Air Quality in Ontario

MINISTRY OF THE ENVIRONMENT AND CLIMATE CHANGE

2016 REPORT

Ontario

Acknowledgements

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Air Quality in Ontario Report 2016

The Air Quality in Ontario Report, the 46th in a series, summarizes the state of ambient air quality in 2016 and 10-year trends for key airborne pollutants affecting Ontario's air quality.

2016 Highlights

Overall, air quality in Ontario has improved significantly over the past 10 years due to substantial decrease in harmful pollutants such as nitrogen dioxide, sulphur dioxide and carbon monoxide that are emitted by vehicles and industry.

There has also been a significant decrease in fine particulate matter which is emitted directly into the atmosphere as a by-product of fuel combustion or formed indirectly in the atmosphere through a series of complex chemical reactions. Fine particulate matter includes aerosols, smoke, fumes, dust, fly ash and pollen, and can have various negative health effects, especially on the respiratory system.

The continued decrease in these pollutants is due in part to Ontario's air quality initiatives such as:

- The phase-out and banning of coal-fired generating stations. The ban not only helped reduce the number of harmful contaminants entering the air, but it was also one of the largest greenhouse gas reduction initiatives in North America.
- Nitrogen oxides and sulphur dioxide emissions cap and trade regulations (O. Reg. 397/01 and O. Reg. 194/05)
- Setting new and updated air standards through the local air quality regulation (O. Reg. 419/05)
- Regulating industrial emissions through the site-specific standard and technical standard compliance options under O. Reg. 419
- Establishing emissions controls at Ontario smelters through site-specific standards under O. Reg. 419/05
- Drive Clean testing of vehicle emissions

Trends in Ambient Air Concentrations and Air Emissions, 2007-2016

Pollutant	Concentrations	Emissions
NO_2/NO_x	↓ 30%	↓ 38%
SO_2	↓ 51%	↓ 40%
CO	↓ 53%	↓ 32%
$PM_{2.5}$	↓ 12%	↓ 16%
O_3	↑ 1%	n/a

Notes:

NO_2 is the concentration measured and NO_x is the emission estimated.

Ozone is a secondary pollutant. It is not directly emitted and only formed when NO_x and VOCs react in the presence of sunlight; therefore emission trends are not available.

Trends in Volatile Organic Compounds, 2007-2016

Pollutant	Concentrations
Benzene	↓ 28%
Toluene	↓ 48%
Ethylbenzene	↓ 49%
m-, p-xylene	↓ 53%
o-xylene	↓ 43%
1,3 butadiene	↓ 50%

Rapport sur la qualité de l'air en Ontario de 2016

Le Rapport sur la qualité de l'air en Ontario, 46e de la série, résume l'état de la qualité de l'air ambiant en 2016 et les tendances sur 10 ans relatives aux principaux polluants atmosphériques qui affectent la qualité de l'air en Ontario.

Faits saillants de 2016

En général, la qualité de l'air en Ontario s'est nettement améliorée ces 10 dernières années grâce à la réduction substantielle des polluants nocifs, comme le dioxyde d'azote, le dioxyde de soufre et le monoxyde de carbone qui sont rejetés par les véhicules et l'industrie.

Il y a aussi eu une baisse importante des particules fines qui sont rejetées dans l'air directement, comme sous-produit du brûlage de combustibles, ou indirectement, par une série de réactions chimiques complexes. Les particules fines, qui incluent les aérosols, la fumée, les vapeurs, la poussière, les cendres volantes et le pollen, peuvent affecter la santé de diverses façons, notamment le système respiratoire.

Ces polluants continuent de baisser, en partie grâce aux mesures prises par l'Ontario pour améliorer la qualité de l'air, dont celles-ci :

- La fermeture progressive, puis l'interdiction des centrales électriques alimentées au charbon. L'interdiction a non seulement aidé à réduire le nombre de polluants nocifs rejetés dans l'atmosphère, mais elle a aussi été l'une des plus importantes initiatives de réduction des gaz à effet de serre en Amérique du Nord.
- L'adoption de règlements sur le plafonnement des émissions d'oxydes d'azote et de dioxyde de soufre et l'échange des droits d'émission de ces substances (Règlement de l'Ontario 397/01 et Règlement de l'Ontario 194/05).
- L'actualisation de normes de qualité de l'air ou l'établissement de nouvelles normes de qualité de l'air (p. ex., pour le benzène) par le Règlement de l'Ontario 419/05 (Pollution atmosphérique – Qualité de l'air ambiant).
- La réglementation des émissions industrielles au moyen des dispositions du Règlement de l'Ontario 419/05 se rapportant aux normes techniques et aux normes relatives à la concentration des polluants à un endroit donné.
- La lutte contre les émissions des fonderies au moyen des dispositions du Règlement de l'Ontario 419/05 se rapportant aux normes relatives à la concentration des polluants à un endroit donné.
- L'analyse des émissions des véhicules dans le cadre du programme Air pur Ontario.

Tendances des concentrations dans l'air ambiant et des émissions dans l'air, 2007-2016

Polluant	Concentrations	Émissions
NO_2/NO_x	↓ 30 %	↓ 38 %
SO_2	↓ 51 %	↓ 40 %
CO	↓ 53 %	↓ 32 %
$PM_{2.5}$	↓ 12 %	↓ 16 %
O_3	↑ 1 %	s/o

À noter :

Le NO_2 est la concentration mesurée et le NO_x est l'émission estimée.

L'ozone est un polluant secondaire. Il n'est pas émis directement, mais se forme quand le NO_x et les COV réagissent sous le rayonnement solaire; par conséquent, les tendances d'émission ne sont pas disponibles.

Tendances des composés organiques volatils, 2007-2016

Polluant	Concentrations
benzène	↓ 28 %
toluène	↓ 48 %
éthylbenzène	↓ 49 %
m-, p-xylène	↓ 53 %
o-xylène	↓ 43 %
1,3-butadiène	↓ 50 %

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1.0 Introduction

This annual report, the 46th in a series, summarizes the state of ambient air quality in Ontario during 2016 and examines 10-year trends. It reports on the measured levels of six common air pollutants: nitrogen dioxide (NO_2), fine particulate matter ($PM_{2.5}$), ground-level ozone (O_3), carbon monoxide (CO), sulphur dioxide (SO_2) and total reduced sulphur (TRS) compounds, and how Ontario is performing compared to the province's Ambient Air Quality Criteria (AAQC). The ambient air monitoring sites featured in this report are generally representative of regional air quality which is less influenced by local and industrial sources of air contaminants. This report also provides an overview of the Air Quality Health Index (AQHI) and Air Quality Alert programs in Ontario, plus the monitoring of select volatile organic compounds (VOCs) in the province. Annual statistics, as well as 10-year trends of ambient air quality data are provided in the attached Appendix.

An AAQC is a desirable concentration of a contaminant in air, based on protection against adverse effects on health or the environment. The term "ambient" is used to reflect general air quality independent of location or source of a contaminant. AAQCs are most commonly used in environmental assessments, special studies using ambient air monitoring data, assessment of general air quality in a community and annual reporting on air quality across the province. AAQCs are set with different averaging times appropriate for the effect they are intended to protect against. The effects may be health, vegetation, soiling, visibility, corrosion or other effects. AAQCs may be changed from time to time based on new science.

Contaminant	1-hour AAQC	8-hour AAQC	24-hour AAQC	Annual AAQC
NO_2	200 ppb	–	100 ppb	–
$PM_{2.5}$	–	–	28 µg/m³ (1)	–
O_3	80 ppb	–	–	–
SO_2	250 ppb	–	100 ppb	20 ppb
CO	30 ppm	13 ppm	–	–

Notes:
ppb – parts (of contaminant) per billion (parts of air) – by volume.
µg/m³ – micrograms (of contaminant) per cubic metre (of air) – by weight.
ppm – parts (of contaminant) per million (parts of air) – by volume.
(1) Reference Level based on Canadian Ambient Air Quality Standard (CAAQS).

Ontario continues to benefit from one of the most comprehensive air monitoring systems in North America, comprised of 39 monitoring sites across the province that undergo regularly scheduled maintenance and strict data quality assurance and quality control (QA/QC) procedures to ensure a high standard of data quality and data completeness. The data, which are collected continuously at these sites, are used to determine the current state of ambient air quality and are reported every hour on the ministry's web site, www.airqualityontario.com.

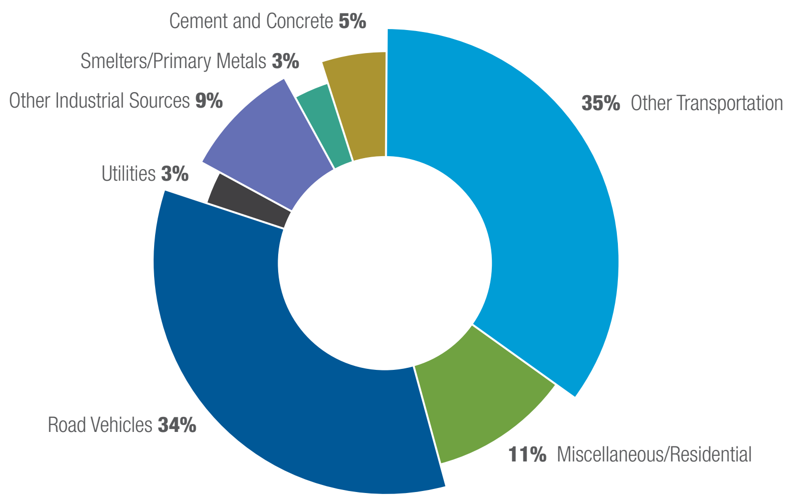
2.0 Nitrogen Dioxide

Nitrogen dioxide is a reddish-brown gas with a pungent odour, which transforms in the atmosphere to form gaseous nitric acid and nitrates. It plays a major role in atmospheric reactions that produce ground-level ozone, a major component of smog. Nitrogen dioxide also reacts in the air and contributes to the formation of $PM_{2.5}$ (Seinfeld and Pandis, 2006). All combustion in air produces nitrogen oxides (NO_x), of which NO_2 is a component. Major sources of NO_x emissions include the transportation sector, industrial processes and utilities.

Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infection. People with asthma and bronchitis have increased sensitivity to NO_2. Nitrogen dioxide chemically transforms into nitric acid in the atmosphere and, when deposited, contributes to the acidification of lakes and soils in Ontario. Nitric acid can also corrode metals, fade fabrics, degrade rubber, and damage trees and crops.

Figure 1 shows the estimates for Ontario's NO_x emissions from point, area and transportation sources. The transportation sectors accounted for approximately 69 per cent of NO_x emissions (Air Pollutant Emission Inventory 1990-2016, 2016).

Figure 1: Ontario Nitrogen Oxides Emissions by Sector (2016 Estimates for Point/Area/Transportation Sources)

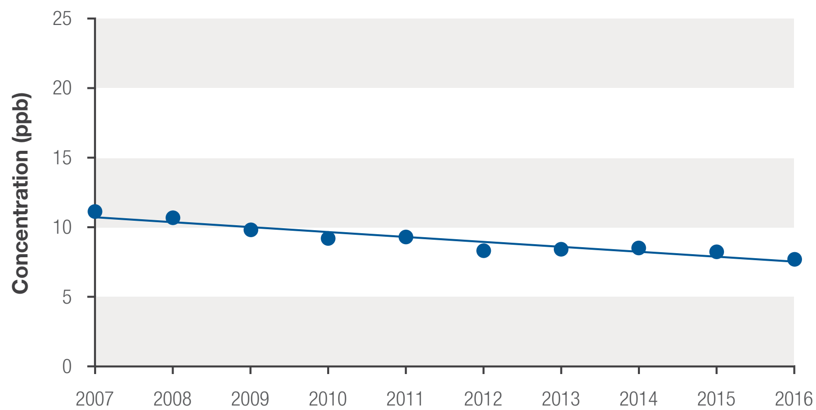


Note: Excludes emissions from open and natural sources.

There were no exceedances of the provincial one-hour and 24-hour AAQC for NO_2, 200 ppb and 100 ppb, respectively, at any of the 39 AQHI air monitoring stations in Ontario during 2016. The Toronto West air monitoring station, located in an area of Toronto influenced by significant vehicular traffic, recorded the highest NO_2 annual mean (15.7 ppb) during 2016; whereas Tiverton, a rural site, recorded the lowest NO_2 annual mean (1.8 ppb). The highest NO_2 means were recorded in large urbanized areas, such as the Greater Toronto Area of southern Ontario. The Toronto East station recorded the highest one-hour NO_2 concentration (68 ppb), and Toronto West recorded the highest 24-hour NO_2 concentration (41 ppb).

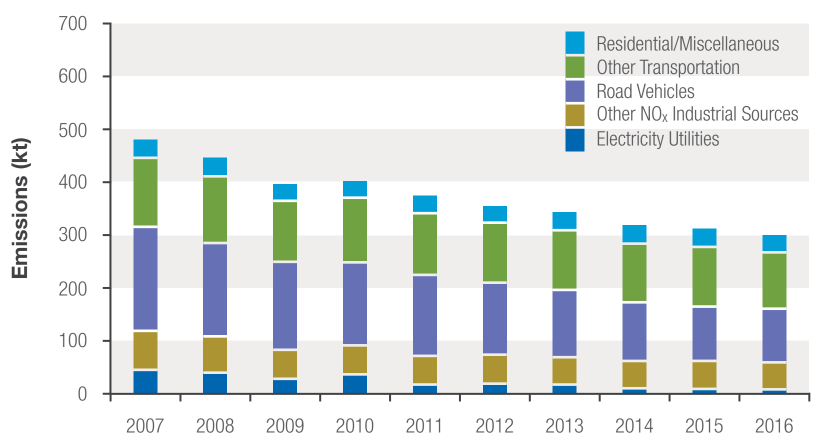
The NO_2 annual mean concentrations across Ontario have decreased 30 per cent from 2007 to 2016, as displayed in *Figure 2*. The NO_x emission trend from 2007 to 2016 indicates a decrease of approximately 38 per cent as shown in *Figure 3* (Air Pollutant Emission Inventory 1990-2016, 2016). Ontario's emissions trading regulations on sulphur dioxide and nitrogen oxides (O. Reg. 397/01 and O. Reg. 194/05) have contributed to the reduction in nitrogen oxides emissions in recent years. Nitrogen oxides emissions from on-road vehicles have also decreased due to the phase-in of new vehicles having more stringent emission standards. The implementation of the Ontario Drive Clean program in southern Ontario in 1999 has also helped further reduce the NO_x emissions from light duty gasoline vehicles.

Figure 2: Trend of NO_2 Annual Means Across Ontario (2007-2016)



Note: 10-year trend is a composite mean based on data from 31 monitoring sites.

Figure 3: Ontario NO_x Emission Trend (2007-2016)



Note: Excludes emissions from open and natural sources.

3.0 Fine Particulate Matter

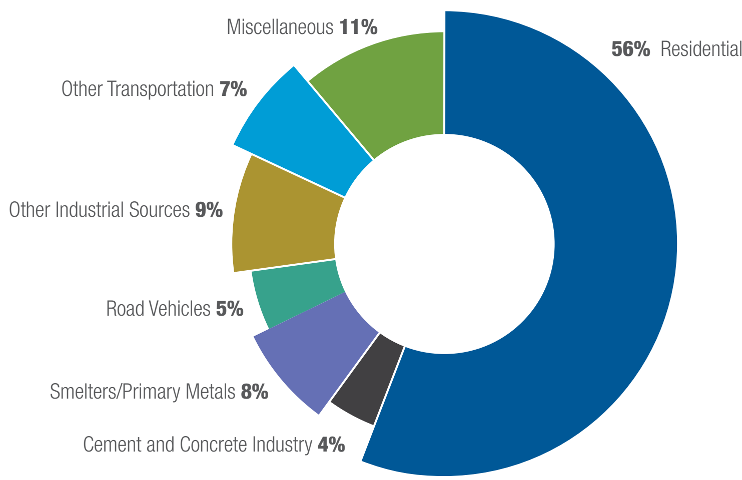
Airborne particulate is the general term used to describe a mixture of microscopic solid particles and liquid droplets suspended in air. Particulate matter (PM) includes aerosols, smoke, fumes, dust, fly ash and pollen. Its composition is complex and varies with origin, residence time in the atmosphere, time of year and environmental conditions. Particulate matter is classified according to its size, since different health effects are associated with particles of different diameters. Fine particulate matter, denoted as $PM_{2.5}$, is less than 2.5 micrometres in diameter, approximately 30 times smaller than the average diameter of a human hair.

Fine particulate matter can have various negative health effects, especially on the respiratory and cardiovascular systems. Particulate matter increases respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing. People with heart or lung disease, children and older adults are particularly sensitive to this pollutant.

Major components of $PM_{2.5}$ in Ontario are typically nitrates, sulphates, organic matter and particle-bound water. Higher nitrate levels are common in the cooler months whereas sulphates are more elevated during warm temperatures. Fine particulate matter may be emitted directly into the atmosphere as a by-product of fuel combustion or it may be formed indirectly in the atmosphere through a series of complex chemical reactions. Major sources of $PM_{2.5}$ include motor vehicles, smelters, power plants, industrial facilities, residential fireplaces and wood stoves, agricultural burning and forest fires.

The 2016 estimates for Ontario's $PM_{2.5}$ emissions from point, area and transportation sources (excluding emissions from open and natural sources) indicate that residential fuel combustion accounted for 56 per cent, as shown in *Figure 4*. The major contributor to residential emissions is fuel wood combustion in fireplaces and wood stoves. Industrial processes and transportation sectors accounted for 21 per cent and 12 per cent, respectively (Air Pollutant Emission Inventory 1990-2016, 2016).

Figure 4: Ontario $PM_{2.5}$ Emissions by Sector (2016 Estimates for Point/Area/Transportation Sources)

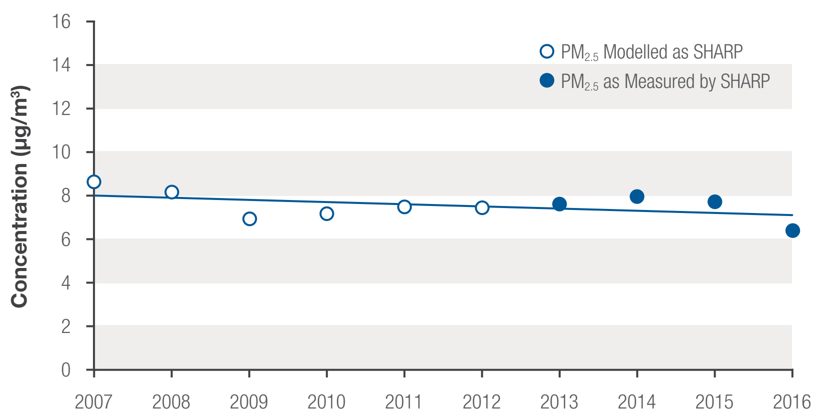


Note: Excludes emissions from open and natural sources.

In 2016, 39 AQHI air monitoring stations measured $PM_{2.5}$; annual mean concentrations ranged from 4.4 μg/m³ in Petawawa to 8.5 μg/m³ in Windsor. The $PM_{2.5}$ 24-hour maximum concentrations ranged from 13 μg/m³ in Thunder Bay to 31 μg/m³ recorded at Cornwall. Only three air monitoring stations measured daily averages above Ontario's 24-hour $PM_{2.5}$ reference level of 28 μg/m³: Hamilton Downtown exceeded the $PM_{2.5}$ reference level on two occasions, and Cornwall and Ottawa Central both exceeded the $PM_{2.5}$ reference level on only one occasion.

In 2013, as part of a national initiative funded by Environment and Climate Change Canada, Ontario replaced its Tapered Element Oscillating Microbalance (TEOM) monitors with the Synchronized Hybrid Ambient Real-time Particulate (SHARP) instrument across its ambient air monitoring network and started reporting with this new technology. While annual means and maximums are reported for 2016, 10-year trends for the entire ambient air monitoring network cannot be determined since the 2013 to 2016 $PM_{2.5}$ dataset is not directly comparable to data collected using the older technology. It is however possible to apply an approximate correction factor to the TEOM data to generate an approximate 10-year trend. Applying the approximate correction factor to the TEOM data shows a 12 per cent decrease in $PM_{2.5}$, from 2007 to 2016 as shown in *Figure 5*.

Figure 5: Trend of $PM_{2.5}$ Annual Means Across Ontario (2007-2016)



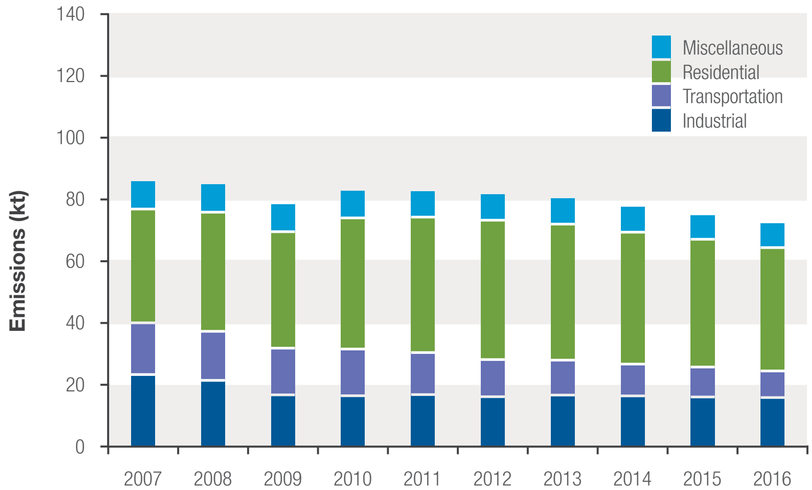
Note:

The trend is a composite mean based on data from 39 sites over 10 years.

A correction factor was applied to $PM_{2.5}$ concentrations measured by TEOM (2007-2012) to approximate SHARP-like measurements. $PM_{2.5}$ concentrations measured by SHARP are reflected from 2013 and onward.

Provincial $PM_{2.5}$ emissions have decreased approximately 16 per cent from 2007 to 2016 as shown in *Figure 6*. Fine particulate matter emissions from electric utilities and industrial processes have been reduced approximately 33 per cent during this period. Emissions from the transportation sector decreased 48 per cent with the phase-in of new vehicles/engines having more stringent emission standards over the same period (Air Pollutant Emission Inventory 1990-2016, 2016).

Figure 6: Ontario $PM_{2.5}$ Emission Trend (2007-2016)



Note: Excludes emissions from open and natural sources.

4.0 Ground-Level Ozone

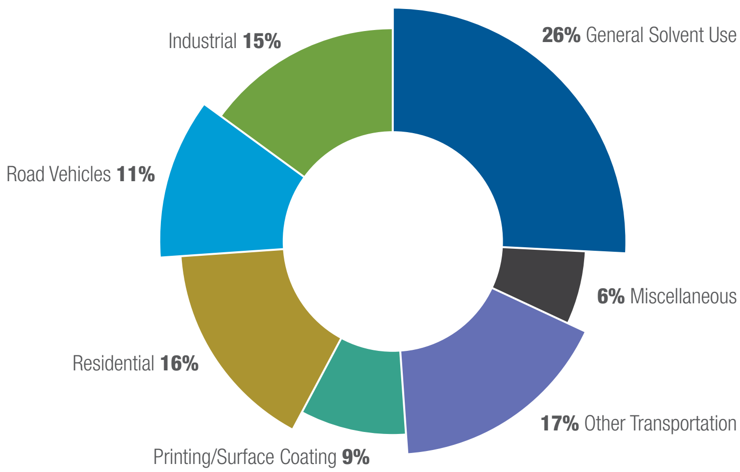
Ground-level ozone is a gas formed when NO_x and VOCs react in the presence of sunlight. Nitrogen oxides are comprised of NO_2 and nitric oxide (NO). Nitric oxide reacts quickly with ground-level ozone to form NO_2 (known as scavenging). Nitrogen dioxide efficiently absorbs sunlight in summer and then breaks down to generate oxygen atoms (O) and NO. These oxygen atoms then react rapidly with molecular oxygen (O_2) to produce ground-level ozone. These series of reactions, however, experience interference with other chemicals, such as VOCs. Ground-level ozone increases when VOCs are present and react with NO reducing the scavenging effect.

Ozone is a colourless, odourless gas at typical ambient concentrations, and is a major component of smog. The formation and transport of ozone is strongly dependent on weather conditions and emissions of chemicals that contribute to the formation of ozone, such as NO_x and VOCs. Changing weather patterns contribute to differences in ozone concentrations hour-to-hour, day-to-day, season-to-season, and year-to-year. In Ontario, the highest concentrations of ground-level ozone are typically recorded on hot and sunny days mainly from May to September, between noon and early evening.

Ozone irritates the respiratory tract and eyes. Exposure to ozone in sensitive people can result in chest tightness, coughing and wheezing. Children who are active outdoors during the summer, when ozone levels are highest, are particularly at risk. Individuals with pre-existing respiratory disorders, such as asthma and chronic obstructive pulmonary disease (COPD), are also at risk. Ozone is associated with increased hospital admissions and premature deaths. Ozone may also be harmful to vegetation causing losses in agricultural crops each year in Ontario, with visible leaf damage in many crops, garden plants and trees, especially during the summer months. While ozone at ground level is a significant environmental and health concern, the naturally occurring ozone in the stratosphere, 10 to 40 kilometres (km) above the earth's surface, is beneficial as it shields the earth from harmful ultraviolet radiation.

Figure 7 shows the 2016 estimates of Ontario's VOCs emissions from point, area and transportation sources. The transportation sectors accounted for approximately 28 per cent of VOCs and the second largest source was general solvent use, accounting for approximately 26 per cent (Air Pollutant Emission Inventory 1990-2016, 2016).

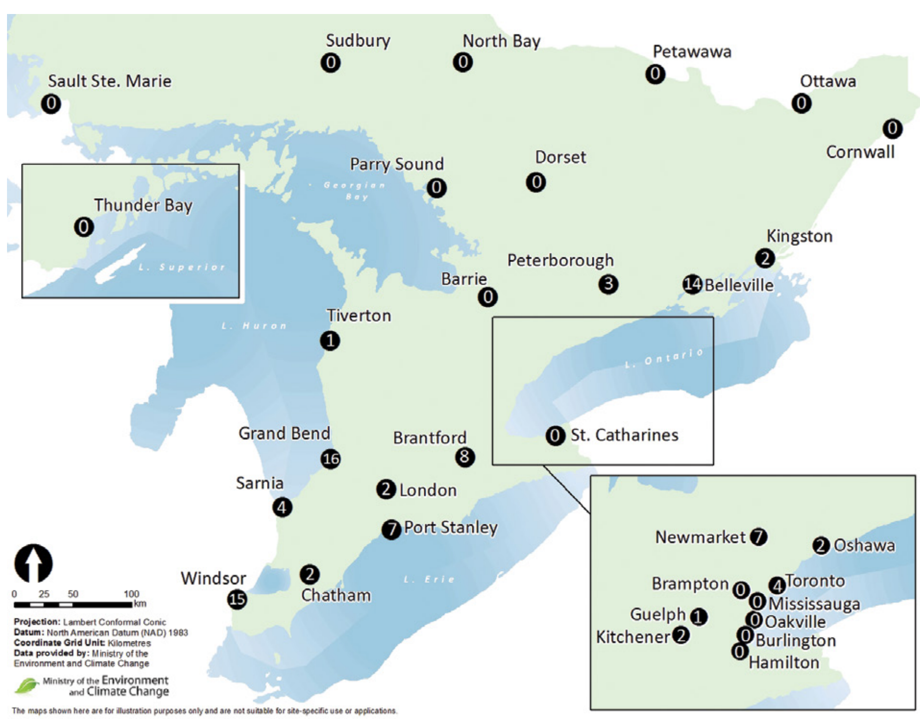
Figure 7: Ontario VOCs Emissions by Sector (2016 Estimates for Point/Area/Transportation Sources)



Note: Note: Excludes emissions from open and natural sources.

In 2016, ozone was monitored at the ministry's 39 AQHI air monitoring stations. The highest annual mean was 33.1 parts per billion (ppb), measured at Tiverton, a transboundary-influenced site on the eastern shore of Lake Huron. The lowest annual mean, 22.1 ppb, was measured at Toronto West, an urban site located near a major transportation corridor, Highway 401, and directly impacted by local NO emissions from vehicles. Generally, ozone concentrations are lower in urban areas because ozone is depleted by reacting with NO emitted by vehicles and other local combustion sources.

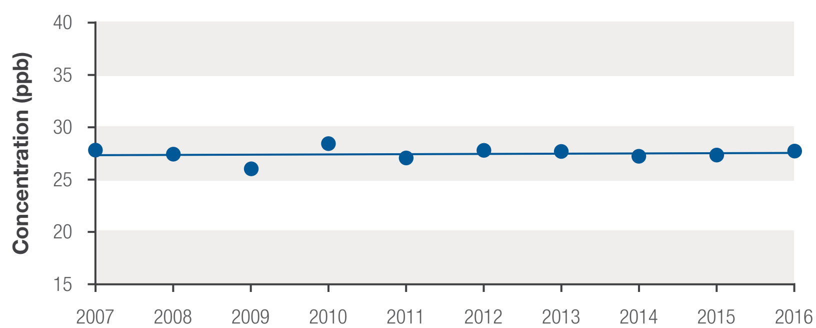
Figure 8: Geographical Distribution of the Number of Hours Above the 1-Hour Ozone AAQC Across Ontario in 2016



The maximum one-hour ozone concentrations ranged from 62 ppb recorded in Thunder Bay, to 99 ppb recorded in Toronto East. In 2016, 19 air monitoring sites situated in 16 locations across the province measured ozone levels above Ontario's one-hour AAQC of 80 ppb for at least one hour as shown in *Figure 8*. Ontario's one-hour AAQC for ozone was exceeded the most often at Grand Bend on 16 occasions.

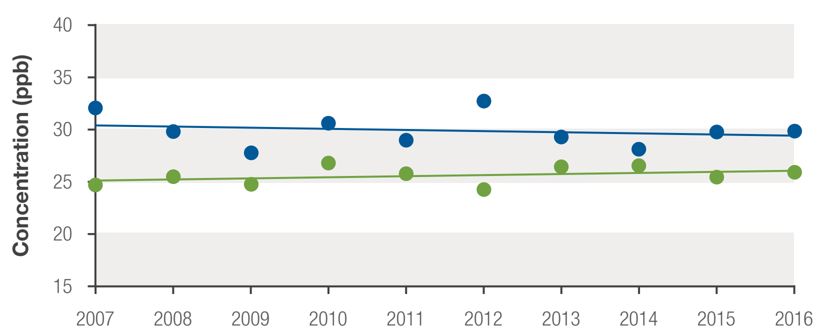
The ozone annual means presented in *Figure 9* show an increasing trend of 1 per cent for the 10-year period from 2007 to 2016. The trend for ozone summer means and ozone winter means are shown in *Figure 10*. The ozone summer means trend decreased by 3 per cent from 2007 to 2016, whereas the ozone winter means have increased by 4 per cent over the same 10-year period. The decrease in summer means over the past 10 years is largely due to the progressive reductions of NO_x emissions in Ontario and the U.S. resulting in the decrease in local ozone formation and transboundary influences especially during the summer months. Summer ozone, however, continues to exceed the Ontario AAQC during the warmer months and remains a challenge in areas of the province. The increases in the ozone winter means are mainly attributed to the rising global background concentrations (Reid et al, 2008) and reduced scavenging effect. Industrial activities in Europe, the U.S. and rapidly growing Asia contribute to this global background (Reid et al, 2008; Parrish et al, 2012). In general, even with the increase in ozone winter means, ozone concentrations during the winter months continue to remain well below the Ontario AAQC of 80 ppb.

Figure 9: Trend of Ozone Annual Means Across Ontario (2007-2016)



Note: 10-year trend is a composite annual mean based on data from 39 monitoring sites.

Figure 10: Trend of Ozone Summer and Winter Means Across Ontario (2007-2016)



Notes:

10-year trends are composite means for the summer and winter months based on data from 39 monitoring sites.

Summer: May - September; Winter: January - April, October - December.

Comparison of Smog Episodes with Similar Meteorological Conditions – 2005 vs 2016

Smog is a contraction of smoke and fog, and includes ground-level ozone, $PM_{2.5}$ and other pollutants. In Ontario, the traditional summer smog season is defined as the period between May and September, and usually driven by ground-level ozone and $PM_{2.5}$. Elevated levels of ozone and $PM_{2.5}$ are typically due to regional weather patterns that affect the lower Great Lakes region. Such weather patterns are invariably associated with slow moving high pressure cells across the region and result in the long-range transport of smog pollutants from neighbouring U.S. industrial and urbanized states during warm south to southwesterly air flow conditions.

Smog episodes are highly dependent on meteorological conditions which vary from year to year. The summers in 2005 and 2016 both recorded warmer than normal temperatures combined with southwesterly air flows – ideal weather conditions for smog episodes to occur. During smog season, Ontario recorded 30 and 25 *hot days* (a *hot day* is a day where the maximum temperature recorded is greater than 30°C) in 2005 and 2016, respectively. Meteorological observations were similar for the summers of 2005 and 2016; however, there are noticeable differences in the general characteristics of smog events between these two years.

Smog episodes in the summer of 2005 were frequent, commonly multi-day events that were dominated by elevated concentrations of ozone and $PM_{2.5}$. In 2016, the summer smog events were less frequent, shorter, less intense and only subject to ozone. The time of day at which elevated ozone concentrations occurred also differed between the two years. For instance, in 2005, elevated ozone concentrations would emerge in the early afternoon and last longer, whereas in 2016, elevated ozone concentrations materialized in late afternoon for only short time periods.

The number of exceedances of Ontario's Ambient Air Quality Criteria (AAQC) for ozone occurred more often in 2005. Port Stanley recorded the most instances (172) above the Ontario AAQC in 2005; 166 of those instances occurred between May to September 2005. In the summer of 2016, Grand Bend recorded the most instances (16) above the Ontario AAQC. Due to the absence of elevated $PM_{2.5}$ concentrations in the summer of 2016, this section compares select ozone events in the summers of 2005 and 2016 when meteorological conditions were similar.

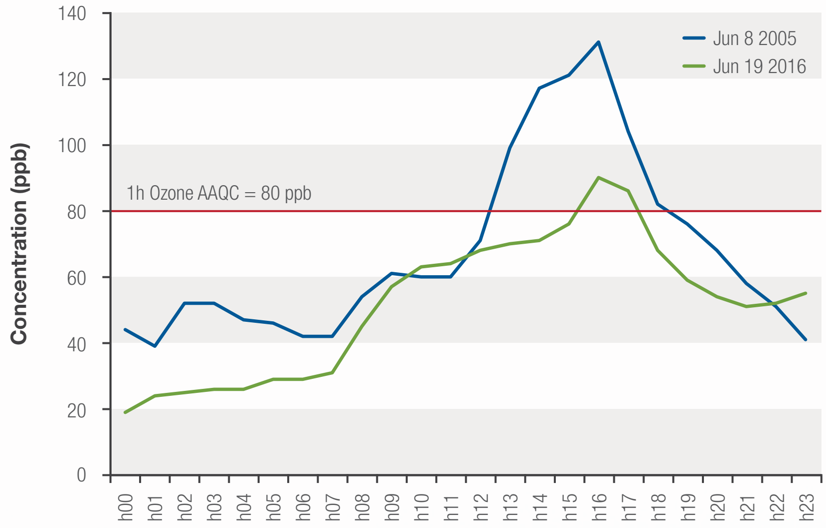
CASE STUDY 1

June 7-14, 2005 *vs* June 18-20, 2016

The ozone events of June 7-14, 2005 and June 18-20, 2016 shared a very similar meteorological pattern. A high pressure ridge moved eastward over southern Ontario followed by a low pressure trough that moved over northern Ontario causing sunny skies and winds over southern Ontario from the southwest with increasing temperatures. These weather conditions are ideal for elevated ozone concentrations; however, the ozone levels observed in the 2005 episode were more intense and widespread when compared to the 2016 episode. The event in 2005 persisted for eight days driven by elevated ozone levels as well as $PM_{2.5}$ concentrations, whereas the event in 2016 lasted only three days due only to elevated ozone.

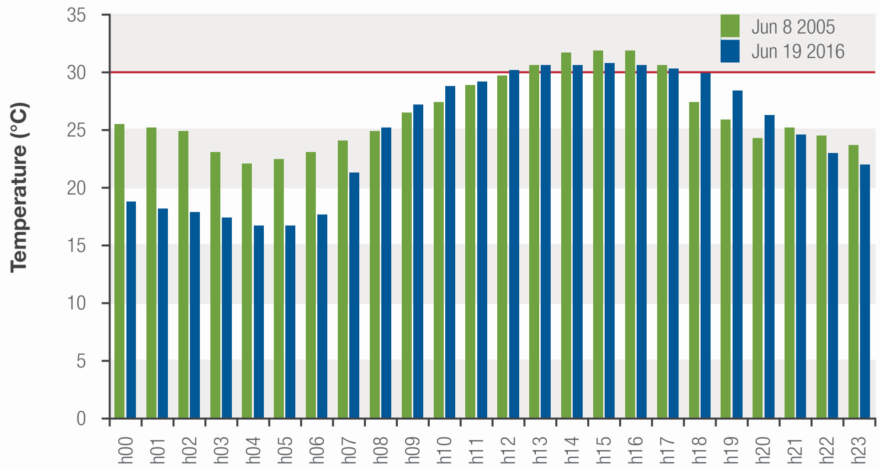
Twenty-five air monitoring stations exceeded Ontario's one-hour AAQC on at least one occasion during the June 7-14, 2005 event; while only five air monitoring stations exceeded the AAQC for ozone from June 18-20, 2016. The highest one-hour ozone concentration recorded during each of the two events was 131 ppb measured at Grand Bend and 99 ppb measured in Toronto for June 7-14, 2005 and June 18-20, 2016, respectively. The daily patterns for the ozone maximum concentrations recorded at Grand Bend are shown in *Figure 11* for June 8, 2005 and June 19, 2016 - the second day of both episodes. This figure highlights the differences in the ozone peak levels starting in the afternoon hours.

Figure 11: Daily Pattern of Ozone at Grand Bend



On June 8, 2005, ozone at Grand Bend reached 131 ppb and exceeded the Ontario AAQC for six consecutive hours; on June 19, 2016, ozone climbed to 90 ppb and was in exceedance of the Ontario AAQC for only two hours. Typically, ozone is at its highest between noon and early evening and that is evident in the daily pattern. Even though the ozone maximums both occurred at 4 p.m., it took more time for ozone to develop on June 19, 2016. As shown in *Figure 12*, temperatures exceeded 30°C for both events, yet the duration of elevated ozone and peak concentrations were more intense in 2005.

Figure 12: Hourly Temperatures at Grand Bend



Note: A hot day is defined as a day where the temperature is greater than 30°C.

CASE STUDY 2

June 24-29, 2005 *vs* August 10-11, 2016

The ozone events of June 24-29, 2005 and August 10-11, 2016 shared a very similar meteorological pattern. A high pressure ridge over the northeastern U.S. and southern Ontario followed by a low pressure trough over northern Ontario, resulted in southwesterly winds and a flow of very warm and humid air across southern Ontario. The June 24-29, 2005 episode was persistent and widespread across the province, while the August 10-11, 2016 episode was brief and occasional. The one-hour ozone maximum concentrations recorded during the 2005 and 2016 episodes in Case Study 2 are displayed in *Figure 13*. The one-hour ozone maximums recorded in 2005 were significantly higher than those recorded in 2016. The highest one-hour ozone concentration was 125 ppb at Grand Bend during the 2005 episode and 96 ppb at Belleville during the 2016 episode.

Figure 14 displays the geographical distribution of one-hour ozone exceedances for the duration of the ozone events in Case Study 2. With the exception of Sault Ste. Marie and Thunder Bay, Ontario's AAQC was exceeded at all air monitoring locations across the province during the 2005 episode showing that elevated ozone was widespread. Over the two-day episode in 2016, only five air monitoring stations exceeded the ozone AAQC during this time.

In summary, the 2005 and 2016 episodes, illustrated in Case Studies 1 and 2, shared very similar meteorological patterns, and experienced weather conditions conducive to ozone formation as southwesterly flows of warm air travelled across southern Ontario. Ozone episodes were short-lived and less widespread with lower maximums in 2016 - an obvious contrast to the observations in 2005, thus implying that the formation of ozone has decreased over time. The similarity in meteorological conditions between the episodes in the two case studies suggests that the reduction in emissions of ozone precursors (nitrogen oxides and volatile organic compounds) over the past 10 years in Ontario and the U.S. has contributed to the substantial decrease in ozone concentrations. However, additional analyses of the 2005 and 2016 data are needed to better understand the differences in smog formation between these two time periods.

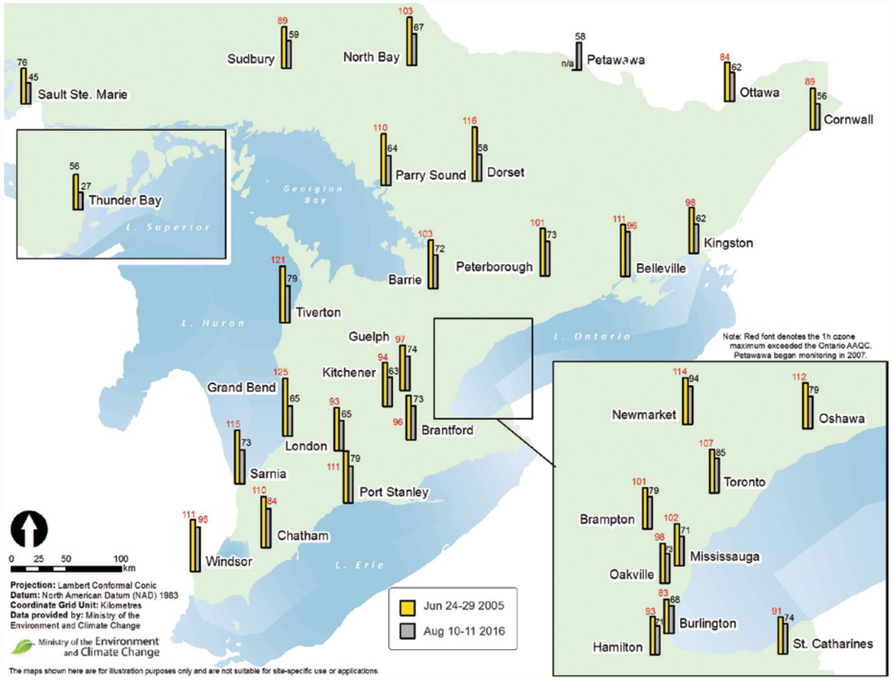


Figure 13: Geographical Distribution of One-Hour Ozone Maximums Recorded Across Ontario During Two Episodes (Jun 24-29, 2005 and Aug 10-11, 2016)

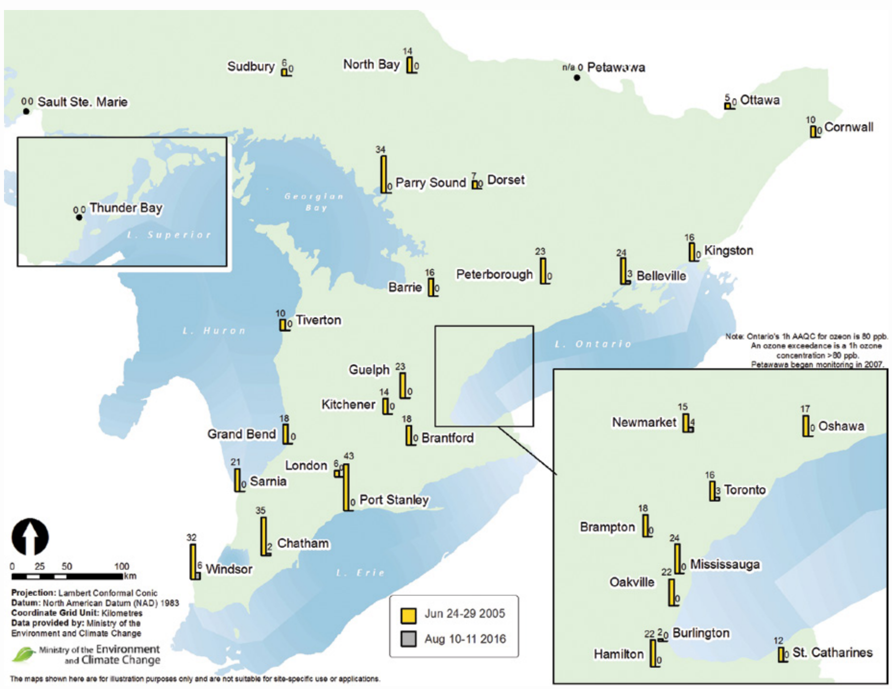


Figure 14: Geographical Distribution of One-Hour Ozone Exceedances Across Ontario During Two Episodes (Jun 24-29, 2005 and Aug 10-11, 2016)

5.0 Sulphur Dioxide

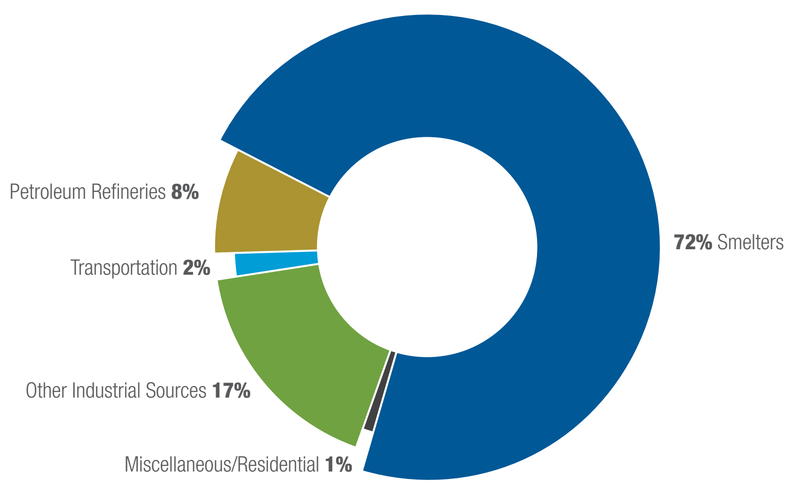
Sulphur dioxide is a colourless gas that smells like burnt matches. It can also be oxidized in the atmosphere to form sulphuric acid aerosols. In addition, sulphur dioxide is a precursor to sulphates, one of the main components of airborne secondary $PM_{2.5}$. Major sources of SO_2 include smelters, industrial processes and electric utilities.

Health effects caused by exposure to high levels of SO_2 include breathing problems, respiratory illness, and the exacerbation of respiratory and cardiovascular disease. People with asthma, chronic lung disease or heart disease are the most sensitive to SO_2. Sulphur dioxide damages trees and crops. Similar to NO_2, SO_2 leads to the formation of $PM_{2.5}$ and is also a precursor to acid rain, which contributes to the acidification of soils, lakes and streams, accelerated corrosion of buildings, and reduced visibility.

Smelters in central Ontario are the major sources of SO_2 emissions in Ontario, accounting for approximately 72 per cent of the provincial SO_2 emissions according to 2016 estimates for point, area and transportation sources (excluding emissions from open and natural sources), as shown in *Figure 15*. Industrial processes (e.g. petroleum refining, cement and concrete manufacturing) accounted for an additional 25 per cent. The transportation sector and miscellaneous sources accounted for the remaining 3 per cent of all SO_2 emissions in the province (Air Pollutant Emission Inventory 1990-2016, 2016).

There were no exceedances of the provincial one-hour, 24-hour and annual AAQC for SO_2 of 250 ppb, 100 ppb and 20 ppb, respectively, at any of the ambient air monitoring locations in Ontario during 2016. Hamilton Downtown recorded the highest SO_2 annual mean (3.2 ppb) during 2016, and the highest 24-hour maximum concentration (23 ppb) was recorded at Sudbury. Sudbury also recorded the highest one-hour maximum concentration (243 ppb) during 2016.

Figure 15: Ontario Sulphur Dioxide Emissions by Sector (2016 Estimates for Point/Area/Transportation Sources)



Note: Excludes emissions from open and natural sources.

The SO_2 annual mean concentrations from 2007 to 2016 show a decreasing trend of 51 per cent across Ontario in *Figure 16*. Overall, provincial SO_2 emissions have decreased by approximately 40 per cent from 2007 to 2016 as shown in *Figure 17* (Air Pollutant Emission Inventory 1990-2016, 2016). The reduction of SO_2 emissions over the years is the result of various initiatives, which include, but are not limited to,

i. Control orders for Ontario smelters;

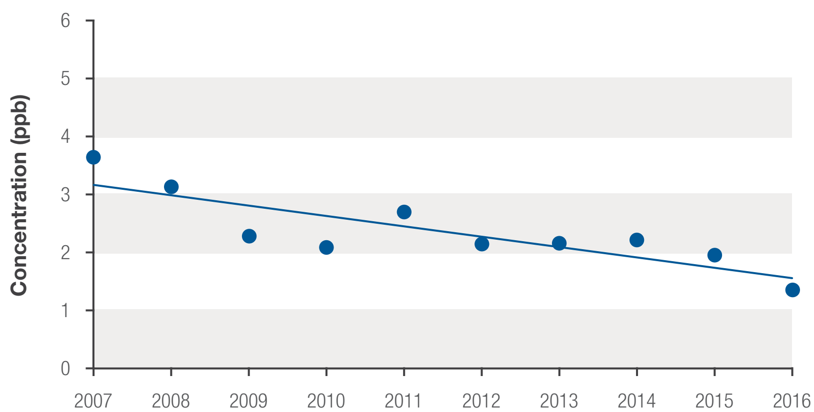
ii. Countdown Acid Rain program and Canada-wide Acid Rain Strategy;

iii. Ontario emissions trading regulations on sulphur dioxide and nitrogen oxides (O. Reg. 397/01 and O. Reg. 194/05);

iv. Cessation of coal use in electricity generation; and

v. Low sulphur content in transportation fuels.

Figure 16: Trend of SO_2 Annual Means Across Ontario (2007-2016)

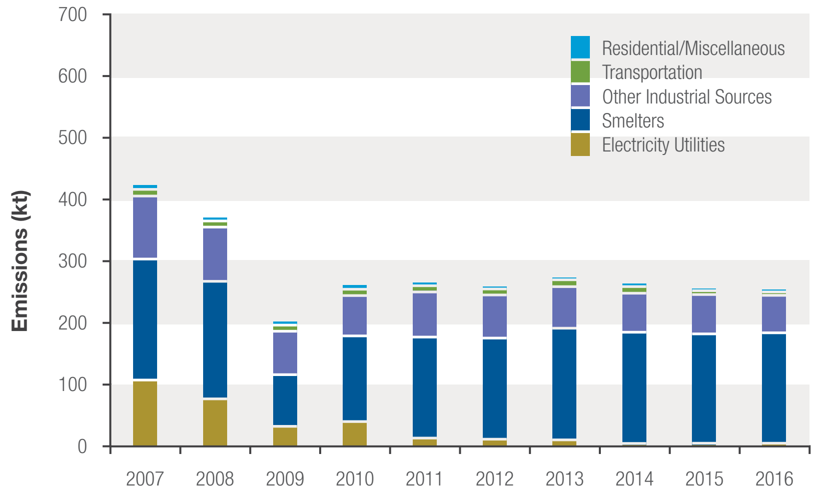


Note: 10-year trend is a composite mean based on 9 ambient air monitoring sites.

The NO_x and SO_2 Electricity Sector Emissions Trading Regulation, O.Reg.397/01, placed limits on Ontario Power Generation's (OPG) fossil fuel-fired generating stations starting in 2002. The Regulation was expanded in 2004 to also cover independent power producers. The primary goal of the program is to facilitate the cost-effective reduction of NO_x and SO_2 emissions through industry caps and incentives that reward innovation and voluntary action. Emissions from electricity generators covered by the program decreased by approximately 80% for NO_x and 95% for SO_2 between 2007 and 2016 (this was mostly the result of phasing out coal-fired electricity generation in the province).

The NO_x and SO_2 Emissions Trading for Industry Regulation, O.Reg. 194/05, includes large industrial emitters of NO_x and SO_2. Thirty facilities from seven industrial sectors are included in the program. Capped sectors include glass, petroleum refining, cement, iron and steel, pulp and paper, carbon black, and base metal smelting. Emissions from industry covered by the program decreased by approximately 30% for NO_x and 30% for SO_2 between 2007 and 2016.

Figure 17: Ontario SO_2 Emission Trend (2007-2016)



Note: Excludes emissions from open and natural sources.

6.0 Carbon Monoxide

Carbon monoxide is a colourless, odourless, tasteless and, at high concentrations, poisonous gas. This gas can enter the bloodstream and reduce oxygen delivery to the organs and tissues. People with heart disease are particularly sensitive to CO. Carbon monoxide is produced primarily by the incomplete combustion of fossil fuels. The 2016 estimates for point, area and transportation sources (excluding emissions from open and natural sources) indicate that the transportation sector accounted for 71 per cent of all CO emissions (Air Pollutant Emission Inventory 1990-2016, 2016).

In 2016 there were no exceedances of the provincial one-hour and eight-hour AAQC of 30 parts per million (ppm) and 13 ppm, respectively, at any of the AQHI air monitoring stations that measure CO in Ontario. Windsor Downtown recorded the highest one-hour CO maximum of 2.29 ppm and Toronto West recorded the highest eight-hour maximum of 1.23 ppm. Higher CO concentrations recorded in urban centres are attributable to vehicle emissions.

The composite means of the one-hour and eight-hour CO maximums have decreased 53 per cent and 24 per cent, respectively, across the province from 2007 to 2016. Carbon monoxide emissions have been reduced by approximately 32 per cent from 2007 to 2016 (Air Pollutant Emission Inventory 1990-2016, 2016).

7.0 Canadian Ambient Air Quality Standards

In May of 2013 the federal government published the Canadian Ambient Air Quality Standards (CAAQS) as non-binding objectives under the *Canadian Environmental Protection Act*. The CAAQS were developed under the direction of the Canadian Council of Ministers of the Environment (CCME) as outdoor air quality targets that "set the bar" for air quality actions across the country.

The CAAQS replaced the existing Canada-wide Standards (CWS) for $PM_{2.5}$ and ozone in 2013 by setting stricter targets, and introducing an annual standard for $PM_{2.5}$. An annual standard helps protect human health from long-term or chronic exposure to fine particles. The purpose of the CAAQS is to drive continuous improvement in air quality. In 2015, provinces and territories were formally required to report ambient air quality measurements against the CAAQS. Table 1 shows the standards for achieving the CAAQS.

Table 1: CAAQS Standards

$PM_{2.5}$ 24h	$PM_{2.5}$ Annual	Ozone 8h
28 µg/m³(1)	10 µg/m³(2)	63 ppb(3)

(1) based on the 98th percentile 24-hour average annually, averaged over three consecutive years.

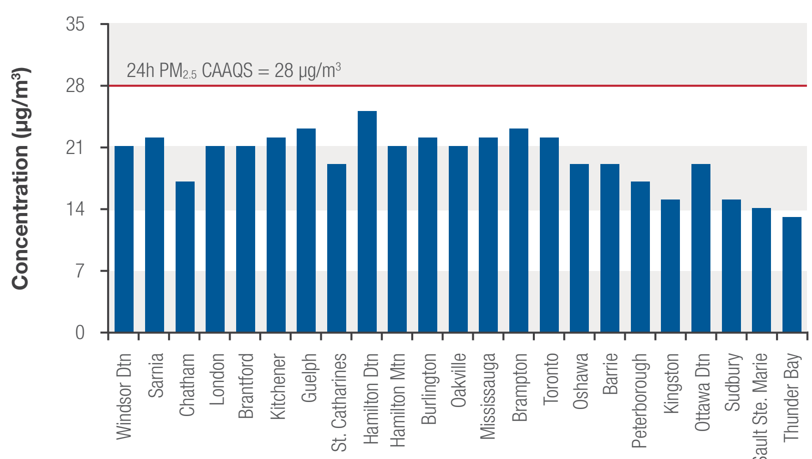
(2) based on the annual mean averaged over three consecutive years.

(3) based on the annual 4th highest daily maximum eight-hour running average, averaged over three consecutive years.

Meeting $PM_{2.5}$ CAAQS in Ontario

The 2016 24-hour $PM_{2.5}$ CAAQS metric values ranged from 13 µg/m³, reported for both Sudbury and Thunder Bay, to 25 µg/m³, reported for Hamilton Downtown. The 2016 annual $PM_{2.5}$ CAAQS metric concentrations ranged from 4.9 µg/m³, reported for Sault Ste. Marie, to 9.8 µg/m³, reported for Hamilton Downtown. The 24h and annual $PM_{2.5}$ CAAQS were not exceeded in 2016. The CAAQS metric values for the 24h and annual $PM_{2.5}$ are displayed in *Figures 18 and 19*, respectively, and in Table A19 of the Appendix.

Figure 18: 24h $PM_{2.5}$ CAAQS Metric Values for Designated Sites Across Ontario, 2016

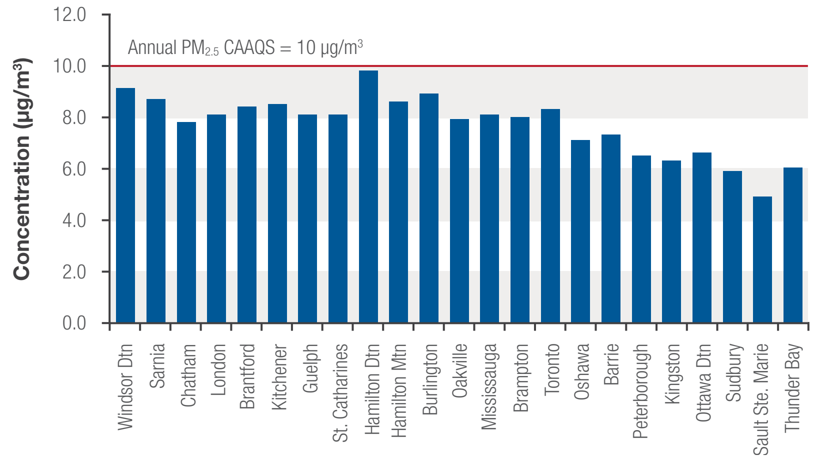


Note:

The CAAQS for 24h $PM_{2.5}$ (28 µg/m³) is based on the 98th percentile measurement annually, averaged over three consecutive years.

Sarnia's metric is based on a two-year average.

Figure 19: Annual $PM_{2.5}$ CAAQS Metric Values for Designated Sites Across Ontario, 2016



Note:

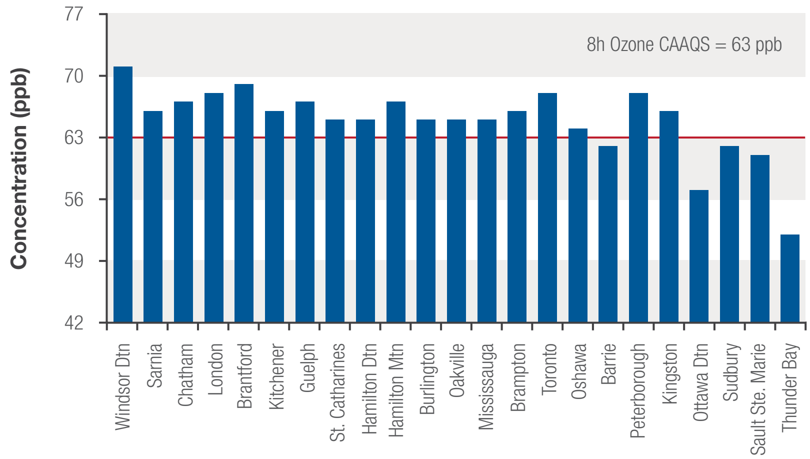
The CAAQS for annual $PM_{2.5}$ (10 µg/m^3) is based on the annual mean averaged over three consecutive years.

Sarnia's metric is based on a two-year average.

Meeting Ozone CAAQS in Ontario

The ozone CAAQS metric values for CAAQS designated Ontario ambient air monitoring sites for 2016 are based on a three-year average, 2014-2016. The 2016 ozone CAAQS metric values ranged from 52 ppb, reported for Thunder Bay, to 71 ppb, reported for Windsor Downtown. Five of the 23 designated sites met the CAAQS of 63 ppb for ozone in 2016. *Figure 20* shows the 2016 ozone CAAQS metric values for designated CAAQS sites across Ontario; they are also displayed in Table A19 of the Appendix. Transboundary influences, from both the U.S. and beyond, account for a significant portion of Ontario's smog when their levels are higher. A Weight of Evidence (WOE) analysis demonstrates the influence of transboundary flow on days with elevated ozone concentrations and confirms that Ontario's CAAQS reporting stations would have met the ozone CAAQS if transboundary flow days were excluded from the calculated metric. (The WOE approach consists of performing, evaluating and documenting a series of technical analyses that collectively support the conclusion that exceedances of the standard on a given day were influenced by transboundary flows or exceptional events). Emission reductions in Ontario and the U.S. have contributed to decreases in $PM_{2.5}$ and ozone concentrations. However, while ambient concentrations have improved, the province continues to experience high levels of ozone due to transboundary air pollution, increasing global background levels, and reduced scavenging effect which has contributed to exceedances of the ozone standard.

Figure 20: Ozone CAAQS Metric Values for Designated Sites Across Ontario, 2016



Note:

The CAAQS for ozone (63 ppb) is based on the consecutive three year average of the annual 4th highest daily maximum eight-hour running average.

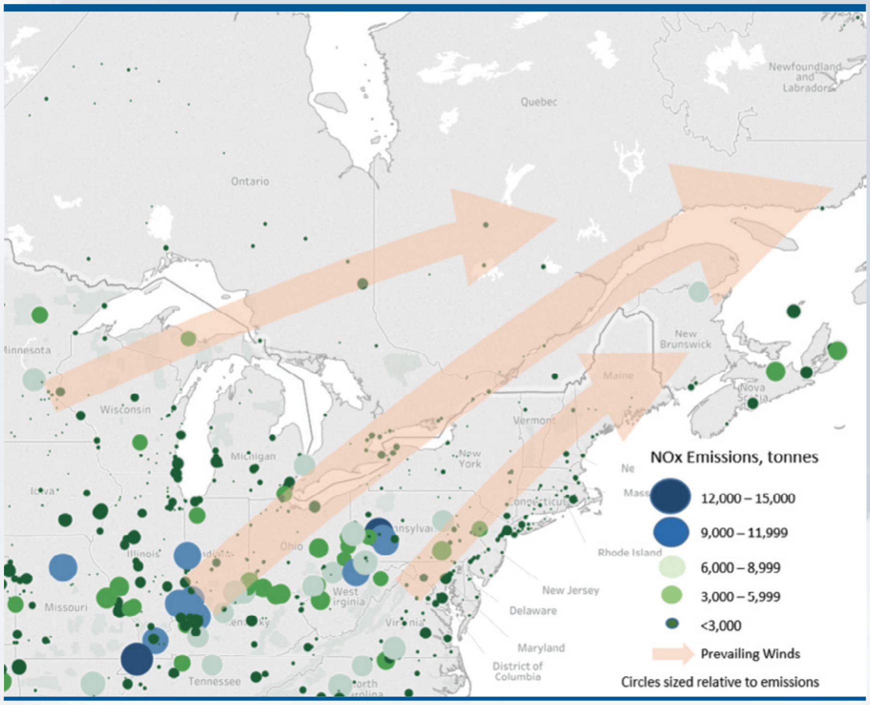
Transboundary Influences on Ontario's Smog

Smog related air pollutants (i.e. $PM_{2.5}$, ozone and their precursors) are generated both locally and regionally, and, with winds, can travel hundreds of kilometres, affecting areas far from the source of the pollution. Long-range transport and transboundary flow of air pollutants play a significant role in Ontario's air quality.

Elevated levels of $PM_{2.5}$ and ground-level ozone are often associated with distinct weather patterns that affect air quality in the lower Great Lakes region. Such weather conditions are generally associated with slow-moving high pressure systems south of the lower Great Lakes. This results in long-range transport of smog pollutants from neighbouring U.S. industrial and urbanized states during south to southwesterly flow conditions (Yap et al, 2005).

As shown in *Figure 21*, during smog season prevailing southwesterly airflows result in the transport of smog related pollutants from U.S. (e.g. emissions from electricity generators in the Ohio Valley) into Ontario.

Figure 21: 2016 NO_x Emissions from Electricity Generators Located in Eastern U.S. and Canada with Prevailing Winds During Smog Season



The Community Multi-scale Air Quality model (CMAQ) (USEPA, 2018), developed by the U.S. Environmental Protection Agency, was used to characterize and predict the formation, transportation and transformation of smog related pollutants (e.g. ozone and $PM_{2.5}$) in the atmosphere. The CMAQ model results presented in *Figures 22 and 23* quantify the impact of transboundary flows of smog related pollutants into and across Ontario. Emissions of smog precursors from a region that included eastern North America were used along with meteorological conditions to assess ambient concentrations of pollutants for 2010. With advances in computer technology, the accuracy of these model results is much better than earlier modelling studies for Ontario i.e. model resolution has improved from 36x36 km to 12x12 km (Yap et al, 2005).

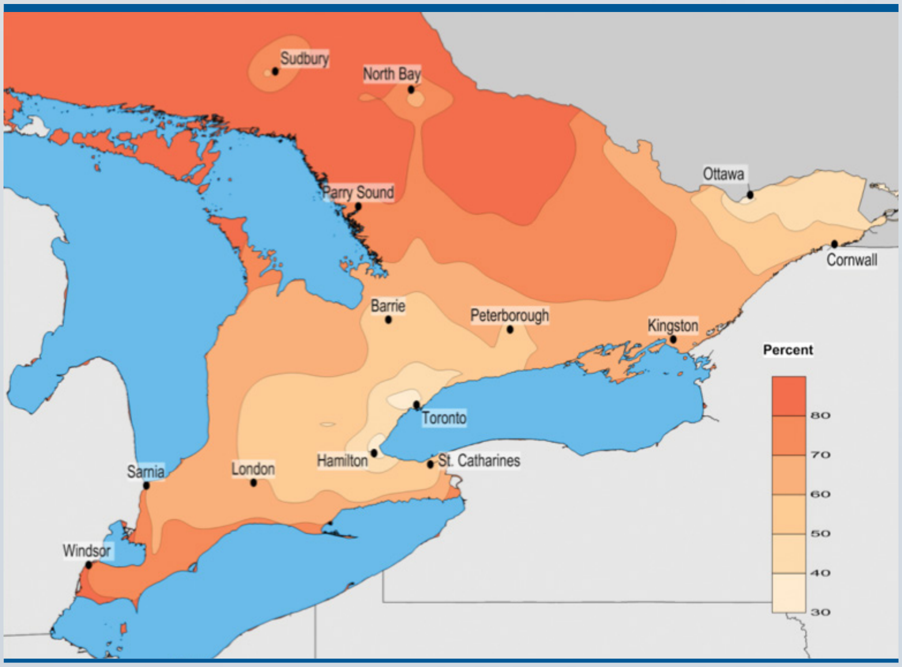


Figure 22: Transboundary Influences on Ontario's Annual Average $PM_{2.5}$ Concentrations

$PM_{2.5}$

Transboundary contributions to Ontario's $PM_{2.5}$ concentrations are dominated by U.S. sources since global background levels of $PM_{2.5}$ are relatively small.

The influence of transboundary sources on levels of $PM_{2.5}$ in Ontario varies across the province, depending on whether there are significant local sources in the area that directly emit $PM_{2.5}$ (e.g., from construction or wood burning) or if the area is mainly affected by secondary $PM_{2.5}$ formation. Secondary $PM_{2.5}$ is formed in the atmosphere through a series of complex reactions of the precursor emissions (i.e. SO_2, NO_x, VOCs, and ammonia) from upwind emission sources. Generally, Ontario's secondary $PM_{2.5}$ originates mainly from the U.S. and is transported into the province.

In border areas of southwestern Ontario, such as Windsor and Sarnia, transboundary sources of $PM_{2.5}$ dominate, contributing to over 80 per cent or more of the annual $PM_{2.5}$ concentrations in some areas. These transboundary contributions, which are mainly due to secondary $PM_{2.5}$, decrease further away from the U.S. border as shown in *Figure 22*.

The transboundary contributions to $PM_{2.5}$ concentrations are different in the GTA where there are many more sources of directly emitted $PM_{2.5}$ spread across the region and thus transboundary contributions of $PM_{2.5}$ are much less (up to 40%). Outside of the GTA, transboundary influences increase in all directions. Similar patterns are found in areas around other large urban centers such as Ottawa where transboundary contributions are 30-40%, on an annual basis.

Towards Kingston, the transboundary contributions to $PM_{2.5}$ concentrations are still significant (between 60-70%), because there are few sources of directly emitted $PM_{2.5}$ in this area; however, this is balanced by secondary $PM_{2.5}$ resulting from Ontario precursor emission sources which are located upwind (i.e. GTA) as shown in *Figure 22*.

With very few local sources of $PM_{2.5}$ in much of northern Ontario, the majority of the $PM_{2.5}$ in this part of the province originates from outside of Ontario (over 80%). In some areas, such as Sudbury and North Bay, where there are significant local sources of directly emitted $PM_{2.5}$, transboundary influence is less, but still significant (60-70%). In general, the United States' contribution to $PM_{2.5}$ concentrations in Ontario ranges from 30% to over 80% annually, depending on the location in the province.

Ozone

Ozone is regional in nature and not emitted directly into the atmosphere but is formed from precursor emissions including NO_x and VOCs. Accordingly, transboundary sources including the U.S., as well as sources from around the globe (global background), are significant contributors to Ontario's ozone levels. The combined influence of these transboundary sources, which varies across the province, is most significant in southwestern Ontario, and decreases moving from the province's southwest to northeast.

Generally, ozone concentrations in Ontario are higher between May and September, when the meteorological conditions are favourable for the formation and accumulation of ozone. During this period, a significant amount of Ontario's ozone can originate from emission sources in the U.S.

Transboundary contributions are most notable in areas of southwestern Ontario, in close proximity to the U.S. border, and along the northern shore of Lake Erie and the eastern shore of Lake Huron/Georgian Bay. On higher concentration days (i.e. 4^{th} highest daily concentration in a year), over 95% of the ozone concentrations are attributable to transboundary sources, with the U.S. contributing to as much as 40% of this as shown in *Figure 23*. In general, global background contributions to ozone concentrations in Ontario on poor air quality days ranges from 60-80% depending on the location in the province.

Global background contributions to ozone also play a significant role in Ontario's transboundary air pollution. Sources which contribute to global background include long-range transport of man-made emissions from outside North America and natural emissions (e.g. the downward transport of ozone from the stratosphere or ozone produced from lighting strikes).

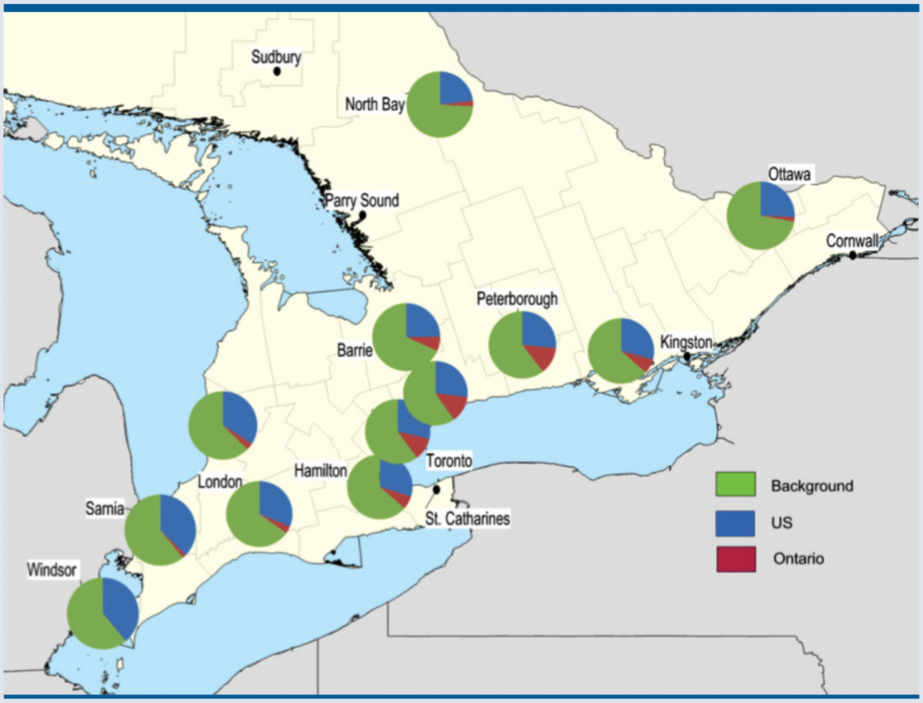
Global background levels are much more significant in areas of northern and eastern Ontario where there are fewer local sources of ozone precursor emissions (e.g. NO_x and VOCs) and the influence of the U.S. is relatively small. In these areas, global background accounts for, on average, over 60% of the ozone levels on higher concentration days.

In large urban centres, generally ozone concentrations are lower, and in the downwind suburban and rural areas, higher. This occurs because ozone is depleted when it reacts with NO emissions from sources such as motor vehicles. This reaction, known as scavenging, results in reduced ozone concentrations and produces NO_2. Further downwind, the NO_2 reacts with volatile organic compounds in the presence of sunlight to produce ozone.

This is evidenced by the elevated ozone concentrations in the areas downwind of the province's Greater Golden Horseshoe area, such as Belleville and Peterborough. Due to the substantial upwind scavenging impacts, the transboundary influences in these downwind areas are generally less as compared to the Greater Toronto Area (GTA).

As ozone precursor emissions continue to decrease across North America, the rising global background levels play an increasingly important role in Ontario's air quality (Environment and Climate Change Canada, 2013).

Figure 23: Transboundary Influences on Ontario's Ozone Concentrations on High Concentration Days

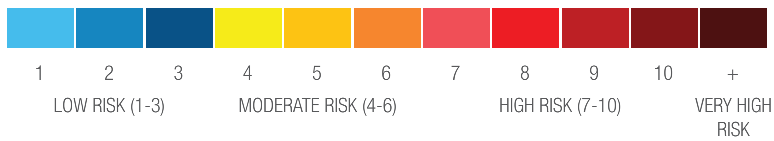


8.0 Air Quality Health Index and Air Quality Alerts

The Air Quality Health Index (AQHI)

The AQHI was developed and implemented by Health Canada with the assistance of Environment and Climate Change Canada and all provinces. It derives a value based on the cumulative health effects of three pollutants – NO_2, $PM_{2.5}$ and ozone. The AQHI provides real-time air quality information using a scale of one through 10 or greater, with lower numbers representing better air quality, as depicted in *Figure 24*. Index values between one and three are considered low risk, four to six are moderate risk, seven to 10 are high risk and greater than 10 are very high risk. Table 2 outlines the health messages associated with the AQHI. The ministry website, www.airqualityontario.com, provides index values and corresponding categories and health messages.

Figure 24: AQHI Scale



Source: Environment & Climate Change Canada.

The AQHI also reflects exceedances of Ontario's AAQC: 200 ppb for NO_2, 80 ppb for ozone, 250 ppb for SO_2, 30 ppm for CO, and 27 ppb for TRS compounds. If an hourly air pollutant concentration exceeds Ontario's AAQC and the AQHI value is in the low or moderate risk categories (AQHI of 6 or less), then the AQHI is reported with the appropriate high risk value (AQHI of 7 or greater) to reflect the exceedance.

Based on the AQHI categories, in 2016, Ontario reported low risk air quality 93 per cent of the time, moderate risk 6.7 per cent of the time, and high risk less than 1 per cent of the time; there were no very high risk hours reported. Table A20 of the Appendix provides the percentage distribution of hourly AQHI readings for each of the 39 monitoring sites by AQHI value and the number of high risk AQHI days.

Access to Air Quality Information

Near real-time and historic pollutant concentration data and AQHI values are available to the public (24 hours per day, 7 days a week) from across the province on the ministry's web site, www.airqualityontario.com. The public can also access index values via the Interactive Voice Response (IVR) system. (To access a recording in English or French, call 1.800.387.7768, or in Toronto, call 416.246.0411). The ministry's web site also provides air quality forecasts throughout the day, based on regional meteorological conditions and current pollution levels in Ontario and bordering American states.

Table 2: Air Quality Health Index Categories and Health Messages

Health Risk	Air Quality Health Index	Health Messages	
		At Risk Population*	General Population
Low	1-3	Enjoy your usual outdoor activities	Ideal air quality for outdoor activities.
Moderate	4-6	Consider reducing or rescheduling strenuous activities outdoors if you are experiencing symptoms.	No need to modify your usual activities unless you experience symptoms such as coughing and throat irritation.
High	7-10	Reduce or reschedule strenuous activities outdoors. Children and the elderly should also take it easy.	Consider reducing or rescheduling strenuous activities outdoors if you experience symptoms such as coughing and throat irritation.
Very High	Above 10	Avoid strenuous activities outdoors. Children and the elderly should also avoid outdoor physical exertion.	Reduce or reschedule strenuous activities outdoors, especially if you experience symptoms such as coughing and throat irritation.

* People with heart or breathing problems are at greater risk. Follow your doctor's usual advice about exercising and managing your condition.

Source: Environment & Climate Change Canada

Air Quality Alerts

Ontario maintains a two-level air quality alert system in partnership with Environment and Climate Change Canada: The first level is a Special Air Quality Statement (SAQS), which informs the public of the potential for degrading air quality and is issued if an AQHI of 7 or greater is expected to last for 1 or 2 hours (i.e., "pop-up"). A SAQS is also issued for areas where forest fire smoke is expected to cause deteriorating air quality. The last major forest fire impact in Ontario was in July 2013 due to forest fire smoke that originated in northwestern Quebec, east of James Bay. In Ontario, potential impacts of forest fires are forecasted by determining prevalent meteorological conditions and observing air pollutants at AQHI air monitoring stations (Sofowote and Dempsey, 2015).

The second level is a Smog and Air Health Advisory (SAHA), issued when "high risk" AQHI levels (AQHI of 7 or greater) are expected to be persistent and continue for 3 hours or more. The SAQS does not constitute a SAHA, but serves as a notification for Ontarians, especially those at risk, to be aware of the air quality and adjust their activities if adverse health effects are observed.

Air quality alerts are issued via the Ministry of the Environment and Climate Change web site, Environment and Climate Change Canada's web site, and through email air quality alert notifications. To subscribe for air quality alert notifications, please visit the ministry web site, www.airqualityontario.com/alerts/signup.php.

Ontario issued one SAHA in 2016 and 10 SAQS for regions across the province. The SAHA was issued for the City of Toronto where elevated ozone concentrations reached a maximum of 99 ppb. All 10 SAQS were issued as a result of elevated ozone concentrations across Ontario. Table A21 of the Appendix summarizes the number of SAQS and SAHA issued for Ontario in 2016.

9.0 Air Toxics – Select VOCs

Volatile organic compounds (VOCs) are organic chemical compounds that may evaporate under normal ambient conditions of temperature and pressure. VOCs are precursors of ground-level ozone and $PM_{2.5}$. VOCs are emitted into the atmosphere from a variety of emission sources, including vehicles, fossil fuel combustion, steel-making, petroleum refining, fuel-refilling, industrial and residential solvent use, paint application, manufacturing of synthetic materials (e.g. plastics, carpets), food processing, agricultural activities and wood processing and burning. As stated in Section 2.0, transportation sectors accounted for approximately 28 per cent of VOCs and the second largest source was general solvent use accounting for approximately 26 per cent. (Refer to *Figure 7* for the estimates of Ontario's VOCs emissions from point, area and transportation sources).

VOC Monitoring

Specialized, non-routine monitoring and analytical techniques are required to measure VOCs because they are usually present in the atmosphere in a gaseous form at ultra-trace concentrations. VOC samples are collected by automatically drawing ambient air into empty stainless steel canisters over a 24-hour period (midnight to midnight), following the National Air Pollution Surveillance (NAPS) sampling schedule (typically every sixth day) for urban sites. Concentrations for up to 161 selected VOCs are reported for each sample. For the purposes of this report, commonly detected VOCs (benzene, toluene, ethylbenzene, xylene, and 1,3-butadiene) measured at seven AQHI air monitoring stations (Windsor West, Sarnia, London, Kitchener, Hamilton Downtown, Newmarket and Ottawa) between 2007 and 2016 are included in this discussion. Data from these sites are provided by Environment and Climate Change Canada as part of a co-operative federal-provincial program under NAPS and are available online at http://maps-cartes.ec.gc.ca/rnspa-naps/data.aspx. Annual 2016 statistics for the six select VOCs are presented in Tables A22-A27 of the Appendix.

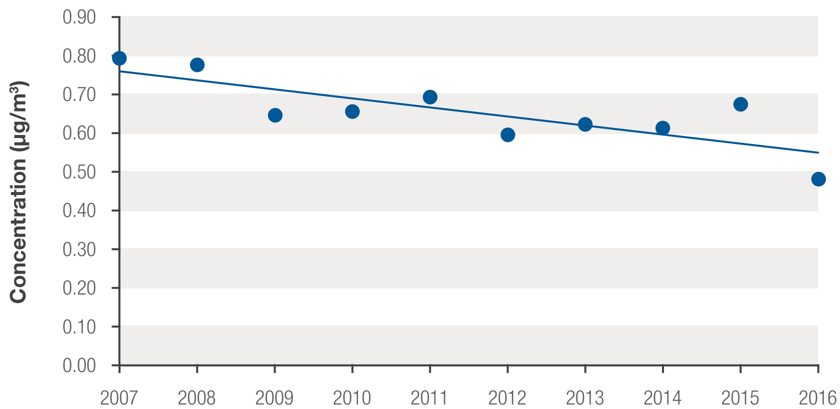
Benzene, Toluene, Ethylbenzene, Xylene (BTEX)

Benzene is a VOC, which is primarily used in the production of plastics and other chemical products. Large quantities of benzene are obtained from petroleum, either by direct extraction from certain types of crude oils or by chemical treatment of gasoline. Benzene is classified as a human carcinogen (USEPA, 2016).

In 2016, benzene annual means ranged from 0.34 µg/m³ at Newmarket to 0.70 µg/m³ in Sarnia. Ontario's 24h AAQC for benzene of 2.3 µg/m³ was only exceeded at the Sarnia AQHI air monitoring station on one occasion. The 24-hour maximum benzene concentration reported at Sarnia was 2.5 µg/m³.

Of the seven monitoring locations, the Ontario annual AAQC for benzene of 0.45 µg/m³ was exceeded at three AQHI air monitoring stations – Windsor West, Sarnia, and Hamilton Downtown. The annual mean for benzene reported at Windsor West, Sarnia and Hamilton Downtown were 0.52 µg/m³, 0.70 µg/m³ and 0.68 µg/m³, respectively. Over the 10-year period from 2007 to 2016, benzene concentrations in Ontario have decreased 28 per cent as shown in *Figure 25*.

Figure 25: Trend of Benzene Annual Means Across Ontario (2007-2016)



Note: 10-year trend is a composite mean based on 7 sites.

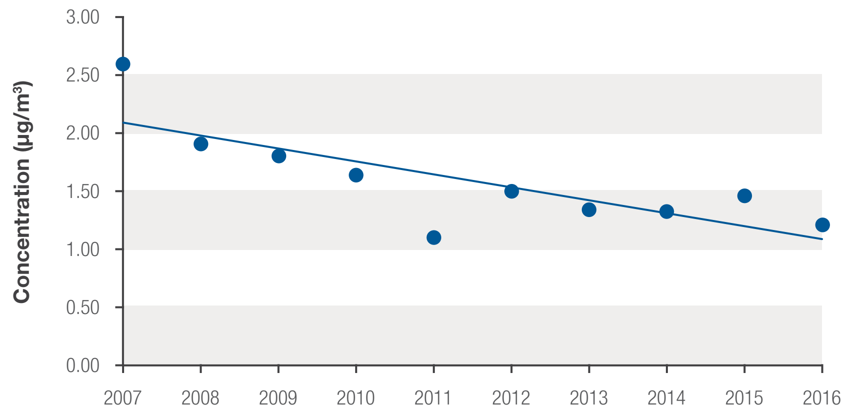
Toluene is a VOC used to make chemicals, explosives, dyes and many other compounds. It is used as a solvent for inks, paints, lacquers, resins, cleaners, glues and adhesives. Toluene is found in gasoline and aviation fuel. Studies reveal that toluene affects the central nervous system of humans and animals; however, there is little evidence to classify it as a carcinogen (USEPA, 2016).

In 2016, the highest 24-hour maximum toluene concentration (12.2 µg/m³) was measured at the Sarnia AQHI air monitoring station. The Ontario 24-hour AAQC for toluene of 2,000 µg/m³ was not exceeded at any of the AQHI air monitoring stations. Toluene annual means ranged from 0.73 µg/m³ at the London AQHI air monitoring station to 1.78 µg/m³ at the Sarnia AQHI air monitoring station. *Figure 26* shows a 48 per cent decrease in toluene annual mean concentrations from 2007 to 2016.

Ethylbenzene, a VOC, is a colourless liquid that smells like gasoline and is mainly used in the manufacture of styrene. Exposure to ethylbenzene occurs from the use of consumer products, fuel, pesticides, solvents, carpet glues, varnishes, paints and tobacco smoke. In humans, acute exposure results in respiratory effects; limited information is available on the carcinogenic effects of ethylbenzene (USEPA, 2016).

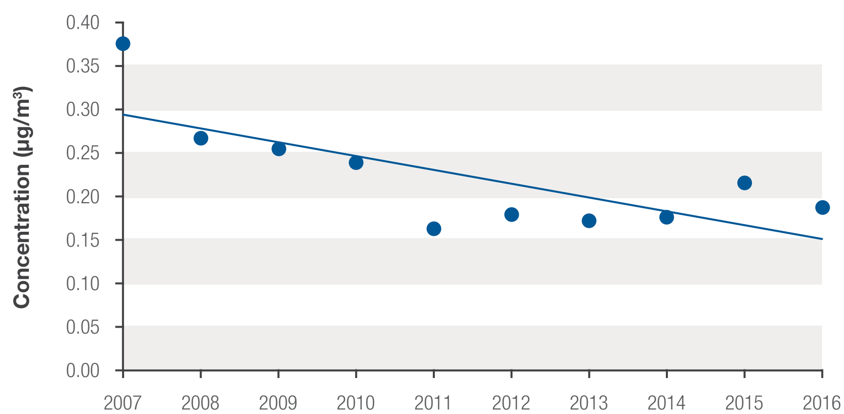
In 2016, Sarnia recorded the highest 24-hour maximum ethylbenzene concentration (1.5 μg/m³). The Ontario 24-hour AAQC for ethylbenzene of 1,000 μg/m³ was not exceeded at any of the AQHI air monitoring stations. Ethylbenzene annual means ranged from 0.11 μg/m³ at the London AQHI air monitoring station to 0.28 μg/m³ at the Sarnia AQHI air monitoring station. There has been a 49 per cent decrease in ethylbenzene annual mean concentrations from 2007 to 2016 as shown in *Figure 27*.

Figure 26: Trend of Toluene Annual Means Across Ontario (2007-2016)



Note: 10-year trend is a composite mean based on 7 sites.

Figure 27: Trend of Ethylbenzene Annual Means Across Ontario (2007-2016)

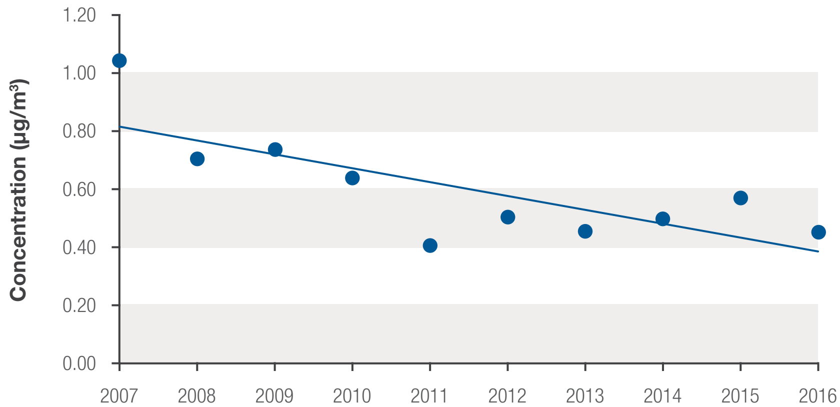


Note: 10-year trend is a composite mean based on 7 sites.

Xylene, a VOC, is a colourless, sweet-smelling liquid or gas occurring naturally in petroleum, coal and wood tar; it is also used as a solvent in the printing, rubber, paint and leather industries. Xylene, also referred to as mixed xylenes, is a mixture of three isomers: *ortho-*, *meta-* and *para*-xylene, commonly known as *o-*, *m-* and *p*-xylene, which have the same molecular formula but different chemical structure, meaning the arrangement of their atoms are different. There is no information on the carcinogenic effects of mixed xylenes on humans (USEPA, 2016).

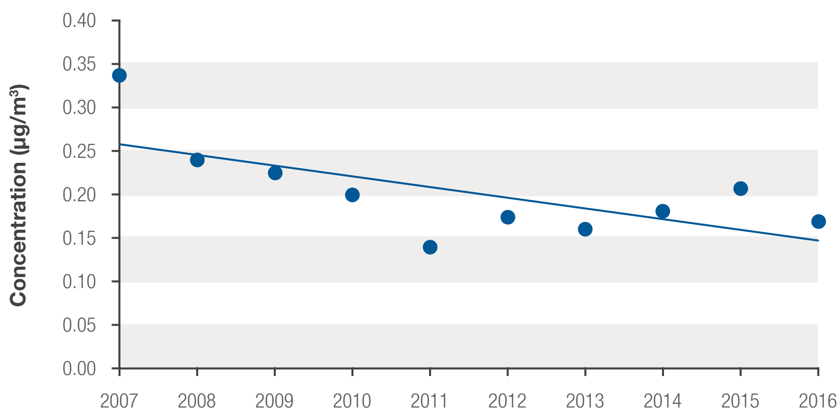
In 2016, m- and p-xylene annual means ranged from 0.27 µg/m³ at the London AQHI air monitoring station to 0.64 µg/m³ at the Windsor West AQHI air monitoring station. The annual mean concentrations of o-xylene ranged from 0.11 µg/m³ at London to 0.23 µg/m³ in Windsor West. As shown in *Figure 28*, there has been a 53 per cent decrease in m- and p-xylene annual mean concentrations from 2007 to 2016. Similarly, in *Figure 29*, o-xylene annual mean concentrations decreased 43 per cent over the same 10-year period.

Figure 28: Trend of m- and p-xylene Annual Means Across Ontario (2007-2016)



Note: 10-year trend is a composite mean based on 7 sites.

Figure 29: Trend of o-xylene Annual Means Across Ontario (2007-2016)



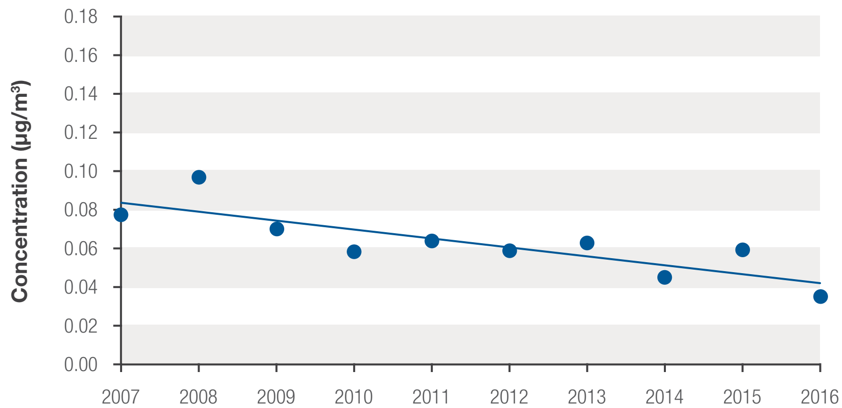
Note: 10-year trend is a composite mean based on 7 sites.

1,3-Butadiene

1,3-Butadiene, a VOC, is a colourless gas with a mild gasoline-like odour. It is released into the air through motor vehicle exhaust, manufacturing and processing facilities, forest fires or other combustion, and cigarette smoke. Acute exposure to 1,3-butadiene by inhalation in humans results in irritation of the eyes, nasal passages, throat and lungs; in addition, 1,3-butadiene is carcinogenic in humans by inhalation (USEPA, 2016).

In 2016, 1,3-butadiene annual means ranged from 0.02 µg/m³ reported at two sites – the London and the Newmarket AQHI air monitoring stations – to 0.09 µg/m³ at the Sarnia AQHI air monitoring station. The Ontario annual AAQC for 1,3-butadiene of 2 µg/m³ was met at each of the seven AQHI air monitoring stations. Over the 10-year period, 2007 to 2016, 1,3-butadiene concentrations have decreased 50 per cent as shown in *Figure 30*.

Figure 30: Trend of 1,3-Butadiene Annual Means Across Ontario (2007-2016)



Note: 10-year trend is a composite mean based on 7 sites.

Acronyms

AAQC	Ambient Air Quality Criterion (Ontario)
AQHI	Air Quality Health Index
CAAQS	Canadian Ambient Air Quality Standard
CCME	Canadian Council of Ministers of the Environment
CO	carbon monoxide
NO	nitric oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_3	ozone
PM	particulate matter
$PM_{2.5}$	fine particulate matter
SAHA	Smog and Air Health Advisory
SAQS	Special Air Quality Statement
SHARP	Synchronized Hybrid Ambient Real-time Particulate
SO_2	sulphur dioxide
TEOM	Tapered Element Oscillating Microbalance
TRS	total reduced sulphur
U.S.	United States (of America)
VOCs	volatile organic compounds
WOE	weight of evidence
km	kilometre
kt	kilotonnes
$\mu g/m^3$	micrograms (of contaminant) per cubic metre (of air) – by weight
ppb	parts (of contaminant) per billion (parts of air) – by volume
ppm	parts (of contaminant) per million (parts of air) – by volume

Glossary

Air Quality Health Index real-time information system that provides the public with an indication of air quality in cities, towns and in rural areas across Ontario. The AQHI derives a value based on the cumulative health effects of three pollutants – O_3, $PM_{2.5}$ and NO_2.

AQHI station continuous monitoring station used to inform the public of general ambient air quality levels over an entire region (not a localized area) on a real-time basis; station reports on criteria pollutant levels that are not unduly influenced by a single emission source, but rather are the result of emissions from multiple sources, including those in neighbouring provinces and states.

Ambient air outdoor or open air.

Ambient monitoring measurements of regional air quality less influenced by local and industrial sources of air contaminants.

Annual mean the average value of hourly data for a given year.

Area sources small collective emission sources that are inventoried as a group, such as any small residential, governmental, institutional, commercial or industrial fuel combustion operations, which are too numerous to inventory as point sources.

Carbon monoxide a colourless, odourless, tasteless, and at high concentrations, poisonous gas.

Continuous pollutants pollutants for which a continuous measurement record exists; effectively, pollutants that have hourly data (maximum 8,760 values per year except leap year – e.g. 2004 where maximum values for the year are 8,784).

Continuous station where pollutants are measured on a real-time basis and data determined hourly (for example ozone, sulphur dioxide).

Criterion maximum concentration or level (based on potential effects) of pollutant that is desirable or considered acceptable in ambient air.

Downwind the direction the wind is going to. If the wind is blowing towards the Southeast (blowing from the Northwest), then the downwind direction is towards the Southwest and the upwind direction is towards the Northeast.

Exceedance above the air pollutant concentration levels established by environmental protection criteria or other environmental standards.

Fine Particulate Matter also referred as respirable particles: particles smaller than 2.5 micrometres in aerodynamic diameter, which arise mainly from fuel combustion, condensation of hot vapours and chemically-driven gas-to-particle conversion processes; also referred to as $PM_{2.5}$ or respirable particles. These are fine enough to penetrate deep into the lungs.

Fossil fuels	natural gas, petroleum, coal and any form of solid, liquid or gaseous fuel derived from organic materials for the purpose of generating heat.
Fly ash	generated as a by-product of coal combustion and is used as a replacement for cement in concrete, among other uses.
Ground-level ozone	colourless gas formed from chemical reactions between nitrogen oxides and volatile organic compounds (VOCs) in the presence of sunlight near the Earth's surface.
Meteorological conditions	atmospheric conditions are related to the physical, dynamical and chemical state of the earth's atmosphere, and the interactions between the earth's atmosphere and the underlying surface, whereas weather conditions are related to the state of the atmosphere at a given time and place (e.g. temperature, atmospheric pressure, humidity, wind, cloudiness, and precipitation). The term weather is used mostly for conditions over short periods of time.
Micrometre	a millionth of a metre.
Natural sources	emission sources such as biogenic emissions from vegetation, biological and geological sources, wildfires, and other sources not made by humans.
Nitrogen dioxide	a reddish-brown gas with a pungent and irritating odour.
Open sources	emission sources that emit air contaminants over large geographical areas. Examples include dust from farms, construction, and paved and unpaved roads.
Oxidation	a chemical reaction where a substance gains an oxygen; for example, in the atmosphere, sulphur dioxide is oxidized by hydroxyl radicals to form sulphate.
Particulate matter	the general term used to describe a mixture of microscopic solid particles and liquid droplets suspended in air.
Point sources	sources that have a fixed location and are identified individually by name and location.
Primary pollutant	pollutant emitted directly to the atmosphere.
Residence time	the average length of time during which a particle is in a given location or condition.
Respirable particles	see definition for fine particulate matter.
Secondary pollutant	pollutant formed from other pollutants in the atmosphere.

Smog a contraction of smoke and fog; colloquial term used for photochemical smog, which includes ozone, fine particulate matter and other contaminants; tends to be a brownish haze.

Stratosphere atmosphere 10 to 40 kilometres above the Earth's surface.

Stratospheric ozone ozone formed in the stratosphere from the conversion of oxygen molecules by solar radiation; ozone found there absorbs some of the sun's ultraviolet radiation and prevents it from reaching the Earth.

Styrene primarily a synthetic chemical that is used extensively in the manufacture of plastics, rubber, and resins. It is also known as vinylbenzene, ethenylbenzene, cinnamene, or phenylethylene.

Sulphur dioxide a colourless gas that smells like burnt matches.

Transportation sources mobile emission sources such as wheeled vehicles, ships, aircraft and railroad locomotives.

Troposphere atmospheric layer extending from the surface up to about 10 kilometres above the Earth's surface.

Upwind the direction the wind is coming from. If the wind is blowing from the Northwest (blowing toward the Southeast) then the upwind direction is toward the Northwest and the downwind direction is toward the Southeast.

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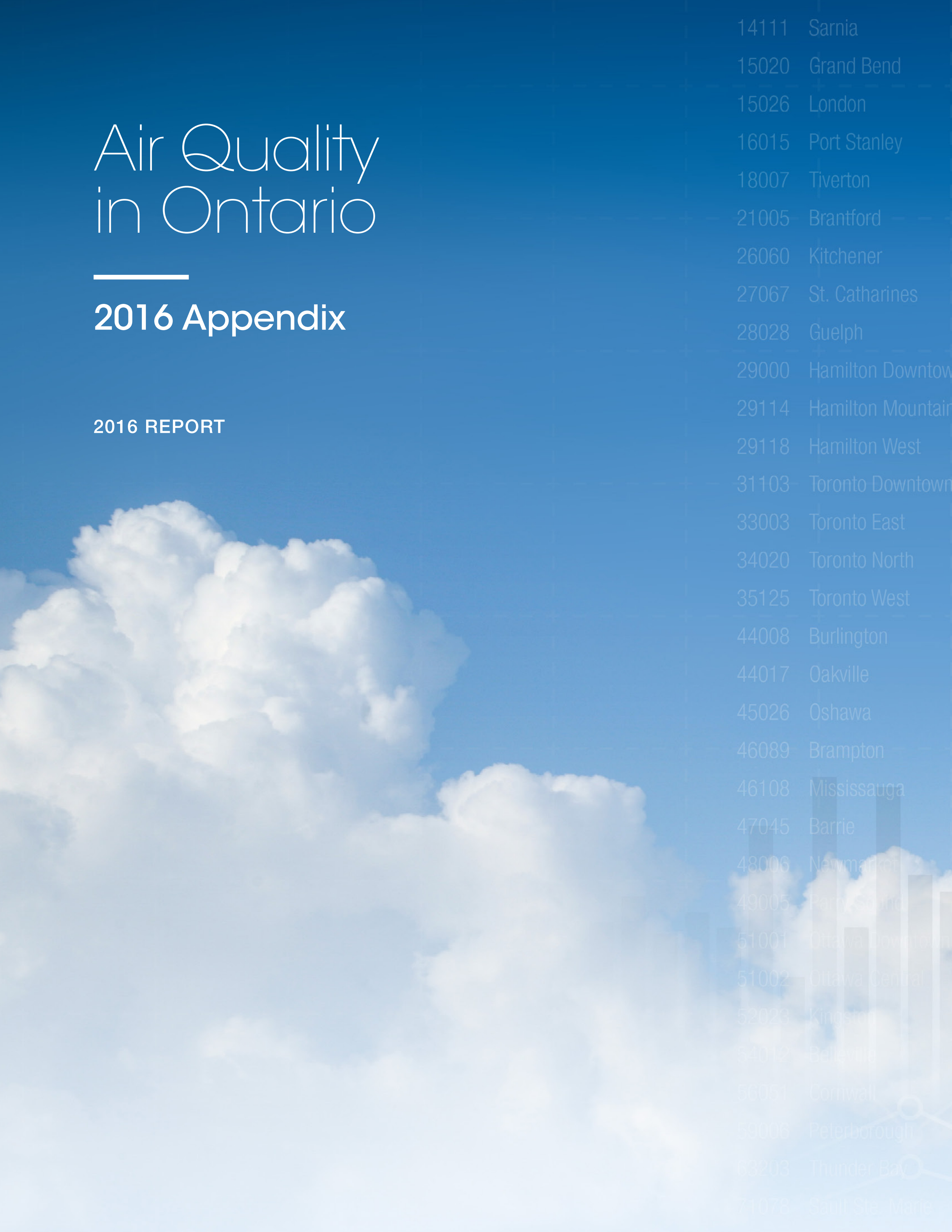
Air Quality in Ontario

2016 Appendix

2016 REPORT




12008 Windsor Downtown
12016 Windsor West
13001 Chatham
14111 Sarnia
15020 Grand Bend
15026 London
16015 Port Stanley
18007 Tiverton
21005 Brantford
26060 Kitchener
27067 St. Catharines
28028 Guelph
29000 Hamilton Downtown
29114 Hamilton Mountain
29118 Hamilton West
31103 Toronto Downtown
33003 Toronto East
34020 Toronto North
35125 Toronto West
44008 Burlington
44017 Oakville
45026 Oshawa
46089 Brampton
46108 Mississauga
47045 Barrie
48006 Newmarket
49005 Parry Sound
51001 Ottawa Downtown
51002 Ottawa Central
52023 Kingston
54012 Belleville
56051 Cornwall
59006 Peterborough
63203 Thunder Bay
71078 Sault Ste. Marie
75010 North Bay
77233 Sudbury
5655.58
1112.54
3458.69
9654.87
31103 Toronto Downtown
33003 Toronto East
34020 Toronto North
35125 Toronto West
44008 Burlington
44017 Oakville
2013 2014 2015 2016 Change Over Time
12.4 14.0 12.7 11.4 ↓ 27%
11.5 11.8 11.4 10.6 ↓ 35%
6.0 6.8 6.8 5.4 ↓ 25%
8.1 9.0 9.3 INS ↓ 20%
6.4 6.9 6.6 5.4 ↓ 53%
1.9 2.7 2.4 1.8 ↓ 25%
4.8 5.5 5.5 4.8 ↓ 36%
6.7 7.0 6.8 6.2 ↓ 35%
7.7 7.3 7.3 6.6 ↓ 43%
1233.15
1561.21
1527.52
3215.24

Appendix

The Appendix is intended for use in conjunction with the 2016 Annual Air Quality in Ontario Report.

The Appendix briefly describes the provincial Air Quality Health Index (AQHI) network, quality assurance and quality control procedures, and the Ministry of the Environment and Climate Change's air quality database. It also includes a series of tables displaying station locations and a listing of the summary statistics including means, maximums, percentile values and the number of exceedances of the Ontario Ambient Air Quality Criteria (AAQC) for each pollutant. In addition, trends for select pollutants are displayed for a 10-year period.

Monitoring Network Operations

NETWORK DESCRIPTION

In 2016, the Environmental Monitoring and Reporting Branch (EMRB) operated 39 ambient air monitoring sites across Ontario as part of the AQHI network. Monitoring site locations for the AQHI network are illustrated in Map A1. The AQHI network was comprised of 132 continuous monitoring instruments at 39 sites. These instruments have the capability of recording minute data (approximately 70 million data points per year) that are used to scan and validate the continuous hourly data.

QUALITY ASSURANCE AND QUALITY CONTROL

Day-to-day maintenance and support of the instruments are administered by EMRB staff. Instrumentation precision is verified by daily automatic internal zero and span checks. Data analysts and station operators review span control charts to confirm instrument precision using a telemetry system. A quarterly quality assurance and quality control (QA/QC) review is performed on the ambient data set in order to highlight anomalies and administer corrective action in a timely manner.

The air monitoring station operators routinely inspect and maintain monitoring equipment and stations with mandatory bi-monthly on-site visits where secondary transfer standards are used to calibrate instrumentation. Station maintenance activities are recorded using FieldWorker Inc. software, an electronic documentation solution; this information is transferred directly to the ministry's database. The instrumentation used throughout the provincial air monitoring network has been standardized to Thermo Electron Corporation analyzers in an effort to streamline parts inventory and leverage common hardware used within each analyzer. The following is a summary of the instrumentation deployed within the network and are all US EPA designated equivalent methods:

- Nitrogen Oxides – TE42C/I
- Fine Particulate Matter – SHARP 5030
- Ozone – TE49C/I
- Sulphur Dioxide – TE43C/I
- Carbon Monoxide – TE48C/I
- Total Reduced Sulphur – TE43C/CDN101

EMRB operates a laboratory with gas reference standards that adhere to those of the U.S. National Institute of Standards and Technology (NIST) and the Air Quality Research Division of Environment & Climate Change Canada. The secondary transfer standards used by station operators are referenced and certified to EMRB's NIST primary standards on a quarterly basis.

The Ontario ambient air quality monitoring network undergoes constant maintenance to ensure a high standard of quality control. Continuous real-time data are consistently reviewed, assessed and validated by EMRB staff. Immediate actions are taken to correct any inconsistencies that may affect the validity of the data. These measures ensure ambient air monitoring data are valid, complete, comparable, representative and accurate. As a result, the 2016 ambient air quality monitoring network had greater than 98 per cent valid data from over one million hourly data points.

DATA BASE

The ambient air quality data used in this report are stored in the ministry's air quality information system (AQUIS) and are made available through the Air Quality Ontario web site, http://www.airqualityontario.com/history/ and the ministry's Open Data Catalogue web page, https://www.ontario.ca/search/data-catalogue?sort=asc. A statistical pattern test is used to identify data anomalies, such as unusual pollutant concentrations. Each pollutant has a predetermined concentration range based on historical data. Values outside this range are flagged for further investigation.

Data are obtained from automated ambient air monitoring instruments that operate continuously to produce an average measurement for every hour for a possible total of 8,760 measurements in a given year. Hourly parameters measured include $NO/NO_2/NO_x$, $PM_{2.5}$, O_3, SO_2, CO and TRS compounds. A valid annual mean requires at least 6,570 hourly readings. In addition, each quarter of the year should have 75 per cent valid data for $PM_{2.5}$, whereas for ozone, only the 2nd and 3rd quarters of the year require 75 per cent valid data.

Network Descriptive Table

The AQHI network for 2016 is summarized in Table A1. The table displays the station name, numerical identifier and pollutants measured. The numerical identifier is the station (ID) number, the first digit of which identifies the geographic region in which the station is located. Air monitoring stations within the AQHI network can measure up to six common pollutants (NO_2, $PM_{2.5}$, ozone, SO_2, CO and TRS compounds) based on the pollutant(s) of concern for the regional area it represents.

Table A1 also identifies the type of air monitoring site: ambient, road-side, Canadian Ambient Air Quality Standard (CAAQS), and/or National Air Pollution Surveillance (NAPS). Ambient sites represent the general air quality of an area without any direct influence of local industrial sources. Road-side sites are within approximately 100 m of a major roadway with daily traffic volumes greater than 10,000 vehicles per day.

Annual Statistics and 10-Year Trends

The 2016 statistical data and 10-year trends for various continuous pollutants are provided in Tables A2-A9, and Tables A10-A18, respectively. The annual averages, maximums and percentiles are displayed in the annual statistics tables. (A percentile value is the percentage of the data set that is equal to or below the stated value; for example, if the 70 percentile value is 0.10 ppm, then 70 percent of the data are equal to or below 0.10 ppm). To be included in the 10-year trend analysis, a site must have valid annual means for a minimum of 8 years over the 10-year period from 2007-2016.

Other Informative Tables

The calculated CAAQS metrics for $PM_{2.5}$ and ozone are presented for 2016 (based on a three-year average, 2014-2016) in Table A19. The percentage distribution of hourly AQHI readings within the various health risk categories for each of the 39 monitoring sites are displayed in Table A20. Table A21 summarizes the number of air quality alerts issued in Ontario during 2016. The 2016 statistical data for selected toxics are provided in Tables A22-A27.

Map A1: Air Quality Health Index (AQHI) Monitoring Sites Across Ontario in 2016

Table A1: 2016 Ontario Continuous Ambient Air Monitoring Network

ID	STATION NAME	STATION LOCATION	YEAR	LATITUDE (D:M:S)	LONGITUDE (D:M:S)	AIR INTAKE (AGL)	TYPE	AQHI	NO_2	$PM_{2.5}$	O_3	SO_2	CO	TRS
12008	Windsor Downtown	467 University Ave. W.	1969	42°18'56.8"	-83°02'37.2"	8	A/RS/C/N	Y	T	T	T	T	T	.
12016	Windsor West	College Ave./South St.	1975	42°17'34.4"	-83°04'23.3"	4	A/N	Y	T	T	T	T	.	T
13001	Chatham	435 Grand Ave. W.	2005	42°24'13.3"	-82°12'29.9"	15	A/C/N	Y	T	T	T	.	.	.
14111	Sarnia	700 Christina St. N.	2016	42°59'25."	-82°23'43.2"	3	A/C/N	Y	T	T	T	T	.	T
15020	Grand Bend	Point Blake Conservation Area	1991	43°19'59.1"	-81°44'34.4"	5	A/N	Y	T	T	T	.	.	.
15026	London	42 St. Julien St.	2013	42°58'28.1"	-81°12'03.1"	5	A/C/N	Y	T	T	T	.	.	.
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plant	2002	42°40'19.5"	-81°09'46.4"	5	A/N	Y	T	T	T	.	.	.
18007	Tiverton	4Th Concession/Bruce Rd. 23	1979	44°18'52.1"	-81°32'59.0"	4	A/N	Y	T	T	T	.	.	.
21005	Brantford	324 Grand River Ave.	2004	43°08'19.0"	-80°17'33.5"	5	A/C/N	Y	T	T	T	.	.	.
26060	Kitchener	West Ave./Homewood Ave.	1990	43°26'37.8"	-80°30'13.7"	5	A/C/N	Y	T	T	T	.	.	.
27067	St. Catharines	Argyle Cres., Pump Stn.	1987	43°09'36.2"	-79°14'05.1"	4	A/C/N	Y	T	T	T	.	.	.
28028	Guelph	Exhibition St./Clark St. W.	2000	43°33'05.8"	-80°15'51.0"	4	A/C/N	Y	T	T	T	.	.	.
29000	Hamilton Downtown	Elgin St./Kelly St.	1987	43°15'28.0"	-79°51'42.0"	4	A/RS/C/N	Y	T	T	T	T	T	T
29114	Hamilton Mountain	Vickers Rd./E. 18Th St.	1985	43°13'45.9"	-79°51'46.0"	3	A/C/N	Y	T	T	T	T	.	.
29118	Hamilton West	Main St. W./Hwy 403	1985	43°15'26.8"	-79°54'27.9"	3	A/RS/N	Y	T	T	T	.	.	.
31103	Toronto Downtown	Bay St./Wellesley St. W.	2000	43°39'46.7"	-79°23'17.2"	10	A/RS/C/N	Y	T	T	T	.	.	.
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	1970	43°44'52.5"	-79°16'26.6"	4	A/RS/C/N	Y	T	T	T	.	.	.
34020	Toronto North	Hendon Ave./Yonge St.	1988	43°46'53.8"	-79°25'03.8"	5	A/RS/C/N	Y	T	T	T	.	.	.
35125	Toronto West	125 Resources Rd.	2003	43°42'34.0"	-79°32'36.6"	8	A/RS/C/N	Y	T	T	T	T	T	.
44008	Burlington	North Shore Blvd. E./ Lakeshore Rd.	1979	43°18'54.4"	-79°48'09.5"	5	A/C/N	Y	T	T	T	.	.	.
44017	Oakville	Eighth Line/Glenashton Dr., Halton Reservoir	2003	43°29'12.9"	-79°42'08.2"	12	A/C/N	Y	T	T	T	.	.	.
45026	Oshawa	2000 Simcoe St. N., Durham College	2005	43°56'45.4"	-78°53'41.7"	7	A/RS/C/N	Y	T	T	T	.	.	.
46089	Brampton	525 Main St. N., Peel Manor	2000	43°41'55.5"	-79°46'51.3"	5	A/C/N	Y	T	T	T	.	.	.
46108	Mississauga	3359 Mississauga Rd. N., U Of T Mississauga	2007	43°32'49.1"	-79°39'31.3"	5	A/C/N	Y	T	T	T	.	.	.
47045	Barrie	83 Perry St.	2001	44°22'56.5"	-79°42'08.3"	5	A/C/N	Y	T	T	T	.	.	.
48006	Newmarket	Eagle St. W./Mccaffrey Rd.	2001	44°02'39.5"	-79°28'59.7"	5	A/N	Y	T	T	T	.	.	.

Table A1: 2016 Ontario Continuous Ambient Air Monitoring Network (continued)

ID	STATION NAME	STATION LOCATION	YEAR	LATITUDE (D:M:S)	LONGITUDE (D:M:S)	AIR INTAKE (AGL)	TYPE	AQHI	NO_2	$PM_{2.5}$	O_3	SO_2	CO	TRS
49005	Parry Sound	7 Bay St.	2001	45°20'16.3"	-80°02'17.4"	5	A/N	Y	T	T	T	.	.	.
49010	Dorset	1026 Bellwood Acres Rd.	1981	45°13'27.4"	-78°55'58.6"	3	A/N	Y	.	T	T	.	.	.
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	1971	45°26'03.6"	-75°40'33.6"	4	A/C/N	Y	T	T	T	T	T	.
51002	Ottawa Central	960 Carling Ave.	2007	45°22'57.1"	-75°42'51.1"	5	A/N	Y	T	T	T	.	.	.
51010	Petawawa	Petawawa Research Forest Facility	2007	45°59'48.2"	-77°26'28.3"	6	A/N	Y	.	T	T	.	.	.
52023	Kingston	23 Beechgrove Lane	2014	44°13'11.5"	-76°31'16.1"	5	A/C/N	Y	T	T	T	.	.	.
54012	Belleville	2 Sidney St., Water Treatment Plant	2002	44°09'01.9"	-77°23'43.8"	10	A/N	Y	T	T	T	.	.	.
56051	Cornwall	Bedford St./3Rd St. W.	1970	45°01'04.7"	-74°44'06.8"	4	A/N	Y	T	T	T	.	.	.
59006	Peterborough	10 Hospital Dr.	1998	44°18'06.9"	-78°20'46.4"	10	A/C/N	Y	T	T	T	.	.	.
63203	Thunder Bay	421 James St. S.	2004	48°22'45.8"	-89°17'24.6"	15	A/RS/C/N	Y	T	T	T	.	.	.
71078	Sault Ste. Marie	Sault College	2004	46°31'59.5"	-84°18'35.7"	8	A/N	Y	T	T	T	T	.	T
75010	North Bay	Chippewa St. W., Dept. National Defence	1979	46°19'23.5"	-79°26'57.4"	4	A/RS/N	Y	T	T	T	.	.	.
77233	Sudbury	155 Elm St.	2013	46°29'31.0"	-81°00'11.2"	3	A/C/N	Y	T	T	T	T	.	.
TOTAL								**39**	**37**	**39**	**39**	**9**	**4**	**4**

Notes:

ID	station identfication number
Year	year station began monitoring
Air intake	height of air intake above ground (m)
Type	type of monitoring site: A = ambient, RS = road-side, C = CAAQS, N = NAPS
AQHI	Air Quality Health Index site
T	telemetry
NO_2	nitrogen dioxide
$PM_{2.5}$	fine particulate matter
O_3	ground-level ozone
SO_2	sulphur dioxide
CO	carbon monoxide
TRS	total reduced sulphur

Table A2: 2016 Nitric Oxide (NO) Annual Statistics

Unit: parts per billion (ppb)

ID	City	Location	Valid h	PERCENTILES 10%	30%	50%	70%	90%	99%	Mean	Maximum 1h	24h
12008	Windsor Downtown	467 University Ave. W.	8522	0	1	1	3	6	31	3.1	127	28
12016	Windsor West	College Ave./South St.	8746	0	0	1	2	6	41	2.9	149	35
13001	Chatham	435 Grand Ave. W.	8606	0	0	0	1	4	13	1.4	68	13
14111	Sarnia	700 Christina St. N.	6396	0	1	1	1	3	16	INS	78	14
15020	Grand Bend	Point Blake Conservation Area	8736	0	0	0	1	1	3	0.4	20	3
15026	London	42 St. Julien St.	8572	0	0	0	1	2	18	1.0	76	16
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plt	8652	0	0	0	0	1	5	0.2	20	4
18007	Tiverton	4th Concession/Bruce Rd. 23	8501	0	0	0	1	2	4	0.6	25	4
21005	Brantford	324 Grand River Ave.	8711	0	0	0	0	2	15	0.8	112	14
26060	Kitchener	West Ave./Homewood Ave.	8536	0	0	0	1	2	24	1.3	133	38
27067	St. Catharines	Argyle Cres., Pump Stn.	8649	0	0	0	1	2	25	1.5	143	50
28028	Guelph	Exhibition St./Clark St. W.	8686	0	0	0	0	2	24	1.1	90	34
29000	Hamilton Downtown	Elgin St./Kelly St.	8683	0	1	1	2	8	55	4.2	184	72
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8647	0	0	0	1	2	18	1.2	66	30
29118	Hamilton West	Main St. W./Hwy 403	8752	0	0	1	3	14	89	6.2	207	89
31103	Toronto Downtown	Bay St./Wellesley St. W.	8700	0	1	1	2	5	25	2.6	139	34
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8593	0	1	2	5	10	56	5.4	281	70
34020	Toronto North	Hendon Ave./Yonge St.	8631	0	1	1	2	7	39	3.5	197	56
35125	Toronto West	125 Resources Rd.	8650	0	1	2	6	19	95	8.2	297	94
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8693	0	1	1	3	9	49	3.9	151	51
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8709	0	0	0	1	4	26	1.8	106	37
45026	Oshawa	2000 Simcoe St. N., Durham College	8695	0	1	1	2	5	22	2.5	104	21
46089	Brampton	525 Main St. N., Peel Manor	8698	0	0	1	2	6	51	3.4	176	75
46108	Mississauga	3359 Mississauga Rd. N., U Of T Campus	8669	0	0	1	1	7	55	3.6	165	62
47045	Barrie	83 Perry St.	8671	1	1	2	2	5	55	3.7	261	65
48006	Newmarket	Eagle St. W./McCaffrey Rd.	8719	0	0	1	1	3	20	1.6	103	21
49005	Parry Sound	7 Bay St.	8633	0	0	0	0	1	8	0.6	44	11
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8709	0	0	1	1	3	22	1.7	95	36
51002	Ottawa Central	960 Carling Ave.	8605	0	0	1	1	3	23	1.5	73	17
52023	Kingston	23 Beechgrove Lane	8681	0	0	0	1	2	10	0.7	65	12
54012	Belleville	2 Sidney St., Water Treatment Plant	8512	0	1	1	1	3	20	1.8	110	18
56051	Cornwall	Bedford St./3rd St. W.	8714	0	1	1	1	3	30	2.1	126	25
59006	Peterborough	10 Hospital Dr.	8587	0	0	1	1	2	16	1.3	71	15
63203	Thunder Bay	421 James St. S.	8499	0	1	1	2	11	36	3.8	96	44
71078	Sault Ste. Marie	Sault College	8670	0	0	1	1	2	8	1.0	64	8
75010	North Bay	Chippewa St. W., Dept. National Defence	8772	0	1	1	1	3	21	2.0	128	36
77233	Sudbury	155 Elm Street	8687	1	1	1	2	5	46	3.3	205	46

Note: INS indicates there was insufficient data to calculate a valid annual mean.

Table A3: 2016 Nitrogen Dioxide (NO_2) Annual Statistics

Unit: parts per billion (ppb)
NO_2 1h AAQC: 200 ppb
NO_2 24h AAQC: 100 ppb

ID	City	Location		PERCENTILES							Maximum		No. of Times Above Criteria	
			Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h	24h
12008	Windsor Downtown	467 University Ave. W.	8522	4	7	9	13	22	35	11.4	52	30	0	0
12016	Windsor West	College Ave./South St.	8746	3	6	8	12	21	36	10.6	51	27	0	0
13001	Chatham	435 Grand Ave. W.	8605	2	3	4	6	10	20	5.4	42	18	0	0
14111	Sarnia	700 Christina St. N.	6396	2	4	6	9	16	28	INS	51	23	0	0
15020	Grand Bend	Point Blake Conservation Area	8736	0	1	2	3	6	11	2.8	25	14	0	0
15026	London	42 St. Julien St.	8572	1	3	4	6	11	24	5.4	42	20	0	0
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plt	8652	1	2	2	3	5	13	2.9	20	9	0	0
18007	Tiverton	4th Concession/Bruce Rd. 23	8501	0	1	1	2	4	8	1.8	21	10	0	0
21005	Brantford	324 Grand River Ave.	8711	1	2	4	5	10	21	4.8	52	23	0	0
26060	Kitchener	West Ave./Homewood Ave.	8536	2	3	4	7	13	28	6.2	51	24	0	0
27067	St. Catharines	Argyle Cres., Pump Stn.	8648	2	3	5	7	14	30	6.6	42	25	0	0
28028	Guelph	Exhibition St./Clark St. W.	8685	2	3	4	7	13	28	6.2	42	28	0	0
29000	Hamilton Downtown	Elgin St./Kelly St.	8678	4	6	9	14	24	39	11.9	51	39	0	0
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8647	2	4	6	9	17	33	7.9	47	31	0	0
29118	Hamilton West	Main St. W./Hwy 403	8752	4	6	9	14	24	38	11.8	56	31	0	0
31103	Toronto Downtown	Bay St./Wellesley St. W.	8700	5	8	11	16	25	39	13.3	57	31	0	0
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8597	3	6	9	14	25	44	12.1	68	36	0	0
34020	Toronto North	Hendon Ave./Yonge St.	8635	3	6	9	15	25	40	12.0	56	39	0	0
35125	Toronto West	125 Resources Rd.	8649	5	9	13	19	31	46	15.7	64	41	0	0
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8693	2	5	8	12	22	38	10.2	62	33	0	0
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8709	2	4	6	9	18	35	8.2	50	28	0	0
45026	Oshawa	2000 Simcoe St. N., Durham College	8695	1	3	4	7	14	27	6.3	43	29	0	0
46089	Brampton	525 Main St. N., Peel Manor	8698	2	4	6	11	23	40	9.7	51	35	0	0
46108	Mississauga	3359 Mississauga Rd. N., U Of T Campus	8677	2	4	6	10	19	33	8.6	51	27	0	0
47045	Barrie	83 Perry St.	8671	2	3	5	9	18	40	8.1	63	32	0	0
48006	Newmarket	Eagle St. W./McCaffrey Rd.	8719	1	3	4	7	15	33	6.5	47	30	0	0
49005	Parry Sound	7 Bay St.	8633	1	1	2	3	7	17	2.9	32	11	0	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8709	2	3	5	8	15	32	6.9	48	29	0	0
51002	Ottawa Central	960 Carling Ave.	8605	1	2	3	6	13	30	5.6	39	22	0	0
52023	Kingston	23 Beechgrove Lane	8681	1	2	3	4	10	24	4.4	47	18	0	0
54012	Belleville	2 Sidney St., Water Treatment Plant	8512	1	2	4	5	11	24	5.1	43	21	0	0
56051	Cornwall	Bedford St./3rd St. W.	8714	1	2	3	5	12	34	5.5	48	29	0	0
59006	Peterborough	10 Hospital Dr.	8587	1	2	3	5	10	24	4.5	58	22	0	0
63203	Thunder Bay	421 James St. S.	8499	2	3	5	8	15	31	7.1	43	27	0	0
71078	Sault Ste. Marie	Sault College	8670	1	2	3	4	9	19	4.0	42	18	0	0
75010	North Bay	Chippewa St. W., Dept. National Defence	8772	1	2	3	4	11	33	4.7	49	28	0	0
77233	Sudbury	155 Elm Street	8687	2	3	4	7	16	43	7.0	73	31	0	0

Note: INS indicates there was insufficient data to calculate a valid annual mean.

Table A4: 2016 Nitrogen Oxides (NO_x) Annual Statistics

Unit: parts per billion (ppb)

ID	City	Location		PERCENTILES							Maximum	
			Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h
12008	Windsor Downtown	467 University Ave. W.	8522	5	8	11	16	28	62	14.5	160	50
12016	Windsor West	College Ave./South St.	8746	4	7	10	14	26	72	13.5	188	54
13001	Chatham	435 Grand Ave. W.	8606	2	4	5	8	13	29	6.8	108	29
14111	Sarnia	700 Christina St. N.	6396	3	5	7	10	18	41	INS	113	30
15020	Grand Bend	Point Blake Conservation Area	8736	1	2	3	4	6	13	3.3	39	16
15026	London	42 St. Julien St.	8573	2	3	5	7	13	37	6.5	94	35
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plt	8652	1	2	2	3	6	17	3.1	38	9
18007	Tiverton	4th Concession/Bruce Rd. 23	8501	0	1	2	3	5	9	2.4	46	11
21005	Brantford	324 Grand River Ave.	8711	2	3	4	6	11	34	5.7	164	37
26060	Kitchener	West Ave./Homewood Ave.	8536	2	3	5	7	15	50	7.5	173	61
27067	St. Catharines	Argyle Cres., Pump Stn.	8646	2	4	5	8	16	52	8.2	177	75
28028	Guelph	Exhibition St./Clark St. W.	8686	2	3	5	7	15	48	7.3	130	63
29000	Hamilton Downtown	Elgin St./Kelly St.	8683	4	7	11	17	32	90	16.1	220	111
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8647	3	4	6	10	19	49	9.2	110	61
29118	Hamilton West	Main St. W./Hwy 403	8752	4	7	11	17	40	109	17.9	249	108
31103	Toronto Downtown	Bay St./Wellesley St. W.	8700	6	9	13	18	29	61	15.9	182	65
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8593	4	8	12	18	34	98	17.5	333	100
34020	Toronto North	Hendon Ave./Yonge St.	8610	3	7	11	17	32	77	15.4	252	95
35125	Toronto West	125 Resources Rd.	8662	6	10	17	25	48	134	23.8	339	135
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8693	3	6	9	15	30	83	14.2	183	83
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8709	2	4	7	10	21	57	10.1	149	64
45026	Oshawa	2000 Simcoe St. N., Durham College	8695	2	4	6	9	18	47	8.8	140	46
46089	Brampton	525 Main St. N., Peel Manor	8697	3	5	7	13	30	85	13.1	219	108
46108	Mississauga	3359 Mississauga Rd. N., U Of T Campus	8669	2	4	7	12	26	78	12.2	201	85
47045	Barrie	83 Perry St.	8671	3	5	7	10	23	90	11.9	313	96
48006	Newmarket	Eagle St. W./Mccaffrey Rd.	8719	2	3	5	8	17	50	8.1	151	51
49005	Parry Sound	7 Bay St.	8633	1	1	2	3	8	23	3.6	56	17
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8709	2	4	5	9	18	49	8.6	142	66
51002	Ottawa Central	960 Carling Ave.	8605	2	3	4	7	16	50	7.2	108	39
52023	Kingston	23 Beechgrove Lane	8681	1	2	3	5	11	32	5.2	100	30
54012	Belleville	2 Sidney St., Water Treatment Plant	8512	2	3	4	7	13	43	6.7	145	37
56051	Cornwall	Bedford St./3rd St. W.	8714	2	3	4	6	15	59	7.6	173	48
59006	Peterborough	10 Hospital Dr.	8587	1	2	4	6	12	39	5.9	121	37
63203	Thunder Bay	421 James St. S.	8499	3	4	7	11	25	59	11	139	71
71078	Sault Ste. Marie	Sault College	8670	1	2	3	5	11	25	5.1	93	24
75010	North Bay	Chippewa St. W., Dept. National Defence	8772	2	2	4	6	14	51	6.7	176	64
77233	Sudbury	155 Elm Street	8687	2	4	5	9	21	84	10.2	278	78

Note: INS indicates there was insufficient data to calculate a valid annual mean.

Table A5: 2016 Fine Particulate Matter ($PM_{2.5}$) Annual Statistics

Unit: micrograms per cubic metre (µg/m³)
$PM_{2.5}$ 24h Reference Level: 28 µg/m³

ID	City	Location	Valid h	PERCENTILES 10%	30%	50%	70%	90%	99%	Mean	Maximum 1h	24h	No. of Times Above Reference Level 24h
12008	Windsor Downtown	467 University Ave. W.	8750	2	4	7	10	15	26	8.1	64	21	0
12016	Windsor West	College Ave./South St.	8748	3	5	7	10	16	27	8.5	106	24	0
13001	Chatham	435 Grand Ave. W.	8588	2	4	6	8	13	21	6.6	36	20	0
14111	Sarnia	700 Christina St. N.	6374	2	4	6	8	13	24	INS	44	22	0
15020	Grand Bend	Point Blake Conservation Area	8705	2	3	5	7	12	22	6.0	30	20	0
15026	London	42 St. Julien St.	8648	2	4	6	9	13	25	7.1	40	23	0
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plt	8620	2	4	5	8	12	21	6.5	41	17	0
18007	Tiverton	4th Concession/Bruce Rd. 23	8500	1	2	4	6	10	20	5.1	35	19	0
21005	Brantford	324 Grand River Ave.	8738	2	4	6	9	14	25	7.3	96	22	0
26060	Kitchener	West Ave./Homewood Ave.	8514	2	4	6	9	14	26	7.3	41	23	0
27067	St. Catharines	Argyle Cres., Pump Stn.	8051	2	4	6	8	13	24	6.9	38	23	0
28028	Guelph	Exhibition St./Clark St. W.	8642	2	4	6	8	13	26	6.9	40	25	0
29000	Hamilton Downtown	Elgin St./Kelly St.	8740	2	4	7	10	16	30	8.2	47	29	2
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8755	2	4	6	9	14	26	7.2	48	25	0
29118	Hamilton West	Main St. W./Hwy 403	8730	2	4	7	9	15	29	7.9	42	28	0
31103	Toronto Downtown	Bay St./Wellesley St. W.	8646	2	4	6	8	13	23	7.0	36	22	0
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8583	3	4	6	8	13	25	7.0	54	27	0
34020	Toronto North	Hendon Ave./Yonge St.	8612	2	4	6	9	14	26	7.3	46	26	0
35125	Toronto West	125 Resources Rd.	8708	2	4	6	8	13	25	7.0	43	24	0
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8753	2	4	6	9	15	27	7.6	45	27	0
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8723	2	4	6	8	13	26	7.0	42	24	0
45026	Oshawa	2000 Simcoe St. N., Durham College	8645	1	3	5	7	12	23	5.9	70	22	0
46089	Brampton	525 Main St. N., Peel Manor	8634	2	4	5	8	14	27	6.8	45	24	0
46108	Mississauga	3359 Mississauga Rd. N., U Of T Campus	8716	2	4	6	9	14	26	7.2	47	24	0
47045	Barrie	83 Perry St.	8731	2	3	5	8	13	27	6.5	55	26	0
48006	Newmarket	Eagle St. W./McCaffrey Rd.	8769	1	3	4	7	13	24	6.0	41	23	0
49005	Parry Sound	7 Bay St.	8616	1	2	4	5	10	18	4.8	37	16	0
49010	Dorset	1026 Bellwood Acres Rd.	8543	1	2	4	6	9	17	4.6	35	15	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8661	2	3	5	7	12	23	5.9	37	27	0
51002	Ottawa Central	960 Carling Ave.	8502	2	3	4	7	12	22	5.6	41	28	1
51010	Petawawa	Petawawa Research Forest Facility	8746	2	2	3	5	8	15	4.4	35	20	0
52023	Kingston	23 Beechgrove Lane	8680	2	3	5	7	11	19	5.8	28	19	0
54012	Belleville	2 Sidney St., Water Treatment Plant	8719	2	3	4	6	11	20	5.5	36	20	0
56051	Cornwall	Bedford St./3rd St. W.	8720	2	4	5	7	12	25	6.4	55	31	1
59006	Peterborough	10 Hospital Dr.	8508	1	3	5	7	12	22	5.8	38	21	0
63203	Thunder Bay	421 James St. S.	8599	2	3	4	6	9	15	4.9	32	13	0
71078	Sault Ste. Marie	Sault College	8708	2	3	4	6	10	19	4.9	58	16	0
75010	North Bay	Chippewa St. W., Dept. National Defence	8761	1	2	4	5	9	17	4.6	28	17	0
77233	Sudbury	155 Elm Street	8731	2	3	4	6	11	21	5.4	64	17	0

Notes:

Measurements taken by SHARP 5030.

INS indicates there was insufficient data in any one quarter to calculate a valid annual mean.

Table A6: 2016 Ozone (O_3) Annual Statistics

Unit: parts per billion (ppb)
O_3 1h AAQC: 80 ppb

ID	City	Location	PERCENTILES								Maximum		No. of Times Above Criterion
			Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h
12008	Windsor Downtown	467 University Ave. W.	8749	9	20	27	34	47	68	27.7	95	55	7
12016	Windsor West	College Ave./South St.	8745	9	20	27	34	47	68	27.7	95	54	15
13001	Chatham	435 Grand Ave. W.	8607	15	23	29	35	45	63	29.6	84	55	2
14111	Sarnia	700 Christina St. N.	6395	14	22	28	35	45	66	28.8	83	53	4
15020	Grand Bend	Point Blake Conservation Area	8731	17	25	30	36	44	65	30.7	91	61	16
15026	London	42 St. Julien St.	8676	8	22	29	35	46	63	28.2	82	57	2
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plt	8672	18	27	32	38	48	68	32.9	84	68	7
18007	Tiverton	4th Concession/Bruce Rd. 23	8593	21	27	33	38	45	64	33.1	85	66	1
21005	Brantford	324 Grand River Ave.	8712	10	23	30	36	47	67	29.5	84	63	8
26060	Kitchener	West Ave./Homewood Ave.	8539	12	23	29	35	45	63	28.8	81	57	2
27067	St. Catharines	Argyle Cres., Pump Stn.	8639	13	24	30	36	46	64	29.8	80	66	0
28028	Guelph	Exhibition St./Clark St. W.	8670	12	22	29	35	45	64	28.7	82	54	1
29000	Hamilton Downtown	Elgin St./Kelly St.	8699	10	20	27	32	43	64	26.7	78	62	0
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8706	14	23	29	35	45	65	29.5	76	58	0
29118	Hamilton West	Main St. W./Hwy 403	8750	4	18	25	31	40	60	24.4	78	55	0
31103	Toronto Downtown	Bay St./Wellesley St. W.	8706	11	19	25	31	40	61	25.6	81	49	1
33003	Toronto East	Kennedy Rd./Lawrence Ave. E.	8661	8	19	25	31	42	65	25.5	99	50	4
34020	Toronto North	Hendon Ave./Yonge St.	8663	9	19	26	32	42	64	25.9	85	55	3
35125	Toronto West	125 Resources Rd.	8697	4	14	21	28	40	61	22.1	79	50	0
44008	Burlington	North Shore Blvd. E./Lakeshore Rd.	8692	10	21	28	34	44	64	27.6	80	56	0
44017	Oakville	Eighth Line/Glenashton Dr., Halton Res.	8709	11	21	27	33	41	62	27.1	74	55	0
45026	Oshawa	2000 Simcoe St. N., Durham College	8698	12	21	27	33	41	62	27.2	81	54	2
46089	Brampton	525 Main St. N., Peel Manor	8696	9	20	27	34	43	64	27.1	79	55	0
46108	Mississauga	3359 Mississauga Rd. N., U Of T Campus	8679	6	19	27	33	42	63	26.0	79	56	0
47045	Barrie	83 Perry St.	8747	9	20	26	32	40	58	25.9	79	51	0
48006	Newmarket	Eagle St. W./McCaffrey Rd.	8719	13	23	28	34	44	64	28.6	94	57	7
49005	Parry Sound	7 Bay St.	8664	15	25	30	35	42	58	29.6	74	57	0
49010	Dorset	1026 Bellwood Acres Rd.	8737	10	21	28	34	41	58	27.4	74	51	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8707	10	19	26	32	40	55	25.6	73	58	0
51002	Ottawa Central	960 Carling Ave.	8593	10	19	26	32	40	54	25.5	71	58	0
51010	Petawawa	Petawawa Research Forest Facility	8772	11	20	27	33	40	54	26.4	68	51	0
52023	Kingston	23 Beechgrove Lane	8639	15	25	30	36	45	63	30.5	82	62	2
54012	Belleville	2 Sidney St., Water Treatment Plant	8718	14	25	30	36	46	66	30.5	96	64	14
56051	Cornwall	Bedford St./3rd St. W.	8714	10	21	28	34	41	56	27.1	74	58	0
59006	Peterborough	10 Hospital Dr.	8597	14	24	29	35	44	67	29.7	85	61	3
63203	Thunder Bay	421 James St. S.	8506	7	17	24	30	36	48	23.2	62	45	0
71078	Sault Ste. Marie	Sault College	8676	14	22	28	32	39	52	27.3	80	51	0
75010	North Bay	Chippewa St. W., Dept. National Defence	8772	11	20	27	33	40	57	26.4	78	56	0
77233	Sudbury	155 Elm Street	8692	11	20	26	31	38	53	25.1	80	51	0

Table A7: 2016 Sulphur Dioxide (SO_2) Annual Statistics

Unit: parts per billion (ppb)
SO_2 1h AAQC: 250 ppb
SO_2 24h AAQC: 100 ppb
SO_2 1y AAQC: 20 ppb

ID	City	Location	PERCENTILES								Maximum		No. of Times Above Criteria		
			Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h	24h	1y
12008	Windsor Downtown	467 University Ave. W.	8749	0	0	0	1	3	13	1.1	44	12	0	0	0
12016	Windsor West	College Ave./South St.	8745	0	0	0	1	5	12	1.4	33	10	0	0	0
14111	Sarnia	700 Christina St. N.	6442	0	0	0	0	4	29	INS	71	22	0	0	0
29000	Hamilton Downtown	Elgin St./Kelly St.	8699	0	0	1	2	10	32	3.2	80	20	0	0	0
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8691	0	0	0	1	5	23	1.8	57	18	0	0	0
35125	Toronto West	125 Resources Rd.	8686	0	0	1	1	1	3	0.6	10	3	0	0	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8710	0	0	0	0	0	1	0	16	1	0	0	0
71078	Sault Ste. Marie	Sault College	8689	0	0	0	0	1	13	0.6	32	8	0	0	0
77233	Sudbury	155 Elm Street	8701	0	0	0	0	5	36	2.1	243	23	0	0	0

Note: INS indicates there was insufficient data to calculate a valid annual mean.

Table A8: 2016 Carbon Monoxide (CO) Annual Statistics

Unit: parts per million (ppm)
CO 1h AAQC: 30 ppm
CO 8h AAQC: 13 ppm

ID	City	Location	PERCENTILES								Maximum		No. of Times Above Criteria	
			Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h	8h
12008	Windsor Downtown	467 University Ave. W.	8695	0	0	0	0	0	1	0.3	2.29	1.18	0	0
29000	Hamilton Downtown	Elgin St./Kelly St.	8695	0	0	0	0	0	1	0.2	1.38	1.08	0	0
35125	Toronto West	125 Resources Rd.	8239	0	0	0	0	0	1	0.2	1.67	1.23	0	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	8602	0	0	0	0	0	1	0.2	0.93	0.68	0	0

Table A9: 2016 Total Reduced Sulphur (TRS) Compounds Annual Statistics

Unit: parts per billion (ppb)

ID	City	Location	PERCENTILES								Maximum	
			Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h
12016	Windsor West	College Ave./South St.	8754	0	0	0	0	1	4	0.3	15	3
14111	Sarnia	700 Christina St. N.	6393	0	0	0	0	0	1	INS	3	1
29000	Hamilton Downtown	Elgin St./Kelly St.	8740	0	0	0	0	0	2	0.1	5	2
71078	Sault Ste. Marie	Sault College	8688	0	0	0	0	0	1	0	3	1

Note: INS indicates there was insufficient data to calculate a valid annual mean.

Table A10: 10y Trend for NO

Annual Mean (ppb)

ID	City/Town	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Change Over Time
12008	Windsor Downtown	6.4	5.9	5.6	4.7	4.5	4.7	3.7	4.0	3.5	3.1	↓ 51%
12016	Windsor West	6.5	5.1	5.4	6.1	3.8	4.6	3.6	3.8	4.2	2.9	↓ 48%
13001	Chatham	2.4	3.1	3.5	2.6	1.9	1.8	1.6	1.5	1.7	1.4	↓ 58%
14111	Sarnia	3.2	3.2	2.8	2.2	3.1	2.1	1.7	1.9	2.4	INS	↓ 43%
15026	London	3.6	3.1	2.8	2.9	3.3	4.2	1.4	1.3	1.4	1.0	↓ 68%
18007	Tiverton	0.2	0.2	0.4	0.7	0.9	0.7	0.1	1.3	0.3	0.6	rb
21005	Brantford	1.8	1.3	1.7	1.3	1.2	1.1	1.2	0.9	1.3	0.8	↓ 44%
26060	Kitchener	2.7	2.5	2.1	2.5	2.0	2.1	1.6	1.6	1.6	1.3	↓ 49%
27067	St. Catharines	4.5	3.6	3.7	2.8	2.3	2.5	2.2	1.7	2.1	1.5	↓ 67%
29000	Hamilton Downtown	7.7	6.5	5.8	5.0	4.8	4.6	4.3	3.9	1.3	4.2	↓ 62%
29114	Hamilton Mountain	3.2	2.4	2.5	2.2	2.3	1.9	2.0	2.0	1.8	1.2	↓ 50%
31103	Toronto Downtown	5.9	5.0	5.1	4.1	3.4	2.8	2.7	2.5	2.7	2.6	↓ 64%
33003	Toronto East	10.8	9.2	7.8	7.8	7.6	6.6	5.7	6.2	5.8	5.4	↓ 49%
34020	Toronto North	8.3	7.7	7.1	5.7	6.2	5.0	4.1	4.3	3.9	3.5	↓ 61%
35125	Toronto West	17.5	16.2	13.5	13.4	12.4	11.3	8.6	9.5	9.2	8.2	↓ 55%
44008	Burlington	8.8	6.5	5.9	5.0	4.6	4.6	4.6	4.6	3.9	3.9	↓ 54%
44017	Oakville	3.9	4.0	3.5	3.6	2.7	3.4	2.1	3.4	2.7	1.8	↓ 44%
45026	Oshawa	3.2	3.2	3.0	2.3	2.3	2.1	1.5	2.0	2.3	2.5	↓ 37%
46089	Brampton	6.0	5.8	6.5	3.7	4.6	4.4	4.6	4.0	3.8	3.4	↓ 43%
46108	Mississauga	n/a	6.1	5.1	4.1	4.1	3.8	3.1	2.9	3.1	3.6	↓ 52%
47045	Barrie	5.5	5.5	5.1	4.3	3.8	3.2	3.2	3.7	3.5	3.7	↓ 43%
48006	Newmarket	2.2	2.6	3.2	2.3	2.2	2.0	1.5	1.4	1.7	1.6	↓ 46%
51001	Ottawa Downtown	3.4	2.7	2.4	1.6	1.8	2.4	2.1	1.9	2.0	1.7	↓ 40%
51002	Ottawa Central	2.4	2.7	1.8	1.4	1.5	2.0	2.8	1.0	1.6	1.5	↓ 35%
52023	Kingston	0.6	1.1	0.6	0.3	0.5	0.4	0.2	0.8	0.9	0.7	↓ 3%
54012	Belleville	3.2	3.0	1.9	2.3	2.3	1.6	1.7	1.2	1.5	1.8	↓ 56%
56051	Cornwall	3.5	3.6	3.2	2.0	1.9	2.2	1.9	1.5	1.8	2.1	↓ 57%
59006	Peterborough	2.3	3.0	1.9	1.7	2.2	1.8	1.7	1.8	1.5	1.3	↓ 45%
63203	Thunder Bay	5.4	5.1	5.7	4.6	5.9	5.1	4.7	4.2	5.2	3.8	↓ 22%
71078	Sault Ste. Marie	1.4	1.4	1.8	1.9	2.0	1.7	1.3	2.0	1.7	1.0	↓ 8%
75010	North Bay	3.5	3.8	4.2	3.4	4.0	2.9	2.5	2.6	2.1	2.0	↓ 50%

Notes:

n/a indicates data not available.

INS indicates there was insufficient data to calculate a valid annual mean.

rb indicates regional background measurements near detection limit of analyzer; trend is statistically insignificant.

Station 14111 replaced station 14064 as the Sarnia site in 2016.

Station 15026 replaced station 15025 as the London site in 2013.

Station 46108 replaced station 46109 as the Mississauga site in 2008.

Station 52023 replaced station 52022 as the Kingston site in 2014.

Table A11: 10y Trend for NO_2 Annual Mean (ppb)

ID	City/Town	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Change Over Time
12008	Windsor Downtown	17.2	15.2	14.4	15.6	14.5	13.2	12.4	14.0	12.7	11.4	↓ 27%
12016	Windsor West	16.1	16.2	13.2	14.5	12.9	11.4	11.5	11.8	11.4	10.6	↓ 35%
13001	Chatham	8.6	7.0	7.5	6.4	6.6	5.7	6.0	6.8	6.8	5.4	↓ 25%
14111	Sarnia	11.3	10.8	8.2	8.0	8.6	8.6	8.1	9.0	9.3	INS	↓ 20%
15026	London	11.7	10.8	9.0	8.8	8.3	6.3	6.4	6.9	6.6	5.4	↓ 53%
18007	Tiverton	2.9	3.0	2.3	1.9	2.5	2.5	1.9	2.7	2.4	1.8	↓ 25%
21005	Brantford	7.7	6.9	7.3	5.8	6.1	5.4	4.8	5.5	5.5	4.8	↓ 36%
26060	Kitchener	9.7	9.0	8.6	7.7	7.7	7.1	6.7	7.0	6.8	6.2	↓ 35%
27067	St. Catharines	12.0	10.4	9.9	9.1	8.5	8.1	7.7	7.3	7.3	6.6	↓ 43%
29000	Hamilton Downtown	17.0	14.7	13.6	12.7	13.5	11.9	12.4	12.4	12.2	11.9	↓ 26%
29114	Hamilton Mountain	11.9	10.5	9.9	8.9	9.9	8.6	9.0	9.3	9.0	7.9	↓ 25%
31103	Toronto Downtown	18.2	17.0	16.5	16.1	14.9	13.4	13.5	14.0	13.4	13.3	↓ 29%
33003	Toronto East	17.2	16.5	14.9	14.8	15.2	14.0	13.6	14.2	13.9	12.1	↓ 24%
34020	Toronto North	16.7	16.5	15.8	14.3	15.4	13.4	12.9	13.4	12.9	12.0	↓ 28%
35125	Toronto West	22.1	20.8	19.0	20.1	19.1	16.3	16.1	17.1	16.6	15.7	↓ 29%
44008	Burlington	16.0	13.6	12.5	12.2	11.8	11.0	11.0	10.9	10.4	10.2	↓ 33%
44017	Oakville	13.0	12.0	11.1	9.2	10.3	9.1	9.2	8.2	7.5	8.2	↓ 41%
45026	Oshawa	8.1	8.5	7.4	7.2	7.0	5.6	5.9	6.8	6.6	6.3	↓ 26%
46089	Brampton	13.9	13.1	13.3	10.7	11.3	10.4	9.1	10.6	9.9	9.7	↓ 32%
46108	Mississauga	n/a	12.3	12.2	10.4	10.6	9.6	9.5	9.2	9.2	8.6	↓ 33%
47045	Barrie	11.5	10.8	9.9	8.7	8.6	8.1	7.8	8.1	7.4	8.1	↓ 34%
48006	Newmarket	8.3	8.0	7.8	7.2	8.1	7.2	6.8	6.8	6.8	6.5	↓ 21%
51001	Ottawa Downtown	8.7	11.4	8.6	7.4	7.9	7.8	7.9	7.4	7.4	6.9	↓ 28%
51002	Ottawa Central	7.9	8.1	6.6	6.2	6.6	6.6	6.6	6.0	5.8	5.6	↓ 27%
52023	Kingston	5.5	5.5	5.0	4.3	4.6	4.0	3.6	3.9	4.4	4.4	↓ 27%
54012	Belleville	6.4	7.3	6.0	5.5	6.3	4.7	4.7	4.5	4.8	5.1	↓ 33%
56051	Cornwall	7.6	7.5	7.3	6.5	6.5	6.1	6.2	5.6	5.3	5.5	↓ 32%
59006	Peterborough	6.4	7.0	5.6	5.0	4.3	3.7	5.0	5.3	5.1	4.5	↓ 29%
63203	Thunder Bay	8.7	8.1	8.4	7.8	8.6	7.3	7.3	7.8	7.5	7.1	↓ 15%
71078	Sault Ste. Marie	5.0	5.5	5.1	5.5	5.3	4.8	5.0	5.3	4.8	4.0	↓ 14%
75010	North Bay	7.4	7.5	8.2	7.6	7.4	6.1	5.8	5.6	5.6	4.7	↓ 38%

Notes:

n/a indicates data not available.

INS indicates there was insufficient data to calculate a valid annual mean.

Station 14111 replaced station 14064 as the Sarnia site in 2016.

Station 15026 replaced station 15025 as the London site in 2013.

Station 46108 replaced station 46109 as the Mississauga site in 2008.

Station 52023 replaced station 52022 as the Kingston site in 2014.

Table A12: 10y Trend for NO_x Annual Mean (ppb)

ID	City/Town	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Change Over Time
12008	Windsor Downtown	23.6	21.1	20.0	20.2	18.9	17.8	16.2	18.0	16.2	14.5	↓ 34%
12016	Windsor West	22.6	21.3	18.6	20.6	16.7	16.0	15.2	15.7	15.5	13.5	↓ 39%
13001	Chatham	11.0	10.1	10.9	9.0	8.4	7.5	7.7	8.2	8.5	6.8	↓ 35%
14111	Sarnia	14.5	13.9	11.0	10.2	11.7	10.7	9.8	10.9	11.7	INS	↓ 25%
15026	London	15.3	13.9	11.9	11.7	11.6	10.5	7.8	8.3	8.0	6.5	↓ 56%
18007	Tiverton	3.0	3.3	2.7	2.6	3.4	3.1	2.1	4.0	2.9	2.4	↑ 7%
21005	Brantford	9.5	8.2	9.1	7.2	7.3	6.7	5.7	6.4	6.8	5.7	↓ 38%
26060	Kitchener	12.4	11.5	10.8	10.3	9.6	9.2	8.3	8.5	8.4	7.5	↓ 38%
27067	St. Catharines	16.5	14.0	13.7	11.8	10.9	10.6	9.9	9.1	9.4	8.2	↓ 49%
29000	Hamilton Downtown	24.7	21.2	19.5	17.8	18.3	16.6	16.8	16.3	7.7	16.1	↓ 46%
29114	Hamilton Mountain	15.1	12.9	12.4	11.2	12.2	10.5	11.0	11.3	10.9	9.2	↓ 30%
31103	Toronto Downtown	24.2	22.1	21.6	20.3	18.4	16.2	16.1	16.5	16.1	15.9	↓ 37%
33003	Toronto East	28.0	25.7	22.7	22.6	22.8	20.6	19.4	20.4	19.7	17.5	↓ 33%
34020	Toronto North	25.0	24.3	22.8	20.0	21.5	18.5	17.0	17.7	16.9	15.4	↓ 39%
35125	Toronto West	39.6	37.0	32.5	33.5	31.5	27.6	24.7	26.5	25.7	23.8	↓ 40%
44008	Burlington	24.8	20.0	18.4	17.2	16.4	15.6	15.6	15.5	14.3	14.2	↓ 40%
44017	Oakville	16.9	16.1	14.6	12.8	13.0	12.6	11.2	11.6	10.1	10.1	↓ 41%
45026	Oshawa	11.3	11.7	10.4	9.5	9.2	7.8	7.4	8.8	8.9	8.8	↓ 29%
46089	Brampton	19.9	18.9	19.9	14.4	15.9	14.8	13.9	14.6	13.7	13.1	↓ 36%
46108	Mississauga	n/a	18.4	17.3	14.5	14.7	13.4	12.6	12.1	12.3	12.2	↓ 39%
47045	Barrie	17.0	16.3	15.1	13.1	12.4	11.3	11.0	11.8	10.9	11.9	↓ 37%
48006	Newmarket	10.4	10.4	11.0	9.5	10.3	9.2	8.4	8.2	8.5	8.1	↓ 26%
51001	Ottawa Downtown	12.0	14.0	11.0	9.0	9.7	10.2	10.1	9.3	9.5	8.6	↓ 30%
51002	Ottawa Central	10.2	10.8	8.4	7.5	8.1	8.7	9.4	7.1	7.5	7.2	↓ 28%
52023	Kingston	6.3	6.5	5.7	4.7	5.3	4.6	3.8	4.8	5.3	5.2	↓ 24%
54012	Belleville	9.6	10.2	7.9	7.8	8.7	6.4	6.3	5.7	6.2	6.7	↓ 41%
56051	Cornwall	11.0	11.1	10.6	8.5	8.4	8.4	8.0	7.0	7.1	7.6	↓ 39%
59006	Peterborough	8.6	10.0	7.5	6.7	6.6	5.4	6.6	7.1	6.6	5.9	↓ 33%
63203	Thunder Bay	14.1	13.2	14.1	12.4	14.5	12.4	12.0	11.9	12.7	11	↓ 18%
71078	Sault Ste. Marie	6.4	6.9	6.9	7.4	7.2	6.4	6.3	7.3	6.6	5.1	↓ 13%
75010	North Bay	10.9	11.3	12.4	11.0	11.5	9.1	8.3	8.1	7.8	6.7	↓ 42%

Notes:

n/a indicates data not available.

INS indicates there was insufficient data to calculate a valid annual mean.

Station 14111 replaced station 14064 as the Sarnia site in 2016.

Station 15026 replaced station 15025 as the London site in 2013.

Station 46108 replaced station 46109 as the Mississauga site in 2008.

Station 52023 replaced station 52022 as the Kingston site in 2014.

Table A13: 10y Summary for $PM_{2.5}$ Annual Mean (µg/m³)

ID	City/Town	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
12008	Windsor Downtown	9.5	8.3	7.2	7.7	7.6	7.4	**9.2**	**10.1**	**9.3**	**8.1**
12016	Windsor West	9.8	8.9	7.4	7.8	7.8	7.6	**10.0**	**10.7**	**9.9**	**8.5**
13001	Chatham	7.9	7.3	6.3	6.5	6.6	6.0	**8.1**	**8.6**	**8.1**	**6.6**
14111	Sarnia	12.2	11.4	9.8	10.4	10.5	10.2	**8.5 (7.0*)**	**9.0 (6.7*)**	**8.4 (7.1*)**	**INS**
15020	Grand Bend	6.7	6.8	5.8	6.1	6.1	5.8	**7.3**	**8.1**	**7.7**	**6.0**
15026	London	6.5	6.8	5.7	INS	6.2	6.5	**9.1**	**8.8**	**8.3**	**7.1**
16015	Port Stanley	7.2	6.7	5.6	5.9	6.0	5.9	**7.4 (5.3*)**	**8.2 (5.6*)**	**8.0 (5.3*)**	**6.5**
18007	Tiverton	5.6	5.0	4.0	4.5	4.7	INS	**5.8**	**6.5**	**6.4**	**5.1**
21005	Brantford	7.7	6.8	5.8	6.5	6.6	6.2	**8.5**	**9.2**	**8.7**	**7.3**
26060	Kitchener	8.0	7.1	5.8	6.3	6.2	6.0	**8.7**	**9.3**	**8.8**	**7.3**
27067	St. Catharines	8.2	7.4	6.0	6.5	6.3	6.3	**8.5**	**8.8**	**8.4**	**6.9**
28028	Guelph	7.5	6.5	5.6	5.7	5.9	5.8	**8.1**	**8.9**	**8.4**	**6.9**
29000	Hamilton Downtown	8.9	8.3	6.8	7.7	8.1	8.3	**10.1 (7.8*)**	**10.8 (8.5)**	**10.2 (7.3*)**	**8.2**
29114	Hamilton Mountain	7.8	7.3	6.3	6.2	6.7	6.5	**9.2**	**9.4**	**9.0**	**7.2**
29118	Hamilton West	8.3	7.6	6.1	6.8	7.1	7.3	**9.6**	**9.9**	**9.9**	**7.9**
31103	Toronto Downtown	7.3	6.6	5.6	6.0	6.2	6.4	**8.3**	**8.7**	**8.4**	**7.0**
33003	Toronto East	7.8	6.7	5.9	6.7	6.2	6.3	**8.2**	**8.9**	**8.5**	**7.0**
34020	Toronto North	7.8	7.3	5.9	6.2	7.7	7.3	**8.3**	**9.2**	**9.4**	**7.3**
35125	Toronto West	8.4	7.5	6.1	6.5	6.9	7.1	**8.8 (6.6*)**	**9.1 (6.7*)**	**8.5 (6.8*)**	**7.0**
44008	Burlington	7.3	6.9	5.9	6.2	6.2	6.4	**8.7**	**9.6**	**9.4**	**7.6**
44017	Oakville	7.6	6.7	5.3	5.7	6.4	6.1	**8.0**	**8.5**	**8.3**	**7.0**
45026	Oshawa	6.8	6.3	5.2	5.6	5.5	5.5	**7.4**	**7.7**	**7.5**	**5.9**
46089	Brampton	7.4	6.8	5.6	5.8	6.0	5.7	**8.5**	**8.9**	**8.4**	**6.8**
46108	Mississauga	7.2	7.1	5.8	6.1	6.0	6.0	**7.9**	**8.7**	**8.5**	**7.2**
47045	Barrie	6.9	6.1	5.2	5.4	5.7	5.6	**7.5**	**7.6**	**7.6**	**6.5**
48006	Newmarket	6.6	6.0	5.1	5.6	5.5	5.6	**7.3**	**7.3**	**7.1**	**6.0**
49005	Parry Sound	5.5	4.7	3.9	4.4	4.7	4.8	**5.8**	**5.8**	**5.7**	**4.8**
49010	Dorset	5.0	4.5	3.6	4.0	4.1	4.1	**5.4**	**5.3**	**5.6**	**4.6**
51001	Ottawa Downtown	6.0	5.3	4.6	4.5	4.9	4.8	**7.0 (5.1*)**	**7.0 (4.8*)**	**6.9 (5.1*)**	**5.9**
51002	Ottawa Central	5.8	5.1	4.4	4.3	4.5	5.0	**7.1**	**6.8**	**6.9**	**5.6**
51010	Petawawa	4.0	3.9	3.1	3.2	3.4	3.6	**4.8**	**4.7**	**4.8**	**4.4**
52023	Kingston	7.5	7.0	6.4	6.5	6.9	6.8	**6.5**	**6.8**	**6.3**	**5.8**
54012	Belleville	6.2	6.1	4.9	INS	4.8	5.1	**6.9**	**6.8**	**6.6**	**5.5**
56051	Cornwall	6.4	6.1	5.4	5.7	5.7	5.4	**7.7 (5.2*)**	**7.0 (5.1*)**	**6.9 (4.7*)**	**6.4**
59006	Peterborough	6.4	6.0	4.9	5.1	5.5	4.9	**7.4**	**6.9**	**6.8**	**5.8**
63203	Thunder Bay	4.4	4.2	3.8	4.1	4.8	4.1	**6.3**	**6.6**	**6.5**	**4.9**
71078	Sault Ste. Marie	5.3	4.4	4.0	4.1	4.4	4.4	**5.6**	**6.0**	**5.9**	**4.9**
75010	North Bay	5.0	4.6	3.8	3.8	4.2	4.1	**5.2 (3.8*)**	**5.3 (3.8*)**	**5.3 (4.0*)**	**4.6**
77233	Sudbury	4.9	4.1	3.4	3.6	4.0	4.0	**5.7**	**6.0**	**6.3**	**5.4**

Notes:

* For data comparison purposes, measurements were taken by Tapered Element Oscillating Microbalance (TEOM) sampler at selected sites.

From 2004-2012, measurements taken by TEOM sampler operated at 30°C with a Sample Equilibration System (SES).

As of 2013, measurements taken by Synchronized Hybrid Ambient Real-time Particulate (SHARP) 5030.

Due to change in the $PM_{2.5}$ monitoring method in 2013, it is inappropriate to calculate a change over time.

INS indicates there was insufficient data in any one quarter to calculate a valid annual mean.

Station 14111 replaced station 14064 as the Sarnia site in 2016.

Station 15026 replaced station 15025 as the London site in 2013.

Station 46108 replaced station 46109 as the Mississauga site in 2008.

Station 52023 replaced station 52022 as the Kingston site in 2014.

Station 77233 replaced station 77219 as the Sudbury site in 2013.

Table A14: 10y Trend for O_3 Annual Mean (ppb)

ID	City/Town	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Change Over Time
12008	Windsor Downtown	27.0	26.9	24.8	28.0	27.2	28.0	26.9	26.0	27.0	27.7	↑ 2%
12016	Windsor West	25.3	25.9	24.9	26.7	26.4	28.0	26.7	27.2	26.5	27.7	↑ 8%
13001	Chatham	30.9	30.9	28.8	31.9	29.7	29.5	29.6	29.3	29.6	29.6	↓ 4%
14111	Sarnia	28.6	28.7	26.6	30.7	29.7	29.7	28.6	27.1	27.8	28.8	↓ 2%
15020	Grand Bend	31.7	31.3	29.6	35.0	32.8	33.2	32.3	31.0	30.4	30.7	↓ 3%
15026	London	27.2	27.0	25.1	28.2	26.8	27.7	28.7	28.1	27.9	28.2	↑ 7%
16015	Port Stanley	34.3	34.3	30.9	34.6	32.8	33.1	33.9	32.3	32.8	32.9	↓ 3%
18007	Tiverton	34.3	32.6	31.4	33.8	32.1	32.0	32.4	31.8	32.5	33.1	↓ 2%
21005	Brantford	28.9	28.4	26.5	29.4	28.7	28.8	29.0	29.4	28.9	29.5	↑ 4%
26060	Kitchener	28.6	28.1	27.0	29.4	27.6	28.0	28.0	27.3	27.9	28.8	→ 0%
27067	St. Catharines	28.1	27.5	25.6	28.3	28.0	28.7	28.6	28.5	28.6	29.8	↑ 8%
28028	Guelph	28.1	27.9	27.3	30.7	28.9	28.8	29.0	27.8	27.7	28.7	→ 0%
29000	Hamilton Downtown	24.8	25.1	24.3	26.9	25.4	25.7	25.0	25.3	25.9	26.7	↑ 5%
29114	Hamilton Mountain	29.2	29.0	27.2	29.7	28.8	30.2	29.5	29.1	29.4	29.5	↑ 3%
29118	Hamilton West	23.0	23.3	21.8	24.5	24.2	24.2	24.4	22.7	23.9	24.4	↑ 5%
31103	Toronto Downtown	25.7	26.0	24.6	26.1	25.4	26.6	26.2	25.7	25.7	25.6	↑ 1%
33003	Toronto East	23.2	21.6	22.1	23.0	23.3	24.6	24.1	23.4	23.5	25.5	↑ 11%
34020	Toronto North	24.5	22.7	22.1	24.8	23.6	25.7	25.3	25.3	25.7	25.9	↑ 12%
35125	Toronto West	21.1	20.7	19.5	20.6	20.1	21.5	21.5	21.1	21.3	22.1	↑ 7%
44008	Burlington	24.6	24.9	24.1	26.6	25.9	26.7	26.4	25.5	26.5	27.6	↑ 10%
44017	Oakville	27.5	27.0	25.5	28.0	26.8	27.7	28.3	27.2	27.4	27.1	↑ 2%
45026	Oshawa	28.0	27.0	25.5	28.0	26.6	27.0	27.2	27.2	26.2	27.2	↓ 1%
46089	Brampton	26.8	26.6	25.2	27.5	26.1	26.6	26.7	26.5	26.5	27.1	↑ 1%
46108	Mississauga	23.3	24.6	24.0	25.9	24.1	25.6	25.2	25.4	25.4	26.0	↑ 8%
47045	Barrie	25.9	26.5	24.3	26.8	25.3	26.3	25.5	25.6	25.4	25.9	↓ 1%
48006	Newmarket	31.7	29.5	28.6	31.5	27.8	29.4	28.7	28.6	28.5	28.6	↓ 8%
49005	Parry Sound	31.8	32.1	29.7	31.3	29.7	30.1	30.4	29.6	30.4	29.6	↓ 6%
49010	Dorset	29.9	29.3	27.7	28.6	27.0	28.0	28.1	27.7	27.0	27.4	↓ 7%
51001	Ottawa Downtown	24.7	23.3	23.4	25.7	24.2	26.0	25.6	24.8	25.6	25.6	↑ 7%
51002	Ottawa Central	26.5	27.4	24.7	26.6	24.8	25.6	26.6	26.6	27.0	25.5	→ 0%
51010	Petawawa	28.3	27.6	27.3	27.9	26.7	27.7	27.6	26.8	26.7	26.4	↓ 5%
52023	Kingston	33.9	32.7	30.3	32.6	30.3	32.7	30.3	31.4	30.3	30.5	↓ 8%
54012	Belleville	32.0	29.8	28.5	30.0	27.9	28.0	29.2	29.6	29.6	30.5	↓ 2%
56051	Cornwall	28.3	26.6	25.5	27.9	26.1	27.1	26.9	27.3	27.9	27.1	↑ 1%
59006	Peterborough	27.6	28.2	27.7	30.5	27.9	29.1	28.6	29.2	29.3	29.7	↑ 6%
63203	Thunder Bay	24.2	23.0	24.2	25.7	25.2	25.0	26.3	23.4	24.0	23.2	↓ 1%
71078	Sault Ste. Marie	29.7	28.9	27.8	28.4	27.8	28.8	28.9	28.4	27.8	27.3	↓ 5%
75010	North Bay	27.1	27.7	26.1	28.0	26.7	26.1	27.4	26.7	27.0	26.4	↓ 2%
77233	Sudbury	28.1	27.9	25.9	28.7	28.7	28.5	27.2	26.3	25.7	25.1	↓ 9%

Notes:

Station 14111 replaced station 14064 as the Sarnia site in 2016.

Station 15026 replaced station 15025 as the London site in 2013.

Station 46108 replaced station 46109 as the Mississauga site in 2008.

Station 52023 replaced station 52022 as the Kingston site in 2014.

Station 77233 replaced station 77219 as the Sudbury site in 2013.

Table A15: 10y Trend for O_3 Summer Means (May - September)

Summer Mean (ppb)

ID	City/Town	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Change Over Time
12008	Windsor Downtown	36.3	34.1	30.4	34.6	33.8	36.8	32.5	30.9	33.3	33.4	↓ 5%
12016	Windsor West	33.5	32.1	29.5	31.8	31.9	35.7	30.9	30.9	31.8	33.0	→ 0%
13001	Chatham	38.2	36.7	32.6	36.5	34.4	36.6	34.2	32.4	34.4	32.9	↓ 10%
14111	Sarnia	34.2	33.0	28.6	34.3	32.9	36.6	32.0	29.4	31.1	32.1	↓ 5%
15020	Grand Bend	34.9	32.4	29.7	37.8	33.9	38.9	33.1	31.5	32.3	32.0	↓ 4%
15026	London	33.2	31.6	28.4	32.5	30.7	34.4	30.9	29.5	31.0	30.4	↓ 4%
16015	Port Stanley	40.4	38.8	33.2	38.9	35.5	38.4	36.9	33.7	35.6	35.2	↓ 10%
18007	Tiverton	38.3	34.0	30.3	33.3	31.7	36.0	32.5	30.8	33.3	34.1	↓ 6%
21005	Brantford	33.6	31.0	27.5	31.6	31.1	33.5	30.1	29.9	31.2	32.2	→ 0%
26060	Kitchener	34.2	31.0	28.8	31.6	30.2	33.5	29.8	28.5	30.2	31.8	↓ 5%
27067	St. Catharines	33.9	31.2	27.7	32.0	31.2	35.0	31.2	29.5	31.7	33.2	↑ 1%
28028	Guelph	33.1	30.4	28.7	32.5	31.3	34.5	30.4	28.9	30.2	31.2	↓ 3%
29000	Hamilton Downtown	30.8	29.8	28.2	31.6	28.7	32.4	28.4	27.5	29.5	30.6	↓ 2%
29114	Hamilton Mountain	36.1	33.6	31.0	34.4	32.3	37.4	32.5	31.6	33.9	33.2	↓ 3%
29118	Hamilton West	26.9	26.7	23.9	27.9	26.2	29.2	26.4	22.7	26.5	27.1	↓ 2%
31103	Toronto Downtown	33.2	30.9	27.9	31.1	29.5	33.3	30.1	28.9	30.8	29.6	↓ 5%
33003	Toronto East	28.3	24.9	25.2	26.7	27.4	30.6	27.1	25.9	27.7	29.7	↑ 8%
34020	Toronto North	29.9	26.4	25.6	28.0	27.5	32.7	29.4	28.6	30.7	30.7	↑ 12%
35125	Toronto West	25.9	24.8	22.5	24.3	23.6	27.5	24.4	23.5	25.0	25.9	↑ 2%
44008	Burlington	30.0	28.3	26.7	30.2	29.2	32.5	29.2	27.4	30.1	30.5	↑ 4%
44017	Oakville	32.8	30.8	28.2	31.5	29.9	34.2	30.6	28.3	30.2	29.9	↓ 5%
45026	Oshawa	31.5	28.3	26.4	29.5	28.5	31.1	28.3	27.9	28.9	29.4	↓ 1%
46089	Brampton	31.9	31.0	28.5	30.8	29.3	32.7	29.5	28.9	30.3	31.2	↓ 2%
46108	Mississauga	28.6	27.3	26.2	29.0	26.7	30.4	26.5	26.5	28.0	28.5	→ 0%
47045	Barrie	28.6	30.0	25.0	27.9	26.2	29.7	25.6	25.4	26.8	27.4	↓ 7%
48006	Newmarket	36.0	32.1	30.9	34.4	30.5	34.2	30.3	29.4	31.2	31.7	↓ 10%
49005	Parry Sound	33.6	32.2	28.6	30.4	28.7	32.8	30.1	28.2	31.4	28.9	↓ 8%
49010	Dorset	30.0	27.2	25.0	25.2	23.8	28.3	25.3	24.4	24.6	25.1	↓ 12%
51001	Ottawa Downtown	28.2	24.9	24.6	26.1	25.1	29.3	26.5	24.6	27.8	27.5	↑ 4%
51002	Ottawa Central	27.9	25.3	26.3	25.4	29.4	27.0	26.2	26.2	28.7	26.7	↑ 3%
51010	Petawawa	26.7	24.7	24.4	23.8	22.8	28.1	24.5	22.9	24.4	23.4	↓ 7%
52023	Kingston	39.3	35.4	32.5	35.9	32.0	38.5	32.4	32.7	32.2	33.3	↓ 12%
54012	Belleville	37.0	32.3	30.6	34.2	29.9	32.7	30.6	30.4	33.2	33.7	↓ 5%
56051	Cornwall	31.1	27.6	27.1	29.8	26.7	30.7	28.1	27.0	29.7	28.7	↓ 1%
59006	Peterborough	30.0	31.6	29.2	32.0	29.8	34.2	29.5	30.0	31.5	32.3	↑ 4%
63203	Thunder Bay	24.6	21.3	24.2	23.9	24.2	25.3	24.7	22.7	23.6	22.0	↓ 3%
71078	Sault Ste. Marie	31.5	28.4	27.5	27.2	26.4	30.3	28.2	27.4	28.1	26.3	↓ 8%
75010	North Bay	28.5	28.3	26.5	28.4	26.3	28.5	26.9	26.2	27.8	26.4	↓ 5%
77233	Sudbury	29.5	26.0	25.7	26.3	26.9	29.8	28.0	27.0	27.7	26.6	→ 0%

Notes:

Station 14111 replaced station 14064 as the Sarnia site in 2016.

Station 15026 replaced station 15025 as the London site in 2013.

Station 46108 replaced station 46109 as the Mississauga site in 2008.

Station 52023 replaced station 52022 as the Kingston site in 2014.

Station 77233 replaced station 77219 as the Sudbury site in 2013.

Table A16: 10y Trend for O_3 Winter Means (January-April, October-December)

Winter Mean (ppb)

ID	City/Town	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Change Over Time
12008	Windsor Downtown	20.3	21.7	20.8	23.2	22.5	21.7	22.8	22.8	22.4	23.6	↑ 11%
12016	Windsor West	19.4	21.5	21.6	22.8	22.5	22.3	23.4	24.5	22.7	23.9	↑ 17%
13001	Chatham	25.4	26.8	26.1	28.5	26.7	24.3	26.2	27.1	26.3	27.2	↑ 2%
14111	Sarnia	24.7	25.5	25.2	28.1	27.4	24.7	26.2	25.4	25.4	INS	↑ 1%
15020	Grand Bend	29.4	30.5	29.5	33.0	32.1	29.1	31.8	30.6	29.1	29.8	↓ 1%
15026	London	22.8	23.7	22.8	25.0	24.2	22.9	26.9	27.1	25.8	26.6	↑ 18%
16015	Port Stanley	30.0	31.0	29.4	31.5	31.0	29.3	31.8	31.3	31.2	31.2	↑ 4%
18007	Tiverton	31.5	31.7	32.3	34.1	32.2	29.2	32.4	32.7	31.9	32.4	↑ 1%
21005	Brantford	25.5	26.6	25.8	27.8	27.1	25.4	28.3	28.8	27.2	27.7	↑ 8%
26060	Kitchener	24.6	26.0	25.9	27.8	25.7	24.0	26.7	26.5	26.1	26.6	↑ 4%
27067	St. Catharines	24.1	24.9	24.1	25.6	25.8	24.1	26.8	27.9	26.3	27.2	↑ 14%
28028	Guelph	24.8	26.1	26.4	29.3	27.2	24.8	28.0	27.0	26.0	26.8	↑ 3%
29000	Hamilton Downtown	20.5	21.7	21.5	23.5	23.1	20.9	22.5	23.7	23.3	23.9	↑ 12%
29114	Hamilton Mountain	24.2	25.7	24.5	26.3	26.3	25.0	27.3	27.3	26.3	26.8	↑ 10%
29118	Hamilton West	20.1	20.9	20.4	22.1	22.7	20.6	23.0	22.8	22.1	22.5	↑ 11%
31103	Toronto Downtown	20.4	22.2	22.4	22.4	22.6	21.8	23.5	23.5	22.0	22.7	↑ 7%
33003	Toronto East	19.5	19.3	19.9	20.4	20.4	20.3	22.0	21.6	20.5	22.5	↑ 14%
34020	Toronto North	20.7	20.1	19.5	22.5	20.8	20.7	22.3	22.8	22.1	22.6	↑ 13%
35125	Toronto West	17.7	17.7	17.4	18.0	17.7	17.2	19.5	19.4	18.6	19.4	↑ 11%
44008	Burlington	20.7	22.5	22.3	23.9	23.5	22.5	24.4	24.1	23.8	25.6	↑ 16%
44017	Oakville	23.7	24.4	23.6	25.5	24.7	23.1	26.6	26.5	25.3	25.1	↑ 8%
45026	Oshawa	25.6	25.7	24.9	26.9	25.2	24.1	26.4	26.7	24.3	25.6	↓ 1%
46089	Brampton	23.1	23.4	22.8	25.2	23.8	22.2	24.6	24.8	23.8	24.1	↑ 4%
46108	Mississauga	19.2	22.8	22.5	23.7	22.5	22.2	24.3	24.7	23.6	24.2	↑ 16%
47045	Barrie	24.0	24.2	23.8	26.0	24.7	23.9	25.5	25.8	24.4	24.8	↑ 4%
48006	Newmarket	28.6	27.6	27.1	29.4	25.8	26.0	27.5	28.1	26.6	26.3	↓ 5%
49005	Parry Sound	30.6	32.0	30.5	31.9	30.4	28.1	30.6	30.6	29.8	30.0	↓ 4%
49010	Dorset	30.1	30.7	29.6	31.0	29.5	27.7	30.1	30.1	28.8	29.0	↓ 4%
51001	Ottawa Downtown	22.0	22.2	22.6	25.5	23.6	23.5	24.9	25.1	24.0	24.3	↑ 11%
51002	Ottawa Central	25.6	27.0	24.1	26.8	24.5	22.9	26.3	26.9	25.8	24.5	↓ 2%
51010	Petawawa	29.5	29.6	29.5	30.8	29.5	27.5	29.9	29.6	28.5	28.6	↓ 4%
52023	Kingston	30.1	30.6	28.6	30.0	29.0	28.6	28.8	30.4	28.9	28.5	↓ 4%
54012	Belleville	28.4	28.0	26.9	27.0	26.4	24.6	28.2	29.1	27.0	28.2	↑ 1%
56051	Cornwall	26.3	26.0	24.5	26.5	25.7	24.2	25.7	27.6	26.6	26.0	↑ 3%
59006	Peterborough	25.9	26.0	26.7	29.5	26.6	25.5	28.0	28.6	27.7	27.8	↑ 7%
63203	Thunder Bay	23.9	24.3	24.2	27.1	26.1	24.7	27.4	23.8	24.2	24.2	→ 0%
71078	Sault Ste. Marie	28.6	29.3	28.4	29.3	28.9	27.6	29.4	29.2	27.7	28.0	↓ 3%
75010	North Bay	26.2	27.2	25.8	27.7	27.0	24.4	27.8	27.1	26.4	26.4	→ 0%
77233	Sudbury	27.2	29.3	26.0	30.5	30.0	27.6	26.6	25.8	24.3	24.0	↓ 15%

Notes:

INS indicates there was insufficient data to calculate a valid winter mean.

Station 14111 replaced station 14064 as the Sarnia site in 2016.

Station 15026 replaced station 15025 as the London site in 2013.

Station 46108 replaced station 46109 as the Mississauga site in 2008.

Station 52023 replaced station 52022 as the Kingston site in 2014.

Station 77233 replaced station 77219 as the Sudbury site in 2013.

Table A17: 10y Trend for SO_2

Annual Mean (ppb)
SO_2 1y AAQC: 20 ppb

ID	City/Town	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Change Over Time
12008	Windsor Downtown	5.5	4.5	3.5	3.5	3.5	2.8	2.4	2.4	1.9	1.1	↓ 74%
12016	Windsor West	5.2	4.7	3.6	3.2	3.4	2.8	2.6	2.8	1.9	1.4	↓ 69%
14111	Sarnia	8.0	7.7	4.5	3.9	5.3	4.1	3.8	3.5	3.2	INS	↓ 70%
29000	Hamilton Downtown	4.2	4.3	3.3	3.3	5.2	4.8	4.8	5.1	4.3	3.2	↑ 5%
29114	Hamilton Mountain	3.5	3.0	3.0	2.9	4.1	3.7	2.8	2.9	2.6	1.8	↓ 30%
35125	Toronto West	1.5	1.4	1.2	0.9	1.5	0.6	0.6	0.7	1.0	0.6	↓ 57%
51001	Ottawa Downtown	0.9	1.0	0.9	0.2	0.4	0.3	0.3	0.3	0.4	0	↓ 92%
71078	Sault Ste. Marie	1.8	1.2	0.6	0.7	0.8	0.6	0.8	0.8	0.8	0.6	↓ 56%
77233	Sudbury	2.3	2.0	1.1	1.3	1.5	1.3	2.8	2.4	2.4	2.1	↑ 39%

Notes:

INS indicates there was insufficient data to calculate a valid annual mean.

Station 14111 replaced station 14064 as the Sarnia site in 2016.

Station 77233 replaced station 77219 as the Sudbury site in 2013.

Table A18: 10y Trend for CO

1h Maximum (ppm)
CO 1h AAQC: 30 ppm

ID	City/Town	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Change Over Time
12008	Windsor Downtown	5.0	1.3	1.4	2.5	3.8	2.1	1.9	1.8	1.9	2.3	↓ 39%
29000	Hamilton Downtown	6.0	3.3	5.0	2.2	1.8	1.7	2.0	2.9	1.3	1.4	↓ 80%
35125	Toronto West	1.4	1.7	1.6	1.8	1.4	1.4	1.4	1.6	1.3	1.7	↓ 6%
51001	Ottawa Downtown	1.5	1.3	1.4	1.5	1.5	0.9	0.9	0.8	0.8	0.9	↓ 49%

Table A19: $PM_{2.5}$ and Ozone CAAQS Metric Values for Designated Sites Across Ontario (2016)

City/Town	24h $PM_{2.5}$ (µg/m³)	Annual $PM_{2.5}$ (µg/m³)	8h Ozone (ppb)
Windsor Downtown	21	9.1	71
Sarnia	22	8.7	64
Chatham	17	7.8	67
London	21	8.1	68
Brantford	21	8.4	69
Kitchener	22	8.5	66
Guelph	23	8.1	67
St. Catharines	19	8.1	65
Hamilton Downtown	25	9.8	65
Hamilton Mountain	21	8.6	67
Burlington	22	8.9	65
Oakville	21	7.9	65
Mississauga	22	8.1	65
Brampton	23	8.0	66
Toronto	23	8.6	68
Oshawa	19	7.1	64
Barrie	19	7.3	62
Peterborough	17	6.5	68
Kingston	15	6.3	66
Ottawa Downtown	19	6.6	57
Sudbury	15	5.9	62
Sault Ste. Marie	14	4.9	61
Thunder Bay	13	6.0	52

Notes:

Designated sites normally refer to communities with populations greater than 100,000.

Sarnia's $PM_{2.5}$ metrics are based on a two-year average.

Toronto reporting is based on Toronto Downtown, Toronto North, Toronto East and Toronto West stations.

The CAAQS for 24h $PM_{2.5}$ is based on the 98^{th} percentile measurement annually, averaged over three consecutive years.

The CAAQS for annual $PM_{2.5}$ is based on the annual mean averaged over three consecutive years.

The CAAQS for ozone is based on the consecutive three year average of the annual 4^{th} highest daily maximum eight-hour running average.

Red font indicates an exceedance of the CAAQS.

Table A20: 2016 Air Quality Health Index Summary

Station ID	City/Town	No. of Valid Hours	Percentage of Valid AQHI Hours										No. of Days At Least 1 Hour > 6
			Low Risk			Moderate Risk			High Risk				
			1	2	3	4	5	6	7	8	9	10	
12008	Windsor Downtown	8514	2.22	32.83	49.72	13.52	1.53	0.11	0.08	0	0	0	3
12016	Windsor West	8733	1.68	36.79	48.87	11.19	1.21	0.05	0.21	0	0	0	7
13001	Chatham	8585	8.75	58.02	28.70	4.19	0.31	0	0.02	0	0	0	1
14111	Sarnia	6368	7.57	50.53	32.63	7.80	1.16	0.24	0.06	0	0	0	2
15020	Grand Bend	8709	14.85	64.45	17.33	2.80	0.39	0	0.18	0	0	0	5
15026	London	8540	12.01	55.50	28.62	3.51	0.33	0	0.02	0	0	0	2
16015	Port Stanley	8564	10.68	60.58	23.65	4.41	0.60	0	0.08	0	0	0	3
18007	Tiverton	8400	14.18	65.43	17.55	2.54	0.30	0	0.01	0	0	0	1
21005	Brantford	8738	11.82	53.64	30.00	3.91	0.54	0	0.09	0	0	0	3
26060	Kitchener	8507	8.21	54.39	31.77	5.17	0.43	0	0.02	0	0	0	1
27067	St. Catharines	7936	4.88	52.77	35.65	6.12	0.58	0	0	0	0	0	0
28028	Guelph	8601	10.06	52.51	32.22	4.93	0.28	0	0.01	0	0	0	1
29000	Hamilton Downtown	8713	2.39	36.26	45.35	13.18	2.58	0.25	0	0	0	0	0
29114	Hamilton Mountain	8696	3.85	48.68	38.37	8.20	0.90	0	0	0	0	0	0
29118	Hamilton West	8727	4.01	42.42	42.16	9.72	1.60	0.09	0	0	0	0	0
31103	Toronto Downtown	8644	2.58	32.67	50.97	11.23	2.23	0.27	0.05	0	0	0	2
33003	Toronto East	8502	3.45	40.81	42.79	10.03	2.55	0.32	0.04	0	0	0	2
34020	Toronto North	7739	5.18	38.02	39.91	13.37	3.20	0.23	0.08	0	0	0	4
35125	Toronto West	8673	2.25	33.19	49.22	12.48	2.63	0.22	0.01	0	0	0	0
44008	Burlington	8739	3.30	40.41	45.06	9.47	1.66	0.10	0	0	0	0	0
44017	Oakville	8642	6.90	51.70	34.30	6.20	0.86	0.05	0	0	0	0	0
45026	Oshawa	8647	12.79	57.72	24.92	4.09	0.45	0	0.02	0	0	0	1
46089	Brampton	7828	4.62	47.42	35.96	10.69	1.25	0.05	0	0	0	0	0
46108	Mississauga	8701	5.96	54.87	32.42	5.73	1.01	0	0	0	0	0	0
47045	Barrie	8641	11.32	53.65	27.31	6.50	1.12	0.09	0	0	0	0	0
48006	Newmarket	8774	10.43	55.92	27.07	5.89	0.60	0.01	0.08	0	0	0	3
49005	Parry Sound	8556	19.69	63.49	15.05	1.75	0.01	0	0	0	0	0	0
49010	Dorset	8540	25.28	60.78	12.73	1.21	0	0	0	0	0	0	0
51001	Ottawa Downtown	8652	16.17	54.05	25.53	4.11	0.14	0	0	0	0	0	0
51002	Ottawa Central	8482	19.58	59.18	18.97	2.26	0	0	0	0	0	0	0
51010	Petawawa	8745	28.83	60.03	10.34	0.80	0	0	0	0	0	0	0
52023	Kingston	8615	11.11	61.45	23.37	3.81	0.24	0	0.02	0	0	0	2
54012	Belleville	8504	7.47	64.72	23.54	3.89	0.20	0.01	0.16	0	0	0	4
56051	Cornwall	8724	15.49	57.30	23.93	2.98	0.28	0.02	0	0	0	0	0
59006	Peterborough	8547	14.22	57.28	23.79	4.01	0.67	0	0.04	0	0	0	3
63203	Thunder Bay	8533	21.56	54.61	22.40	1.42	0.01	0	0	0	0	0	0
71078	Sault Ste. Marie	8680	20.58	62.05	16.27	1.00	0.10	0	0	0	0	0	0
75010	North Bay	8761	23.25	58.36	16.41	1.86	0.11	0	0	0	0	0	0
77233	Sudbury	8702	16.71	59.68	19.02	3.67	0.87	0.06	0	0	0	0	0

Table A21: 2016 Air Quality Alert Summary

Air Quality Forecast Region	SAQS	SAHA
Algonquin	0	0
Atikokan - Upsala - Quetico	0	0
Attawapiskat	0	0
Bancroft - Bon Echo Park	0	0
Barrie - Orillia - Midland	0	0
Belleville - Quinte - Northumberland	1	0
Big Trout Lake - Sachigo Lake	0	0
Brockville - Leeds and Grenville	0	0
Burk's Falls - Bayfield Inlet	0	0
Chapleau - Gogama	0	0
City of Hamilton	1	0
City of Ottawa	0	0
City of Thunder Bay	0	0
City of Toronto	1	1
Cornwall - Morrisburg	0	0
Dryden - Ignace	0	0
Dufferin - Innisfil	0	0
Dunnville - Caledonia - Haldimand	1	0
Elgin	1	0
Elliot Lake - Ranger Lake	0	0
Fort Frances - Rainy Lake	0	0
Fort Hope - Webequie	0	0
Fort Severn	0	0
Geraldton - Manitouwadge - Hornepayne	0	0
Greater Sudbury and Vicinity	0	0
Grey - Bruce	1	0
Haliburton	0	0
Halton - Peel	1	0
Huron - Perth	1	0
Kapuskasing - Hearst	0	0
Kenora - Nestor Falls	0	0
Kingston - Prince Edward	1	0
Kirkland Lake - New Liskeard - Temagami	0	0
Lake Nipigon - Wabakimi	0	0
London - Middlesex	1	0
Manitoulin - Blind River - Killarney	0	0
Manitoulin - Northshore - Killarney	0	0
Moosonee - Fort Albany	0	0
Niagara	1	0
Nipigon - Marathon - Superior North	0	0
North Bay - West Nipissing	0	0
Oxford - Brant	1	0
Parry Sound - Muskoka - Huntsville	0	0
Peawanuck	0	0

Table A21: 2016 Air Quality Alert Summary (continued)

Air Quality Forecast Region	SAQS	SAHA
Peterborough - Kawartha Lakes	1	0
Pickle Lake - Wunnummin Lake	0	0
Prescott and Russell	0	0
Red Lake - Ear Falls	0	0
Renfrew - Pembroke - Barry's Bay	0	0
Sandy Lake - Pikangikum	0	0
Sarnia - Lambton	1	0
Sault Ste. Marie - Superior East	0	0
Simcoe - Delhi - Norfolk	1	0
Sioux Lookout - Savant Lake	0	0
Smiths Falls - Lanark - Sharbot Lake	0	0
Stirling - Tweed - South Frontenac	0	0
Superior West	0	0
Timmins - Cochrane	0	0
Waterloo - Wellington	1	0
Wawa - White River - Pukaskwa	0	0
Windsor - Essex - Chatham - Kent	1	0
York - Durham	1	0
ONTARIO	**10**	**1**

Table A22: 2016 Benzene Annual Statistics

Unit: micrograms per cubic metre (μg/m³)
Benzene 24h AAQC: 2.3 μg/m³
Benzene Annual AAQC: 0.45 μg/m³

ID	City	Location	No. of Samples	PERCENTILES 10%	25%	50%	75%	90%	Max	Min	Mean	Std. Dev.	No. of Times Above Criteria 24h	Annual
12016	Windsor West	College Ave./South St.	56	0.301	0.375	0.475	0.631	0.721	1.288	0.188	0.523	0.221	0	1
14111	Sarnia	700 Christina St. N.	41	0.185	0.256	0.385	0.977	1.711	2.466	0.112	0.696	0.656	1	1
15026	London	42 St. Julien St.	52	0.165	0.223	0.334	0.464	0.580	0.815	0.122	0.355	0.167	0	0
26060	Kitchener	West Ave./Homewood Ave.	58	0.199	0.248	0.345	0.491	0.661	1.423	0.163	0.406	0.214	0	0
29000	Hamilton Downtown	Elgin St./Kelly St.	59	0.204	0.318	0.569	0.896	1.426	2.115	0.163	0.683	0.473	0	1
48006	Newmarket	Eagle St. W./McCaffrey Rd.	51	0.145	0.197	0.274	0.412	0.549	1.111	0.102	0.342	0.221	0	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	56	0.155	0.231	0.306	0.475	0.627	1.208	0.131	0.377	0.232	0	0

Table A23: 2016 Toluene Annual Statistics

Unit: micrograms per cubic metre (µg/m³)
Toluene 24h AAQC (based on odour): 2,000 µg/m³

ID	City	Location	No. of Samples	PERCENTILES 10%	25%	50%	75%	90%	Max	Min	Mean	Std. Dev.	No. of Times Above Criteria 24h
12016	Windsor West	College Ave./South St.	56	0.484	0.627	1.043	1.532	2.117	5.439	0.233	1.272	0.951	0
14111	Sarnia	700 Christina St. N.	41	0.306	0.455	1.065	1.944	3.401	12.165	0.101	1.778	2.232	0
15026	London	42 St. Julien St.	52	0.253	0.412	0.562	0.794	1.350	3.007	0.166	0.727	0.567	0
26060	Kitchener	West Ave./Homewood Ave.	58	0.342	0.451	0.731	1.198	2.074	4.158	0.148	1.020	0.879	0
29000	Hamilton Downtown	Elgin St./Kelly St.	59	0.441	0.513	0.794	2.677	3.608	6.797	0.125	1.642	1.590	0
48006	Newmarket	Eagle St. W./McCaffrey Rd.	51	0.251	0.481	0.891	1.732	2.135	3.267	0.105	1.118	0.781	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	56	0.293	0.489	0.762	1.298	1.645	2.645	0.159	0.902	0.564	0

Table A24: 2016 Ethylbenzene Annual Statistics

Unit: micrograms per cubic metre (µg/m³)
Ethylbenzene 24h AAQC: 1,000 µg/m³

ID	City	Location	No. of Samples	PERCENTILES 10%	25%	50%	75%	90%	Max	Min	Mean	Std. Dev.	No. of Times Above Criteria 24h
12016	Windsor West	College Ave./South St.	56	0.089	0.124	0.200	0.269	0.354	1.243	0.043	0.235	0.190	0
14111	Sarnia	700 Christina St. N.	41	0.055	0.076	0.165	0.307	0.764	1.459	0.016	0.283	0.321	0
15026	London	42 St. Julien St.	52	0.045	0.066	0.089	0.127	0.182	0.399	0.023	0.110	0.075	0
26060	Kitchener	West Ave./Homewood Ave.	58	0.058	0.075	0.121	0.193	0.308	0.633	0.028	0.159	0.129	0
29000	Hamilton Downtown	Elgin St./Kelly St.	59	0.075	0.092	0.137	0.225	0.411	0.632	0.022	0.186	0.140	0
48006	Newmarket	Eagle St. W./McCaffrey Rd.	51	0.045	0.085	0.200	0.295	0.415	0.607	0.012	0.217	0.148	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	56	0.041	0.065	0.095	0.143	0.229	0.400	0.033	0.121	0.083	0

Table A25: 2016 m-, and p-xylene Annual Statistics

Unit: micrograms per cubic metre (µg/m³)

ID	City	Location	No. of Samples	PERCENTILES 10%	25%	50%	75%	90%	Max	Min	Mean	Std. Dev.
12016	Windsor West	College Ave./South St.	56	0.204	0.298	0.529	0.732	1.022	3.634	0.091	0.635	0.573
14111	Sarnia	700 Christina St. N.	41	0.126	0.185	0.426	0.624	0.905	2.432	0.026	0.496	0.446
15026	London	42 St. Julien St.	52	0.090	0.140	0.203	0.328	0.472	1.199	0.031	0.269	0.228
26060	Kitchener	West Ave./Homewood Ave.	58	0.124	0.164	0.288	0.526	0.921	1.982	0.060	0.435	0.423
29000	Hamilton Downtown	Elgin St./Kelly St.	59	0.174	0.207	0.341	0.633	1.264	1.938	0.046	0.518	0.449
48006	Newmarket	Eagle St. W./McCaffrey Rd.	51	0.098	0.174	0.438	0.709	1.064	1.514	0.018	0.486	0.371
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	56	0.103	0.154	0.238	0.419	0.680	1.809	0.042	0.341	0.304

Table A26: 2016 o-xylene Annual Statistics

Unit: micrograms per cubic metre (µg/m³)

ID	City	Location	No. of Samples	PERCENTILES								
				10%	25%	50%	75%	90%	Max	Min	Mean	Std. Dev.
12016	Windsor West	College Ave./South St.	56	0.080	0.114	0.192	0.262	0.367	1.307	0.038	0.232	0.202
14111	Sarnia	700 Christina St. N.	41	0.047	0.076	0.153	0.248	0.326	0.691	0.011	0.179	0.138
15026	London	42 St. Julien St.	52	0.034	0.057	0.079	0.124	0.185	0.411	0.014	0.106	0.082
26060	Kitchener	West Ave./Homewood Ave.	58	0.049	0.067	0.111	0.187	0.308	0.640	0.023	0.154	0.136
29000	Hamilton Downtown	Elgin St./Kelly St.	59	0.066	0.082	0.130	0.222	0.457	0.705	0.018	0.190	0.159
48006	Newmarket	Eagle St. W./McCaffrey Rd.	51	0.036	0.069	0.173	0.285	0.409	0.548	0.008	0.194	0.136
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	56	0.041	0.066	0.095	0.158	0.261	0.416	0.023	0.128	0.093

Table A27: 2016 1,3-Butadiene Annual Statistics

Unit: micrograms per cubic metre (µg/m³)
1,3-Butadiene Annual AAQC: 2.0 µg/m³

ID	City	Location	No. of Samples	PERCENTILES									No. of Times Above Criteria
				10%	25%	50%	75%	90%	Max	Min	Mean	Std. Dev.	1y
12016	Windsor West	College Ave./South St.	56	0.017	0.021	0.030	0.040	0.057	0.155	0.009	0.036	0.026	0
14111	Sarnia	700 Christina St. N.	41	0.011	0.020	0.038	0.072	0.337	0.619	0.006	0.089	0.137	0
15026	London	42 St. Julien St.	52	0.010	0.011	0.017	0.022	0.033	0.065	0.006	0.019	0.012	0
26060	Kitchener	West Ave./Homewood Ave.	58	0.010	0.015	0.021	0.027	0.045	0.136	0.006	0.025	0.019	0
29000	Hamilton Downtown	Elgin St./Kelly St.	59	0.014	0.016	0.023	0.034	0.049	0.075	0.006	0.028	0.015	0
48006	Newmarket	Eagle St. W./McCaffrey Rd.	51	0.009	0.011	0.016	0.023	0.039	0.114	0.003	0.022	0.020	0
51001	Ottawa Downtown	Rideau St./Wurtemburg St.	56	0.013	0.015	0.022	0.035	0.046	0.100	0.008	0.029	0.020	0

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