

# Technical Memorandum

## 2017 Aamjiwnaang First Nation Air Quality Mobile Monitoring Survey



Report Prepared by:

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## Executive Summary

The Ministry of the Environment, Conservation and Parks' Southwest Region has conducted regular ambient air quality monitoring surveys using its mobile monitoring vehicle around the Aamjiwnaang First Nation since 2011. These surveys are conducted for exploratory purposes, and provide a short-term "snapshot" in time, to compare with and to complement the data collected at the permanent Aamjiwnaang air monitoring station.

In 2017, half-hour measurements of volatile organic compounds (VOCs) were taken on a monthly basis at six sites. The monitoring instrument measured levels of sixteen different contaminants and detected thirteen of them.

Of the VOC detected, benzene and 1,3-butadiene were seen at levels that were above a half-hour assessment value derived from the ministry's Ambient Air Quality Criteria (i.e. "overages").

Benzene overages were observed in 11% of the samples taken throughout the survey. This is lower than the percentage of benzene overages measured during previous mobile monitoring surveys (2011-2016), which has ranged from 17% to 39% per survey year.

A single 1,3-butadiene overage was observed. This was the first and only 1,3-butadiene detection in the SWR mobile monitoring program between 2011 and 2017.

Naphthalene was monitored for and detected during the survey. However, the ministry confirmed that the survey results for naphthalene are not reliable, following further investigation of the capabilities and limitations of the monitoring instrument to measure naphthalene. The ministry removed naphthalene from the list of monitored contaminants in 2019.

The spatial variability of the mobile monitoring survey results from 2011-2017 was assessed to determine whether any contaminant was more frequently detected or tended to have higher concentrations at one or more of the six sampling sites. No single site consistently measured significantly higher concentrations of any one contaminant, in comparison to all other sites. It is possible that differences in contaminant concentrations between the sampling sites exist, but these differences have not been seen through the mobile monitoring program. Mobile monitoring surveys serve as "spot checks" at given points in time, and are appropriate for exploratory purposes. Stationary monitoring for longer durations would be more suitable for an in-depth analysis of concentrations at different locations.

## **Introduction**

The Ontario Ministry of the Environment, Conservation and Parks (ministry) maintains a permanent air monitoring station at the Aamjiwnaang First Nation, located at 1300 Tashmoo Ave., which was established in the fall of 2008. The ministry reports on the air quality results from this station separately on an annual basis.

The ministry's Southwest Region (SWR) has conducted regular ambient air quality monitoring surveys using its mobile monitoring vehicle in the vicinity of Aamjiwnaang First Nation since 2011. These surveys are conducted for exploratory purposes and to complement the data collected at the permanent air monitoring station. These mobile monitoring surveys consist of a series of half-hour measurements of volatile organic compounds (VOCs) taken at six locations around Aamjiwnaang First Nation.

The results of the 2011-2016 surveys have been reported in previous Technical Memoranda. The results of the 2017 mobile monitoring survey are provided below.

## **Objectives**

The objectives of the ministry's SWR 2017 mobile monitoring survey were to:

1. Measure ambient concentrations of select VOCs in the vicinity of Aamjiwnaang First Nation;
2. Compare the results to assessment values based on Ontario's Ambient Air Quality Criteria (AAQC);
3. Compare the results to surveys conducted in previous years;
4. Assess the results for spatial variability, that is, any differences in the results between sampling locations.

Although this monitoring data is being compared with health-based values, this memorandum should not be interpreted as a health-based assessment. Long-term, continuous monitoring data, such as the data collected at the permanent Aamjiwnaang air monitoring station, is more appropriate for health-based assessments.

## **Methodology**

The ministry's SWR conducted a survey on twelve days between January and December 2017 (one day per month) in the vicinity of Aamjiwnaang First Nation. Real-time air monitoring of VOCs was performed using the SWR mobile monitoring van, which is equipped with a gas-chromatograph/mass-spectrometer (INFICON HAPSITE ER).

On each survey day, consecutive half-hour measurements were taken at six locations, which are shown in Figure 1. A total of 72 samples were collected in 2017. Sampling was conducted at the same six locations that were monitored in previous years (2011-2016) for comparison purposes. Sampling was performed at the same set of locations and in the same order on each occasion. Air was sampled

for 30 minutes at 33-34mL/min for a total of approximately 1000 mL through a tri-bed glass sorbent tube. Once sampling was completed, the sorbent tube was thermally desorbed and analyzed for the sixteen target VOCs (listed in Table 1 below).

The same 16 VOC measured in the 2012-2016 surveys were measured in 2017 for comparison purposes. The first mobile monitoring survey, in 2011, included acrylonitrile and carbon disulphide in place of trichloroethylene and tetrachloroethylene. The target list was updated in 2012 based on the 2011 monitoring results (acrylonitrile and carbon disulphide were not detected in 2011) and to better utilize the capabilities of the mobile monitor's instruments (by adding trichloroethylene and tetrachloroethylene to the target list).

Measurements of general air quality are normally compared to Ambient Air Quality Criteria (AAQC). The AAQC for the VOC sampled are based on 24-hour or annual averaging periods. In order to provide context to the half-hour measurements collected during the survey, results have been compared to half-hour "AAQC Assessment Values", which were calculated using a conversion formula prescribed in O. Reg. 419/05 [Section 17(3)], but which ministry staff use in other contexts, allowing the ministry to convert data between different averaging periods<sup>1</sup>. Briefly, it is noted that conversion factors are typically used for modelling data; however, considering the assumption of continuous emission from area sources, it is not unreasonable to use conversion factors for the purposes within this report. Here, the concentration for one duration  $C_0$  is multiplied by a factor:

$$C_1 = C_0 \cdot \left(\frac{t_0}{t_1}\right)^n$$

where  $t_0$  is the averaging time of the original value, usually 24 hours for AAQC, and  $t_1$  is the averaging time for which one wishes to make the comparison, one-half hour in this case. The standard value of the scaling exponent,  $n$ , was used ( $n=0.28$ ). This conversion has the effect of increasing the assessment value ( $C_1$ ) when going from longer averaging times to shorter ones, as was done for this survey.

Table 1 shows the target VOCs measured in the survey, the current 24-hour AAQC, and the derived assessment values that are used in this report.

<sup>1</sup>Technical Bulletin: Using assessment values for contaminants with annual air standards:

<https://www.ontario.ca/page/technical-bulletin-using-assessment-values-contaminants-annual-air-standards>

<b>Table 1: Target VOCs and Derived ½-hour Assessment Values</b>		
	<b>24-hour AAQC</b>	<b>½-hour Assessment Value</b>
	<b>(all values in µg/m<sup>3</sup>)</b>	
Propylene	4000	12000
Chloromethane	320	950
1,3-Butadiene	10	30
Hexane	2500	7400
Chloroform	1	3
Benzene	2.3	7
Carbon Tetrachloride	2.4	7
Cyclohexane	6100	18000
Trichloroethylene	12	35
Toluene	2000	6000
Tetrachloroethylene	360	1100
Ethylbenzene	1000	3000
m- & p- Xylene <sup>1</sup>	730	2200
Styrene	400	1200
o-Xylene <sup>1</sup>	730	2200
Naphthalene <sup>2</sup>	22.5	67
<sup>1</sup> AAQC is based on total xylenes		
<sup>2</sup> Naphthalene was removed from the monitoring list in 2019 due to instrument limitations		

In cases where the values of the monitored data are over the ½-hour assessment values, they do not necessarily reflect a health risk. Rather, values that approach or are over ½-hr assessment values should be taken as indicators that longer term monitoring or other studies need to be undertaken, or compared to other existing long-term monitoring. The ministry believes that a long and continuous record of environmental measurements, such as the multi-year data from the Aamjiwnaang station, is a more appropriate gauge of local long-term concentrations.

While the monitoring instrument reports measurements in parts per billion (ppb), the ministry publishes most standards and AAQC in micrograms per cubic metre (µg/m<sup>3</sup>). Since conversion between the two depends, in part, on temperature and pressure, and these varied between measurements, the individual results have been converted to µg/m<sup>3</sup>. Temperature and pressure data from the Environment and Climate Change Canada website (Sarnia station, Climate ID 6127510, for the hour that contained the majority of the 30-minute sampling period) were used to convert the results to µg/m<sup>3</sup>.

Wind speed and wind direction data referenced throughout the results were used from the Aamjiwnaang First Nation station (specifically, the hourly average wind speed and wind direction for the hour which contained the majority of the 30-minute sampling period). A wind rose diagram for the Aamjiwnaang station is shown in Figure 2.

To avoid confusion with the term “exceedance”, which is typically used in relation to published AAQC and O. Reg. 419/05 standards or benchmarks, any values in excess of the assessment values are referred to as “overages” throughout this report.

Measurements were made for all species at each location on each sampling day. Not all of the contaminants were detected in each sample. In cases where the concentration of a contaminant was below the detection limit of the monitoring instrument, the result is reported as “n/d” (not detected). This indicates that those contaminants were tested for, but the amount sampled was less than the minimum detectable limit of that methodology.

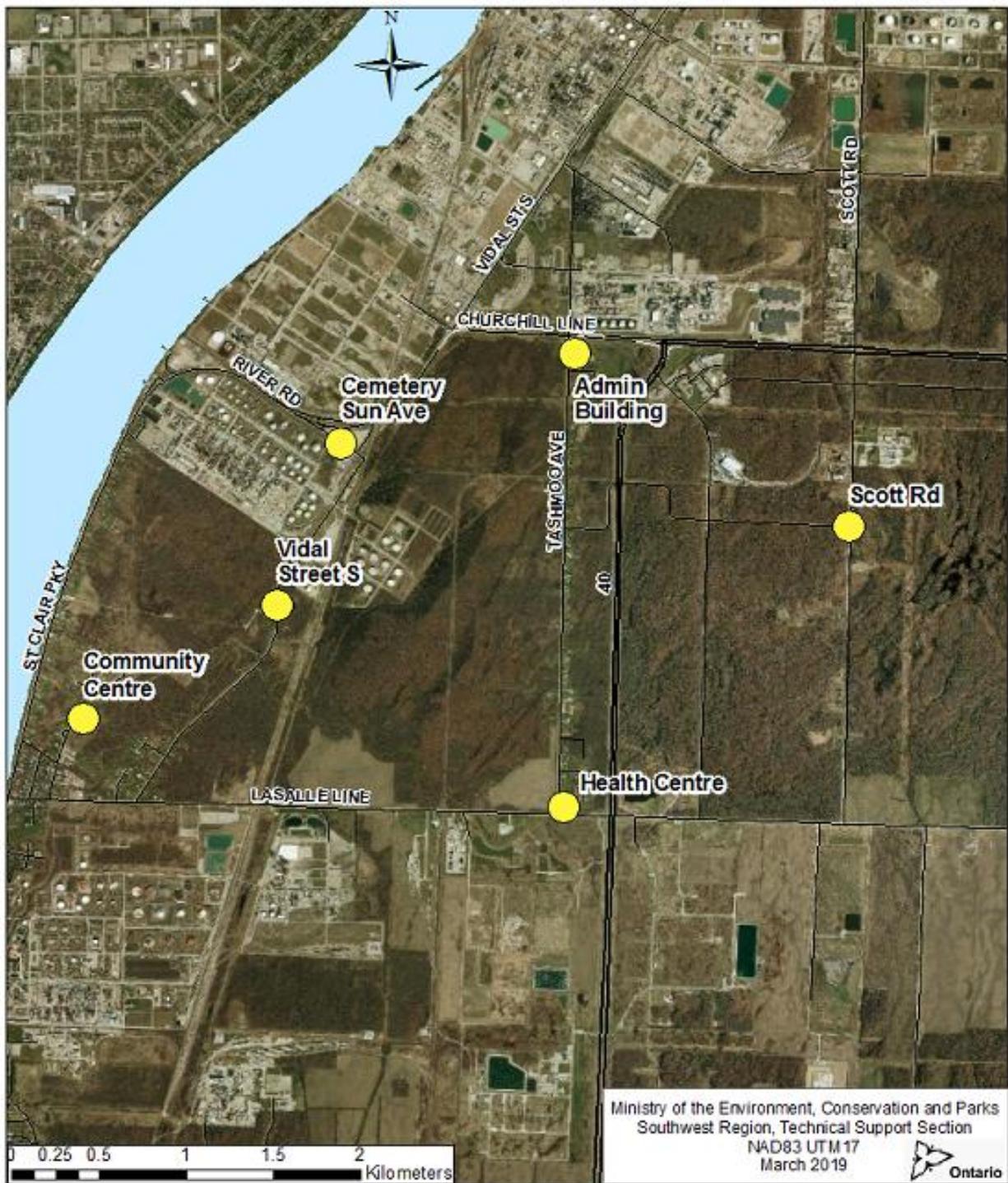
Rather than present averages, the ministry has included all the measurements. In situations where very few values are measured, averages may not be representative. It should also be noted that measurements reported in this survey should not be considered to represent ambient levels for a number of reasons:

- The detection limit for various substances is not determined (it varies between contaminants);
- The measurements do not represent a random sample, for the following reasons:
  - Sampling only occurred between Monday and Friday;
  - Sampling only occurred between 8:30 and 13:30 (Eastern Standard Time);
  - Samples were taken in the same order on all but two days, so samples at any site were typically collected at approximately the same time of day;
- Samples were not simultaneous. Thus, care must be taken in comparing them for assessing spatial variability;
- Wind speed and direction were measured at the Aamjiwnaang air monitoring station and so may vary from conditions at the different monitoring sites;
- In addition, wind speed and direction measurements are hourly averages and so may not accurately reflect the exact conditions for the half-hour sample;
- Similarly, temperature and pressure were taken from the Environment Canada climate site at the Sarnia airport and so may vary slightly from conditions at the measurement sites.

Thus, it is not necessarily appropriate to interpret long-term health risks using limited half-hour mobile monitoring data, as many AAQC are based on long-term continuous exposure. The ministry relies upon long-term monitoring at stations in the area, such as the permanent Aamjiwnaang station, which reflect the typical variation in concentration in locations where changes in exposure can potentially have an impact.

As a part of the non-continuous monitoring program at the Aamjiwnaang First Nation air monitoring station, 24-hour samples are collected using evacuated canisters and sent for VOC analysis at the Environment and Climate Change Canada laboratory. In 2017, these canister samples were collected every six days, and four of the sampling days coincided with the mobile monitoring survey: February 24, May 31, August 29, and December 20. The mobile monitoring survey Site #1 (Health Centre) is located by the permanent Aamjiwnaang air monitoring station, and so the mobile monitoring results from the Health Centre site were compared with canister results for these days for select contaminants.

Figure 1: 2017 Aamjiwnaang First Nation mobile monitoring survey sites.



**Figure 2:** 2011-2017 Wind Rose for the Aamjiwnaang First Nation station

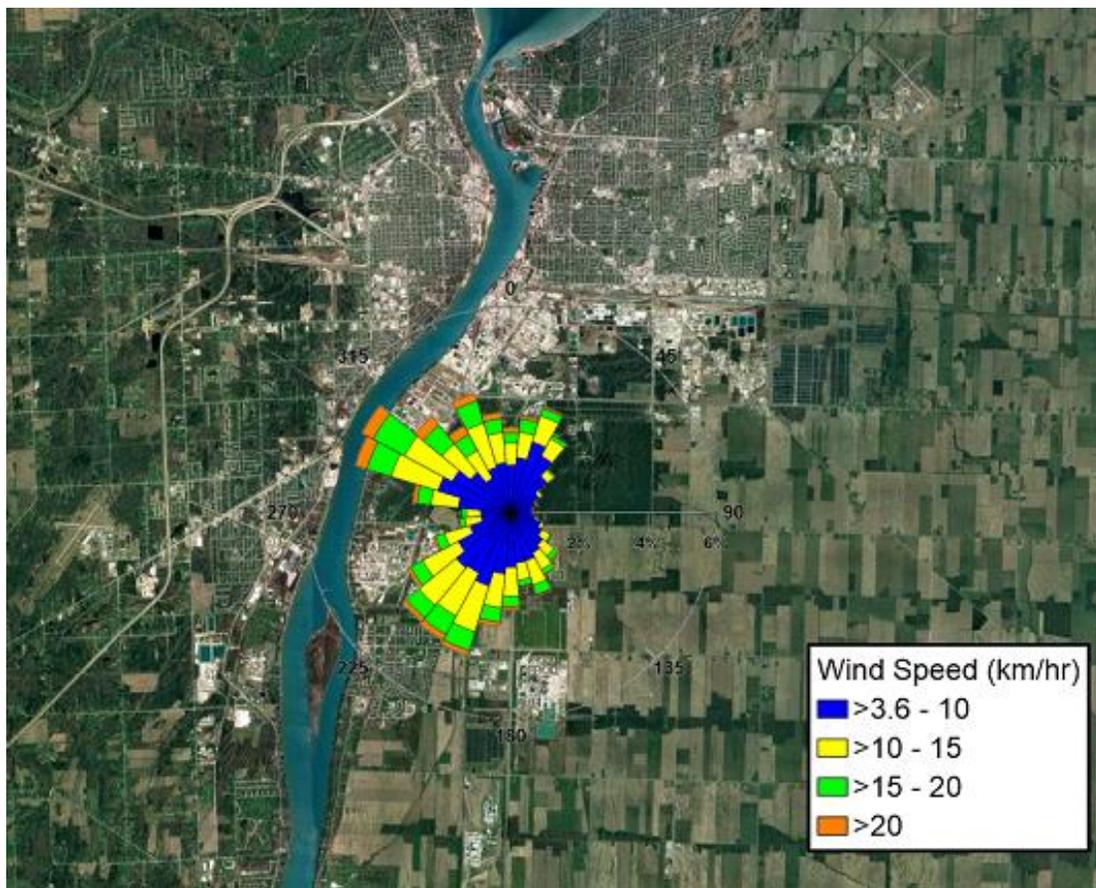


Figure 2 shows the relationship between the wind speed and wind direction measured at the Aamjiwnaang First Nation station between 2011 and 2017. In a wind rose, each bin (or “petal”) depicts the percentage of time that wind was blowing from a particular direction for the various wind speeds measured. The wind directions are given based on the direction from which the wind was blowing; that is, a west (270°) wind is a wind coming from the west (and travelling east). A west wind would be depicted by a petal positioned at “9:00” on a clock scale. The colour scheme for the wind speed is given in the legend at the bottom right of the figure.

The winds measured at the Aamjiwnaang First Nation station are representative of the local wind patterns, and do not necessarily reflect larger-scale wind patterns (such as regional or transboundary). There are several other wind monitors located throughout the Sarnia and area air monitoring network. Variability in wind speed and direction is seen at these different monitors, based on location and proximity to the St. Clair River.

This figure shows that the predominant wind directions measured at the Aamjiwnaang station are southwest and northwest. Winds from the east are rare.

## 2017 Monitoring Results

Thirteen of the sixteen VOC species selected for analysis were detected during the 2017 mobile monitoring program, and three species were not detected, as listed below:

### VOC Species Detected

- 1,3-butadiene
- Hexane
- Chloroform
- Benzene
- Carbon tetrachloride
- Cyclohexane
- Toluene
- Tetrachloroethylene
- Ethylbenzene
- m- & p-xylene
- Styrene
- o-xylene
- Naphthalene

### VOC Species Not Detected

- Propylene
- Trichloroethylene
- Chloromethane

Results are presented in the order in which they were analyzed by the instrument. The tables below provide the results for the thirteen detected VOC species, for each site and sampling date (with the exception of naphthalene, which was detected but could not be quantified). The AAQC assessment values are given in brackets and values higher than their respective assessment value are indicated in bold font.

Measurements were made for all sixteen target contaminants at all the sites on all the sampling days. If the contaminant was not detected during a particular measurement, the results are labelled "n/d".

Pollution roses, which show the relationship between measured concentrations and wind direction, are provided for the contaminants that were most frequently detected during the survey.

### Propylene

Propylene was not detected in 2017.

In previous years (2011-2017), propylene has been detected intermittently (63/390 samples, or 16%). The maximum value, observed in 2011, was 177  $\mu\text{g}/\text{m}^3$ , which is approximately 1.5% of the ½-hour AAQC assessment value of 12,000  $\mu\text{g}/\text{m}^3$ .

### Chloromethane

Chloromethane was not detected in 2017. It has been detected once throughout the 2011-2017 survey years (1/390 samples).

## 1,3-butadiene

All values in µg/m <sup>3</sup>						
Bold font indicates an overage (a value in excess of the AAQC Assessment value)						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 30	n/d	n/d	n/d	n/d	n/d	n/d
Feb. 24	n/d	n/d	n/d	n/d	n/d	n/d
Mar. 31	n/d	n/d	n/d	n/d	n/d	n/d
Apr. 26	n/d	n/d	n/d	n/d	n/d	n/d
May 31	n/d	n/d	n/d	n/d	n/d	n/d
Jun. 28	n/d	n/d	n/d	n/d	n/d	n/d
Jul. 28	n/d	n/d	n/d	n/d	n/d	n/d
Aug. 29	n/d	n/d	n/d	n/d	n/d	n/d
Sep. 27	n/d	n/d	n/d	n/d	n/d	<b>32.22</b>
Oct. 31	n/d	n/d	n/d	n/d	n/d	n/d
Nov. 27	n/d	n/d	n/d	n/d	n/d	n/d
Dec. 20	n/d	n/d	n/d	n/d	n/d	n/d

1,3-butadiene was detected once in 2017, at the Scott Road location. The measured concentration was 32.22 µg/m<sup>3</sup>, which is above the ½ hour AAQC assessment value of 30 µg/m<sup>3</sup>. Winds were from the north-northwest at the time of this observation. This was the first site sampled on this survey day, and 1,3-butadiene was not detected at any other sites.

This was the first and only 1,3-butadiene detection throughout the 2011-2017 mobile monitoring surveys (1/390 samples).

## Hexane

All values in µg/m <sup>3</sup>						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 30	n/d	n/d	n/d	n/d	n/d	n/d
Feb. 24	n/d	n/d	n/d	n/d	n/d	n/d
Mar. 31	247.71	n/d	8.46	n/d	n/d	n/d
Apr. 26	n/d	n/d	n/d	n/d	n/d	n/d
May 31	n/d	n/d	n/d	116.55	2.45	n/d
Jun. 28	4.04	5.03	4.59	6.09	2.75	3.44
Jul. 28	n/d	n/d	3.38	n/d	n/d	n/d
Aug. 29	n/d	n/d	n/d	n/d	n/d	n/d
Sep. 27	n/d	n/d	n/d	n/d	n/d	n/d
Oct. 31	n/d	n/d	n/d	n/d	n/d	n/d
Nov. 27	n/d	n/d	n/d	n/d	n/d	n/d
Dec. 20	n/d	n/d	n/d	n/d	n/d	n/d

Hexane was detected in 9 of the 72 samples (13% of the samples). It was detected at least once at each site, and it was observed at all sites on the June survey day.

The maximum hexane concentration (248 µg/m<sup>3</sup>) was detected at the Health Centre site; this value is approximately 3.3% of the ½-hour AAQC assessment value of 7,400 µg/m<sup>3</sup>.

The 2017 results were similar to previous surveys, which found that hexane was detected in approximately 6 – 31% of samples per year, at levels well below its AAQC assessment value.

## Chloroform

Chloroform was not detected in 2017. Chloroform was detected on four survey days in 2011, and was not detected in any of the other years (4/390 samples).

## Benzene

<b>Table 4: Benzene Half-Hour Concentrations (AAQC Assessment value = 7 µg/m<sup>3</sup>)</b>						
<b>All values in µg/m<sup>3</sup></b>						
<b>Bold font indicates an overage (a value in excess of the AAQC Assessment value)</b>						
<b>Date</b>	<b>Health Centre</b>	<b>Community Centre</b>	<b>Vidal St. South</b>	<b>Cemetery</b>	<b>Administration Building</b>	<b>Scott Road</b>
Jan. 30	0.31	0.41	1.37	0.76	4.55	2.38
Feb. 24	1.94	1.05	4.16	0.27	3.31	0.85
Mar. 31	<b>11.47</b>	n/d	n/d	n/d	<b>11.75</b>	n/d
Apr. 26	n/d	1.98	n/d	n/d	0.46	n/d
May 31	2.44	1.00	0.78	<b>15.75</b>	1.30	6.61
Jun. 28	0.45	0.60	0.86	1.48	2.43	6.01
Jul. 28	1.42	n/d	2.94	3.29	n/d	0.52
Aug. 29	3.15	<b>8.06</b>	<b>35.65</b>	0.86	0.83	<b>19.60</b>
Sep. 27	0.58	2.51	1.43	0.41	1.04	<b>19.03</b>
Oct. 31	n/d	0.64	n/d	2.46	0.77	4.50
Nov. 27	<b>8.95</b>	1.42	1.83	4.00	3.39	2.20
Dec. 20	1.04	0.79	2.03	0.58	0.72	0.48

Benzene was detected in 60 of the 72 samples (83% of the samples). 8 of the samples, or about 11%, were above the AAQC assessment value of 7 µg/m<sup>3</sup>.

The percentage of benzene samples above the assessment value was lower in 2017 than in previous survey years. Between 2011 and 2016, the overage percentage ranged from 17% to 39% per survey year. In the 2016 survey, 11 of the samples, or about 15%, were above the assessment value.

The maximum benzene concentration (35.65 µg/m<sup>3</sup>) was detected on August 29 at the Vidal Street South site. Winds were coming from the south-southeast at the time of this measurement. Benzene was detected at concentrations above the assessment value at two other sites on this day (Community Centre and Scott Road, at 8.06 µg/m<sup>3</sup> and 19.60 µg/m<sup>3</sup> respectively).

Benzene was detected from a variety of wind directions depending upon time and sampling location. This is illustrated in Figure 3 on the following page. Similarly, measurements above the AAQC assessment value were observed with winds coming from a range of directions (including northwest, northeast, and southeast). Overage were observed at least once at each site, and twice at the Health Centre and Scott Road sites.

Figure 3 is a pollution rose diagram, which shows the relationship between benzene concentrations observed at each survey site and the direction from which the wind was blowing during the sampling hour. The colour scheme for the benzene concentrations is given in the legend at the bottom right of the figure.

**Figure 3:** Benzene rose diagram for the 2017 Aamjiwnaang mobile monitoring survey.



## Carbon Tetrachloride

<b>Table 5: Carbon Tetrachloride Half-Hour Concentrations (AAQC Assessment value = 7.2 µg/m<sup>3</sup>)</b>						
<b>All values in µg/m<sup>3</sup></b>						
<b>Bold font indicates an overage (a value in excess of the AAQC Assessment value)</b>						
<b>Date</b>	<b>Health Centre</b>	<b>Community Centre</b>	<b>Vidal St. South</b>	<b>Cemetery</b>	<b>Administration Building</b>	<b>Scott Road</b>
Jan. 30	n/d	n/d	n/d	n/d	n/d	n/d
Feb. 24	n/d	n/d	n/d	n/d	n/d	n/d
Mar. 31	n/d	n/d	n/d	n/d	n/d	n/d
Apr. 26	n/d	n/d	n/d	n/d	n/d	n/d
May 31	n/d	n/d	n/d	n/d	n/d	n/d
Jun. 28	n/d	0.47	n/d	0.40	0.44	0.35
Jul. 28	0.58	0.62	0.62	0.63	n/d	0.65
Aug. 29	n/d	0.81	0.76	0.73	n/d	0.73
Sep. 27	0.55	n/d	0.60	0.68	0.65	0.66
Oct. 31	n/d	n/d	n/d	n/d	n/d	n/d
Nov. 27	0.73	n/d	n/d	0.67	n/d	n/d
Dec. 20	0.88	0.88	0.75	0.74	0.61	0.61

Carbon tetrachloride was detected in 26 of the 72 samples (36% of the samples). This was a greater percentage of detections than what has been seen in previous survey years; carbon tetrachloride had only been detected in 8/318 samples between 2011 and 2016.

However, the carbon tetrachloride detections in 2017 were all below the ½-hour AAQC assessment value of 7.2 µg/m<sup>3</sup>. The maximum concentration (0.88 µg/m<sup>3</sup>, approximately 12% of the AAQC assessment value) was detected at the Health Centre and Community Centre sites on the same day.

Carbon tetrachloride was detected during a variety of wind directions observed throughout the sampling program.

## Cyclohexane

All values in µg/m <sup>3</sup>						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 30	n/d	n/d	n/d	n/d	n/d	n/d
Feb. 24	n/d	n/d	n/d	n/d	n/d	n/d
Mar. 31	n/d	n/d	n/d	n/d	n/d	n/d
Apr. 26	n/d	9.57	n/d	n/d	n/d	n/d
May 31	n/d	n/d	n/d	27.18	n/d	n/d
Jun. 28	20.47	1.18	0.75	1.33	3.08	0.28
Jul. 28	n/d	n/d	1.02	n/d	n/d	n/d
Aug. 29	0.48	1.26	0.80	n/d	n/d	n/d
Sep. 27	n/d	n/d	n/d	n/d	n/d	1.53
Oct. 31	n/d	n/d	n/d	0.69	n/d	n/d
Nov. 27	n/d	n/d	1.09	n/d	2.08	1.64
Dec. 20	n/d	n/d	n/d	n/d	n/d	n/d

Cyclohexane was detected in 17 of the 72 samples (24% of the samples). It was detected at all of the sites on at least two sampling days.

The maximum cyclohexane concentration (27.18 µg/m<sup>3</sup>) was detected at the Cemetery site; this value is approximately 0.15% of the ½-hour AAQC assessment value of 18,000 µg/m<sup>3</sup>.

The 2017 results were similar to previous surveys, which found that cyclohexane was detected in approximately 17 – 24% of samples per year, at levels well below its AAQC assessment value.

## Trichloroethylene

Trichloroethylene was not detected in 2017. Trichloroethylene was added to the mobile monitoring survey target list in 2012. It was not detected between 2012 and 2017 (0/336 samples).

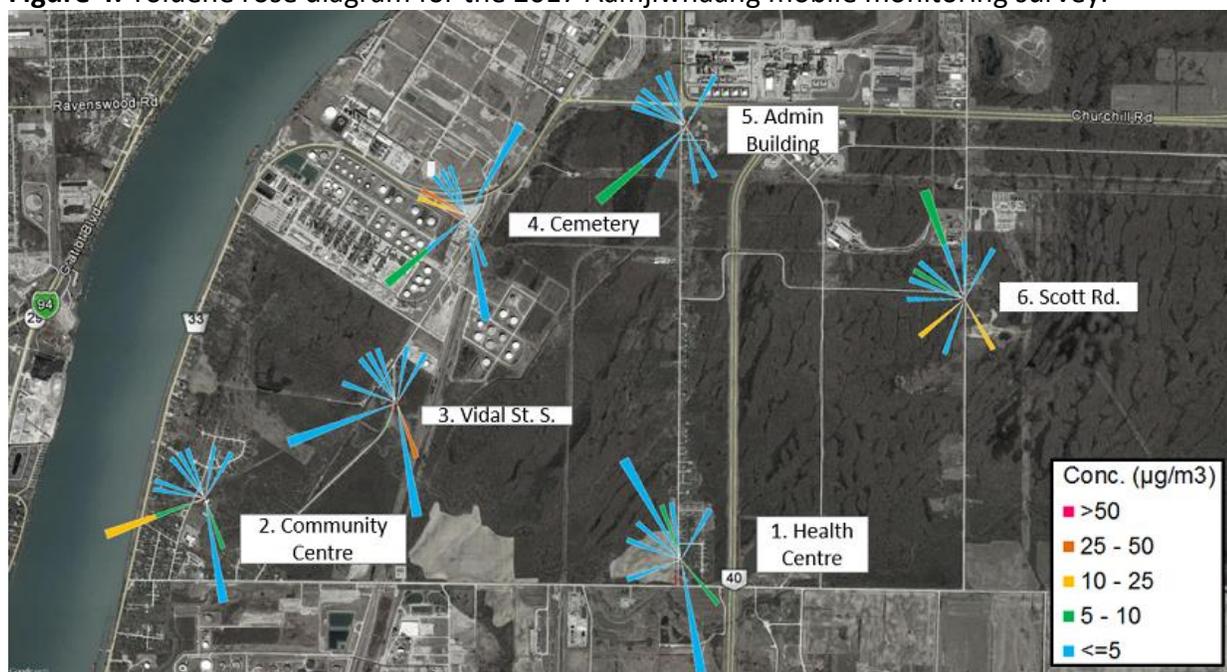
## Toluene

Table 7: Toluene Half-Hour Concentrations (AAQC Assessment value = 6000 µg/m <sup>3</sup> )						
All values in µg/m <sup>3</sup>						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 30	0.29	0.27	0.67	0.70	0.20	2.00
Feb. 24	0.33	0.31	1.21	0.26	0.17	0.25
Mar. 31	4.56	3.20	1.51	1.70	3.12	0.87
Apr. 26	1.35	4.40	1.78	1.65	1.42	n/d
May 31	n/d	1.62	1.93	35.83	2.90	9.88
Jun. 28	2.04	11.95	3.90	6.83	7.00	17.62
Jul. 28	2.26	0.60	3.57	4.58	n/d	0.92
Aug. 29	5.81	8.61	43.69	1.20	1.29	23.19
Sep. 27	1.32	3.80	1.82	0.74	1.74	5.94
Oct. 31	2.45	1.26	n/d	14.63	2.06	3.40
Nov. 27	8.62	6.89	1.63	2.41	2.21	1.59
Dec. 20	0.37	0.54	2.62	0.29	0.58	0.66

Toluene was detected in 68 of the 72 samples (94% of the samples). The maximum toluene concentration (43.69 µg/m<sup>3</sup>) was detected at the Vidal Street South site on August 29; this value is approximately 0.7% of the ½-hour AAQC assessment value of 6,000 µg/m<sup>3</sup>.

The 2017 results were similar to previous survey findings, in that toluene was frequently detected at all sites at levels well below its AAQC assessment value. Figure 4 shows that toluene was detected in all wind directions observed throughout the sampling program.

**Figure 4:** Toluene rose diagram for the 2017 Aamjiwnaang mobile monitoring survey.



## Tetrachloroethylene

All values in µg/m <sup>3</sup>						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 30	n/d	n/d	n/d	n/d	n/d	n/d
Feb. 24	n/d	n/d	n/d	n/d	n/d	n/d
Mar. 31	n/d	n/d	n/d	n/d	n/d	n/d
Apr. 26	n/d	n/d	n/d	n/d	n/d	n/d
May 31	1.21	0.30	n/d	n/d	n/d	n/d
Jun. 28	n/d	0.27	0.29	n/d	n/d	n/d
Jul. 28	n/d	n/d	n/d	n/d	n/d	n/d
Aug. 29	0.38	n/d	n/d	n/d	n/d	n/d
Sep. 27	n/d	n/d	n/d	n/d	n/d	0.24
Oct. 31	n/d	n/d	n/d	n/d	n/d	n/d
Nov. 27	n/d	n/d	n/d	n/d	n/d	n/d
Dec. 20	n/d	n/d	n/d	n/d	n/d	n/d

Tetrachloroethylene was detected in 6 of the 72 samples (8.3% of the samples). It was measured twice at the Health Centre and Community Centre sites, and once at the Vidal Street South and Scott Road sites. Concentrations were well below the AAQC assessment value of 1100 µg/m<sup>3</sup>, with a maximum concentration observed of 1.21 µg/m<sup>3</sup> (0.1% of the assessment value).

Tetrachloroethylene had previously been detected on seven survey days since it was added to the monitoring list in 2012 (in 13/264 samples between 2012 and 2016).

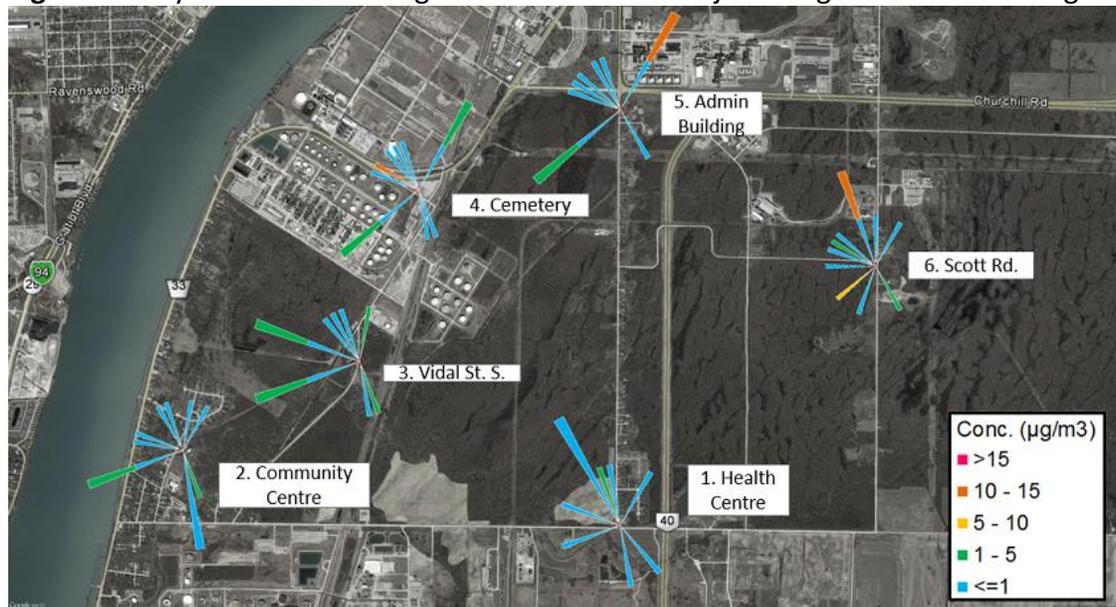
## Ethylbenzene

All values in µg/m <sup>3</sup>						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 30	n/d	n/d	0.18	0.13	0.12	0.23
Feb. 24	0.12	0.14	0.17	0.15	n/d	0.39
Mar. 31	0.81	0.46	n/d	0.45	13.22	0.25
Apr. 26	n/d	0.31	n/d	n/d	n/d	n/d
May 31	n/d	0.83	1.11	10.40	0.89	2.70
Jun. 28	0.35	3.05	1.34	2.43	2.87	8.03
Jul. 28	0.65	0.24	1.30	1.51	0.08	0.17
Aug. 29	0.92	1.12	4.89	0.17	0.14	2.34
Sep. 27	0.12	0.26	0.20	0.08	0.90	11.34
Oct. 31	0.28	0.18	0.09	0.64	0.27	0.37
Nov. 27	1.29	0.51	0.18	0.60	0.69	0.18
Dec. 20	0.14	0.14	0.42	0.09	0.09	0.09

Ethylbenzene was detected in 62 of the 72 samples (86% of the samples). The maximum ethylbenzene concentration (13.22 µg/m<sup>3</sup>) was detected at the Administration Building on March 31. Winds were coming from the northeast at the time of this detection. This value is approximately 0.4% of the ½-hour AAQC assessment value of 3,000 µg/m<sup>3</sup>.

Ethylbenzene detections occurred with all wind directions observed throughout the sampling program (Figure 5). The 2017 results were similar to previous surveys, which found that ethylbenzene was detected in approximately 60 – 90% of samples per year, at levels well below its AAQC assessment value.

**Figure 5:** Ethylbenzene rose diagram for the 2017 Aamjiwnaang mobile monitoring survey.



## Styrene

<i>All values in µg/m<sup>3</sup></i>						
<i>Date</i>	<i>Health Centre</i>	<i>Community Centre</i>	<i>Vidal St. South</i>	<i>Cemetery</i>	<i>Administration Building</i>	<i>Scott Road</i>
Jan. 30	n/d	n/d	0.29	n/d	n/d	n/d
Feb. 24	n/d	n/d	0.55	n/d	0.27	0.92
Mar. 31	n/d	0.20	n/d	n/d	9.62	n/d
Apr. 26	n/d	0.40	n/d	n/d	n/d	n/d
May 31	0.42	0.49	0.63	4.46	0.64	1.59
Jun. 28	n/d	n/d	n/d	n/d	0.32	1.32
Jul. 28	0.24	n/d	0.55	1.65	n/d	n/d
Aug. 29	0.52	0.91	6.26	n/d	1.00	2.93
Sep. 27	n/d	0.22	0.14	n/d	0.08	2.53
Oct. 31	n/d	n/d	n/d	n/d	n/d	0.36
Nov. 27	0.72	n/d	n/d	0.23	0.18	n/d
Dec. 20	n/d	n/d	0.23	n/d	n/d	n/d

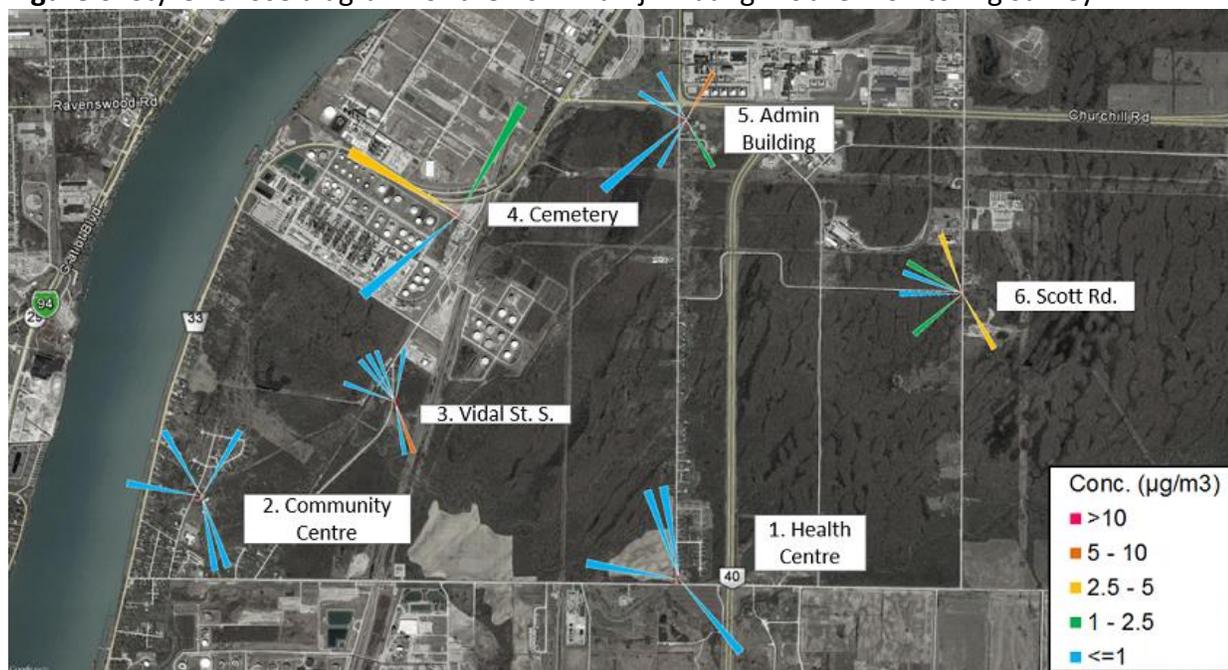
Styrene was detected in 32 of the 72 samples (44% of the samples). It was detected at least once on every sampling day, and it was measured at all locations.

The maximum styrene concentration (9.62 µg/m<sup>3</sup>, approximately 0.8% of the AAQC assessment value of 1200 µg/m<sup>3</sup>) was measured at the Administration Building on March 31. Winds were from the northeast at the time of this observation.

Styrene was measured during a variety of wind directions observed throughout the sampling program, including southwest, northwest, northeast, and southeast (Figure 6).

The percentage of styrene detections in previous years has varied from 8 – 65%. The percentage of styrene detections and the concentrations measured in 2017 was within the range of observations made in previous years.

**Figure 6: Styrene rose diagram for the 2017 Aamjiwnaang mobile monitoring survey.**



Total Xylenes

The AAQC for xylene is based upon the total of the three isomers (m-, p-, and o-xylene). The m-&p-xylene and o-xylene results have been summed and presented in the “Total Xylenes” table below for the purpose of comparison to the AAQC assessment value.

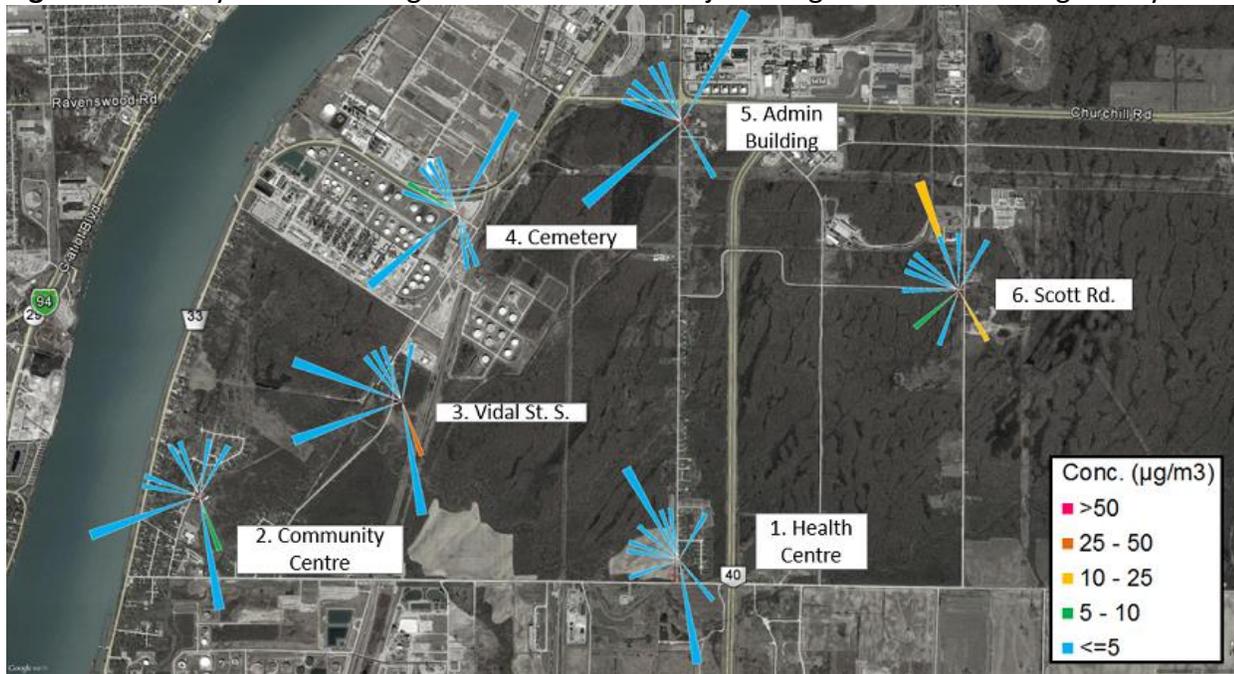
Table 11: Total Xylenes Half-Hour Concentrations (AAQC Assessment value = 2200 µg/m³)						
All values in µg/m³						
Date	Health Centre	Community Centre	Vidal St. South	Cemetery	Administration Building	Scott Road
Jan. 30	n/d	n/d	0.33	0.25	0.21	0.41
Feb. 24	0.21	0.26	0.56	0.26	n/d	1.30
Mar. 31	1.04	0.59	n/d	0.57	0.59	0.44
Apr. 26	0.17	0.50	0.27	n/d	n/d	n/d
May 31	n/d	0.69	1.00	8.88	0.85	2.03
Jun. 28	0.71	2.53	1.20	2.03	2.07	5.66
Jul. 28	0.70	0.31	1.34	1.63	0.14	0.47
Aug. 29	4.62	6.36	35.76	0.58	0.59	16.57
Sep. 27	0.50	1.38	0.98	0.33	1.57	10.21
Oct. 31	1.10	0.78	0.14	2.84	0.46	2.01
Nov. 27	4.70	2.48	0.64	1.57	1.15	0.51
Dec. 20	0.23	0.56	1.97	0.19	0.33	0.61

Xylenes were detected in 64 of the 72 samples (89%). Concentrations remained below 1.6% of the AAQC assessment values of  $2200 \mu\text{g}/\text{m}^3$  throughout the survey. The maximum total xylene concentration of  $35.76 \mu\text{g}/\text{m}^3$  was observed at the Vidal Street South site on August 29.

Xylenes were detected with a variety of wind directions observed throughout the sampling program.

The 2017 results were similar to previous survey findings, in that xylenes were frequently detected at all sites at levels well below the AAQC assessment value.

**Figure 7:** Total xylenes rose diagram for the 2017 Aamjiwnaang mobile monitoring survey.



## Naphthalene

Naphthalene was detected in 56 of the 72 samples (78%). The ministry had concerns about the reliability of the naphthalene results, and investigated the capabilities and limitations of the monitoring instrument to measure naphthalene. The ministry confirmed that the monitoring instrument cannot reliably quantify naphthalene, and that the survey results for naphthalene are not correct. As such, they are not presented in this section or Table A1 in Appendix 1.

The ministry compared results from the Health Centre mobile monitoring site to the 24-hour canister sample results collected at the permanent Aamjiwnaang station for days when the canister sampling and the mobile monitoring survey coincided. The canister sampling method is known to be precise and to produce accurate results. Table 12 shows that naphthalene concentrations, when detected during the mobile monitoring survey, were up to two orders of magnitude greater than the 24-hour canister results. It would be impossible for the mobile monitor to measure a half-hour concentration more than 48 times the canister sample and still be accurate.

<b>Date</b>	<b>0.5-hour Mobile Monitoring Result (Health Centre)</b>	<b>24-hour Canister Sampling Result (Aamjiwnaang Station)</b>	<b>Mobile Monitoring/Canister</b>
Feb. 24	2.03	0.044	46 times greater
May 31	10.88	0.051	213 times greater
Aug. 29	n/d	0.038	n/a
Nov. 27	16.13	0.027	597 times greater

The ministry carried out further testing of the mobile monitoring instrument at the Southwest Region laboratory. This testing found a very poor calibration curve (relationship between the instrument response and known concentrations of naphthalene), as well as residual naphthalene in the sorbent tube that affected subsequent readings.

The ministry concluded that the monitoring instrument is not capable of producing valid naphthalene measurements. Naphthalene was removed from the list of mobile monitoring survey contaminants in 2019.

Naphthalene will continue to be measured at the permanent Aamjiwnaang station through canister sampling. The canister samples results have consistently shown naphthalene at levels well below its AAQC. For example, the maximum naphthalene concentration found in the 2017 canister samples was  $0.105 \mu\text{g}/\text{m}^3$  and the average was  $0.033 \mu\text{g}/\text{m}^3$ , which are well below the 24-hour AAQC of  $22.5 \mu\text{g}/\text{m}^3$ .

## Spatial Variability (2011- 2017)

One of the objectives of the mobile monitoring survey was to assess the results for spatial variability; in particular, to evaluate whether concentrations of any contaminants were regularly higher at one or more sampling sites than the others.

A mobile monitoring survey is one means of assessing variation in air contaminant concentrations spatially. However, mobile monitoring surveys represent a “snapshot” of air quality within a given short-term time period, and emissions and meteorology may be different from one measurement period to the next. For this reason, air quality assessments employing monitoring methods that collect samples over a longer duration at permanent locations (including canisters or passive monitors) will provide for a more in-depth analysis of spatial variability in contaminant concentrations around the Aamjiwnaang First Nation.

Data from all survey years (2011-2017) were included in the following spatial assessment, as a dataset spanning several years offers additional insight into the presence of any spatial trends. The assessment was completed using the original units reported by the instrument (ppb).

Further information on the statistical methodology used to assess spatial variability is given in Appendix 2.

Chloromethane, 1,3-butadiene, Chloroform, Carbon Tetrachloride, Trichloroethylene, Tetrachloroethylene:

- Spatial variability has not been assessed, as these contaminants have been detected in less than 10% of the samples between 2011 and 2017 (or have never been detected).

Hexane, Ethylbenzene, Xylenes:

- No significant differences were found in frequency of detection or in concentrations amongst the survey sites.

Propylene:

- Propylene was most frequently detected at Site 1 (Health Centre) and least frequently detected at Site 6 (Scott Rd.).
- Concentrations were found to be significantly higher at Site 1 (Health Centre) in comparison to Site 6 (Scott Rd.). No other significant differences in concentrations across the survey sites were found.

Benzene:

- There was no significant difference in the frequency of benzene detections across the six sampling sites.
- Concentrations were found to be significantly higher at Site 3 (Vidal St. S.) in comparison to Site 4 (Cemetery). No other significant differences in concentrations across the survey sites were found.

**Figure 8** - Boxplot showing the distribution of benzene concentrations measured in the 2011-2017 surveys, by site. The horizontal lines depict the estimated detection limit (DL≈0.1 ppb) and the half-hour reference value for benzene (2.1 ppb). Asterisks (\*) represent concentrations that were higher than most of the concentrations observed at each site.

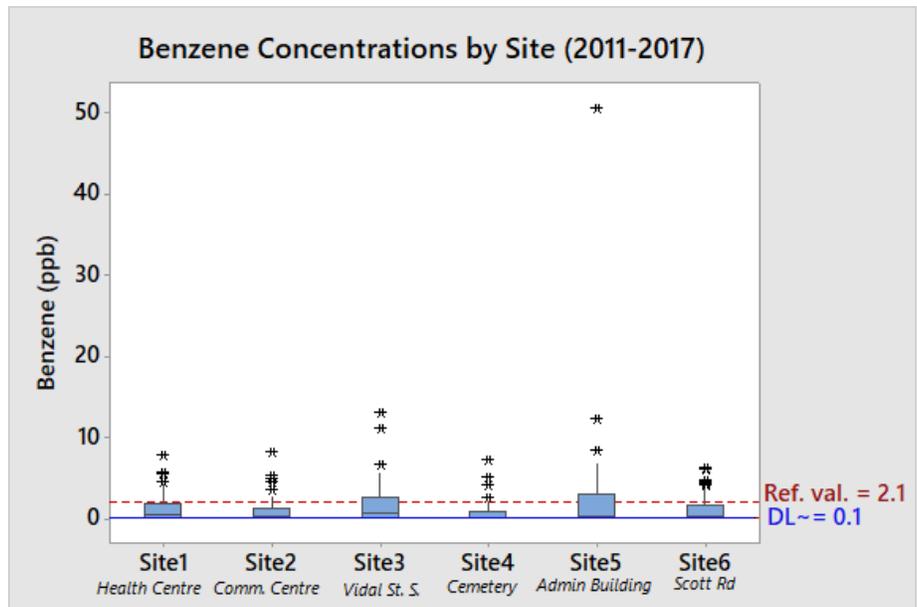
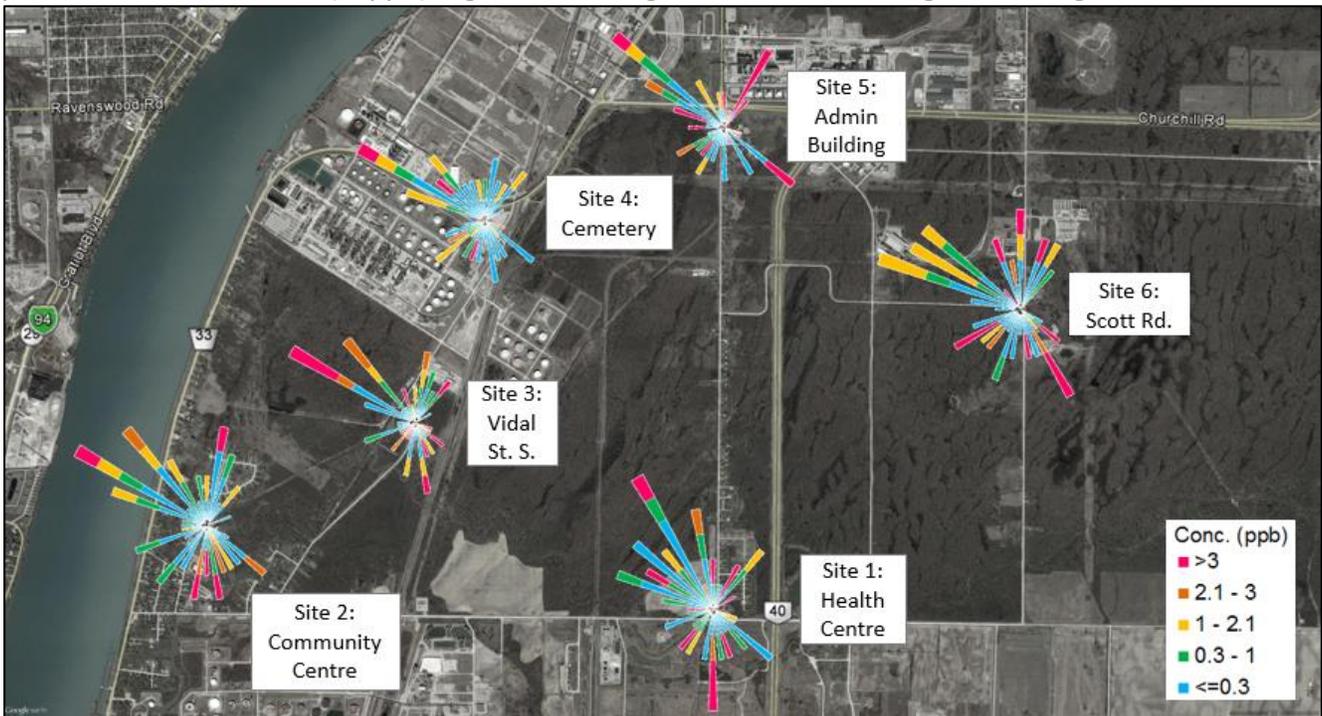


Figure 9 shows a pollution rose diagram for benzene concentrations measured during the 2011-2017 mobile surveys. This diagram allows for further, visual exploration of the spatial variability of benzene concentrations in relation to wind direction. Over the course of the 2011-2017 survey program, benzene was detected from a variety of wind directions. Measurements above the AAQC assessment value (2.1 ppb) were observed at all sites, with winds coming from a range of directions.

**Figure 9:** Benzene rose diagram for the 2011-2017 Aamjiwnaang mobile monitoring surveys. This diagram shows the relationship between detected pollutant concentrations at each survey site and the direction from which the wind was blowing during the sampling hour. The colour scheme for the pollutant concentrations (in ppb) is given in the legend at the bottom right of the figure.



#### Cyclohexane:

- Cyclohexane was most frequently detected at Sites 2 (Community Centre), 3 (Vidal St. St.), and 4 (Cemetery), and least frequently detected at Site 6 (Scott Rd.).
- Cyclohexane concentrations were significantly lower at Site 6 (Scott Rd.) in comparison to Sites 2 (Community Centre), 3 (Vidal St. S.), and 4 (Cemetery).

#### Toluene

- Toluene was most frequently detected at Site 3 (Vidal St. S.).
- Toluene concentrations were significantly higher at Site 3 (Vidal St. S.) in comparison to Site 5 (Admin Building).

#### Styrene:

- Styrene was most frequently detected at Sites 3 (Vidal St. S.) and 5 (Admin Building) and least frequently detected at Sites 1 (Health Centre) and 4 (Cemetery).
- Styrene concentrations were significantly higher at Sites 3 (Vidal St. S.) and 5 (Admin Building) in comparison to Sites 1 (Health Centre) and 4 (Cemetery). There was no difference found in concentrations at Site 3 (Vidal St. S.) in comparison to Site 5 (Admin Building).

This spatial variability assessment shows that some contaminant concentrations were found to be higher or lower at some sites in comparison to others, but no single site consistently measured significantly higher concentrations of any one contaminant in comparison to all other sites. As previously noted in the Methodology section, samples collected through the mobile monitoring program were not random or simultaneous; as such, caution should be applied in considering the results of this spatial variability assessment. This analysis does not prove that there are no differences in contaminant concentrations amongst the survey sites, rather, it shows that the mobile monitoring survey has not found sufficient evidence of any differences. It is important to note that mobile monitoring surveys are better suited for short-term, exploratory sampling purposes, and offer limited insight into spatial variability that is observed over long-term time periods. Continuous monitoring methods are required for a comprehensive investigation of spatial variability in contaminant concentrations.

**Appendix 1 - Table A1:** Half-hour average concentrations ( $\mu\text{g}/\text{m}^3$ ) measured during the 2017 Aamjiwnaang First Nation mobile monitoring survey, along with temperature and pressure data from the Environment and Climate Change Canada Sarnia station, which were used to convert results from ppb to  $\mu\text{g}/\text{m}^3$ . Wind speed and wind direction data are from the Aamjiwnaang air monitoring station.

Date	All concentrations in $\mu\text{g}/\text{m}^3$	Site 1: Health Centre	Site 2: Comm. Centre	Site 3: Vidal St. S.	Site 4: Cemetery	Site 5: Admin Building	Site 6: Scott Rd.
<b>Jan. 30, 2017</b>	Sample Start Time (EST)	10:40	11:05	11:41	12:15	12:52	13:30
	Temperature ( $^{\circ}\text{C}$ )	-6.2	-5.3	-5.3	-4.4	-4.4	-4.7
	Pressure (mb)	992	992	992	992	992	992
	Wind Speed (km/h)	16	14	14	16	14	14
	Wind Direction ( $^{\circ}$ )	313	321	321	322	305	305
	Propylene						
	Chloromethane						
	1,3-Butadiene						
	Hexane						
	Chloroform						
	Benzene	0.31	0.41	1.37	0.76	4.55	2.38
	Carbon Tetrachloride						
	Cyclohexane						
	Trichloroethylene						
	Toluene	0.29	0.27	0.67	0.70	0.20	2.00
	Tetrachloroethylene						
	Ethylbenzene			0.18	0.13	0.12	0.23
	m&p-Xylene			0.20	0.14	0.13	0.24
	Styrene			0.29			
	o-Xylene			0.13	0.11	0.08	0.17
<b>Feb. 24, 2017</b>	Sample Start Time (EST)	9:55	10:33	11:07	11:43	12:20	13:00
	Temperature ( $^{\circ}\text{C}$ )	4.6	4.6	8.9	8.9	12.6	17.6
	Pressure (mb)	983	983	982	982	979	980
	Wind Speed (km/h)	3	3	10	10	15	8
	Wind Direction ( $^{\circ}$ )	165	165	166	166	207	265
	Propylene						
	Chloromethane						
	1,3-Butadiene						
	Hexane						
	Chloroform						
	Benzene	1.94	1.05	4.16	0.27	3.31	0.85
	Carbon Tetrachloride						
	Cyclohexane						
	Trichloroethylene						
	Toluene	0.33	0.31	1.21	0.26	0.17	0.25
	Tetrachloroethylene						
	Ethylbenzene	0.12	0.14	0.17	0.15		0.39
	m&p-Xylene	0.13	0.16	0.44	0.16		1.05
	Styrene			0.55		0.27	0.92
	o-Xylene	0.09	0.10	0.12	0.11		0.24

**Table A1 (continued):** Half-hour average concentrations ( $\mu\text{g}/\text{m}^3$ ) measured in the 2017 survey.

Date	All concentrations in $\mu\text{g}/\text{m}^3$	Site 1: Health Centre	Site 2: Comm. Centre	Site 3: Vidal St. S.	Site 4: Cemetery	Site 5: Admin Building	Site 6: Scott Rd.
<b>Mar. 31, 2017</b>	Sample Start Time (EST)	8:50	9:25	10:00	10:36	11:14	11:50
	Temperature ( $^{\circ}\text{C}$ )	2.8	3	2.5	2.5	2.5	2.5
	Pressure (mb)	984	984	984	984	984	984
	Wind Speed (km/h)	7	7	8	8	9	9
	Wind Direction ( $^{\circ}$ )	28	28	27	27	31	26
	Propylene						
	Chloromethane						
	1,3-Butadiene						
	Hexane	247.71		8.46			
	Chloroform						
	Benzene	11.47				11.75	
	Carbon Tetrachloride						
	Cyclohexane						
	Trichloroethylene						
	Toluene	4.56	3.20	1.51	1.70	3.12	0.87
	Tetrachloroethylene						
	Ethylbenzene	0.81	0.46		0.45	13.22	0.25
	m&p-Xylene	0.42	0.24		0.23	0.24	0.26
	Styrene		0.20			9.62	
	o-Xylene	0.62	0.35		0.34	0.35	0.18
<b>Apr. 26, 2017</b>	Sample Start Time (EST)	9:00	9:37	10:14	10:50	11:37	12:14
	Temperature ( $^{\circ}\text{C}$ )	17.2	17.2	19.2	19.2	20.4	21.5
	Pressure (mb)	985	985	984	984	984	983
	Wind Speed (km/h)	15	15	16	16	16	20
	Wind Direction ( $^{\circ}$ )	165	165	173	172	172	164
	Propylene						
	Chloromethane						
	1,3-Butadiene						
	Hexane						
	Chloroform						
	Benzene		1.98			0.46	
	Carbon Tetrachloride						
	Cyclohexane		9.57				
	Trichloroethylene						
	Toluene	1.35	4.40	1.78	1.65	1.42	
	Tetrachloroethylene						
	Ethylbenzene		0.31				
	m&p-Xylene		0.29	0.11			
	Styrene		0.40				
	o-Xylene	0.17	0.21	0.16			

**Table A1 (continued):** Half-hour average concentrations ( $\mu\text{g}/\text{m}^3$ ) measured in the 2017 survey.

Date	All concentrations in $\mu\text{g}/\text{m}^3$	Site 1: Health Centre	Site 2: Comm. Centre	Site 3: Vidal St. S.	Site 4: Cemetery	Site 5: Admin Building	Site 6: Scott Rd.
<b>May 31 2017</b>	Sample Start Time (EST)	9:02	9:40	10:19	10:53	11:30	12:09
	Temperature ( $^{\circ}\text{C}$ )	16.7	16.7	19	20	20	20.1
	Pressure (mb)	991	991	991	991	991	990
	Wind Speed (km/h)	9	9	11	15	15	15
	Wind Direction ( $^{\circ}$ )	281	281	288	301	301	297
	Propylene						
	Chloromethane						
	1,3-Butadiene						
	Hexane				116.55	2.45	
	Chloroform						
	Benzene	2.44	1.00	0.78	15.75	1.30	6.61
	Carbon Tetrachloride						
	Cyclohexane				27.18		
	Trichloroethylene						
	Toluene		1.62	1.93	35.83	2.90	9.88
	Tetrachloroethylene	1.21	0.30				
	Ethylbenzene		0.83	1.11	10.40	0.89	2.70
	m&p-Xylene		0.43	0.58	5.36	0.46	1.39
	Styrene	0.42	0.49	0.63	4.46	0.64	1.59
	o-Xylene		0.26	0.43	3.52	0.39	0.63
<b>Jun. 28, 2017</b>	Sample Start Time (EST)	9:52	10:32	11:18	12:14	12:52	13:33
	Temperature ( $^{\circ}\text{C}$ )	21.8	21.8	22.6	22.9	22.9	23.4
	Pressure (mb)	997	997	997	997	996	996
	Wind Speed (km/h)	9	9	10	10	12	12
	Wind Direction ( $^{\circ}$ )	252	252	245	227	229	229
	Propylene						
	Chloromethane						
	1,3-Butadiene						
	Hexane	4.04	5.03	4.59	6.09	2.75	3.44
	Chloroform						
	Benzene	0.45	0.60	0.86	1.48	2.43	6.01
	Carbon Tetrachloride		0.47		0.40	0.44	0.35
	Cyclohexane	20.47	1.18	0.75	1.33	3.08	0.28
	Trichloroethylene						
	Toluene	2.04	11.95	3.90	6.83	7.00	17.62
	Tetrachloroethylene		0.27	0.29			
	Ethylbenzene	0.35	3.05	1.34	2.43	2.87	8.03
	m&p-Xylene	0.42	1.57	0.69	1.25	1.47	4.13
	Styrene					0.32	1.32
	o-Xylene	0.29	0.96	0.51	0.79	0.60	1.53

**Table A1 (continued):** Half-hour average concentrations ( $\mu\text{g}/\text{m}^3$ ) measured in the 2017 survey.

Date	All concentrations in $\mu\text{g}/\text{m}^3$	Site 1: Health Centre	Site 2: Comm. Centre	Site 3: Vidal St. S.	Site 4: Cemetery	Site 5: Admin Building	Site 6: Scott Rd.
<b>Jul. 28, 2017</b>	Sample Start Time (EST)	12:17	11:39	11:02	10:27	9:50	9:10
	Temperature ( $^{\circ}\text{C}$ )	22.6	21.3	21.3	20.5	20.5	19.8
	Pressure (mb)	993	993	993	993	993	994
	Wind Speed (km/h)	9	8	8	7	7	6
	Wind Direction ( $^{\circ}$ )	352	12	12	32	32	3
	Propylene						
	Chloromethane						
	1,3-Butadiene						
	Hexane			3.38			
	Chloroform						
	Benzene	1.42		2.94	3.29		0.52
	Carbon Tetrachloride	0.58	0.62	0.62	0.63		0.65
	Cyclohexane			1.02			
	Trichloroethylene						
	Toluene	2.26	0.60	3.57	4.58		0.92
	Tetrachloroethylene						
	Ethylbenzene	0.65	0.24	1.30	1.51	0.08	0.17
	m&p-Xylene	0.40	0.15	0.81	0.94	0.05	0.26
	Styrene	0.24		0.55	1.65		
	o-Xylene	0.30	0.16	0.54	0.70	0.09	0.21
<b>Aug. 29, 2017</b>	Sample Start Time (EST)	9:15	10:00	10:34	11:12	11:51	12:28
	Temperature ( $^{\circ}\text{C}$ )	17.3	18.8	18.8	19	20.1	20.1
	Pressure (mb)	997	997	997	997	997	997
	Wind Speed (km/h)	6	8	8	7	10	10
	Wind Direction ( $^{\circ}$ )	140	155	155	159	151	151
	Propylene						
	Chloromethane						
	1,3-Butadiene						
	Hexane						
	Chloroform						
	Benzene	3.15	8.06	35.65	0.86	0.83	19.60
	Carbon Tetrachloride		0.81	0.76	0.73		0.73
	Cyclohexane	0.48	1.26	0.80			
	Trichloroethylene						
	Toluene	5.81	8.61	43.69	1.20	1.29	23.19
	Tetrachloroethylene	0.38					
	Ethylbenzene	0.92	1.12	4.89	0.17	0.14	2.34
	m&p-Xylene	0.56	0.68	2.95	0.10	0.09	1.41
	Styrene	0.52	0.91	6.26		1.00	2.93
	o-Xylene	4.06	5.69	32.80	0.48	0.50	15.16

**Table A1 (continued):** Half-hour average concentrations ( $\mu\text{g}/\text{m}^3$ ) measured in the 2017 survey.

Date	All concentrations in $\mu\text{g}/\text{m}^3$	Site 1: Health Centre	Site 2: Comm. Centre	Site 3: Vidal St. S.	Site 4: Cemetery	Site 5: Admin Building	Site 6: Scott Rd.
<b>Sep. 27, 2017</b>	Sample Start Time (EST)	11:13	10:40	10:01	9:25	8:49	8:11
	Temperature ( $^{\circ}\text{C}$ )	20.7	21.4	21.4	22.2	22.2	22.1
	Pressure (mb)	993	993	993	993	993	992
	Wind Speed (km/h)	11	11	11	9	9	11
	Wind Direction ( $^{\circ}$ )	333	328	328	334	334	335
	Propylene						
	Chloromethane						
	1,3-Butadiene						32.22
	Hexane						
	Chloroform						
	Benzene	0.58	2.51	1.43	0.41	1.04	19.03
	Carbon Tetrachloride	0.55		0.60	0.68	0.65	0.66
	Cyclohexane						1.53
	Trichloroethylene						
	Toluene	1.32	3.80	1.82	0.74	1.74	5.94
	Tetrachloroethylene						0.24
	Ethylbenzene	0.12	0.26	0.20	0.08	0.90	11.34
	m&p-Xylene	0.07	0.15	0.12	0.05	0.54	6.84
	Styrene		0.22	0.14		0.08	2.53
	o-Xylene	0.42	1.23	0.86	0.28	1.03	3.37
<b>Oct. 31, 2017</b>	Sample Start Time (EST)	9:15	9:55	10:35	11:10	11:50	12:30
	Temperature ( $^{\circ}\text{C}$ )	2.5	3.8	3.8	4.2	5.3	5.3
	Pressure (mb)	994	995	995	995	996	996
	Wind Speed (km/h)	14	14	14	15	16	16
	Wind Direction ( $^{\circ}$ )	285	285	285	289	287	287
	Propylene						
	Chloromethane						
	1,3-Butadiene						
	Hexane						
	Chloroform						
	Benzene		0.64		2.46	0.77	4.50
	Carbon Tetrachloride						
	Cyclohexane				0.69		
	Trichloroethylene						
	Toluene	2.45	1.26		14.63	2.06	3.40
	Tetrachloroethylene						
	Ethylbenzene	0.28	0.18	0.09	0.64	0.27	0.37
	m&p-Xylene	0.14	0.09	0.05	0.41	0.14	0.23
	Styrene						0.36
	o-Xylene	0.97	0.69	0.09	2.43	0.32	1.78

**Table A1 (continued):** Half-hour average concentrations ( $\mu\text{g}/\text{m}^3$ ) measured in the 2017 survey.

Date	All concentrations in $\mu\text{g}/\text{m}^3$	Site 1: Health Centre	Site 2: Comm. Centre	Site 3: Vidal St. S.	Site 4: Cemetery	Site 5: Admin Building	Site 6: Scott Rd.
<b>Nov. 27, 2017</b>	Sample Start Time (EST)	10:00	10:50	11:30	12:05	12:45	13:35
	Temperature ( $^{\circ}\text{C}$ )	3.9	4.4	4.4	4	4	4.1
	Pressure (mb)	1000	1000	1000	1000	1000	999
	Wind Speed (km/h)	4	3	3	4	4	5
	Wind Direction ( $^{\circ}$ )	338	249	249	229	229	197
	Propylene						
	Chloromethane						
	1,3-Butadiene						
	Hexane						
	Chloroform						
	Benzene	8.95	1.42	1.83	4.00	3.39	2.20
	Carbon Tetrachloride	0.73			0.67		
	Cyclohexane			1.09		2.08	1.64
	Trichloroethylene						
	Toluene	8.62	6.89	1.63	2.41	2.21	1.59
	Tetrachloroethylene						
	Ethylbenzene	1.29	0.51	0.18	0.60	0.69	0.18
	m&p-Xylene	0.78	0.32	0.14	0.37	0.41	0.09
	Styrene	0.72			0.23	0.18	
	o-Xylene	3.92	2.16	0.51	1.20	0.74	0.41
<b>Dec. 20, 2017</b>	Sample Start Time (EST)	8:19	9:00	9:38	10:13	10:50	11:27
	Temperature ( $^{\circ}\text{C}$ )	-2	-1.3	-1.3	-0.5	-0.2	-0.2
	Pressure (mb)	997	997	997	998	998	998
	Wind Speed (km/h)	11	12	12	13	11	11
	Wind Direction ( $^{\circ}$ )	327	338	338	341	342	342
	Propylene						
	Chloromethane						
	1,3-Butadiene						
	Hexane						
	Chloroform						
	Benzene	1.04	0.79	2.03	0.58	0.72	0.48
	Carbon Tetrachloride	0.88	0.88	0.75	0.74	0.61	0.61
	Cyclohexane						
	Trichloroethylene						
	Toluene	0.37	0.54	2.62	0.29	0.58	0.66
	Tetrachloroethylene						
	Ethylbenzene	0.14	0.14	0.42	0.09	0.09	0.09
	m&p-Xylene	0.09	0.09	0.28	0.05	0.05	0.09
	Styrene			0.23			
	o-Xylene	0.14	0.47	1.69	0.14	0.28	0.51

## Appendix 2 – Spatial Variability Assessment Methodology

Data from all survey years (2011-2017) were included in the following spatial assessment, as a dataset spanning several years offers additional insight into the presence of any spatial trends. Approximately 65 data points per contaminant, per site were available using all the 2011-2017 results. The assessment was completed using the original units reported by the instrument (ppb).

The instrument detection limit for the monitored contaminants was not known at the time of the survey. The instrument detection limit is the level at which the monitoring instrument can reliably distinguish a measured concentration from zero. The true concentration of a “non-detect” falls somewhere between zero and the detection limit. For the purpose of this assessment, the detection limits have been estimated as listed in Table A2 below, based on several of the lowest non-zero concentrations measured for each contaminant in the 2011-2017 surveys.

Any previously reported results that were less than the estimated detection limits were adjusted to “below detection limit” for this assessment. This ensures that a value potentially less than the detection limit which may have been arbitrarily reported by the instrument is not treated as higher than a non-detect in the statistical analysis. For example, an instrument with a detection limit of 0.3 ppb may report a “0.05 ppb”. There is no way of determining what the true value is, which ranges from 0 ppb to 0.3 ppb. The number of data points that were adjusted to below the estimated detection limit (out of approximately 390 data points, per contaminant) are reported in Table A2.

<b>Table A2 – Estimated detection limits for the mobile monitoring survey spatial variability assessment. Contaminants in italics were not spatially assessed.</b>			
<b>Compound</b>	<b>Estimated Detection Limit</b>		<b>Reported data points adjusted to “below detection limit”</b>
	<b>ppb</b>	<b>µg/m<sup>3</sup></b>	
Propylene	1.0	1.8	0
<i>Chloromethane</i>	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
<i>1,3-butadiene</i>	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
Hexane	0.1	0.4	2
Chloroform	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
Benzene	0.1	0.3	11
<i>Carbon tetrachloride</i>	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
Cyclohexane	0.1	0.4	3
<i>Trichloroethylene</i>	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
Toluene	0.07	0.3	12
<i>Tetrachloroethylene</i>	<i>n/a</i>	<i>n/a</i>	<i>n/a</i>
Ethylbenzene	0.02	0.1	5
Styrene	0.04	0.2	4
Xylenes	0.02	0.1	2

A detection limit has not been estimated for the contaminants which have been detected in less than 10% of the samples (or not at all); these are indicated as “n/a” in Table A2. Similarly, a spatial variability assessment has not been completed for these contaminants.

The results for each parameter, from all sampling years (2011-2017), were evaluated with a contingency table analysis and the Kruskal-Wallis test using the statistical platform R. A contingency table analysis (Pearson’s chi-square test) was used to assess differences in the proportions of detections of each contaminant amongst the six sampling sites, at the  $\alpha=0.05$  level (i.e. to determine whether a contaminant was more frequently detected at one or more sites). The Kruskal-Wallis test is a non-parametric statistical test for differences among groups. This method was selected based on an interest in evaluating typical concentrations (i.e. medians) for each contaminant across the six sampling sites. The Kruskal-Wallis method does not assume that the data follows a particular distribution (such as the normal distribution), which is an appropriate consideration for assessing the mobile monitoring dataset, given the high percentage of values below the detection limit.

If the Kruskal-Wallis test showed a significant difference between concentrations at the sites at the  $\alpha=0.05$  level, a multiple comparison test (the Pairwise Wilcoxon Test with a false discovery rate correction) was conducted to distinguish which sites were different from one another.