Technical Memorandum

2017-2018 Airpointer Survey of St. Marys Cement (St. Marys): Final Report

Ontario Ministry of the Environment, Conservation and Parks

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Survey Background

At the request of the London District Office, Ontario Ministry of the Environment, Conservation and Parks (MECP or Ministry), the Environmental Monitoring and Reporting Branch (EMRB) completed an air monitoring survey of St. Marys Cement, 585 Water Street South, St. Marys, Ontario, between July 5, 2017 and December 20, 2018. The objective of this survey was to measure sulphur dioxide (SO_2), particulate matter (PM) and nitrogen oxides (NO_X) in ambient air in the vicinity of St. Marys Cement over a period of at least one year.

Summary of Activities

For this survey, the Ministry's Terrestrial Assessment and Field Services Unit deployed a portable AirPointer® air monitoring station (herein referred to as St. Marys air monitoring station) at the St. Marys Fire Department, which was located north east of St. Marys Cement in a residential area of St. Marys predominantly downwind from the facility as depicted in Appendix A, Figure 1. The St. Marys air monitoring station was outfitted with instruments that measure SO_2, NO_X ($NO_X = NO + NO_2$), and PM along with an anemometer for local wind measurements.

The St. Marys air monitoring station was installed on July 5, 2017 and reporting began on July 11, 2017. Valid data were collected up to Aug 31, 2018 after which all data were considered invalid as the instrumentation required servicing at EMRB. The station was removed on Dec 20, 2018. Two interim reports have been published: the first interim report, published in January 2018, summarized data collected up to October 11, 2017; the second interim report, published in September 2018, summarized nine months of data collected between October 1, 2017 and June 30, 2018. Data from the interim reports were provisional upon final verification. This is the final report which discusses all data collected during the survey providing a more comprehensive assessment of the air quality in the area, including potential seasonal variations and fluctuations in emissions from contributing sources. All data contained in this report have been fully edited and verified and are considered final.

Comparison of Data Collected at the St. Marys Air Monitoring Station to Benchmarks

Sulphur Dioxide (SO_2)

Sulphur dioxide measurements were taken on a real-time, 1-minute average basis. Concentrations measured between July 11, 2017 and August 31, 2018 have been compared to applicable air quality standards found under *Ontario Regulation 419/05 – Local Air Quality* (O. Reg. 419/05) and Ontario's Ambient Air Quality Criteria (AAQCs). During the survey no exceedances of the air quality standards were measured. Two excursions above the 1-hour AAQC were measured at the station before the updated 1-hour AAQC came into effect. A summary of these measurements is found in Appendix B, Table 6 and the comparison to the air quality standards and AAQCs can be found in Appendix B, Table 1.

Nitrogen Oxides ($NO + NO_2$)

Nitrogen oxides measurements were taken on a real-time, 1-minute average basis. O. Reg 419/05 Standards and AAQCs are based on health effects of NO_2 and so have been compared to monitored

NO_2 data. Concentrations of NO_2 measured between July 11, 2017 and August 31, 2018 have been compared to applicable O. Reg. 419/05 air quality standards and AAQCs. No exceedances of the standards or AAQCs were measured at the station during the survey. A summary of these measurements and comparison data can be found in in Appendix B, Table 6 and Table 2, respectively.

Particulate Monitoring ($PM_{2.5}$/PM_{10})
Particulate measurements were taken on a real-time, 1-minute average basis. Between July 11, 2017 and August 23, 2017, the particulate monitoring instrument was outfitted with a $PM_{2.5}$ size selective inlet which measures particulate matter with an aerodynamic diameter of less than 2.5 µm. After August 24, 2017, the size selective inlet was changed to PM_{10} that allows particles of less than 10 µm in aerodynamic diameter to be measured. Concentration levels have been compared to applicable AAQCs. No exceedances of the AAQCs were measured at the station for $PM_{2.5}$ between July 11, 2017 and August 23, 2017. No exceedances of the AAQCs were measured at the station for PM_{10} between August 24, 2017 and August 31, 2018. A summary of these measurements can be found in Appendix B, Table 6, and comparison data can be found in Appendix B, Tables 3 and 4.

Source Identification

Meteorological parameters were measured concurrently with the sulphur dioxide (SO_2), nitrogen oxides (NO_x) and particulate ($PM_{2.5}$/PM_{10}) measurements at the St. Marys air monitoring station to assist in determining potential source of emissions. The meteorological sensor is integrated with the Airpointer air monitoring station with a 2.5 m tower. This height conforms to acceptable sighting requirements for tripod-mounted or temporary wind sensors (Operations Manual for Air Quality Monitoring in Ontario, PIBS 6687e), however these types of sensors can be influenced by surrounding topography and can thus be representative of a microclimate. There was good correlation however with regional wind direction when the measurements were compared to other permanent meteorological towers in the area. Wind speed data collected from the Airpointer air monitoring station were lower than measurements collected by the permanent regional meteorological towers indicating the influence of the surrounding topography.

To visually assess potential emission sources, survey pollution roses have been created from the 1-hour average meteorological and pollutant data using valid data from July 11, 2017 to August 31, 2018. Pollution roses are a graphical representation of how pollutant concentration and wind direction are distributed at a particular location, over a specified period of time. The data are plotted using a polar coordinate system. The spokes of the pollution rose indicate the direction from which the wind is coming and are divided into five degree increments. The length of the spoke shows the frequency of a particular wind direction expressed as a percentage of time as indicated by the horizontal axis scale. Each spoke is further divided into colour coded bands that indicate pollutant concentration ranges measured and their frequency.

Sulphur Dioxide (SO_2)
The survey pollution rose for sulphur dioxide shows that for the majority of time, concentrations were $\leq$ 5 µg/m^3, indicated by the turquoise colour in the spokes (Appendix A, Figure 2). At times concentrations were measured between 5 and 10 µg/m^3 (green) for all wind directions. During a small percentage of time concentrations were measured between 10 and 25 µg/m^3 (purple) and 25 to 50 µg/m^3 (navy blue), but generally only when winds were from the southwest. Areas in the

vicinity of the St. Marys air monitoring station occasionally experienced SO_2 levels above background levels mainly when winds were from the southwest, coming from the direction of St. Marys Cement. Two excursions above the level of the 1-hour AAQC for SO_2 (100 µg/m^3) were measured; these occurred before the updated 1-hour AAQC came into effect. They were measured on November 21, 2017 at 8:00 am and 9:00 am when the winds were from the southwest.

The annual average SO_2 concentration was similar to the average SO_2 measurements collected by the MECP's Windsor Downtown Air Quality Health Index (AQHI) air quality monitoring station over the same time period (Appendix B, Table 5). The Ministry's AQHI air monitoring stations have been located in cities across Ontario to determine the current state of ambient air quality within those communities. The St. Marys air monitoring station measured an annual average SO_2 concentration of 2.2 µg/m^3 while the annual average SO_2 concentration measured by the Ministry's Windsor AQHI air monitoring station was 2.5 µg/m^3. The Windsor station, while indicative of general ambient air in Windsor, does show some influence from nearby heavy industry (e.g., Zug Island) and vehicular traffic on the Ambassador Bridge. The St. Marys station annual average SO_2 concentration was about one-third the measured value of the annual average SO_2 concentration measured at the Ministry's Hamilton Mountain AQHI station (6.6 µg/m^3). The Hamilton AQHI station, located away from the industrial area of the city, is still influenced by local sources including iron and steel making facilities which are known sources of SO_2. St. Marys Cement Emission Summary and Dispersion Modelling (ESDM) report confirms that the facility is an emitter of SO_2. This suggests that St. Marys Cement is a likely source of SO_2 in the area surrounding the Ministry's temporary air monitoring station.

Nitrogen Dioxide (NO_2)

The NO_2 survey pollution rose (Appendix A, Figure 3) shows that concentrations were measured in four concentration ranges for all wind directions; ≤ 5 µg/m^3 (turquoise), 5-10 µg/m^3 (green), 10-25 µg/m^3 (purple) and 25-50 µg/m^3 (navy). On a few occasions, concentrations were measured above 50 µg/m^3 (yellow) when winds were from the southwest and northeast. The pollution rose indicates that multiple sources of NO_2 were measured at the St. Marys air monitoring station. St. Marys Cement's ESDM report confirms that they emit NO_2, however many sources in urban and industrial environments generate NO_2. While no exceedances of the applicable O. Reg. 419/05 air quality standards or AAQCs were measured, areas in the vicinity of the air monitoring station experienced levels higher than background from all directions. A higher percentage of the 25-50 µg/m^3 concentrations (navy) were measured when winds were from the southwest, the direction of St. Marys Cement, and northeast, with lowest percentage being measured during west winds.

The annual average NO_2 concentration measured at St. Marys air monitoring station between September 1, 2017 and August 31, 2018 (10.0 µg/m^3) was similar to levels measured at the Ministry's AQHI stations located in nearby cities, London (11.1 µg/m^3) and Brantford (10.2 µg/m^3), and lower than stations that show influence from heavy industry and/or significant contributions from vehicular traffic (Appendix B, Table 5). The Ministry's Hamilton Mountain AQHI station measured an annual average NO_2 concentration of 16.0 µg/m^3 while the Ministry's Windsor Downtown AQHI station measured an annual average NO_2 concentration of 22.9 µg/m^3. Other potential sources of NO_2 exist between St. Marys Cement and the air monitoring station including some industrial facilities on James St. S. and vehicular traffic. St. Marys Cement is likely a contributing source of NO_2 in the vicinity of the St. Marys air monitoring station.

Particulate Monitoring ($PM_{2.5}$/PM_{10})

St. Marys Cement's ESDM report states that they are an emitter of total suspended particulate. This confirms that they generate particulate matter, but specifics about particle size distribution are not given. Total suspended particulate matter is typically measured with non-continuous measurement technology, averaged over a 24-hour period, whereas PM_{10} and $PM_{2.5}$ are often measured in real-time.

Real-time particulate matter measurements of PM_{10} and $PM_{2.5}$ were chosen for this survey over TSP since they are more relevant for this type of community monitoring. Larger particulate matter (>10 µm) tends to settle out of the air quickly, is not transported large distances, and is less likely to travel into the community. Source identification and potential health impacts are more easily assessed with real-time PM_{10} and $PM_{2.5}$ measurements. Additionally, $PM_{2.5}$ measurements can be compared to other communities across Ontario since all Ministry AQHI air monitoring stations measure $PM_{2.5}$. Ministry AQHI air monitoring stations do not measure real-time PM_{10} and therefore no comparison can be made for PM_{10}.

The $PM_{2.5}$ survey pollution rose shows that between July 11, 2017 and August 23, 2017 there was no discernable difference in concentrations measured at the St. Marys air monitoring station with wind direction (Appendix A, Figure 4). In addition, $PM_{2.5}$ measured at Ministry AQHI air monitoring stations in other communities gave similar concentrations over the same time period; the average $PM_{2.5}$ concentration measured at St. Marys was 7.7 µg/m^3 versus 7.1 µg/m^3 in London, 7.8 in Brantford µg/m^3, 7.2 µg/m^3 at Hamilton Mountain and 7.9 µg/m^3 at Windsor Downtown. Exceedances of the 1-hour AAQC (30 µg/m^3) are similar for all stations with no exceedances at St. Marys, London and Hamilton Mountain stations, and one exceedance at the Brantford and Windsor Downtown stations (Appendix B, Table 5). This indicates that $PM_{2.5}$ measured at the St. Marys station was dominated by regional area background levels.

The PM_{10} survey pollution rose shows that there were modest differences in concentration levels measured at the St. Marys air monitoring station with wind direction between August 24, 2017 and August 31, 2018 (Appendix A, Figure 5). The average PM_{10} concentration during this time period was 14.3 µg/m^3 (Appendix B, Table 6). Measured concentrations fell within four concentration ranges for all wind directions: ≤ 5 µg/m^3 (turquoise), 5-15 µg/m^3 (green) and 15-30 µg/m^3 (purple) and 30-50 µg/m^3 (navy). Additionally, when winds were coming from the northeast, southwest, east and southeast, concentrations were occasionally measured in the 50 and 100 µg/m^3 concentration range (yellow), with a few measurements >100 µg/m^3 (red). The largest percentage of concentrations measured in the 30 to 50 µg/m^3 range (navy blue) was when winds were from the northeast and southwest. The pollution rose suggests that PM_{10} was being measured from multiple sources from various wind directions. While no exceedances of the province's AAQC were measured, areas in the vicinity of the St. Marys air monitoring station experienced levels higher than background from multiple directions. A higher percentage of the 30-50 µg/m^3 concentrations (navy blue) were measured when winds were from the northeast and southwest, with some contributions coming from the direction of St. Marys Cement (southwest). The lowest concentrations were measured during northwest winds.

Seasonal Variations

Sulphur dioxide, NO_2 and PM_{10} seasonal average concentrations were calculated for St. Marys air monitoring station measurements. Fall (September 1, 2017 - November 30, 2017), Winter (December 1, 2017 - February 28, 2018), Spring (March 1, 2018 - May 31, 2018) and Summer (June 1, 2018 - August 31, 2018) averages are summarized in Appendix B, Table 6 with their respective seasonal pollution roses shown in Appendix A, Figures 6, 7 and 8.

For all three pollutants small differences in seasonal concentrations could be seen. Nitrogen dioxide had a slightly higher concentration in the winter and a slightly lower concentration during the summer. PM_{10} had a slightly higher average for the winter season. These variations appear to be largely driven by seasonal meteorological changes and seasonal fluctuations in local emissions not related the St. Marys Cement (e.g., winter road salting and home heating, seasonal changes in wind patterns, temperature effects on atmospheric chemical processing).

The SO_2 fall average concentration was modestly higher compared to all other seasons. This difference cannot be attributed to changes in meteorological conditions. Increased concentrations coming from the southwest are more prominent in the fall pollution rose (Appendix A, Figure 6). This suggests that St. Marys, which is located to the southwest of the air monitoring station, may have had greater SO_2 emissions during the 2017 fall season compared to the winter, spring and summer.

Summary of Findings

Results from the St. Marys air monitoring station established in St. Marys, Ontario by the Ontario Ministry of the Environment, Conservation and Parks have been presented and discussed in this report for the time period of July 11, 2017 to August 31, 2018. Monitoring results were compared to the existing applicable Ontario Regulation 419/05 air quality standards and Ambient Air Quality Criteria (AAQCs) for all parameters. No exceedances of the air quality standards were measured at the St. Marys air monitoring station during the survey. Two excursions above the updated 1-hour AAQC for sulphur dioxide (SO_2) were measured before the updated AAQC came into effect. The excursions occurred on November 11, 2017 at 8:00 am and 9:00 am when the air monitoring station was downwind of St. Marys Cement.

While pollutant levels did not exceed any provincial air quality standards or AAQCs, pollution roses did show that some measured concentrations were above background and that St. Marys Cement was a potential contributor to levels measured in the vicinity of the St. Marys air monitoring station.

- St. Marys Cement is a likely source of SO_2 with potentially a larger contribution during the fall season. The fall average concentration was moderately higher compared to all other seasons. The survey and fall pollution roses showed discernable increases in levels when winds were coming from the direction of the facility.

- St. Marys Cement is a likely contributing source of nitrogen dioxide (NO_2) along with other nearby industrial and urban activities including vehicular traffic. The survey pollution rose showed that levels were slightly elevated when winds were from southwest and northeast of the monitoring station.

- $PM_{2.5}$ measured at the St. Marys air monitoring station was dominated by regional area background levels. The $PM_{2.5}$ survey pollution rose shows no discernable difference in concentration levels measured at the station amongst different wind directions.

- The St. Marys air monitoring station measured PM_{10} from multiple sources from various wind directions, with possible contributions from St. Marys Cement. There were slightly elevated concentrations when winds were coming from the northeast, southwest, and to a lesser extent, east and the southeast. The lowest concentrations occurred during northwest winds.

In summary, St. Marys Cement is a potential contributor to the concentrations of SO_2, NO_2, and particulate matter measured at the St. Marys air monitoring station established in St. Marys during the survey period. The average concentrations of SO_2, NO_2 and $PM_{2.5}$ are similar to concentrations measured at other comparable Ministry AQHI ambient air monitoring stations.

The area in the vicinity of the St. Marys air monitoring station experienced periods of time where concentrations of these common air pollutants were above background levels. This is typical of urban areas or areas in proximity to industrial activities and/or transportation related sources.

Appendix A: Maps and Pollution Roses

Figure 1: Temporary Air Monitoring Station St. Marys Ontario, July 11, 2017 to August 31, 2018

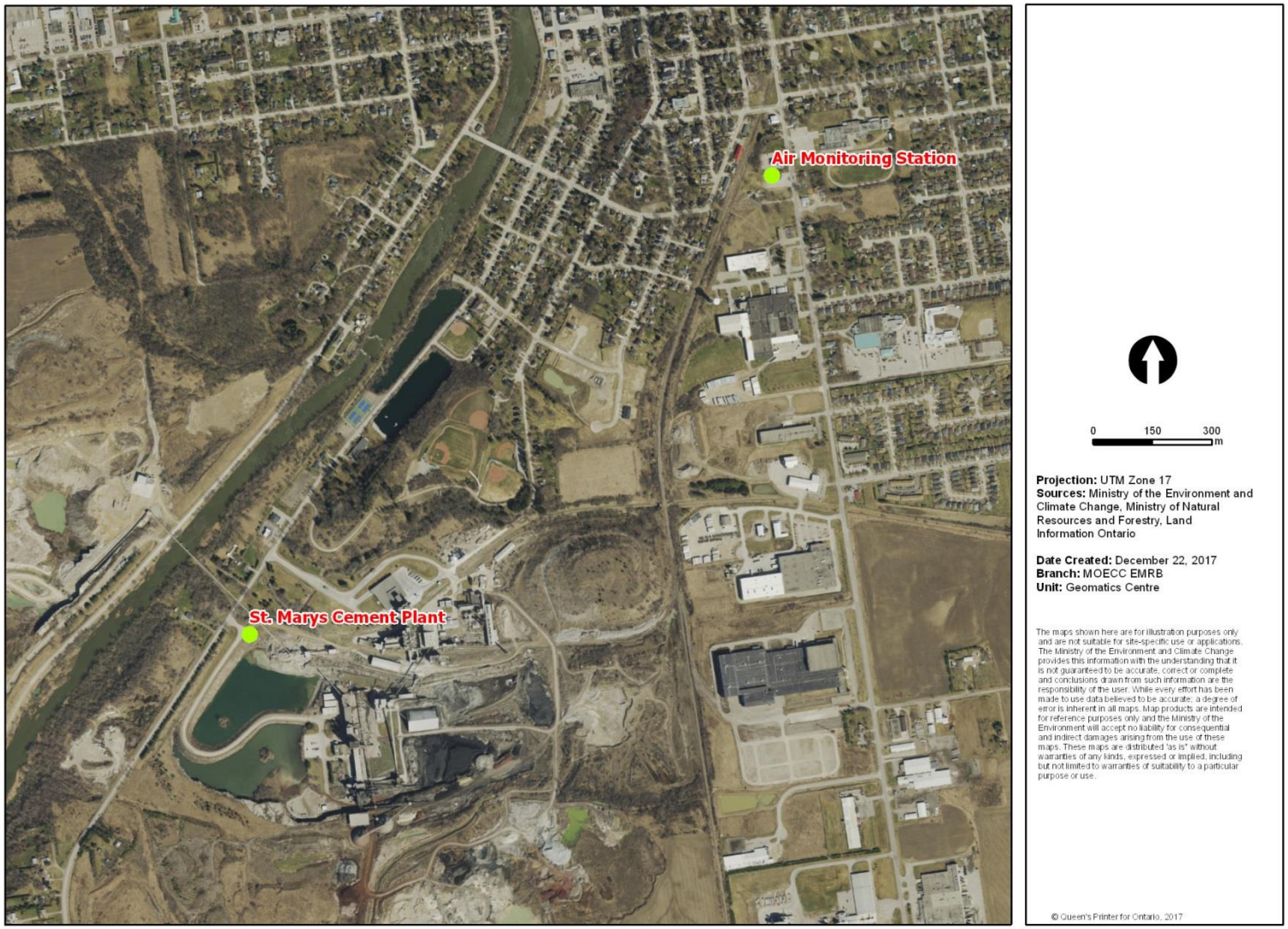


Figure 2: Pollution Rose for Sulphur Dioxide (SO_2), St. Marys, Ontario, July 11, 2017 to August 31, 2018

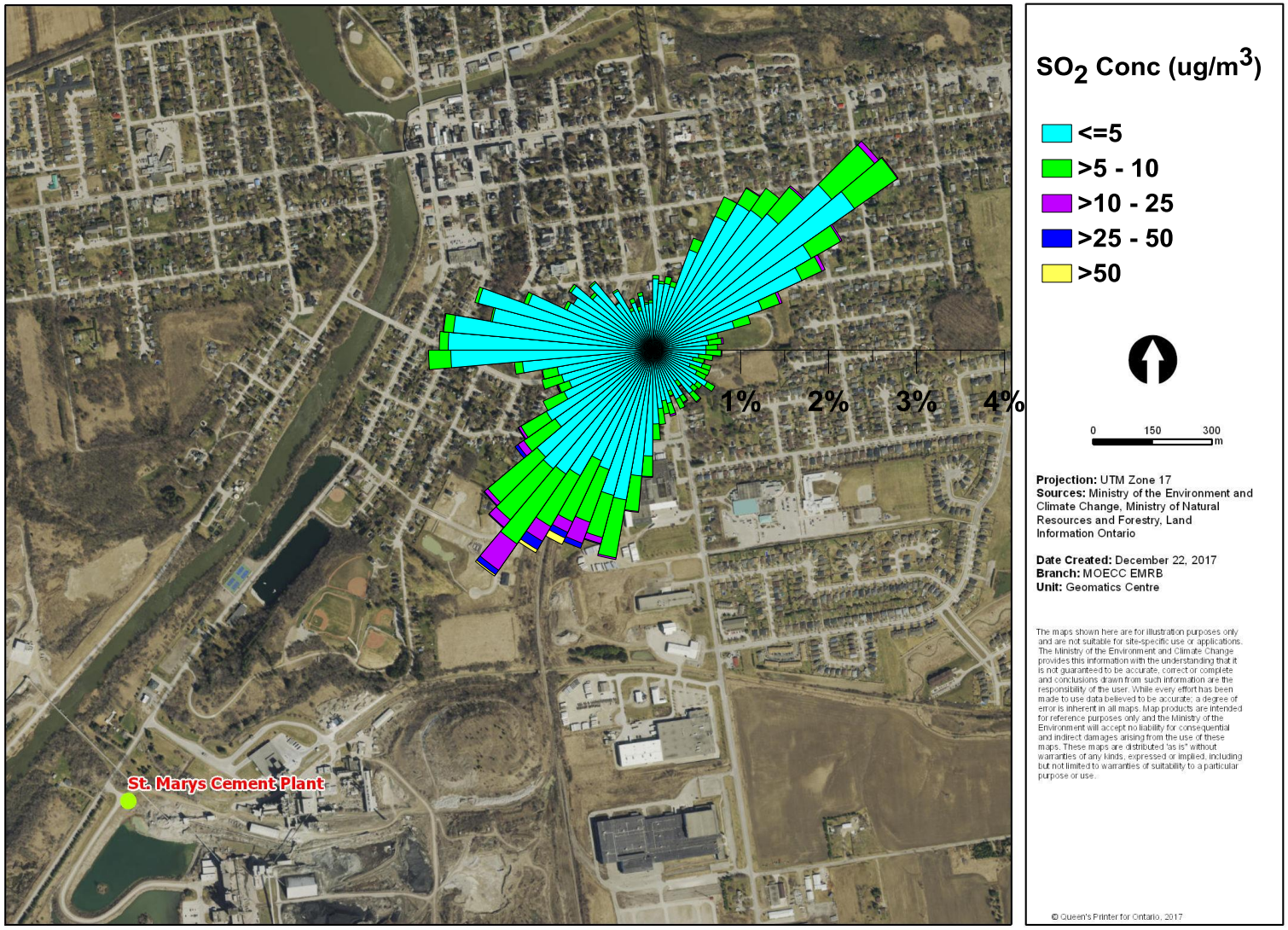


Figure 3: Pollution Rose for Nitrogen Dioxide (NO_2), St. Marys, Ontario, July 11, 2017 to August 31, 2018

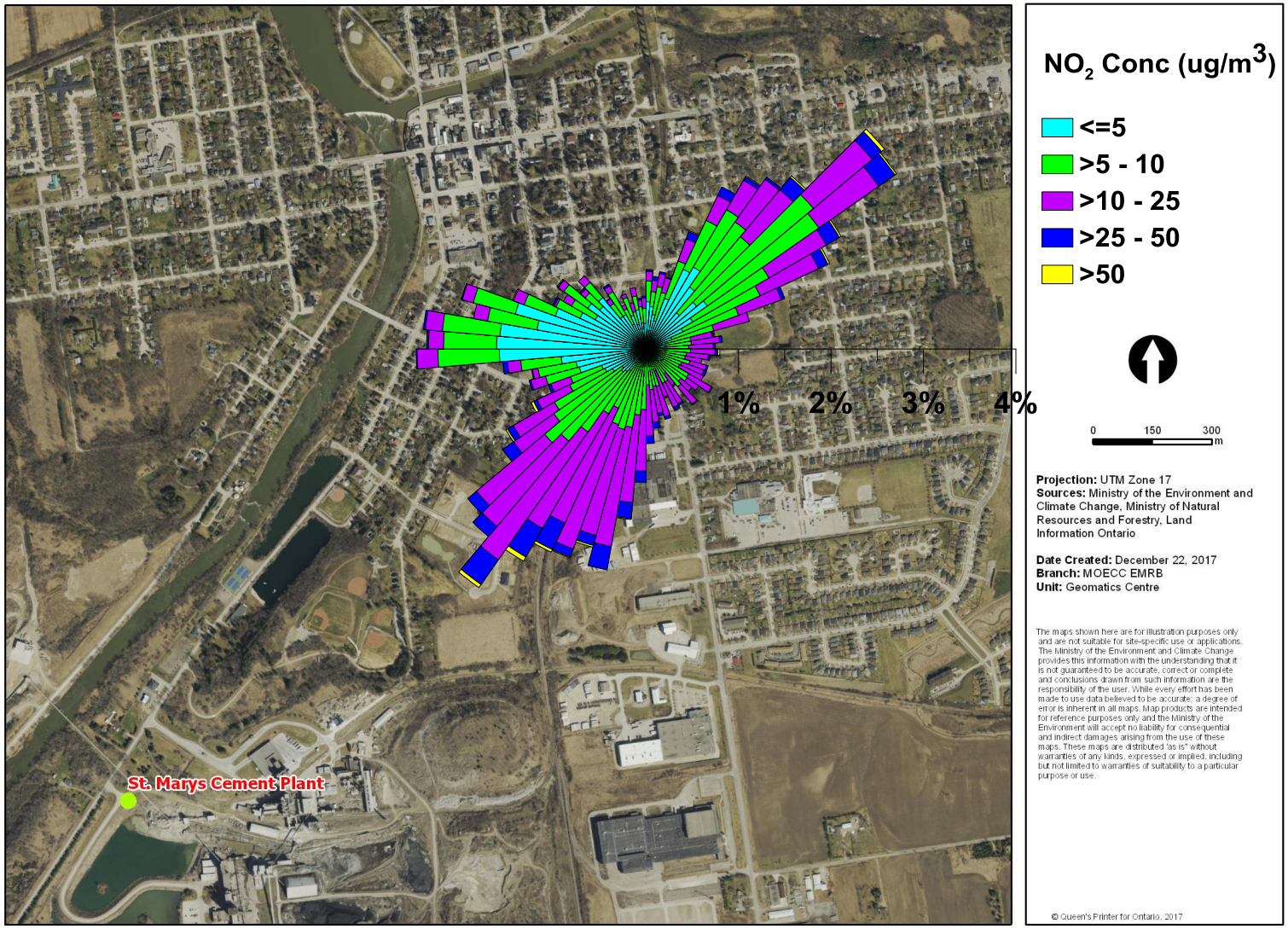


Figure 4: Pollution Rose for $PM_{2.5}$, St. Marys, Ontario, July 11 to August 23, 2017

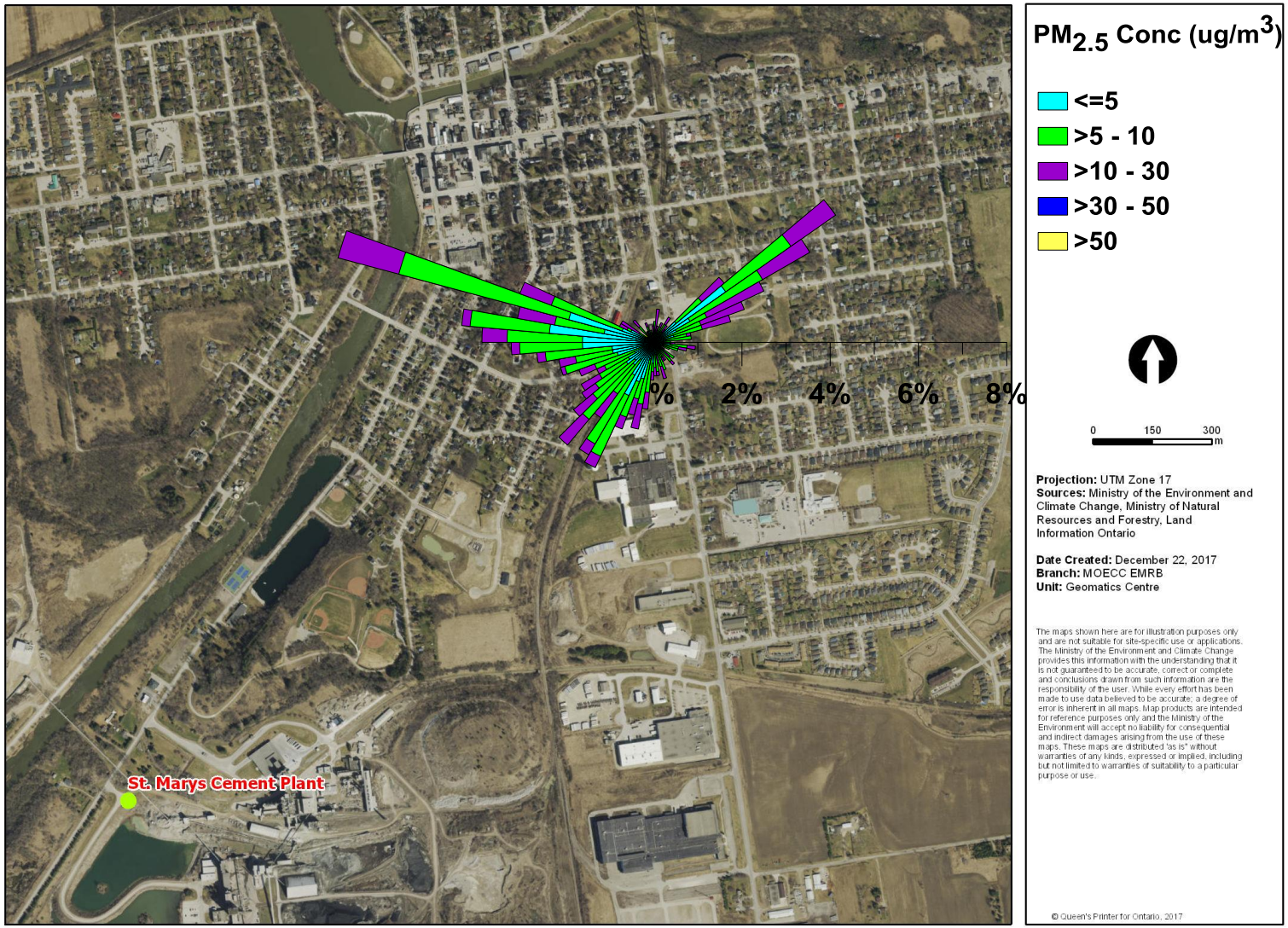


Figure 5: Pollution Rose for PM_{10}, St. Marys, Ontario, August 24, 2017 to August 31, 2018

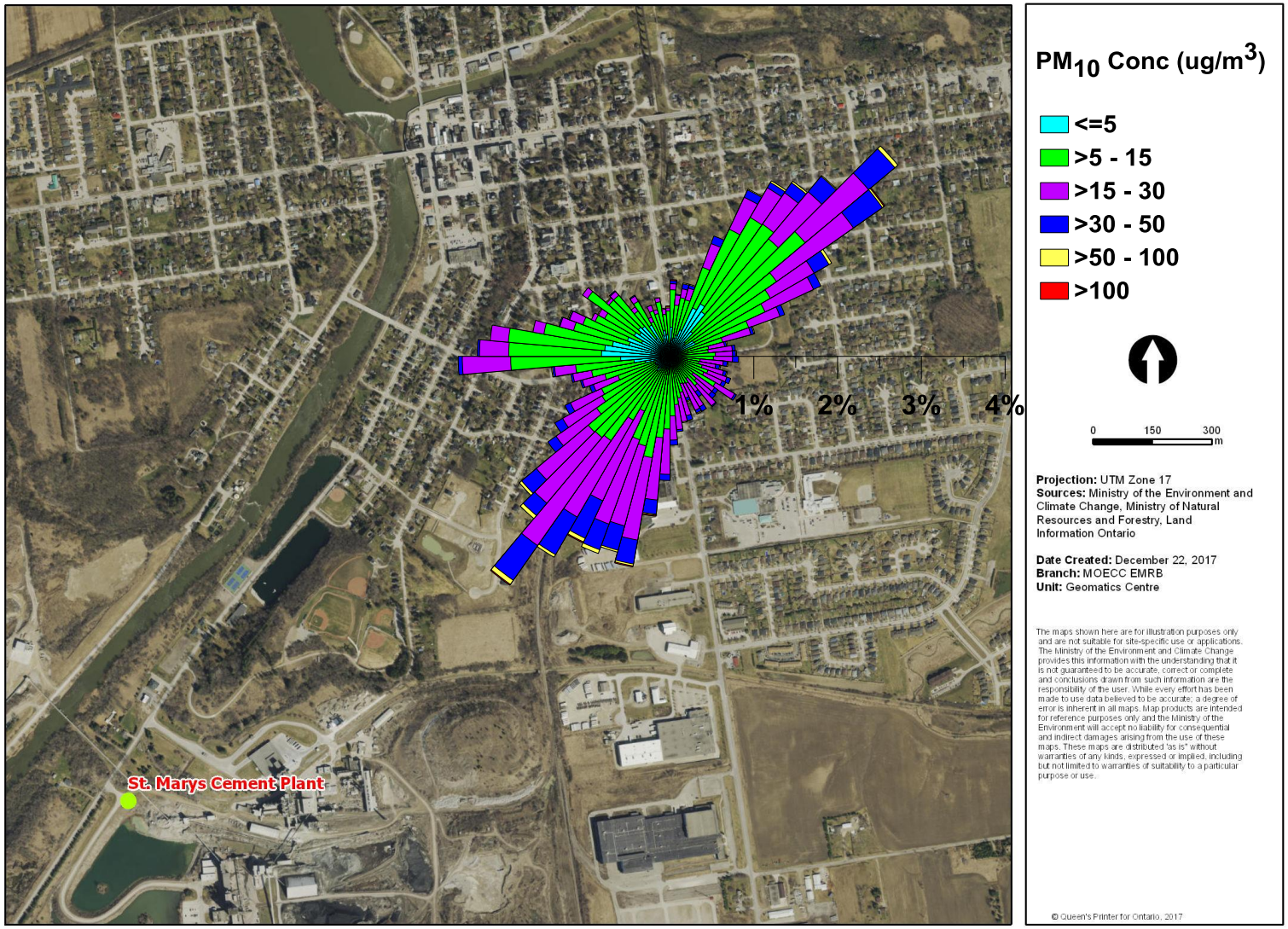


Figure 6: SO_2 Seasonal Pollution Roses, St. Marys Ontario

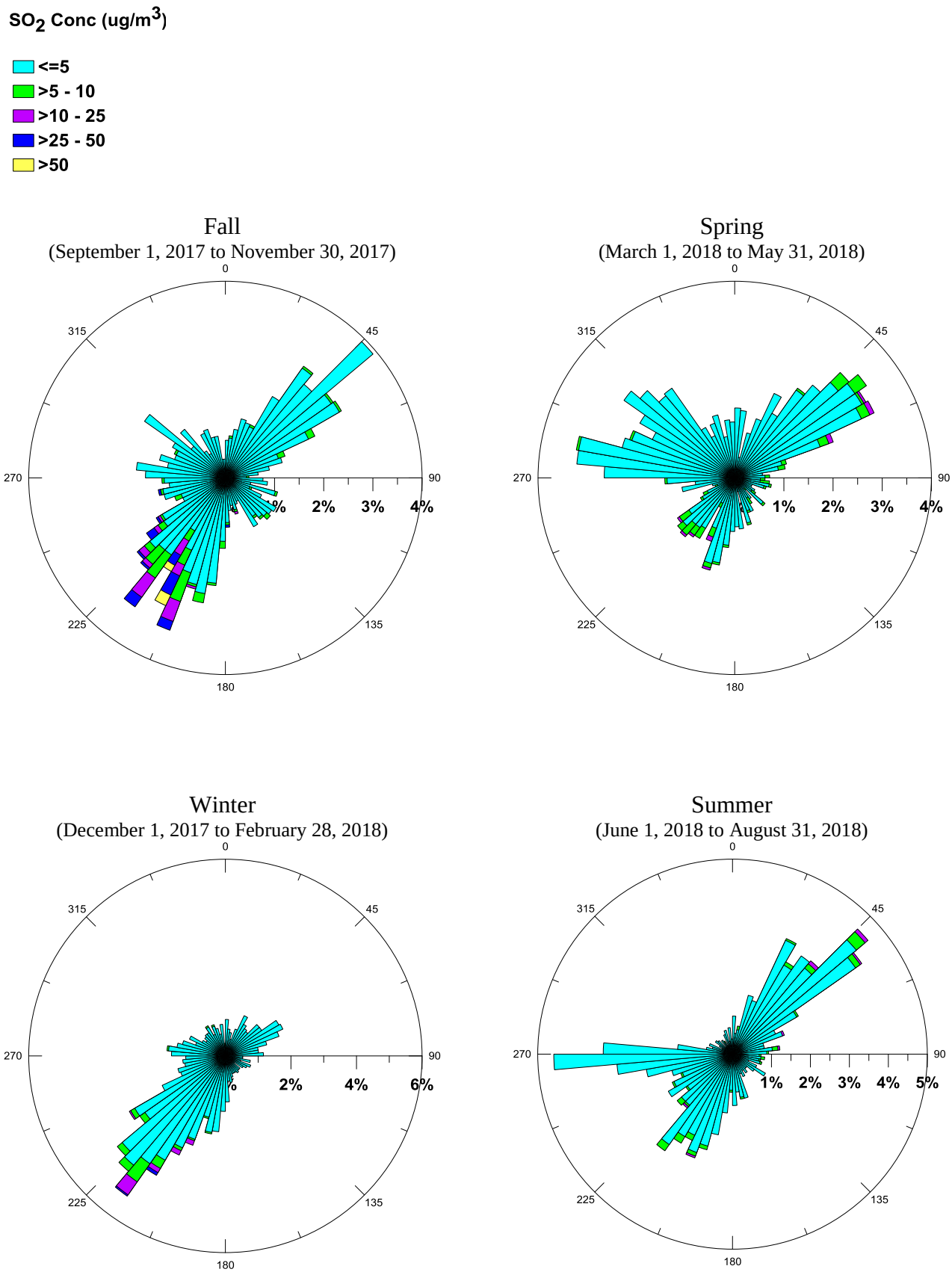


Figure 7: NO_2 Seasonal Pollution Roses, St. Marys Ontario

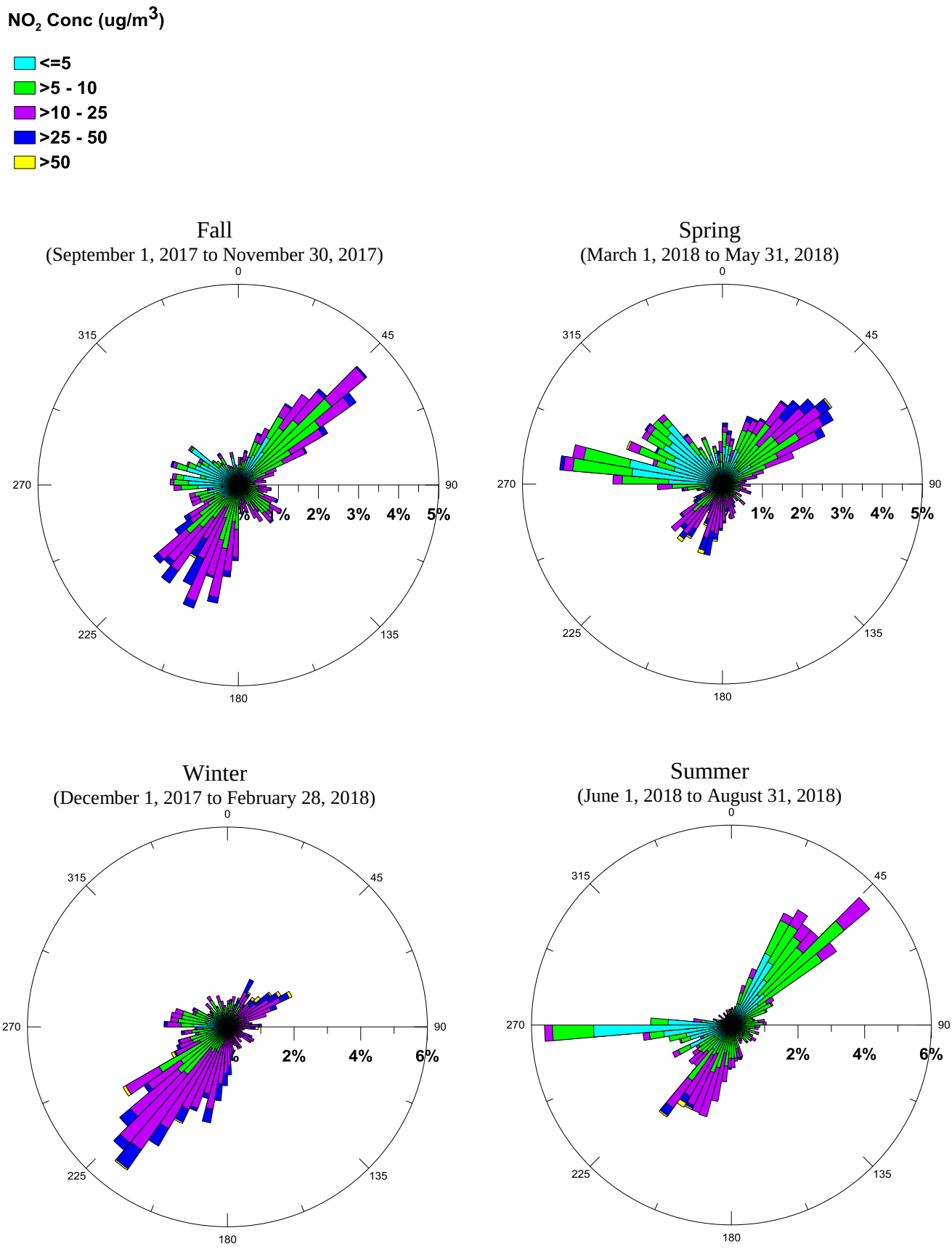
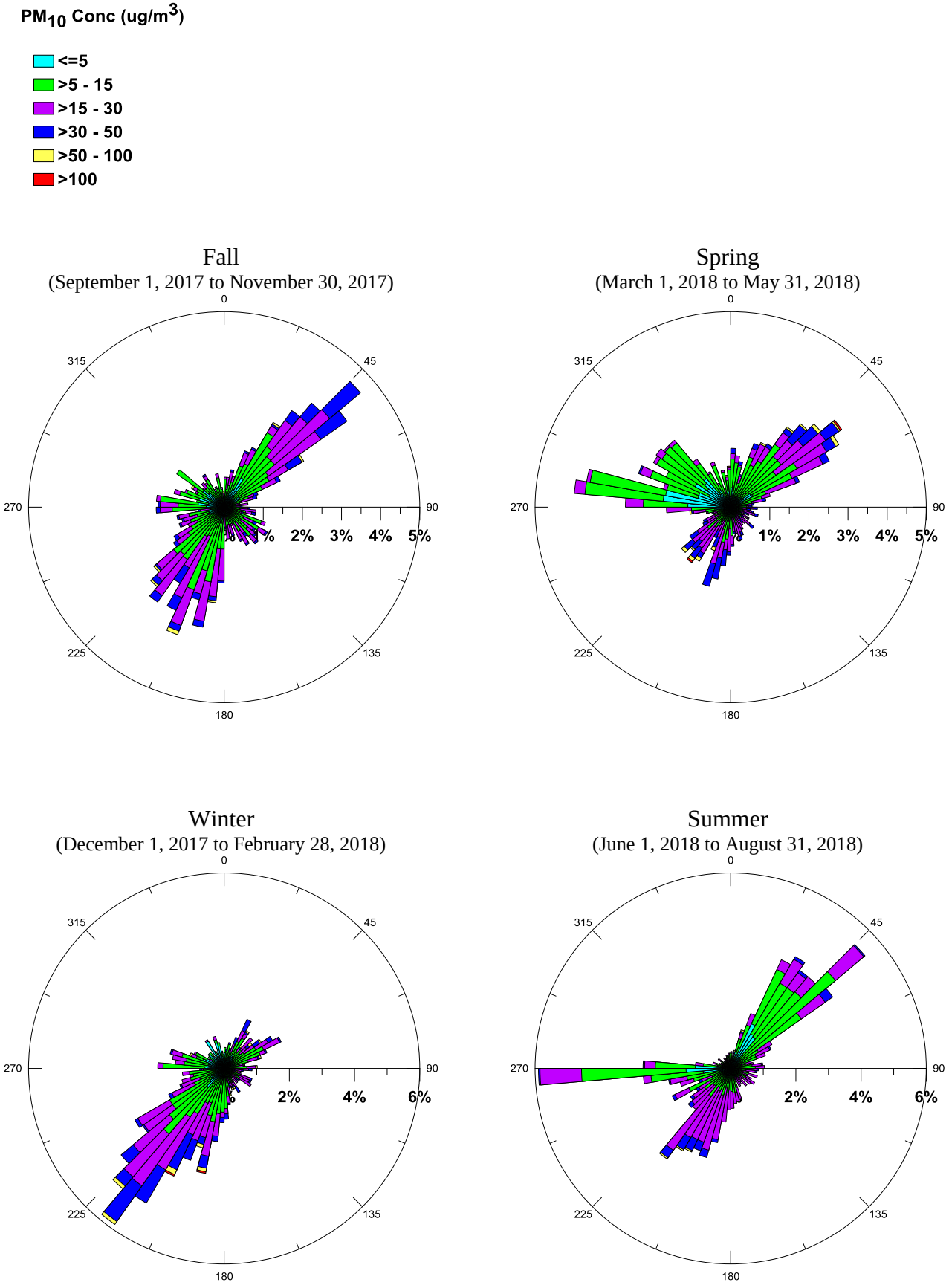


Figure 8: PM_{10} Seasonal Pollution Roses, St. Marys Ontario



Appendix B: Summary Tables

Table 1: Exceedances of the O. Reg. 419/05 Standards and AAQCs for SO_2, St. Marys Ontario, July 11 to August 31, 2018

Standard/AAQC						Exceedance Details	
O. Reg. 419/05 Schedule 3	O. Reg. 419/05 URT	AAQC	Averaging period	Value (µg/m^3)	Total Exceedances	Date & Time	Downwind of St. Marys Cement?
		X†	10-min	180	0	-	-
	X		½-hour	830	0	-	-
		X†	1-hour	100	2	21/11/2017 8:00* 21/11/2017 9:00*	Y Y
X		X‡	1-hour	690	0	-	-
X		X‡	24-hour	275	0	-	-
		X	annual	55‡	0	-	-
				10†	0	-	-

‡ In effect prior to March 20, 2018
†Came into effect March 20, 2018
*AAQC was not in effect during this excursion

Table 2: Exceedances of the O. Reg. 419/05 Standards and AAQCs for NO_2, St. Marys Ontario, July 11 to August 31, 2018

Standard/AAQC				
O. Reg. 419/05 Schedule 3	AAQC	Averaging period	Value	Total Exceedances
X	X	1-hour	400 µg/m^3	0
X	X	24-hour	200 µg/m^3	0

Table 3: Exceedances of the AAQC for $PM_{2.5}$ July 11, 2017 to August 23, 2017, St. Marys Ontario

AAQC		
Averaging period	Value	Total Exceedances
24-hour	30 µg/m^3	0

Table 4: Exceedances of the AAQC for PM_{10} August 24, 2017 to August 31, 2018, St. Marys Ontario

AAQC		
Averaging period	Value	Total Exceedances
24-hour	50 µg/m^3	0

Table 5: Comparison of Measurements at St. Marys Air Monitoring Station to Select AQHI Stations September 1, 2017 to August 31, 2018.

	Annual Average SO_2 µg/m^3	# of Exceedances of the 1-hour AAQC (100 µg/m^3)	Annual Average NO_2 µg/m^3	# of Exceedances of the 1-hour AAQC (400 µg/m^3)	$PM_{2.5}$‡ µg/m^3	# of Exceedances of the 1-hour AAQC (30 µg/m^3)
St. Marys Air Monitoring Station	2.2	2	10.0	0	7.7	0
London AQHI Station	nm	-	11.1	0	7.1	0
Brantford AQHI Station	nm	-	10.2	0	7.8	1
Hamilton Mountain AQHI Station	6.6	29	16.0	0	7.2	0
Windsor Downtown AQHI Station	2.5	0	22.9	0	7.9	1

nm = not measured
‡ measurements taken from July 11 to August 23, 2017.
Real-time PM_{10} measurements are not available for Ministry AQHI air monitoring stations.
Conversions from ppb to µg/m^3 were calculated using T = 10^{o}C, P = 1atm.

Table 6: Average Pollutant Concentrations at St. Marys Air Monitoring Station

	SO_2 µg/m^3	NO_2 µg/m^3	PM_{10} µg/m^3
Full Survey Average (July 11, 2017 to August 31, 2018)	2.0	9.5	14.3†
Annual Average‡ (September 1, 2017 to August 31, 2018)	2.2	10.0	14.3
Fall (September 1, 2017 to November 30, 2017)	3.0	9.2	14.2
Winter (December 1, 2017 to February 28, 2018)	1.9	13.6	15.2
Spring (March 1, 2018 to May 31, 2018)	1.8	9.6	14.2
Summer (June 1, 2018 to August 31, 2018)	1.9	7.4	13.9

† measurements taken from August 24, 2017 to August 31, 2018.
‡ A full year period was selected for which all parameters were concurrently being monitored.
Conversions from ppb to µg/m^3 were calculated using T = 10^{o}C, P = 1atm.