2.72	2.48	2.36	2.45	2.84	2.57	**2.82**	2.42	2.39	2.57	2.72
Bruderheim 1	2.44	2.32	2.14	2.27	2.13	2.24	2.35	2.40	2.43	2.50	3.12	**3.13**
Ft Saskatchewan	2.36	2.38	2.14	2.17	2.09	2.09	2.18	2.20	2.07	2.24	2.69	**2.75**
Lamont	2.22	2.26	2.12	2.23	2.14	2.24	2.40	2.38	2.16	2.27	2.43	**2.48**
Range Road 220	2.50	**2.80**	2.29	2.29	2.18	2.13	2.22	2.26	2.24	2.36	2.69	2.79
Methane CH_4 (ppm)												
KPP	2.37	2.72	2.48	2.36	2.45	**2.83**	2.57	2.82	2.42	2.39	2.57	2.72
Bruderheim 1	2.36	2.32	2.09	2.27	2.13	2.23	2.33	2.39	2.20	2.40	2.69	**2.70**
Ft Saskatchewan	2.36	2.38	2.14	2.16	2.09	2.09	2.17	2.20	2.06	2.22	2.68	**2.74**
Lamont	2.22	2.26	2.10	2.23	2.14	2.24	2.40	2.38	2.16	2.27	2.43	**2.47**
Range Road 220	2.40	2.50	2.22	2.26	2.16	2.13	2.21	2.27	2.18	2.29	2.68	**2.75**
Non-Methane NMHC (ppm)												
KPP	**0.06**	0.00	0.00	0.00	0.00	0.05	0.01	0.00	0.00	0.00	0.00	0.00
Bruderheim 1	0.08	0.01	0.04	0.02	0.02	0.02	0.13	0.04	0.27	0.10	**0.44**	0.43
Ft Saskatchewan	0.02	0.00	0.00	0.03	0.03	0.01	0.04	0.03	0.02	0.03	**0.24**	0.00
Lamont	0.00	**0.08**	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.03	0.01
Range Road 220	0.10	**0.36**	0.15	0.04	0.03	0.02	0.07	0.05	0.11	0.07	0.26	0.11

Figure 15: NMHC Distribution of One-Hour Averages at Newbrook

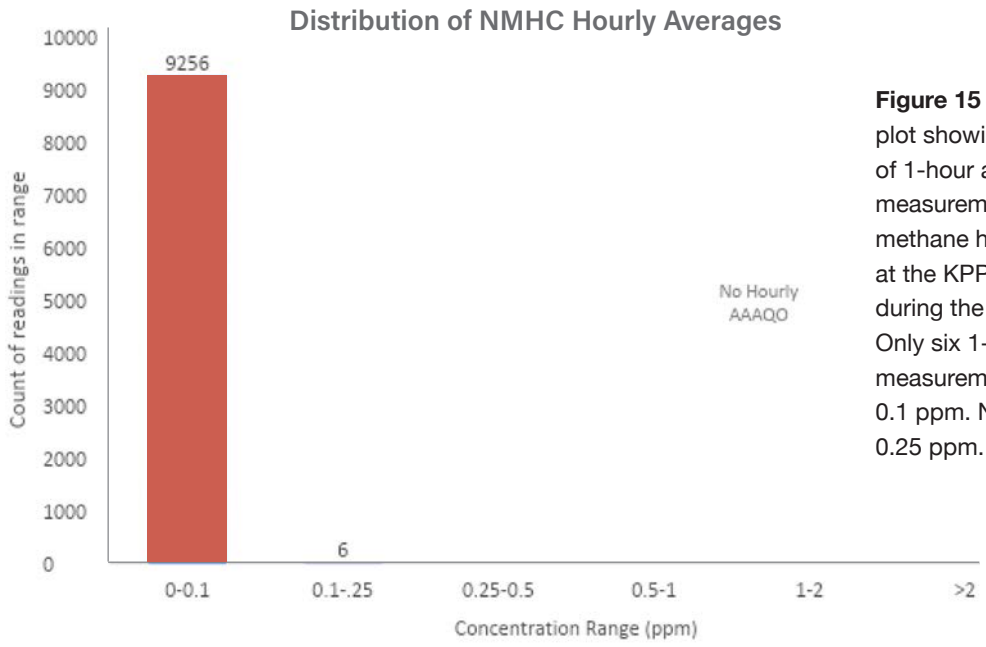


Figure 15 is a histogram plot showing the distribution of 1-hour average measurements of non-methane hydrocarbons at the KPP Newbrook site during the 12-month project. Only six 1-hour average measurements exceeded 0.1 ppm. None exceeded 0.25 ppm.

Hydrogen Sulphide Results

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

H_2S is reported as parts per billion (ppb) throughout this report. Alberta has established the following AAAQOs for H_2S:

- The one-hour average concentration at 10 ppb
- The 24-hour average concentration at 3 ppb

There were no exceedances of the 1-hour AAAQO. The highest one-hour average H_2S recorded at the KPP Newbrook site was 3.3 ppb recorded on August 29, 2023, which represents 33% of the one-hour AAAQO.

There were no exceedances of the 24-hour AAAQO. The highest 24-hour average H_2S recorded at the KPP Newbrook site was 1 ppb recorded on September 5, 2023. This represents 33% of the 24-hour AAAQO.

Figure 16 shows the monthly average concentrations of H_2S at the KPP (Newbrook) site and other HAMP air monitoring stations. All the monthly averages recorded at other stations where H_2S is monitored within HAMP's Airshed varied less than 1 (one) ppb from those recorded at the KPP Newbrook site. The H_2S levels at the KPP Newbrook site were generally lower than other stations, except September. The cause of the slightly higher overall H_2S average in September is unclear.

Figure 16: H_2S Monthly Averages from February 2023 to January 2024

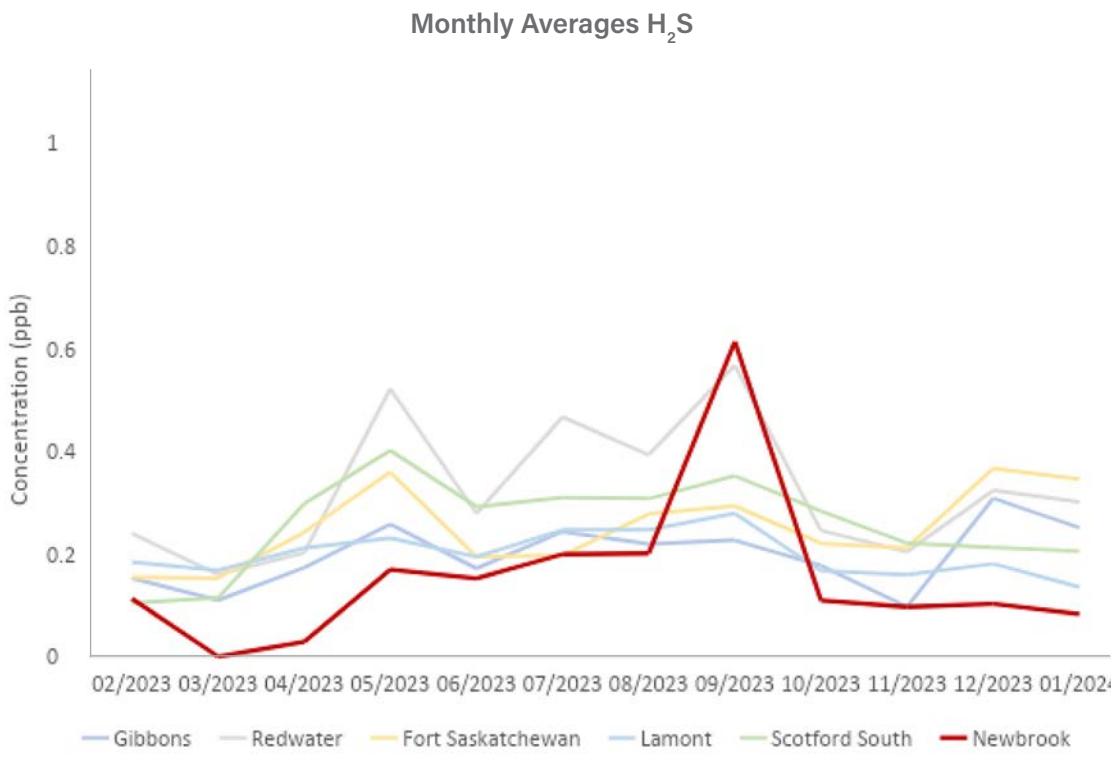


Table 13: Maximum 1-Hour Average H_2S Concentrations (ppb)

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Hydrogen Sulphide H_2S (ppm)												
KPP	0.7	0.5	1.5	1.3	2.5	1.5	**3.3**	2.1	0.8	0.6	2.5	1.0
Ft Saskatchewan	1.9	1.2	**5.9**	3.2	2.8	2.5	4.2	3.6	2.2	1.7	3.1	1.9
Gibbons	1.2	0.9	**4.1**	1.8	1.7	2.6	2.3	2.4	1.7	1.3	1.9	1.8
Lamont	1.2	1.6	**4.4**	1.4	1.3	1.4	1.9	1.1	0.9	0.8	0.8	1.1
Redwater	1.6	2.8	4.9	11.0	6.8	9.1	12.8	**15.6**	5.4	1.0	4.7	8.3
Scotford South	0.8	3.1	5.7	6.0	2.0	1.8	1.9	1.8	**34.8**	1.8	1.4	1.5

Table 13 above shows the maximum 1-hour average H_2S concentrations recorded at the HAMP monitoring stations each month while Table 14 shows the maximum 24-hour averages.

Table 14: Maximum 24-Hour Average H_2S Concentrations (ppb)

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Hydrogen Sulphide H_2S (ppm)												
KPP	0.3	0.3	0.3	0.6	0.5	0.5	0.8	**1.0**	0.5	0.4	0.4	0.5
Ft Saskatchewan	0.4	0.6	0.6	0.9	0.4	0.4	0.9	1.0	0.6	0.7	1.1	**1.1**
Gibbons	0.6	0.4	0.7	0.7	0.4	**1.2**	0.6	0.6	0.7	0.5	0.8	0.8
Lamont	0.5	**0.7**	0.5	0.6	0.4	0.5	0.6	0.5	0.5	0.3	0.5	0.5
Redwater	0.7	0.6	0.7	1.2	1.2	1.3	1.4	**2.6**	0.7	0.6	0.8	1.1
Scotford South	0.3	0.5	1.3	1.0	0.7	0.7	0.7	0.7	**3.7**	0.6	0.7	0.5

Figure 17: H_2S Distribution of One-Hour Averages at Newbrook

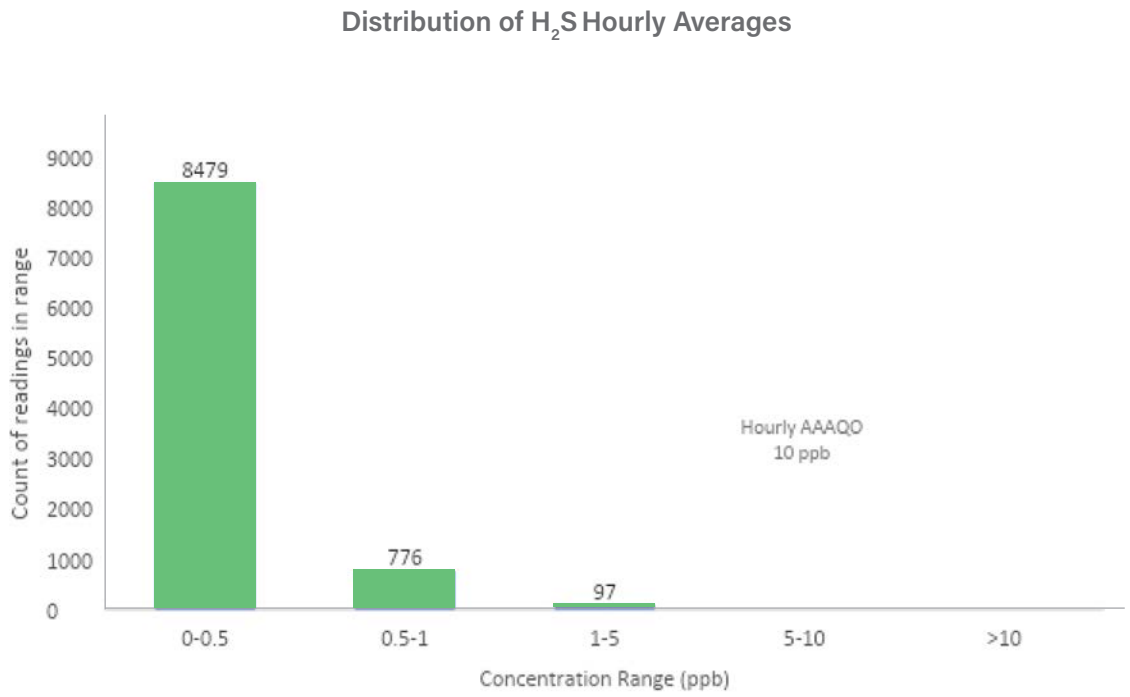


Figure 17 above shows the distribution of 1-hour average H_2S measurements, with no measurements exceeding the AAAQO of 10 ppb during the project.

Nitrogen Dioxide Results

Nitrogen Dioxide (NO_2) is a component of nitrogen oxides (NOx), along with nitric oxide (NO), dinitrogen monoxide (N_2O) and nitrogen pentoxide (NO_5). Most NO in the ambient air will react readily with ozone to form nitrogen dioxide. NO_2 is a reddish-brown gas with a pungent odour and is partially responsible for the brown haze often observed near large cities. Sources of NOx in Alberta include transportation, oil and gas industry, natural gas combustion, heating fuel combustion (including home heating) and wildfires.

NO_2 is reported as parts per billion (ppb). Alberta has established the following AAAQOs for NO_2:

- One-hour average concentration at 159 ppb.
- Annual average concentration at 24 ppb.

The highest one-hour average NO_2 recorded at the KPP Newbrook site was 36.1 ppb, approximately 22.7% of the one-hour AAAQO occurring on January 26, 2024.

The KPP station operated for 11 months in 2023 and one month of 2024. 11 months of data is sufficient to calculate a valid annual average as a minimum of 9 months is required. The annual average calculated for 2023 was 2.1 ppb: equal to 8.9% of the annual AAAQO.

A "rolling" average can also be calculated for the 12 months the KPP Station was in operation. Data is not reported to the Alberta Government against AAAQOs using rolling averages but rather in clock hours and calendar days, months, and years. However, it is useful to use this method as a comparison of the NO_2 average for the time the KPP Station was in operation. The annual average for the duration of this project from February 1, 2023, to January 31, 2024 was 2.31 ppb. This is equal to 9.6% of the annual AAAQO.

Figure 18 below shows the monthly average concentrations of NO_2 at the Newbrook (Newbrook) site and other HAMP air monitoring stations. The NO_2 levels at the KPP Newbrook site were lower than levels recorded at other sites within HAMP during the 12 month project, differing the most during the winter months. Figure 19 below shows the distribution of NO_2 measurements with no 1-hour average measurements exceeding 100 ppb during the project.

Figure 18: NO_2 Monthly Averages from February 2023 to January 2024

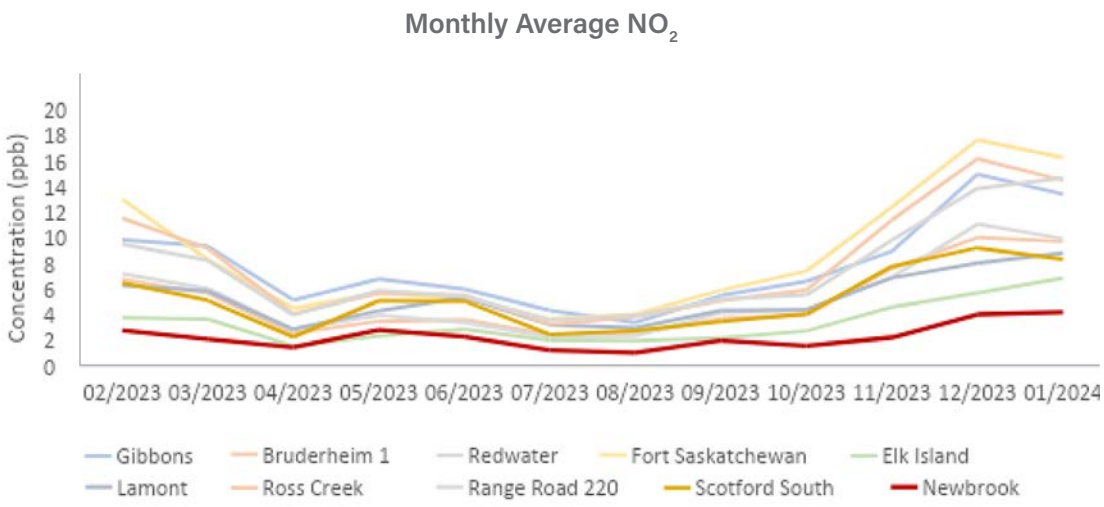


Table 15: Maximum 1-Hour Average NO_2 concentrations

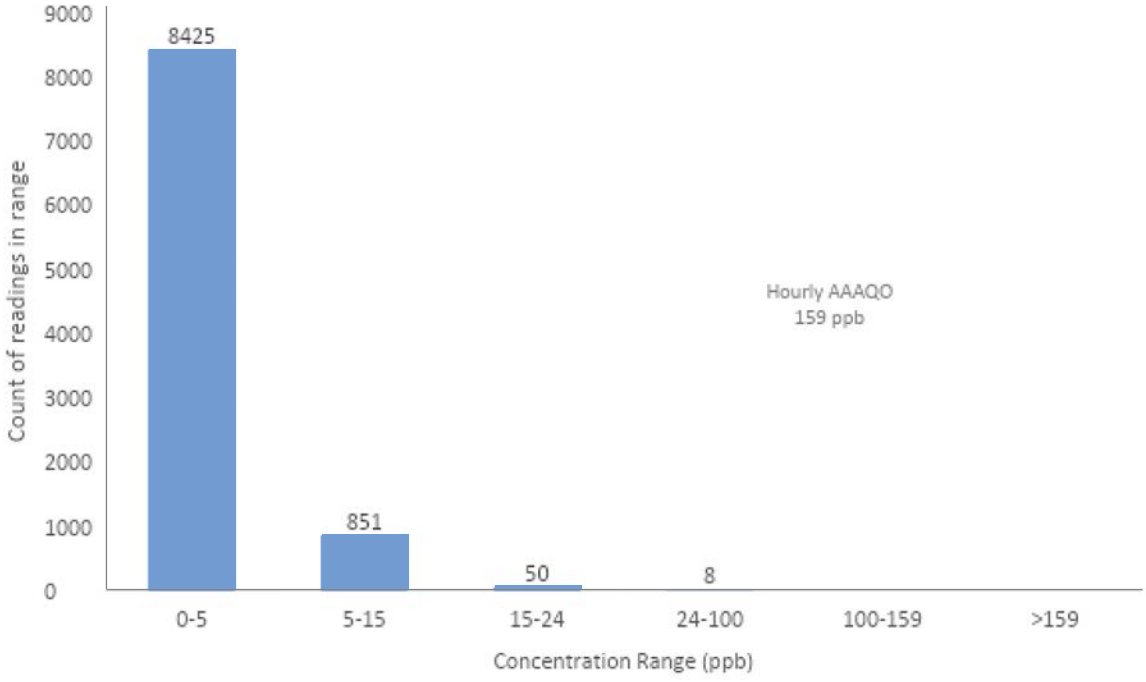
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Nitrogen Dioxide NO_2 (ppm)												
KPP	20.7	14.9	6.7	11.0	16.0	9.7	6.1	10.5	19.2	23.3	32.2	**36.1**
Bruderheim	**45.8**	36.4	12.9	20.1	31.1	12.5	17.9	16.8	22.1	31.9	31.1	42.5
Elk Island	**37.8**	26.5	8.1	11.7	15.0	8.2	10.1	9.9	15.1	20.6	26.6	32.3
Ft Saskatchewan	49.3	**49.5**	26.4	24.7	31.3	16.3	23.5	26.5	25.9	39.9	38.8	46.6
Gibbons	46.5	**48.4**	27.1	26.5	37.5	19.2	23.0	25.0	31.1	40.1	41.2	47.6
Lamont	**40.8**	30.4	12.9	35.0	39.9	18.0	15.9	15.0	24.9	28.1	30.3	35.5
Range Road 220	**48.1**	46.0	25.9	36.8	32.0	18.9	28.1	24.9	26.3	40.5	34.9	47.4
Redwater	40.7	36.8	21.2	15.5	25.9	13.8	16.4	44.1	22.5	31.3	32.6	**44.0**
Ross Creek	**52.3**	51.2	24.6	39.8	35.2	18.7	44.5	22.7	29.1	39.8	41.8	49.9
Scotford South	**45.5**	31.0	13.5	28.6	31.3	10.6	22.5	15.6	33.9	34.8	38.6	36.7

Table 15 above shows the maximum 1-hour average NO_2 concentrations recorded at the HAMP monitoring stations each month while **Table 16** shows the maximum 24-hour averages.

Table 16: Maximum 24-Hour Average NO_2 Concentrations

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
	Nitrogen Dioxide NO_2 (ppm)											
KPP	7.9	5.1	2.9	6.2	6.0	3.7	2.2	3.4	3.2	5.1	10.0	**17.5**
Bruderheim	16.7	19.2	4.9	10.1	9.5	7.0	6.6	6.6	6.6	17.9	22.7	**24.0**
Elk Island	7.8	8.5	3.3	6.5	6.5	4.4	3.9	3.4	5.1	8.2	12.4	**15.5**
Ft Saskatchewan	32.9	27.2	10.4	13.5	9.3	6.6	10.0	10.1	11.7	26.1	28.1	**33.2**
Gibbons	27.1	24.9	12.0	13.4	12.3	8.2	10.1	12.9	12.3	22.5	27.5	**31.9**
Lamont	14.0	16.3	5.7	11.4	13.7	5.8	6.3	7.2	6.3	12.6	18.7	**21.6**
Range Road 220	25.7	20.1	8.8	14.4	10.2	6.0	11.0	8.3	11.7	24.7	22.3	**32.5**
Redwater	20.9	14.9	8.7	8.1	6.9	5.3	4.8	7.5	8.8	13.8	21.2	**29.2**
Ross Creek	32.2	23.6	9.6	12.1	16.8	5.2	9.7	8.9	11.1	26.2	25.8	**35.0**
Scotford South	17.3	15.8	5.3	14.8	12.6	5.4	6.4	5.8	7.7	20.2	19.2	**21.2**

Figure 19: NO_2 Distribution of One-Hour Averages at Newbrook



Ozone Results

Unlike other pollutants ozone (O_3) is not emitted directly by anthropogenic (human made) activities. O_3 in the lower atmosphere is produced by a complicated set of chemical reactions involving oxides of nitrogen (NOx) and volatile organic compounds (VOCs) in the presence of sunlight. Significant natural sources of VOCs in remote and rural areas of Alberta are emissions from trees and vegetation. Ozone is also a by-product of the reaction between sunlight and VOCs found in wildfire smoke.

O_3 is also transported to the ground from the ozone rich upper atmosphere by natural weather processes. O_3 and substances that form ozone, such as NOx and VOCs (referred to as ozone precursors), may also be carried from upwind sources such as urban centers and industrial complexes. This phenomenon can be observed in Alberta particularly in summer when warm temperatures (upwards of 30°C or more), coupled with light winds and abundant sunshine, result in an air quality condition referred to as summertime smog.

O_3 concentrations are generally lower at urban locations than at rural locations due to the destruction of O_3 by nitric oxide (NO) generated by the combustion of fossil fuels. This is known as ozone scavenging. O_3 levels are generally higher during the spring and summer months because of increased concentrations coming from the upper atmosphere and more abundant sunlight, which leads to more rapid chemical reactions that form O_3.

Clear skies and longer summer daylight hours provide ample sunlight, which combined with warm temperatures and a stable air mass, can result in summertime smog. These weather conditions are conducive to the formation of secondary pollutants from ozone precursors emitted by multiple sources both small and large in the Edmonton Metropolitan Area. This smog takes some time to form and is often experienced dozens of kilometers downwind of an urban core.

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

O_3 is reported as parts per billion (ppb). The AAAQO for ozone is:

- A 1-hour daily maximum concentration of 76 ppb

The daily maximum ozone concentration was exceeded 4 times at the KPP Newbrook site. The highest of these was 96.1 ppb. This occurred on June 13th, 2023, due to wildfire smoke as noted above.

Figure 20 below shows the monthly average concentrations of O_3 at the KPP Newbrook site and other HAMP air monitoring stations. The O_3 levels at the KPP Newbrook site did not differ substantially from levels recorded at other communities within HAMP. Monthly averages during the summer months May to September, were on average 3% higher than other HAMP stations. The spring and fall shoulder seasons were an average of 16% higher at the KPP Newbrook site. The winter months December, January and February recorded an average of 34% higher O_3 at the KPP. This is likely due to the more pronounced effect of ozone scavenging as explained above at sites located within other communities during those months. Figure 20 below shows the distribution of O_3 1-hour measurements with all but 18 one-hour averages under 50 ppb during the project.

Figure 20: O_3 Monthly Averages from February 2023 to January 2024

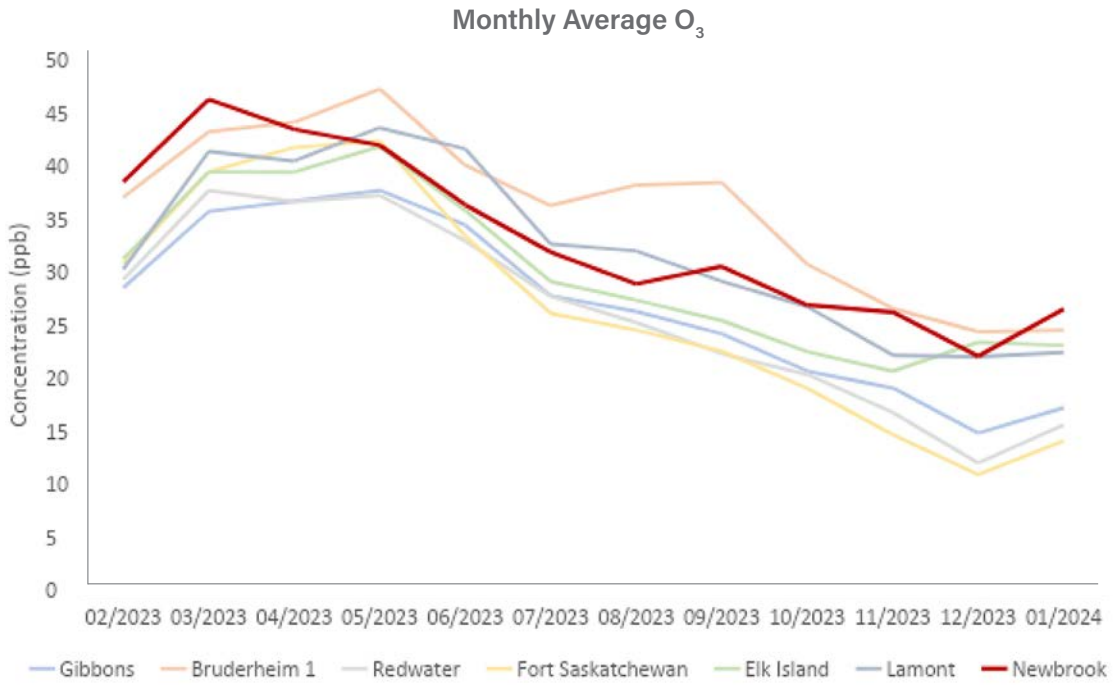


Table 17: Maximum 1-Hour Average O_3 Concentrations

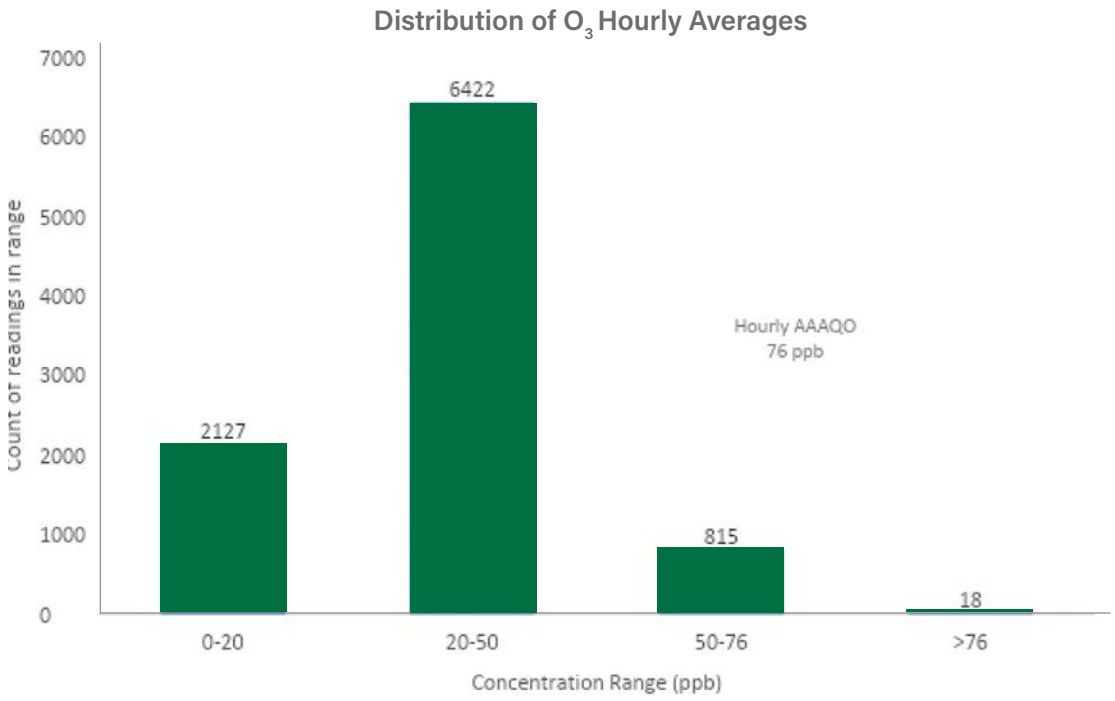
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Ozone O_3 (ppm)												
KPP	52.1	85.1	60.3	72.5	**96.5**	63.5	58.3	60.2	47.6	43.5	42.0	50.3
Bruderheim	50.2	74.0	58.4	91.2	**88.3**	70.5	78.6	69.1	51.4	42.6	44.0	39.2
Elk Island	42.6	71.9	55.8	86.4	**84.6**	65.7	73.7	51.0	42.5	37.6	43.2	45.1
Ft Saskatchewan	50.3	78.2	58.9	80.9	**103.4**	60.7	68.0	51.2	39.1	38.7	35.6	42.0
Gibbons	44.6	73.4	55.7	79.3	**95.4**	67.8	64.6	52.8	40.1	41.0	37.8	44.5
Lamont	47.8	72.6	57.3	92.8	**93.2**	75.5	80.7	58.4	48.7	41.8	45.6	45.3
Redwater	45.3	76.1	52.9	74.6	**88.2**	59.4	61.6	51.7	39.7	36.2	35.5	39.8

Table 17 above shows the maximum 1-hour average O_3 concentrations recorded at the HAMP monitoring stations each month while Table 18 shows the maximum 24-hour averages.

Table 18: Maximum 24-Hour Average O_3 Concentrations

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Ozone O_3 (ppm)												
KPP	49.5	67.6	52.7	51.1	**58.0**	44.9	39.9	43.9	33.0	38.8	36.3	36.8
Bruderheim	44.9	58.6	49.2	**60.0**	55.8	46.8	49.8	50.5	36.3	35.1	35.5	32.3
Elk Island	39.6	52.1	47.1	54.1	**55.9**	42.9	38.8	38.9	28.0	31.6	34.2	35.0
Ft Saskatchewan	44.5	51.0	49.4	**56.6**	55.5	36.6	34.7	35.8	25.1	29.7	29.0	28.6
Gibbons	40.1	43.7	45.5	48.7	**55.3**	42.4	33.6	35.8	26.9	32.4	33.6	31.9
Lamont	43.7	59.7	48.3	53.7	**58.7**	42.2	44.4	37.3	33.8	32.9	35.4	35.0
Redwater	42.1	54.2	42.6	46.5	**52.9**	41.1	33.9	34.2	25.1	28.9	30.1	28.5

Figure 21: O_3 Distribution of One-Hour Averages at Newbrook



Sulphur Dioxide Results

Sulphur dioxide (SO_2) is a colourless gas with a pungent odour. In Alberta, natural gas processing plants are responsible for close to half of the SO_2 emissions in the province. Sources of SO_2 in the Airshed are primarily industrial, from both within and outside HAMP's boundaries. SO_2 is reported as parts per billion (ppb). Alberta has established the following AAAQOs for SO_2:

- **One-hour average concentration at 172 ppb.**
- **24-hour average concentration at 48 ppb.**
- **30-day average concentration at 11 ppb.**
- **Annual average concentration at 8 ppb.**

The highest one-hour average SO_2 recorded at the KPP Newbrook site was 9.9 ppb on March 12, 2023. This represents 5.7% of the one-hour AAAQO. The highest 24-hour average SO_2 recorded at the KPP Newbrook site was 2.65 ppb on May 19, 2023. This represents 6.3% of the 24-hour AAAQO. The highest monthly (30 day) average SO_2 recorded at the KPP Newbrook site was 0.59 ppb in June 2023, representing 5.3% of the 30-day AAAQO.

The KPP station operated for 11 months in 2023 and one month of 2024. 11 months of data is sufficient to calculate a valid annual average as a minimum of 9 months is required. The annual average calculated for 2023 was 0.23 ppb: equal to 2.9% of the annual AAAQO.

A "rolling" average can also be calculated for the 12 months the KPP Station was in operation. Data is not reported to the Alberta Government against AAAQOs using rolling averages but rather in clock hours and calendar days, months, and years. However, it is useful to use this method as a comparison of the SO_2 average for the time the KPP Station was in operation. The annual average calculated for the entire duration of this project from February 1, 2023, to January 31, 2024, was 0.22 ppb: equal to 5.3% of the annual AAAQO.

Figure 22 below shows the monthly average concentrations of SO_2 at the Newbrook (Newbrook) site and other HAMP air monitoring stations. The SO_2 levels at the KPP Newbrook site do not differ substantially from levels recorded at other stations within HAMP, with all monthly averages being within 1.5 ppb of the KPP Newbrook site. Figure 23 below shows the distribution of SO_2 1-hour measurements with no one-hour averages exceeding 10 ppb during the project.

Figure 22: SO_2 Monthly Averages from February 2023 to January 2024

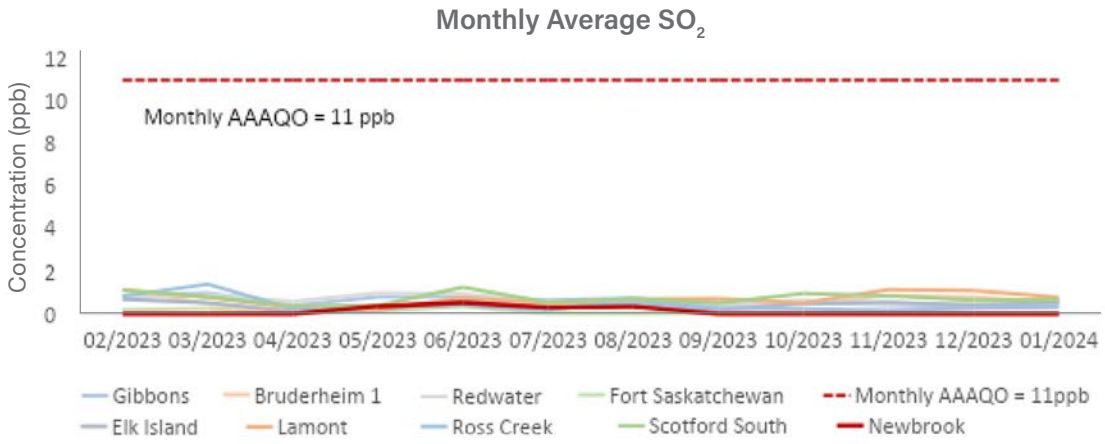


Table 19: Maximum 1-Hour Average SO_2 Concentrations

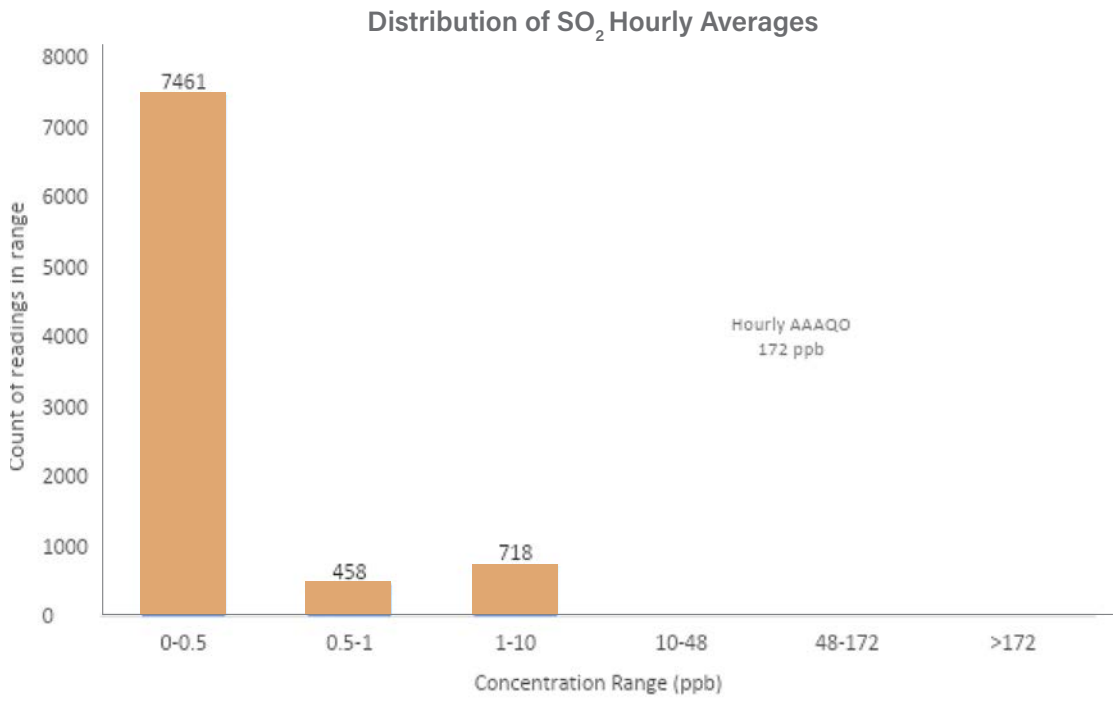
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Sulphur Dioxide SO_2 (ppm)												
KPP	3.3	**9.9**	5.0	8.8	7.7	4.6	6.6	3.3	3.1	0.4	3.0	3.9
Bruderheim	14.4	8.9	17.0	12.4	15.9	9.1	27.2	12.1	**24.1**	11.2	23.0	10.7
Elk Island	10.6	9.4	7.4	8.7	20.2	11.5	10.6	6.3	**48.2**	9.6	4.7	14.6
Ft Saskatchewan	**28.5**	24.4	8.8	18.1	22.7	15.1	5.9	10.1	18.5	3.0	12.2	2.2
Gibbons	**45.1**	34.9	8.8	10.0	19.1	9.8	9.9	6.6	15.9	19.3	10.3	6.3
Lamont	8.4	14.5	9.2	4.3	13.0	9.2	23.3	9.3	8.3	**31.7**	17.3	11.78
Redwater	11.0	14.6	16.0	31.3	11.9	**26.2**	10.9	8.4	22.3	11.8	12.0	7.4
Ross Creek	24.8	**33.9**	16.6	21.0	15.0	15.1	14.3	10.4	20.4	8.2	14.6	6.5
Scotford South	21.6	18.6	11.6	20.3	29.0	21.1	18.6	10.2	**49.7**	12.4	18.6	11.8

Table 19 above shows the maximum 1-hour average SO_2 concentrations recorded at the HAMP monitoring stations each month while **Table 20** shows the maximum 24-hour averages.

Table 20: Maximum 24-Hour Average SO_2 Concentrations

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
	Sulphur Dioxide SO_2 (ppm)											
KPP	0.57	0.76	0.54	**2.65**	1.98	2.30	1.81	1.75	0.55	0.07	0.34	0.89
Bruderheim	**4.11**	2.07	2.26	2.45	2.78	1.92	2.87	1.48	3.74	3.55	2.44	3.45
Elk Island	1.94	1.83	1.29	1.16	3.24	1.70	1.88	0.88	**4.61**	1.27	1.30	2.61
Ft Saskatchewan	1.74	**3.03**	0.95	1.84	2.25	0.76	0.72	1.46	2.34	0.48	1.20	0.53
Gibbons	**5.41**	4.62	1.37	2.81	3.19	2.34	2.34	2.01	3.14	2.31	2.02	1.24
Lamont	3.06	3.65	1.42	1.21	3.62	2.10	2.80	2.47	1.72	**5.02**	3.87	3.07
Redwater	2.38	2.99	3.32	**4.15**	2.64	2.53	1.61	1.19	3.51	2.03	1.72	1.57
Ross Creek	3.00	**4.46**	3.72	2.16	2.17	1.67	3.39	2.53	2.93	0.97	1.45	1.47
Scotford South	5.97	2.92	2.56	2.69	**9.08**	3.26	2.94	1.44	8.19	2.61	2.32	3.05

Figure 23: SO_2 Distribution of One-Hour Averages at Newbrook



4.3 Results vs. Air Quality Health Index

AQHI Risk Distribution

The Alberta Government calculates an Air Quality Health Index (AQHI) using hourly measurements of fine particulate matter, ozone and nitrogen dioxide in the air. Alberta has augmented the national AQHI formulation to better account for rapidly changing air quality and to include hydrogen sulphide, sulphur dioxide and carbon monoxide. The AQHI is a tool that helps people understand what the local outside air quality means to their health using a scale from one to 10. The lower the number, the lower the relative health risk. Alberta Health has outdoor activity recommendations corresponding to each risk category.

Seven of HAMP's continuous air monitoring stations provide data on substances required by the provincial and federal governments to calculate and forecast an AQHI for the region, although only the community stations are shown in the following tables. Daily and forecast ratings are updated every three hours. While the daily rating is based on what is occurring at individual stations, the forecast is a regional prediction of the average concentration of monitored substances at HAMP stations.

The AQHI is designed as a communications tool. It is not used by environmental managers to monitor and measure long-term trends in air quality or to assign management actions.

During the 12-month period that HAMP operated the KPP Station at the Newbrook site, an AQHI was calculated in the same manner as is done for the rest of the HAMP region. However, the AQHI was only calculated by the Alberta Government for 10 months of the project, beginning April 1, 2023. The results compared to other community stations operated by HAMP are summarized in Figure 23.

Figure 24: Percentage of Time in Each AQHI Risk Category at HAMP Community Stations

STATION NAME	HOURS MONITORED	Low Risk %	Moderate Risk %	High Risk %	Very High Risk %	TOTAL
Bruderheim	8,484	85.28%	12.16%	1.71%	0.85%	100%
Elk Island	8,530	87.08%	9.43%	2.52%	0.97%	100%
Ft Saskatchewan	8,428	78.08%	17.88%	2.78%	1.26%	100%
Gibbons	8,361	83.79%	12.57%	2.97%	0.67%	100%
Lamont	8,525	85.91%	10.94%	2.57%	0.57%	100%
Redwater	8,235	86.69%	9.31%		1.29%	97.29%
KP Portable	7,175	87.87%	7.97%	2.22%	1.94%	100%
Total Hours	**57,738**	**49,018**	**6,666**	**1,443**	**611**	
Average		**84.96%**	**11.47%**	**2.46%**	**1.08%**	

Data collected during the Newbrook project was used to calculate the AQHI, as is done at several community stations within HAMP. This site was located within a rural area; however, and not a municipality as are the other HAMP community sites.

The KPP Newbrook site, like all HAMP stations, recorded low risk to health AQHI ratings for the vast majority of the project. The KPP Newbrook site was in the low-risk category 87.8% of the time, a slightly higher percentage than all other HAMP stations. The station was in the High and Very High risk 4.2% of the hours monitored. This is predominately due to the reduced number of hours that the AQHI was calculated at the KPP. Although the station began operating February 1, 2023, the AQHI was not calculated for the entire 12 month project as mentioned above. Stretching back to February 1st, the high and very high would have accounted for 3.6% of the time, the same as Gibbons and less than Redwater or Fort Saskatchewan.

AQHI High and Very-High Risk Events

Table below, breaks down all the monitoring hours in the HAMP network that resulted in an Air Quality Health Index calculation of high or very high risk to health.

Table 21: High and Very High-risk Air Quality Health Events

	Bruderheim		Elk Island		Fort Saskatchewan		Gibbons		Lamont		Redwater		Keith Purves Portable			
AIR QUALITY EVENT DATES	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	High Risk	Very High Risk	TOTAL HOURS	AIR QUALITY EVENT CAUSE
January 1, 2023					1										1	Wintertime inversion
January 4			1												1	Wintertime inversion
January 9, 10, 11	15	3	21		23		5		12						79	Wintertime inversion
January 15							1								1	Wintertime inversion
March 19, 20, 21			2		14		8				4				28	Wintertime inversion
April 1					1										1	Regional meteorology conditions
May 16 - 23	12	60	32	42	34	58	37	19	29	35	20	56	19	54	507	Wildfire smoke and summertime smog
May 27, 28, 31	3		3		1		2		6						15	Wildfire smoke
June 7 - 9	7		20		16		11		12		5		5		76	Wildfire smoke and summertime smog
June 10 - 16	4		18		24		31		29	1	40		24		171	Wildfire smoke
June 19			2		2				1		1				6	Wildfire smoke
June 29									2						2	Summertime smog
July	51	12	60	26	60	22	56	22	72	13	60	29	38	48	569	Wildfire smoke and summertime smog
July 2											3	1			4	Structure fire
August	3		4		17		18		7		20		11		80	Wildfire smoke and summertime smog
September	65		74	15	64	26	84	15	61		67	20	60	37	588	Wildfire smoke
September 18, 25													2		2	Agriculture operations
TOTAL HOURS	160	75	237	83	257	106	253	56	231	49	220	106	159	139	2131	

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