Air Quality in Ontario
2005 Report

Protecting our environment. Ontario

ACKNOWLEDGEMENTS

This report has been prepared by the staff of the Environmental Monitoring and Reporting Branch of the Ontario Ministry of the Environment. Canada's National Air Pollution Surveillance program is also acknowledged for providing air monitoring instrumentation.

PIBs 6041e

2005 Report Findings

- The 2005 air quality report marks 35 years of reporting on the state of air quality in Ontario. This report summarizes province-wide monitoring of ambient air quality.

- Overall, air quality in Ontario has improved significantly over the past 35 years for nitrogen dioxide, carbon monoxide and sulphur dioxide. However, ozone and fine particulate matter ($PM_{2.5}$), the major components of smog, continue to exceed the ambient air quality criteria and set reference levels and thus, remain the pollutants of most concern.

- There were 15 smog advisories covering 53 days (due to ozone and/or fine particulate matter) issued in 2005. This is a record number of smog advisory days in a year issued by the ministry, since the inception of the Smog Alert program. The previous record for number of smog advisories and smog advisory days occurred in 2002 when the ministry issued a total of 10 smog advisories covering 27 days.

- In 2005, 12 of the 15 advisories occurred during the traditional summer smog season, May to September. For the first time, since the inclusion of $PM_{2.5}$ in the Smog Alert program in August 2002, Ontario issued a winter smog advisory. In February 2005, an intense 5-day smog episode occurred due to elevated $PM_{2.5}$ levels. This was followed by the earliest smog advisory issued in April 2005 due to ozone. Another highlight included a widespread autumn $PM_{2.5}$ episode across Ontario in October 2005 which was outside the traditional smog season.

- A record-breaking number of smog advisory days (20) were issued in June 2005, a month with high temperatures and transboundary flow of polluted air into Ontario. This included a record long eight-day episode.

- Analysis of smog and weather data strongly indicates that the American Midwest and Ohio Valley Region of the U.S. continue to be significant contributors to elevated ozone and $PM_{2.5}$ in southern Ontario during the smog season.

- The provincial ambient air quality criteria (AAQC) for nitrogen dioxide and carbon monoxide were not exceeded at any of the ambient monitoring sites in 2005. The one-hour AAQC for sulphur dioxide was only exceeded at the Sudbury site for one hour.

2005 Report Findings continued…

- In 2005, Ontario's AAQC for ozone was exceeded at 37 of the 38 Air Quality Index (AQI) stations on at least one occasion. Thunder Bay was the only site that did not record any hours of ozone above the one-hour AAQC of 80 parts per billion (ppb).

- The designated Canada-wide Standard (CWS) reporting sites were all above the 2010 CWS of 65 ppb for ozone in 2005 with the exception of Thunder Bay where the CWS calculated ozone value was 58 ppb.

- Eleven of the 15 designated CWS reporting sites were above the 2010 CWS of 30 $\mu g/m^3$ for $PM_{2.5}$. The majority of the areas that reported greater than 30 $\mu g/m^3$ were confined to southwestern Ontario and the Golden Horseshoe, including the Greater Toronto Area (GTA).

- A comparison of air quality in 39 cities world-wide was conducted for 2005. Overall, the air quality of the Ontario cities, Windsor, Toronto and Ottawa, was generally better than the other cities used in this analysis for the parameters measured.

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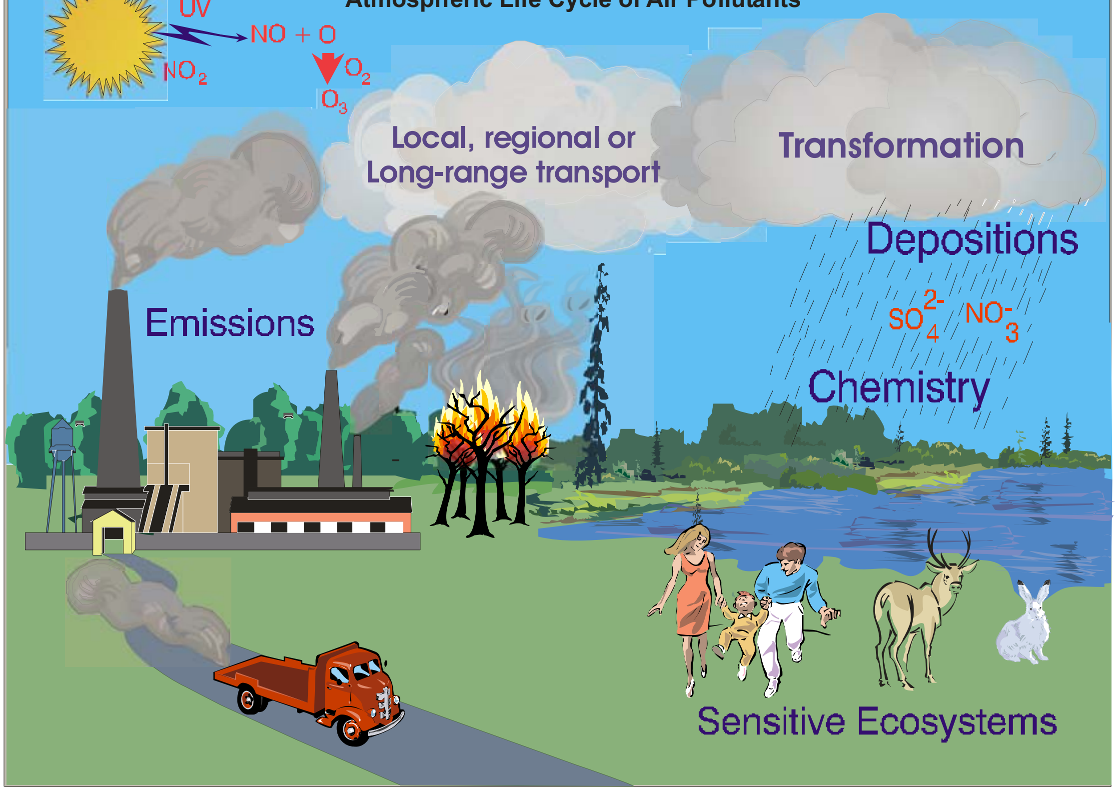
Chapter 1

Overview

Air pollution is of concern to many people who live in Ontario. Although the average levels for the majority of air pollutants in Ontario have decreased over the past 35 years, smog remains a significant issue, especially in southern Ontario where elevated levels of the airborne pollutants comprising of smog are common. As depicted in Figure 1.1, air pollution comes from various sources including stationary sources such as factories, power plants and smelters; mobile sources such as cars, buses, trucks, planes, marine vessels and trains; and, natural sources such as forest fires, windblown dust and biogenic emissions from vegetation.

Many pollutants, including those that are associated with smog (ozone and fine particulate matter) remain in the atmosphere for long periods of time. These air pollutants and/or their precursors are generated locally, regionally, nationally and internationally, and can travel from province to province and country to country, affecting areas far removed from their respective sources of pollution.

Figure 1.1
Atmospheric Life Cycle of Air Pollutants



The release of pollutants into the atmosphere and removal of pollutants from the atmosphere are ongoing processes. Pollutant levels are affected by source strengths, sunlight, moisture, clouds, precipitation, geography, and regional and local weather.

This report focuses on air concentrations based on measurements of key criteria pollutants in the ambient outdoor air to assess the state of air quality in the province of Ontario during 2005 and over the last 35 years.

The Ontario Ministry of the Environment collects continuous ambient air quality data at 38 Air Quality Index (AQI) monitoring sites across the province. These data are used to determine the state of air quality in Ontario and help develop abatement programs to reduce the burden of air pollutants, address key air issues and assess the efficacy of policies and programs. Ambient air monitoring provides information on the actual concentrations of selected pollutants in communities across Ontario. Table 1.1 shows the relationship between monitored air pollutants and current air issues.

Table 1.1: Linkages between Air Pollutants and Current Air Issues

Pollutant	Smog	Global Warming	Acid Deposition	Odour	Visibility/ Soiling
Ozone	Yes	Yes	Yes	No	No
Sulphur Dioxide	Yes	Yes	Yes	No	Yes
Carbon Monoxide	Yes	Yes	No	No	No
Nitrogen Oxides	Yes	Yes	Yes	No	Yes
Volatile Organic Compounds	Yes	Yes	No	Yes	No
Particulate Matter	Yes	Yes	Yes	Yes	Yes
Total Reduced Sulphur Compounds	No	No	No	Yes	No

The data collected by the province's state-of-the-art air monitoring network have contributed to several air quality initiatives and regulations. The Ministry of the Environment continues to monitor air quality across Ontario and uses this information to:

- inform the public about outdoor ambient air quality;
- assess Ontario's air quality and evaluate long-term trends;
- identify areas where criteria are exceeded and identify the origins of pollutants;
- provide the basis for air policy/program development;
- provide quantitative measurements to enable abatement of specific sources;

- determine the significance of pollutants from U.S. sources and their effects on Ontario;
- provide air quality researchers with data to link environmental and human health effects to air quality; and
- provide smog advisories for public health protection and public outreach.

This annual report, the 35th in a series, summarizes the state of ambient air quality in Ontario during 2005 and examines trends over time. It covers the measured levels of six contaminants: ozone (O_3), fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur dioxide (SO_2) and total reduced sulphur (TRS) compounds. Where appropriate, air pollutant concentrations from selected Ontario cities have been compared to the information available in other cities world-wide. The cities included in this comparative study are depicted in Figure 1.2. City populations ranged from approximately 20,000 (Yellowknife, Canada) to 17,000,000 (São Paulo, Brazil), and should be taken into account when examining their reported pollutant concentrations. Monitoring methods and siting procedures may vary from country to country; therefore, comparisons among nations are not intended to be used as a comprehensive ranking. Air quality standards for the chosen criteria pollutants in this study may vary from country to country as well; however, the inter-city comparisons represented here are referenced to Ontario's ambient air quality criteria (AAQC), the national ambient air quality standards (NAAQS) for the United States, and the guidelines given by the World Health Organization (WHO).

The report also summarizes the results from the Air Quality Index (AQI) and Smog Alert programs, and briefly examines smog episodes in 2005.

The main focus of the 2005 publication is to report on the state of Ontario's ambient air quality from the AQI network. The annual statistics and 10-year trends of ambient data are presented in the attached appendix. Ontario continues to benefit from one of the most comprehensive air monitoring systems in North America. The ambient network is designed to measure continuous air quality at 38 monitoring sites across the province and undergoes regular maintenance to ensure a high standard of quality. With these data, informed decisions can be made on what needs to be done to protect and improve the quality of air for all Ontarians.

Figure 1.2
Selected Cities Around the World Used for 2005 Air Quality Comparison

1. Adelaide; 2. Athens; 3. Atlanta; 4. Austin; 5. Belfast; 6. Boston; 7. Chicago; 8. Cleveland; 9 . Copenhagen; 10. Dallas; 11. Denver; 12. Detroit; 13. Erie; 14. Geneva; 15. Hong Kong; 16. Houston; 17. Jacksonville; 18. Miami; 19. Milwaukee; 20. Minneapolis-St. Paul; 21. Montreal; 22. New York; 23. Orlando; 24. Ottawa; 25. Perth; 26. Philadelphia; 27. Pittsburgh; 28. Prague; 29. Reykjavik; 30. San Antonio; 31. Sao Paulo; 32. Seattle; 33. Sydney; 34. Tampa; 35. Toronto; 36. Windsor; 37. Winnipeg; 38. Yellowknife; 39. Zurich.

Chapter 2

Ground-Level Ozone

Ground-level ozone is a gas formed when nitrogen oxides (NO_x) and volatile organic compounds (VOCs) react in the presence of sunlight. While ozone at ground-level is a major environmental and health concern, the naturally occurring ozone in the stratosphere is beneficial as it shields the earth from harmful ultraviolet radiation.

Characteristics, sources and effects

Ozone is a colourless, odourless gas at ambient concentrations, and is a major component of smog. Ground-level ozone is not emitted directly into the atmosphere. The formation and transport of ground-level ozone are strongly dependent on meteorological conditions. Changing weather patterns contribute to short-term and year-to-year differences in ozone concentrations. In Ontario, elevated concentrations of ground-level ozone are generally recorded on hot and sunny days from May to September, between noon and early evening.

The diurnal variation of ozone and its relationship with NO_x for the month of June 2005 are displayed for Windsor in Figure 2.1. The increase in NO_x concentrations, measured as nitric oxide (NO) and nitrogen dioxide, during the morning rush-hour is mainly the result of vehicular traffic; however, the ozone concentrations dip over the same period due to the scavenging effect of NO. By the late morning, ground-level ozone continues to be produced as a result of chemical reactions between VOCs and NO_x in the presence of sunlight. Ozone concentrations start to increase and peak by mid-afternoon when the sunlight is still relatively intense. As the sun goes down, ozone concentrations typically decrease.

Figure 2.2 shows typical estimates of Ontario's VOC emissions from point, area and transportation sources. Transportation sectors accounted for approximately 37 per cent of VOC emissions. General solvents and other industrial processes were the second largest sources of VOC emissions, each accounting for approximately 19 per cent.

Figure 2.3 shows estimates of Ontario's NO_x emissions from point, area and transportation sources. Transportation sectors accounted for approximately 62 per cent of NO_x emissions. Utilities were the second largest source of NO_x emissions, accounting for approximately 13 per cent.

Figure 2.1
Ozone and NO_x Hourly Means at Windsor Downtown
June 2005

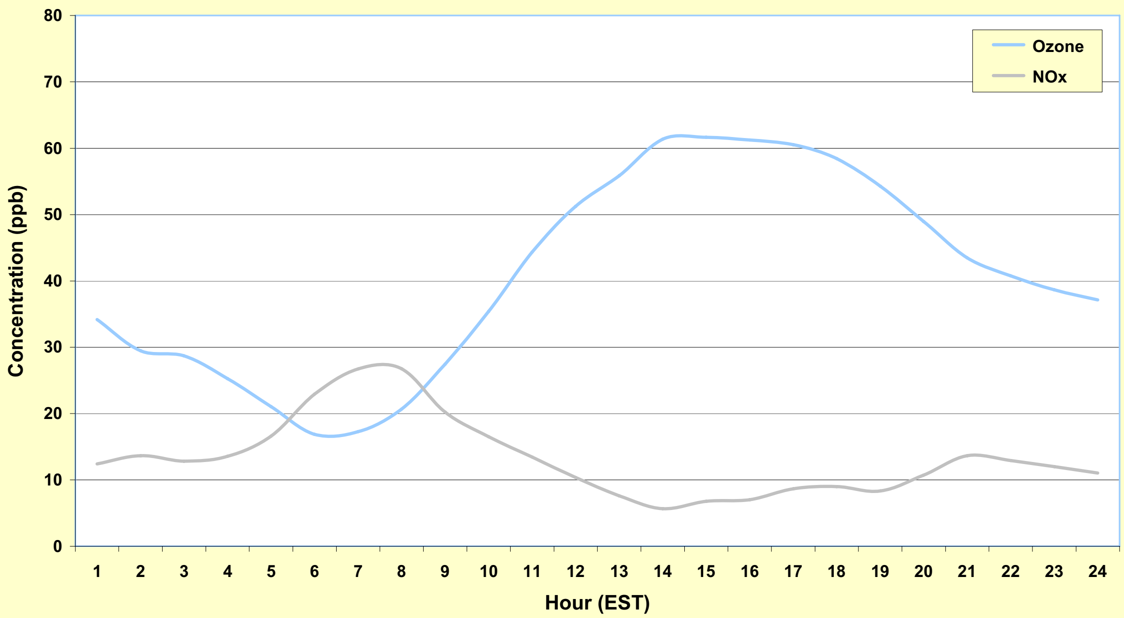
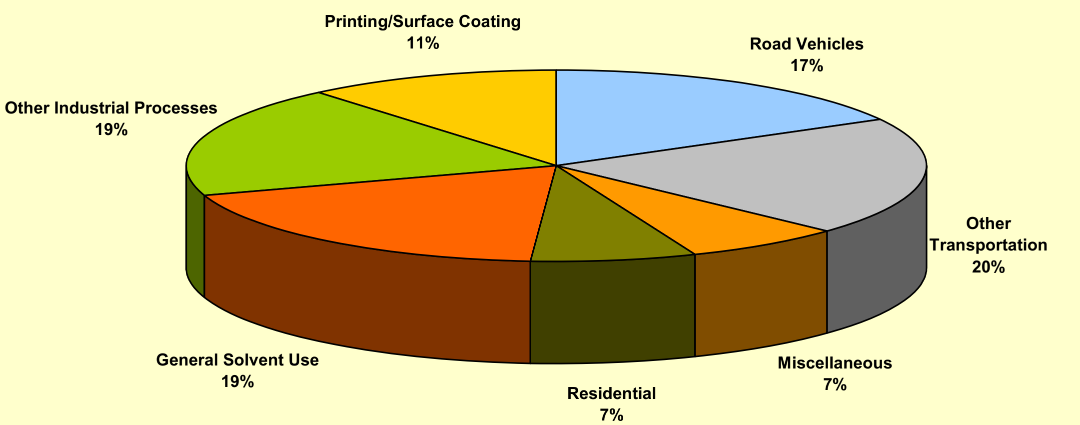
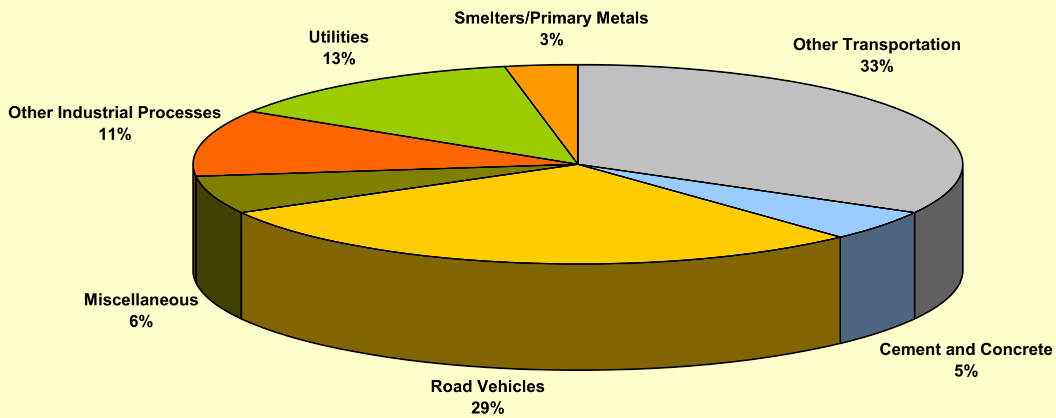


Figure 2.2
Ontario Volatile Organic Compounds Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2002 Estimates)



Note: 2002 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

Figure 2.3
Ontario Nitrogen Oxides Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2002 Estimates)



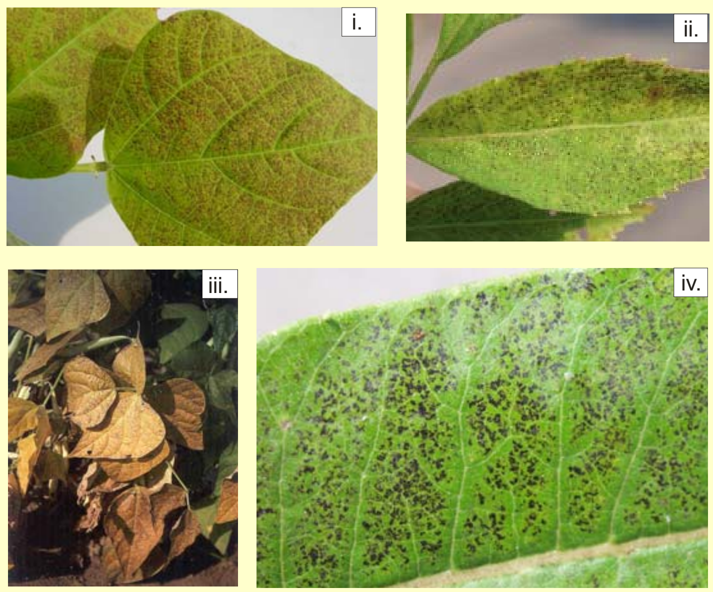
Note: 2002 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

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. Ground-level ozone is linked to increased hospital admissions and premature deaths.

Ozone also causes agricultural crop loss each year in Ontario, with visible leaf damage in many crops, garden plants and trees, especially during the summer months. Ozone injury has been observed on sensitive crops in parts of southwestern and central Ontario where the highest ambient ozone concentrations are generally recorded. For example, ozone injury was observed on foliage of elderberry, yellow poplar, sycamore, walnut and milkweed at a site near Port Stanley in 2005. Overall, foliage of young elderberry and walnut trees had moderate (10-35%) injury, while the other affected plants at this site had light (2-10%) to trace (0-1%) injury. Although the sunny, hot, and humid weather conditions in the summer of 2005 were conducive to ozone formation, the leaf's foliar stomata closed to preserve moisture loss, therefore preventing ozone from entering the leaf. Ozone injury on plant foliage commonly appears as stippling (grey, brown or black-like dots the size of a pin head) on the upper surface of leaves, as depicted in Figure 2.4a. Ozone can also cause visible leaf damage on some species, such as potato and tomato plants, as larger, irregular shaped, shiny grey or bronze spots on the under surface of leaves as shown in Figure 2.4b. Fortunately, plants have the ability to recover from ozone injury.

Figure 2.4a

Ozone Injury on Upper Leaf Surface of Sensitive Vegetation

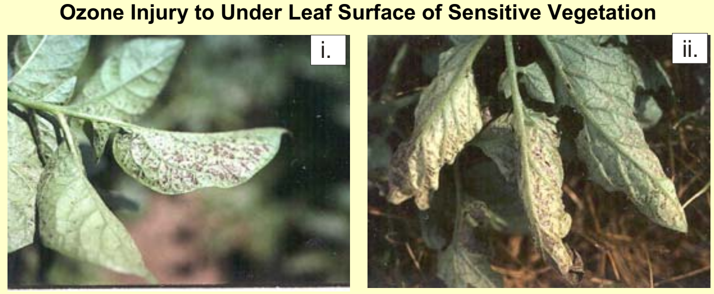


Notes:

- i. *Bean leaf with upper surface ozone stippling and coalescent injury on intervienal tissue.*
- ii. *Elderberry foliage with ozone injury on upper surface.*
- iii. *White bean plant with distinctive ozone stippling and bronzing on upper surface of several leaves.*
- iv. *Milkweed with grayish ozone spotting on upper surface of leaves.*

Figure 2.4b

Ozone Injury to Under Leaf Surface of Sensitive Vegetation



Notes:

- i. *Potato compound leaf with typical bronze spots on under surface.*
- ii. *Tomato compound leaf with shiny copper/bronze ozone lesions on underside of leaflets.*

Sensitive field crops include potato and tomato, however, white bean is the most ozone-sensitive crop grown in Ontario. Elevated ozone concentrations are not the only cause for adverse impacts on the growth and yield of sensitive plants since plant response to ozone may be influenced by the type of crop, variety, development stage, agricultural practices and weather conditions. The *Transboundary Air Pollution in Ontario* report states that the loss of agricultural and forest productivity due to air pollution in Ontario is estimated at approximately $280 million per year in damages.

Monitoring results for 2005

During 2005, ground-level ozone was monitored at all 38 Ontario Ministry of the Environment Air Quality Index monitoring stations. The highest annual mean was 34.6 parts per billion (ppb), measured at Port Stanley, a rural and transboundary-influenced site on the northern shore of Lake Erie, while the lowest annual mean, 20.3 ppb, was measured at Toronto West, a site impacted directly by local nitric oxide emissions. Generally, ozone concentrations are lower in urban areas because it is reduced by reaction with nitric oxide emitted by vehicles and other local combustion sources.

Among urban sites in 2005, the highest one-hour ozone concentration (116 ppb) was recorded at Chatham, whereas the Windsor West site recorded the greatest number of instances (150) when ozone was above Ontario's one-hour AAQC of 80 ppb. Peterborough recorded the highest annual urban mean (31.2 ppb).

At rural sites, Grand Bend measured the highest one-hour concentration (131 ppb), while Port Stanley had the most instances (172) above Ontario's one-hour AAQC, followed by Grand Bend where the AAQC was exceeded 98 times. Both sites, Port Stanley and Grand Bend, are impacted significantly by U.S. emissions.

Ground-level ozone concentrations continued to exceed the provincial AAQC across the province. In 2005, Ontario's one-hour AAQC for ozone was exceeded at 37 of the 38 AQI stations on at least one occasion. Thunder Bay reported a one-hour maximum of 69 ppb and was the only site that did not record any hours of ozone above 80 ppb in 2005.

The geographical distribution of the number of ozone exceedances across Ontario is shown in Figure 2.5. Higher numbers of one-hour ozone exceedances were recorded on the northern shores of Lake Erie and Lake Ontario and the southeastern shore of Lake Huron and eastern shore of Georgian Bay. As stated in the *Transboundary Air Pollution in Ontario* report, elevated ozone levels in these areas are generally attributed to the long-range transport of pollutants into Ontario from the United States. Transboundary air pollution is then combined with a local build-up of pollutants that may be carried throughout the province during a smog episode as demonstrated in Figure 2.6 which displays the ozone pollution roses at select sites across Ontario during an ozone episode June 7-14, 2005. Starting at the southwestern tip of Ontario, represented by the Windsor West monitoring site, the data clearly shows that the predominant winds from the southwest (SW) to south-southwest (SSW) resulted in the transport of air pollution from the United States into Windsor. It was during this period that the majority of high ozone concentrations were recorded. In comparison, the pollution rose for Newmarket, a city located approximately 30 kilometers north of Toronto, shows a slight change in wind direction, with prevailing winds from the SSW to south-southeast (SSE). This reflects the impact from potential transport of pollution from the U.S. and local pollution from Toronto. Morrisburg received the polluted air from the SW to west directions, and like Newmarket and Windsor West, also recorded high ozone concentrations exceeding Ontario's one-hour AAQC of 80 ppb during the episode. The highest frequency of the winds for Sault Ste. Marie were mainly from the southeast; however, the site recorded its highest ozone concentrations when the winds were southwesterly, indicating the transboundary influence.

Figure 2.5
Geographical Distribution of Number of One-Hour Ozone Exceedances Across Ontario
(2005)

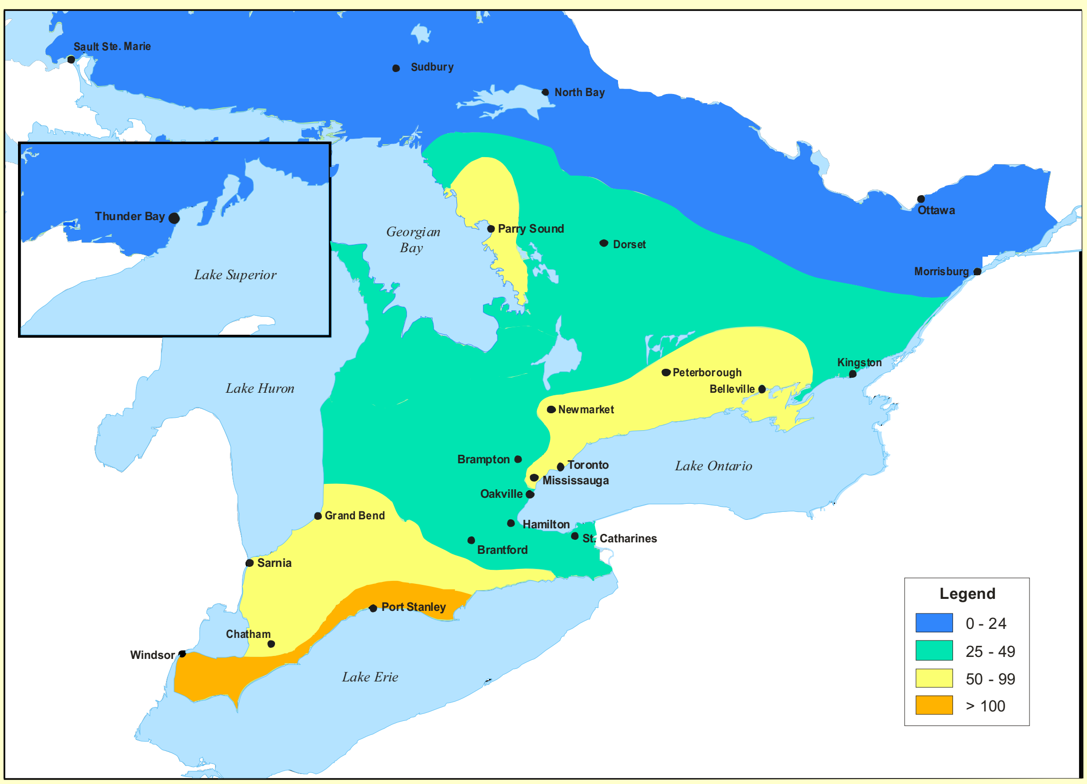
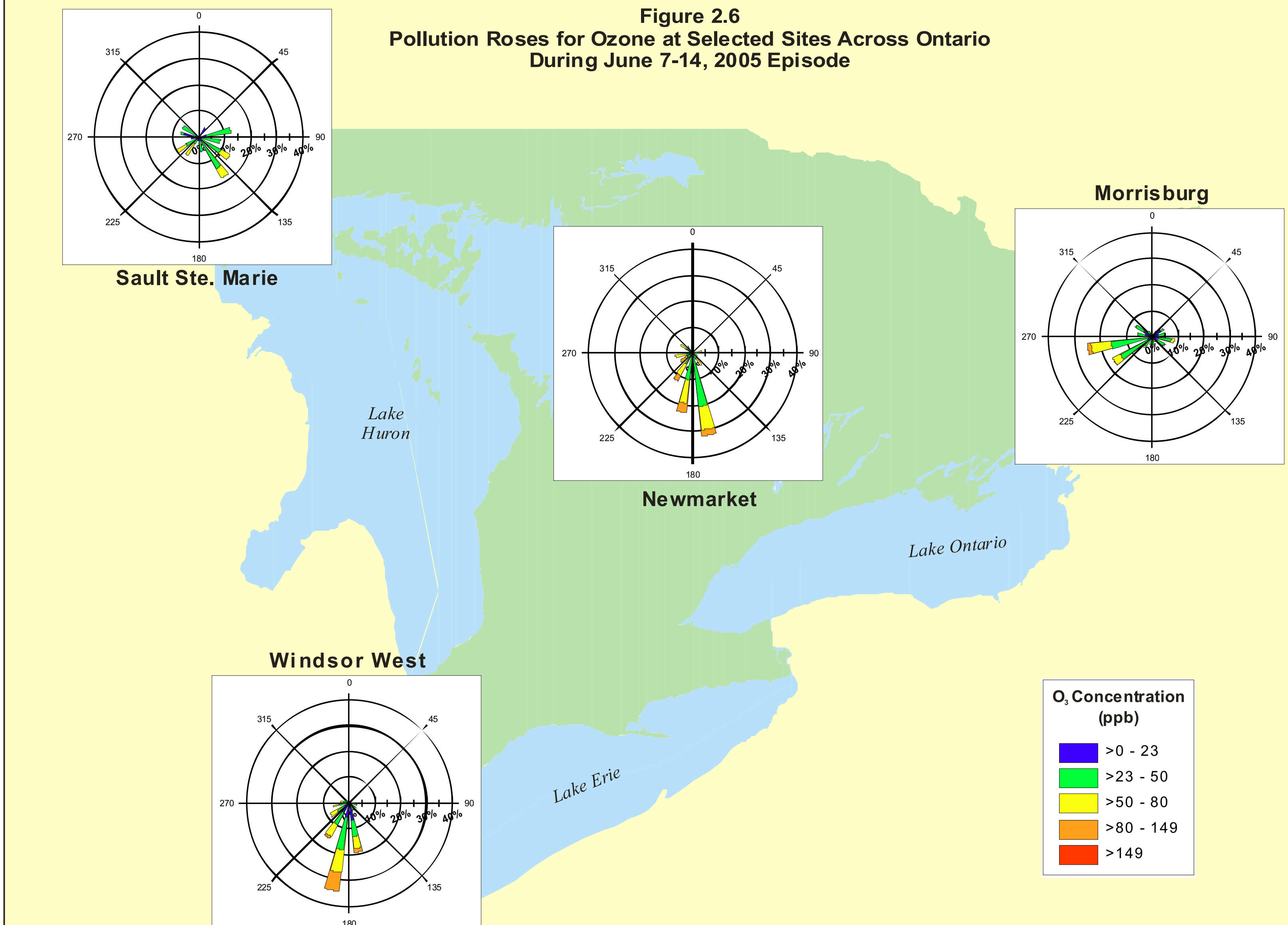


Figure 2.6
Pollution Roses for Ozone at Selected Sites Across Ontario
During June 7-14, 2005 Episode

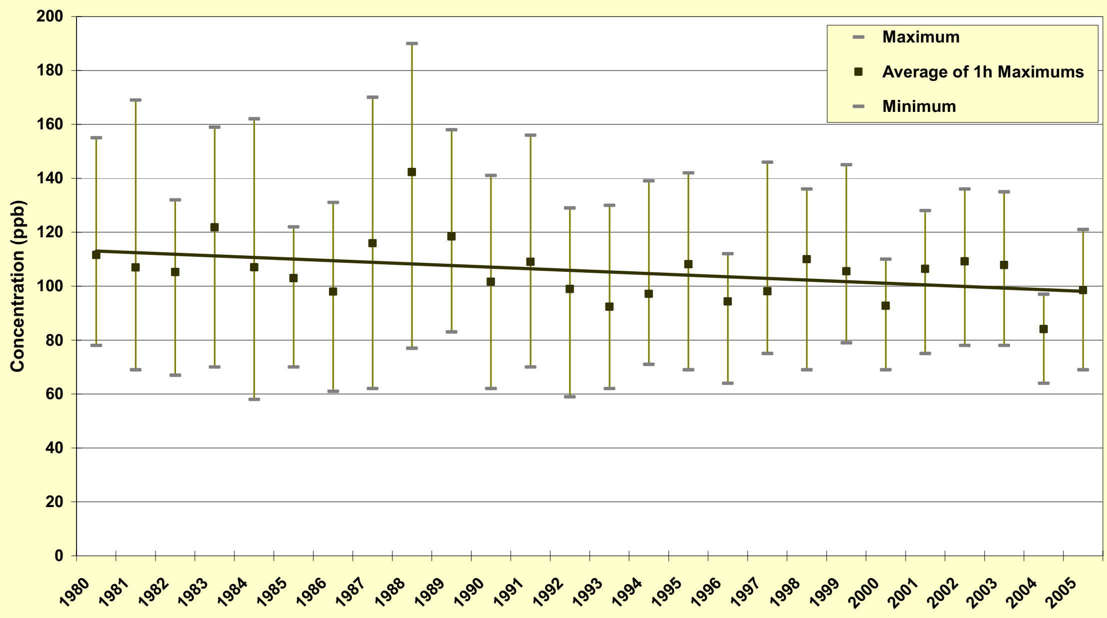


Note: A pollution rose is a diagram indicating the frequency of given concentration levels of a pollutant as a function of wind direction.

Trends

The composite average and range of the annual one-hour maximum ozone concentrations are shown for the 26-year period of 1980 to 2005 in Figure 2.7. For this period, the average of the annual one-hour maximum concentrations range from 84 ppb, recorded in 2004, to 142 ppb, recorded in 1988. The data show random fluctuations but an overall decreasing trend (13 per cent) in the average annual one-hour maximum ozone concentrations from 1980 to 2005 is evident. Over the past 10 years (1996 to 2005), the annual composite means of the one-hour maximum concentrations of ozone have decreased by approximately 3 per cent. For 2005, the one-hour maximums ranged from 69 ppb to 121 ppb with an average of 99 ppb.

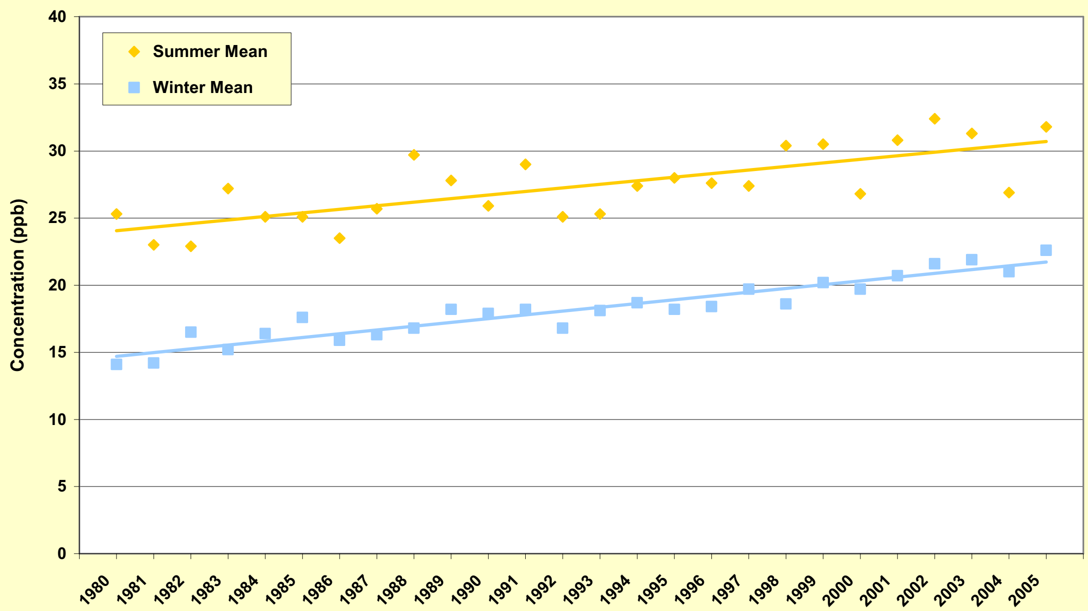
Figure 2.7
Composite Average and Range of Ozone One-Hour Maximum Concentrations in Ontario
(1980 - 2005)



Note: Based on data from 23 ambient ozone sites operated over 26 years.
Ontario 1h AAQC = 80 ppb.

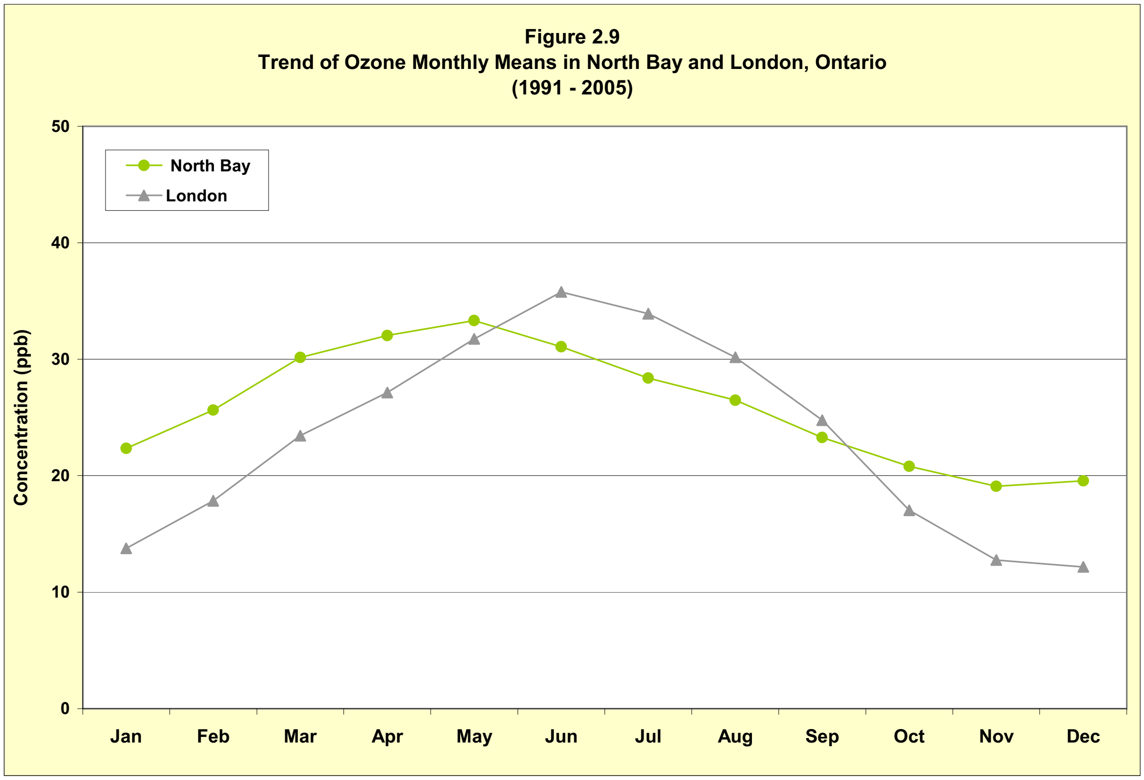
The trend of the ozone seasonal composite means (summer and winter) as recorded at 22 long-term ozone sites for the period 1980 to 2005 is shown in Figure 2.8. It shows that there has been an increasing trend in the ozone seasonal means during the 26-year period where the ozone summer means have increased by approximately 28 per cent and the winter means by approximately 47 per cent. From 1996 to 2005, summer composite means increased by approximately 11 per cent and winter composite means increased by approximately 23 per cent. The increases in summer and winter ozone means appear to be largely related to rising global background ozone concentrations throughout Ontario. There are indications that global background ozone concentrations have been increasing by 0.2-2 per cent per year in recent years. Potential contributions to the increases in the summer composite means may be related to meteorological factors and long-range transport of ozone and its precursors from the U.S.

Figure 2.8
Trend of Ozone Seasonal Means at Sites Across Ontario
(1980 - 2005)



Note: Based on data from 22 ozone sites operated over 26 years.
Seasonal definitions - Summer (May to September); Winter (January to April, October to December).

In Figure 2.9, the averaged ozone monthly means are compared between two locations for the period 1991 to 2005. This figure shows the typical behaviour of ozone concentrations throughout the year in northern and southern Ontario as represented by North Bay and London, respectively. The ozone monthly mean concentrations are higher in North Bay during the colder months of the year. For the month of January, the ozone mean concentration in North Bay is approximately 9 ppb (63 per cent) greater than that observed in London. Among the possible scientific explanations, local emissions of nitric oxide are generally lower in the north, so there is less removal of ozone than in southern urban areas. Also, during late winter and early spring, there is greater potential for stratospheric ozone to be mixed into the lower troposphere in northern Ontario. During the summer months of June and July, the ozone mean concentrations in London are approximately 5 ppb (between 15 and 20 per cent) greater than those reported in North Bay. It is common for ozone and its precursors to be transported into southern Ontario from the mid-western U.S. causing ozone concentrations to increase in southern Ontario over the summer months.

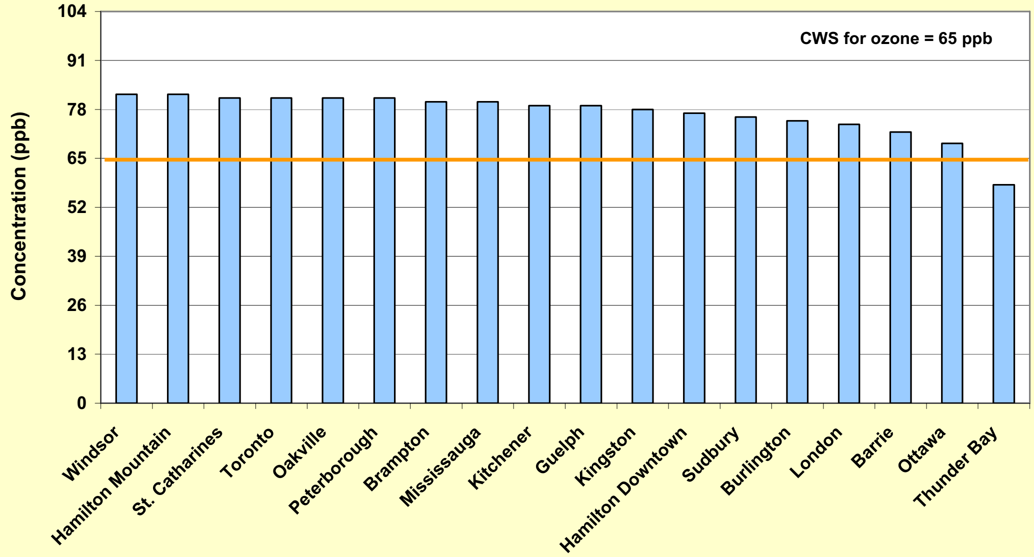


The Canada-wide Standard for Ozone

In 2000, the Canadian Council of Ministers of the Environment (CCME) developed a Canada-wide Standard (CWS) for ozone as a result of the pollutant's adverse effects on human health and the environment. As referenced in the *Guidance Document on Achievement Determination,* the CWS for ozone is 65 ppb, eight-hour running average time, based on the 4th highest annual ambient measurement averaged over three consecutive years. Jurisdictions are required to meet the CWS by 2010 and commence reporting on the achievement of the CWS for ozone by 2011. In the interim, comprehensive reporting on progress toward meeting the CWS for ozone commenced in 2006.

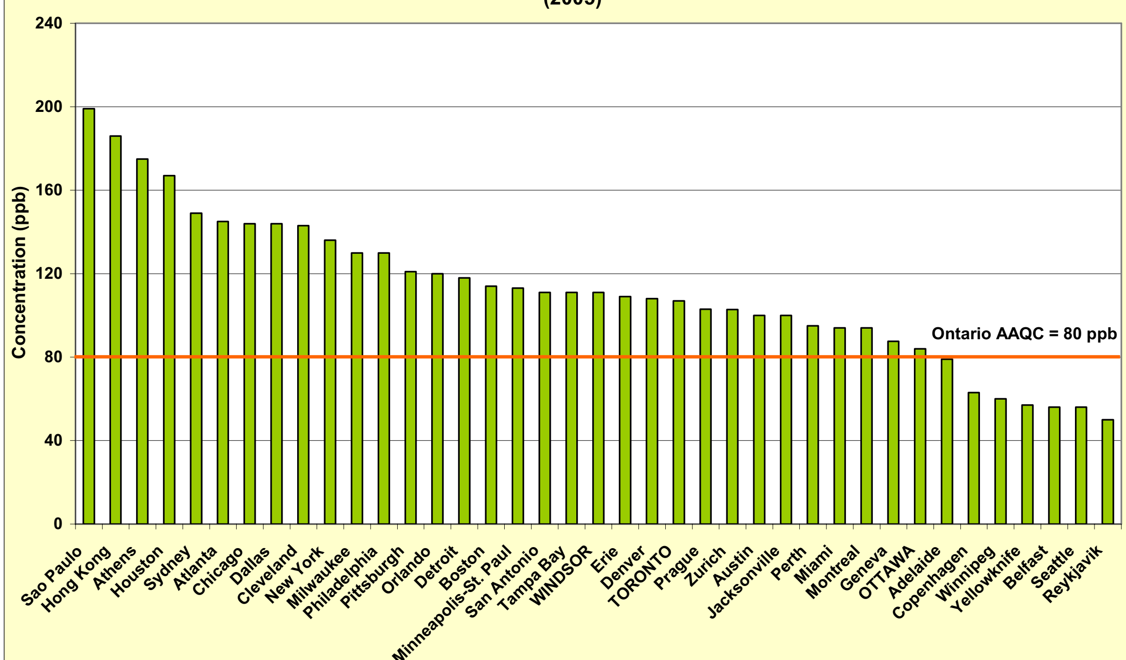
Figure 2.10 displays the 2005 CWS for ozone – based on the 4th highest ozone eight-hour daily maximum – for designated sites across Ontario. (The 2005 CWS consists of an average over a three-year period, 2003 to 2005). All of the sites exceeded the CWS of 65 ppb for ozone, with the exception of Thunder Bay where the three-year average of the 4th highest ozone eight-hour daily maximum was 58 ppb.

Figure 2.10
Ozone Levels at Designated CWS Sites Across Ontario
Based on the CWS for Ozone
(2003 - 2005)



Note: Displayed sites are based on requirements for Canada-wide Standard (CWS) reporting commencing in 2010.
Toronto reporting is based on Toronto Downtown, Toronto North, Toronto East and Toronto West sites.
The CWS for ozone (65 ppb) is based on the 4th highest 8-hour running average over 3 consecutive years (2003 - 2005).

Figure 2.11
Ozone One-Hour Maximum Concentrations for Selected Cities World-wide
(2005)



Note: Ontario cities are displayed in UPPERCASE font.

International Perspective

Figure 2.11 displays the ozone one-hour maximum concentrations in 2005 for 39 cities around the world (see Figure 1.2 for city locations). Sao Paulo recorded the highest ozone one-hour maximum reaching 199 ppb, followed by Hong Kong at 186 ppb. Reykjavik, in Iceland, reported the lowest ozone one-hour maximum at 50 ppb. The Ontario one-hour AAQC of 80 ppb was exceeded at 32 of the cities examined here, including Windsor, Toronto and Ottawa.

Chapter 3

Fine Particulate Matter

Airborne particulate matter is the general term used to describe a mixture of microscopic solid particles suspended in air. Particulate matter is classified according to its aerodynamic size – mainly due to the different health effects associated with particles of different diameters. Fine particulate matter (or respirable particles), denoted as $PM_{2.5}$, refers to particles that are 2.5 microns in diameter and less that may penetrate deep into the respiratory system. To put things in perspective, a fine particle is approximately 30 times smaller than the average diameter of a human hair.

Particles originate from many different industrial and transportation sources, as well as from natural sources. They may be emitted directly from a source or formed in the atmosphere by the transformation of gaseous emissions. This chapter discusses the ambient monitoring results from Ontario's $PM_{2.5}$ monitoring network.

Characteristics, sources and effects

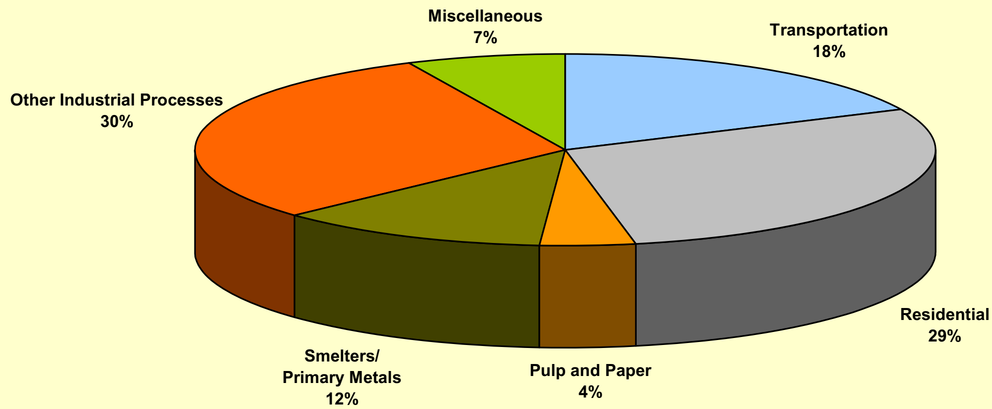
Particulate matter includes aerosols, smoke, fumes, dust, fly ash and pollen. Its composition varies with origin, residence time in the atmosphere, time of year and environmental conditions. Fine particulate matter may be emitted directly to the atmosphere through fuel combustion (e.g. motor vehicles, smelters, power plants, industrial facilities, residential fireplaces and wood stoves, agricultural burning and forest fires) or formed indirectly in the atmosphere through a series of complex chemical reactions.

Figure 3.1 shows estimates of Ontario's primary $PM_{2.5}$ emissions from point, area and transportation sources. Other industrial processes and residential sectors accounted for 30 per cent and 29 per cent of $PM_{2.5}$ emissions, respectively, while the transportation sector accounted for 18 per cent.

Significant amounts of $PM_{2.5}$ measured in southern Ontario are of secondary formation and of transboundary origin. During periods of elevated concentrations of $PM_{2.5}$ in Ontario, it is estimated that there are significant contributions from the U.S., specifically in border communities, such as Windsor, Port Stanley located on the northern shore of Lake Erie, Grand

Bend and Tiverton on the eastern shore of Lake Huron, and Parry Sound in the Georgian Bay area.

Figure 3.1
Ontario $PM_{2.5}$ Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2002 Estimates)



Note: 2002 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

Exposure to $PM_{2.5}$ is associated with hospital admissions and several serious health effects, including premature death. People with asthma, cardiovascular or lung disease, as well as children and elderly people, are considered to be the most sensitive to the effects of $PM_{2.5}$. Adverse health effects have been associated with exposure to $PM_{2.5}$ during both short periods such as a single day, and longer periods of a year or more. Fine particulate matter may also be responsible for environmental impacts such as corrosion, soiling, damage to vegetation and reduced visibility.

Monitoring results in 2005

In 2005, each of Ontario's ambient air monitoring sites operated a Tapered Element Oscillating Microbalance (TEOM) at 30°C with a Sample Equilibration System (SES) to measure the $PM_{2.5}$ concentrations on an hourly basis. The annual mean concentrations ranged from 5.0 micrograms per cubic metre (μg/m³) in Sudbury to 12.8 μg/m³ in Sarnia. The highest 24-hour average of 54 μg/m³ was also recorded in Sarnia. Annual means among the rural sites ranged from 5.8 μg/m³ in Dorset to 8.6 μg/m³ in Port Stanley. The 24-hour $PM_{2.5}$ maximum concentrations measured at rural sites ranged from 39 μg/m³ in Morrisburg to 53 μg/m³ in

Tiverton. The 2005 annual summary statistics for 24-hour $PM_{2.5}$ for sites across Ontario are shown in Figure 3.2. The 98th percentile was less than 30 µg/m³ at three rural sites – Tiverton, Parry Sound and Dorset – and three urban sites – North Bay, Sudbury and Sault Ste. Marie. The $PM_{2.5}$ reference level of 30 µg/m³ for a 24-hour period was exceeded at least once at all sites with the exception of Thunder Bay. Ambient sites located in southwestern Ontario exceeded 30 µg/m³ more frequently than in eastern and northern Ontario. The provincial ambient average for $PM_{2.5}$ during 2005 was 8.4 µg/m³ which is an increase of approximately 1 µg/m³ when compared to 2004.

Figure 3.2
Annual Statistics for 24-Hour Average $PM_{2.5}$ Across Ontario
(2005)

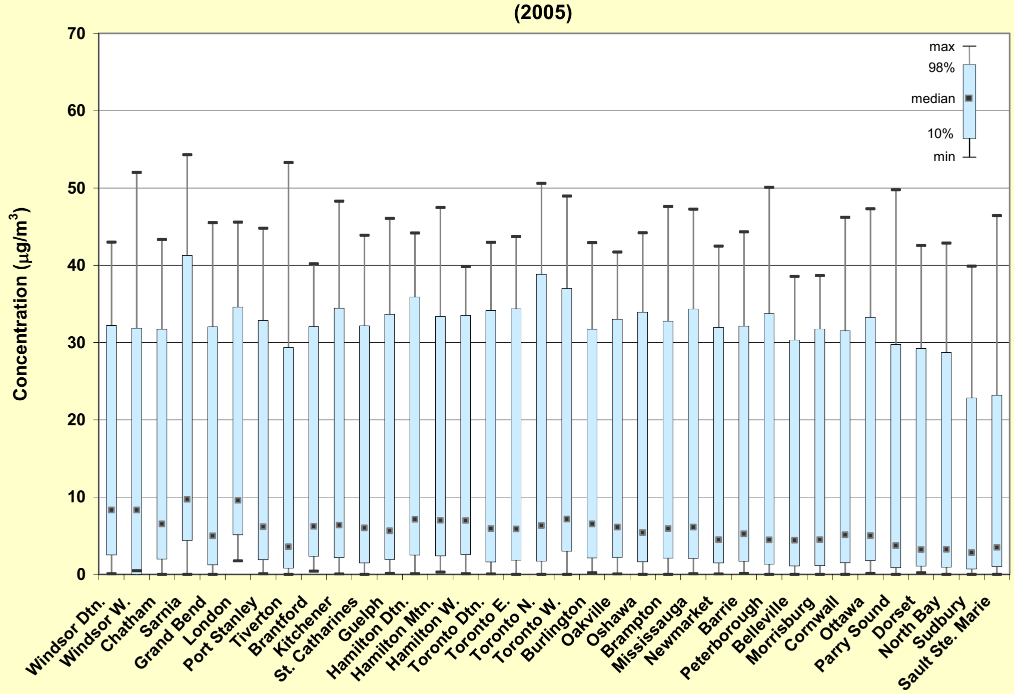


Figure 3.3 shows the geographical distribution of the number of days $PM_{2.5}$ 24-hour concentrations greater than 30 µg/m³ across Ontario. In 2005, Sarnia and Toronto recorded the highest number of days (24 and 19, respectively) in Ontario with 24-hour $PM_{2.5}$ concentrations greater than 30 µg/m³. Most parts of southwestern Ontario, from Windsor to Oshawa and north to Barrie, exceeded the 24-hour average $PM_{2.5}$ concentration of 30 µg/m³ between 9 and 12 days.

Like ozone, fine particulate matter may be transported from the U.S. and combined with local pollutants, has the potential to impact widespread areas of the province during a smog episode. For example, during the September 12-14, 2005 $PM_{2.5}$ episode, the highest $PM_{2.5}$

concentrations were recorded when prevailing winds were from a south-southwesterly direction as illustrated in Figure 3.4.

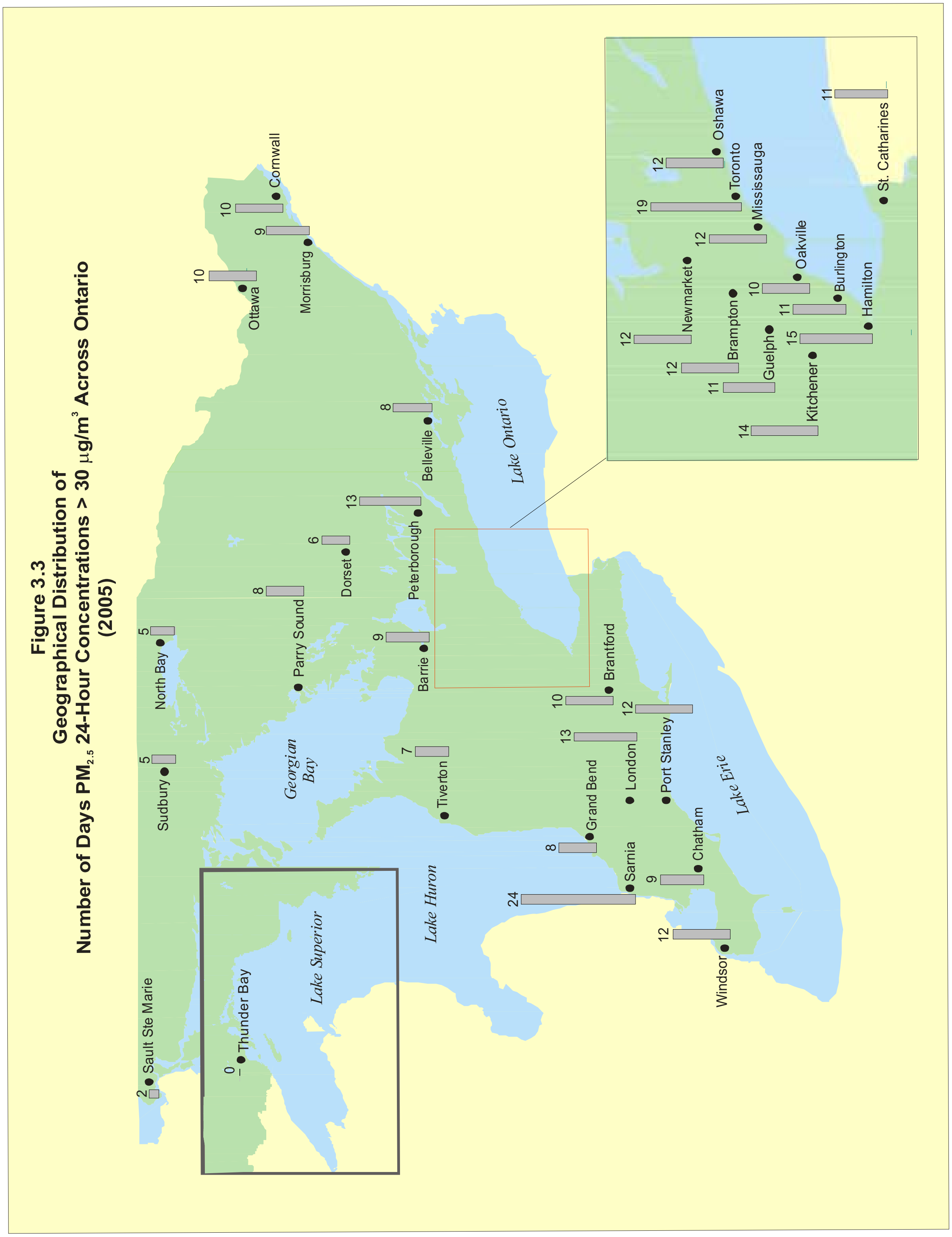
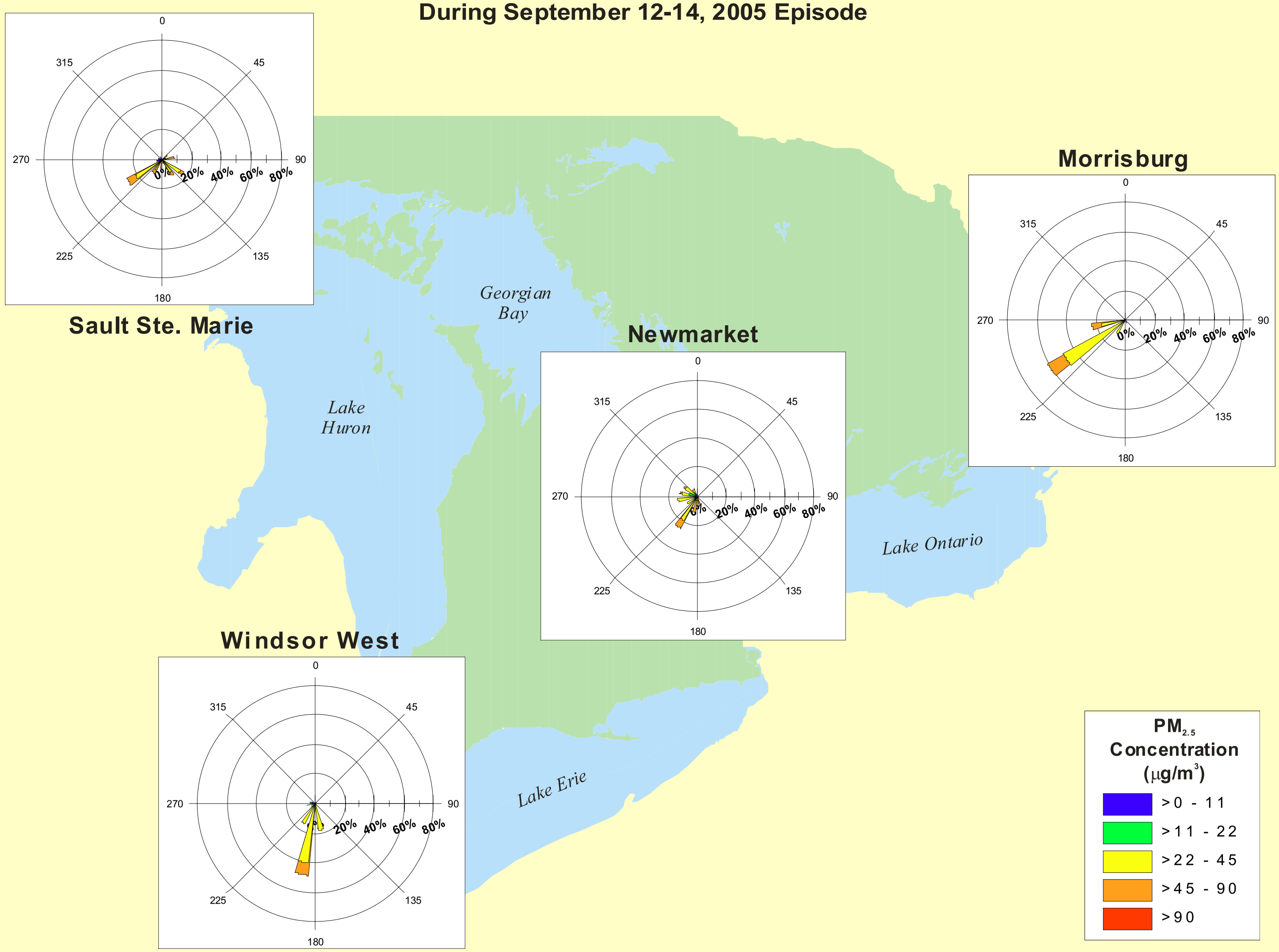


Figure 3.3
Geographical Distribution of
Number of Days $PM_{2.5}$ 24-Hour Concentrations > 30 $\mu g/m^3$ Across Ontario
(2005)

Figure 3.4
Pollution Roses for $PM_{2.5}$ at Selected Sites Across Ontario During September 12-14, 2005 Episode



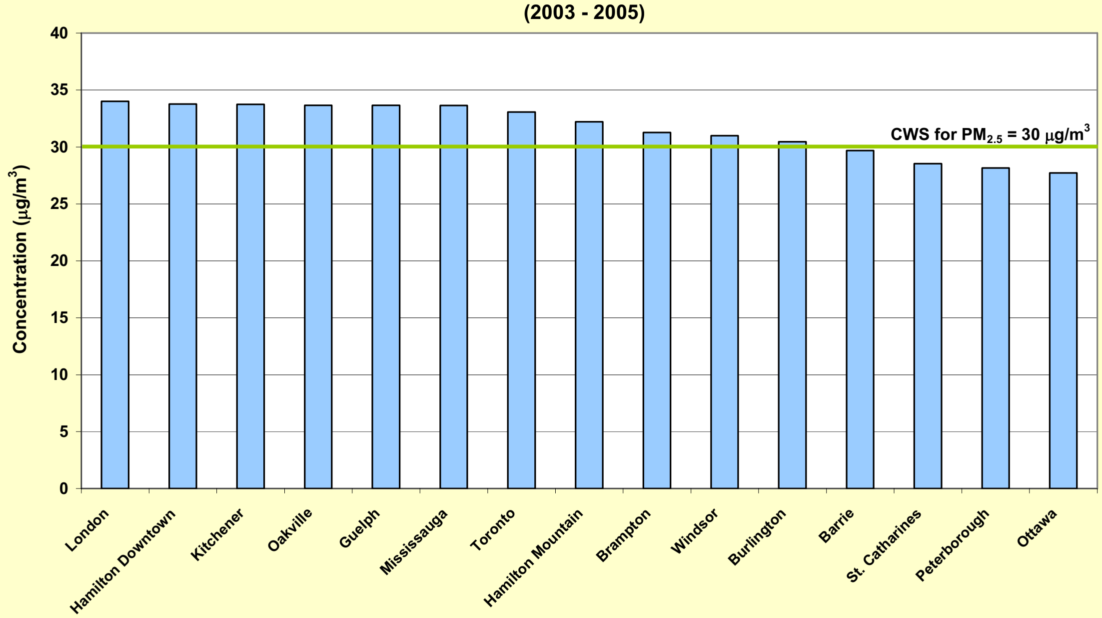
Note: A pollution rose is a diagram indicating the frequency of given concentration levels of a pollutant as a function of wind direction.

The Canada-wide Standard for PM2.5

In 2000, the Canadian Council of Ministers of the Environment developed a CWS for $PM_{2.5}$ as a result of the pollutant's adverse effects on human health and the environment. As referenced in the *Guidance Document on Achievement Determination*, the CWS for $PM_{2.5}$ is 30 µg/m³, 24-hour averaging time, based on the 98th percentile annual ambient measurement averaged over three consecutive years. Jurisdictions are required to meet the CWS by 2010 and commence reporting by year 2011. In the interim, comprehensive reporting on progress toward meeting the CWS for $PM_{2.5}$ commenced in 2006.

Figure 3.5 displays the 2005 CWS for $PM_{2.5}$ – based on the 98th percentile of the daily average for 15 designated sites across Ontario. (The 2005 CWS consists of an average over a three-year period, 2003 to 2005). Based on the three-year average, the 98th percentiles ranged from 34 µg/m³ in London, Hamilton Downtown, Oakville and Mississauga to 28 µg/m³ in Peterborough and Ottawa. (Kitchener and Guelph also recorded 98th percentiles of 34 µg/m³ based on a two-year average). Eleven of the 15 designated sites exceeded the CWS target of 30 µg/m³. The majority of areas that exceeded 30 µg/m³ were confined to southwestern Ontario and the Golden Horseshoe, including the Greater Toronto Area (GTA). The higher levels are due to the combined effect of the transboundary influence and Ontario's own sources in those areas.

Figure 3.5
$PM_{2.5}$ Levels at Designated CWS Sites Across Ontario
Based on the CWS for $PM_{2.5}$
(2003 - 2005)

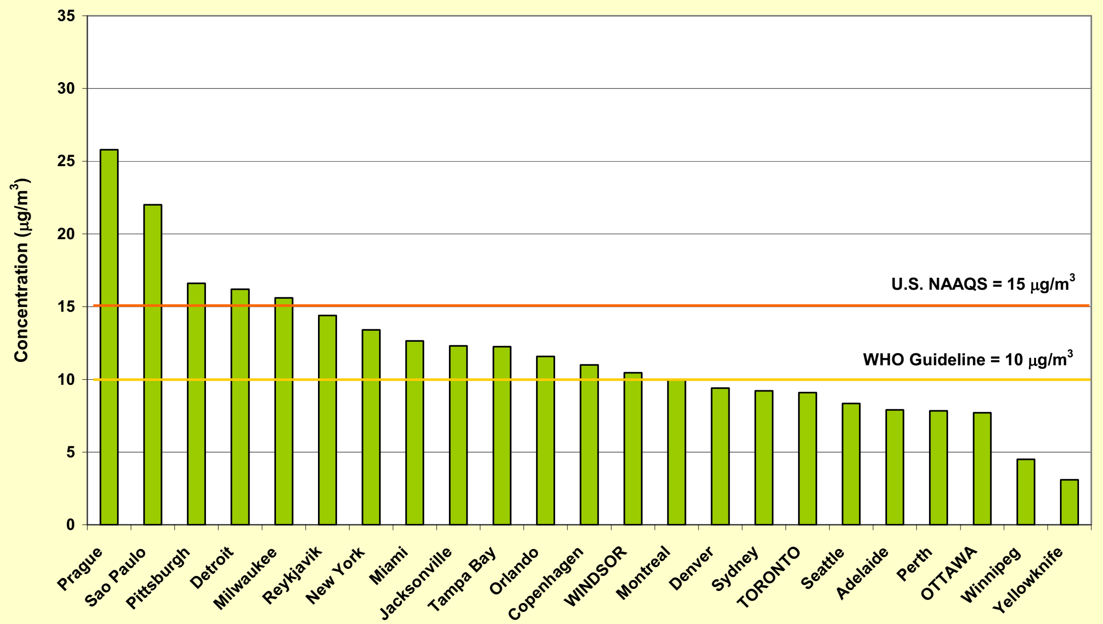


Note: Displayed sites are based on requirements for Canada-wide Standard (CWS) reporting commencing in 2010.
Toronto reporting is based on Toronto Downtown, Toronto North, Toronto East and Toronto West sites.
The CWS for $PM_{2.5}$ (30 µg/m³) is based on the 24-hour, 98th percentile, annual ambient measurement averaged over 3 years (2003-2005).
The values displayed for Kitchener and Guelph are based on 2-year averages (2004-2005).

International Perspective

Figure 3.6 displays $PM_{2.5}$ annual means in 2005 for 23 cities from around the world (see Figure 1.2 for city locations). The $PM_{2.5}$ annual means are all based on continuous measurements; however, monitoring methods and instrument operations may vary between cities; therefore, comparisons among cities are not intended to be used as a comprehensive ranking. Prague reported the highest annual mean $PM_{2.5}$ concentration (25.8 μg/m³) for 2005 and Yellowknife recorded the lowest annual mean $PM_{2.5}$ concentration of 3.1 μg/m³. Five cities (none which were located in Canada) exceeded the annual U.S. NAAQS of 15 μg/m³. Of the 23 selected cities world-wide, 14 exceeded the WHO annual guideline of 10 μg/m³. Figure 3.6 includes three Ontario cities – Windsor, Toronto and Ottawa. Windsor was the only city of the three Ontario sites examined to exceed the WHO guideline of 10 μg/m³ in 2005.

Figure 3.6
$PM_{2.5}$ Annual Means for Selected Cities World-wide
(2005)



Note: Ontario sites are displayed in UPPERCASE font.
Monitoring methods and instrument operations may vary between cities.

Chapter 4

Other Criteria Contaminants

Characteristics, sources and effects of nitrogen dioxide, carbon monoxide and sulphur dioxide are discussed in this chapter, as well as their ambient concentrations during 2005 and trends over time where appropriate. A comparison of pollutant concentrations from an international perspective is also presented.

NITROGEN DIOXIDE

Characteristics, sources and effects

Nitrogen dioxide is a reddish-brown gas with a pungent odour, which transforms in the air to form gaseous nitric acid and nitrates. It also plays a major role in atmospheric reactions that produce ground-level ozone, a major component of smog. Nitrogen dioxide reacts in the air to form organic nitrates, which contribute to the formation of fine particulate matter in the atmosphere.

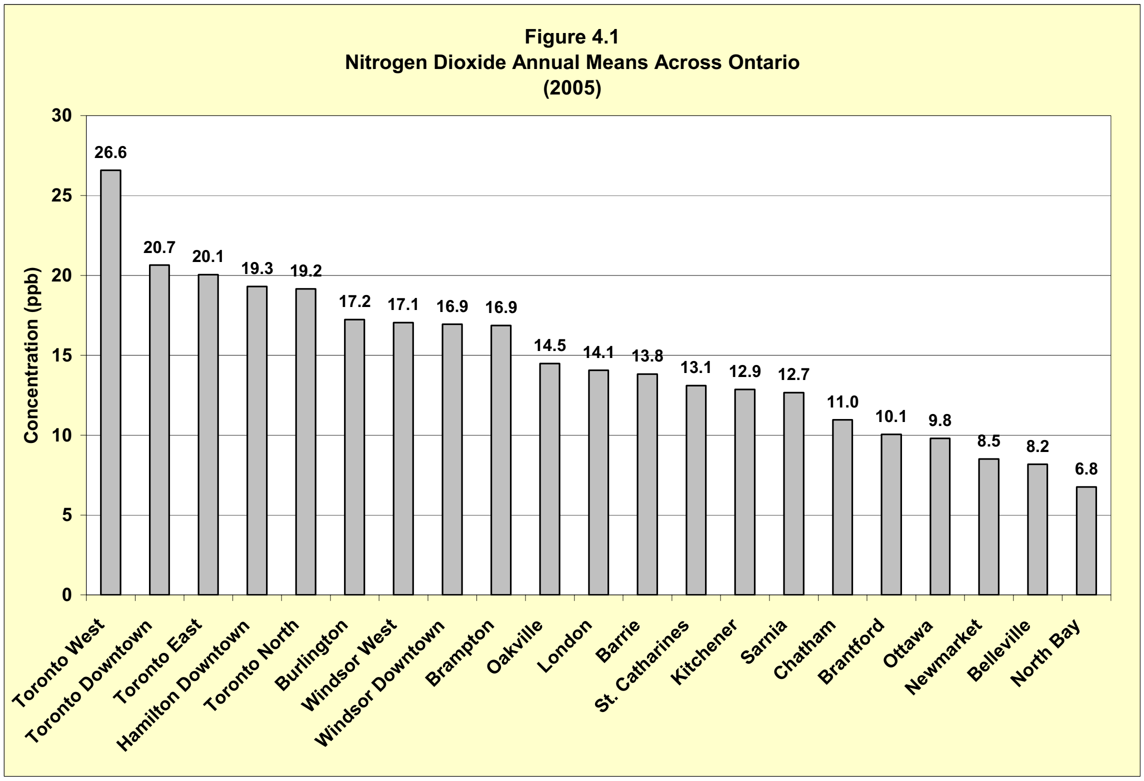
All combustion in air produces nitrogen oxides, of which NO_2 is a component. Major sources of NO_x emissions include the transportation sector, utilities and other processes. (Ontario's nitrogen oxides emission estimates are displayed by sector in Figure 2.3 of Chapter 2).

Nitrogen dioxide can irritate the lungs and lower the 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.

Monitoring results for 2005

Nitrogen dioxide annual means across Ontario are displayed in Figure 4.1. The Toronto West site, located in an area of Toronto influenced by significant vehicular traffic, recorded the highest annual mean (26.6 ppb) for NO_2 during 2005. Typically, the highest NO_2 means are recorded in large urbanized areas, such as the Golden Horseshoe area of southern Ontario including the GTA. The Toronto East and West air monitoring stations recorded the highest 24-

hour average concentration (65 ppb) and the Toronto East site also recorded the highest one-hour concentration (104 ppb) in 2005. The provincial 24-hour criterion of 100 ppb and one-hour criterion of 200 ppb for NO_2 were not exceeded at any of the monitoring locations in Ontario during 2005.



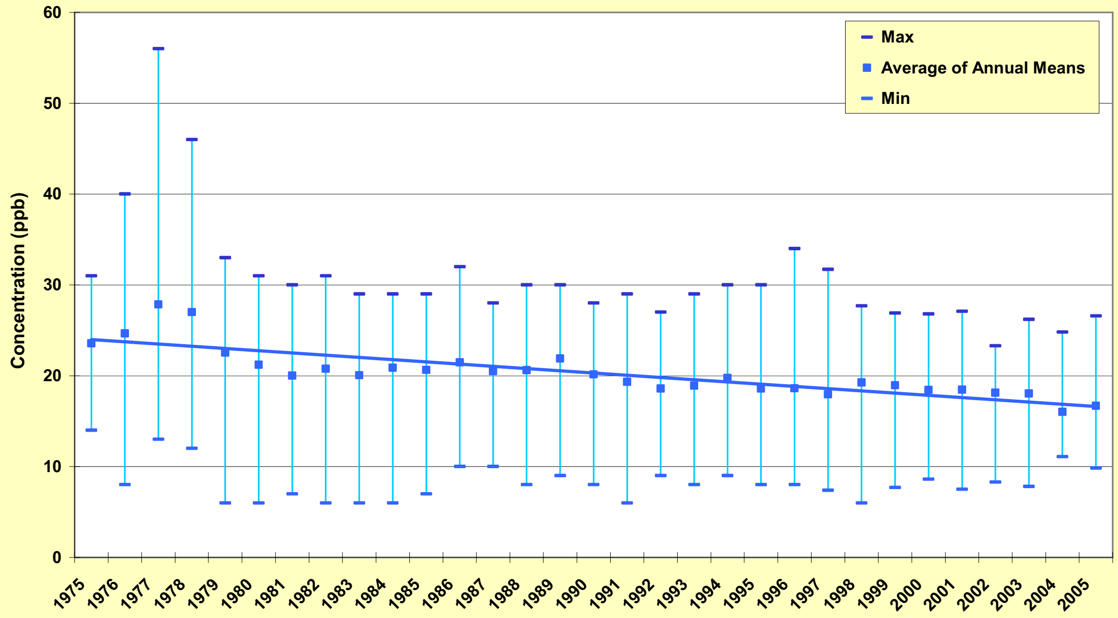
Trends

The trend of the composite annual means for ambient NO_2 concentrations shows a decreasing trend from 1975 to 2005 as displayed in Figure 4.2. Average concentrations decreased by approximately 31 per cent over the 30-year period. There was approximately 25 per cent decrease in average NO_2 concentrations from 1975 to 1995, and approximately 11 per cent decrease over the last decade, 1996 to 2005.

International perspective

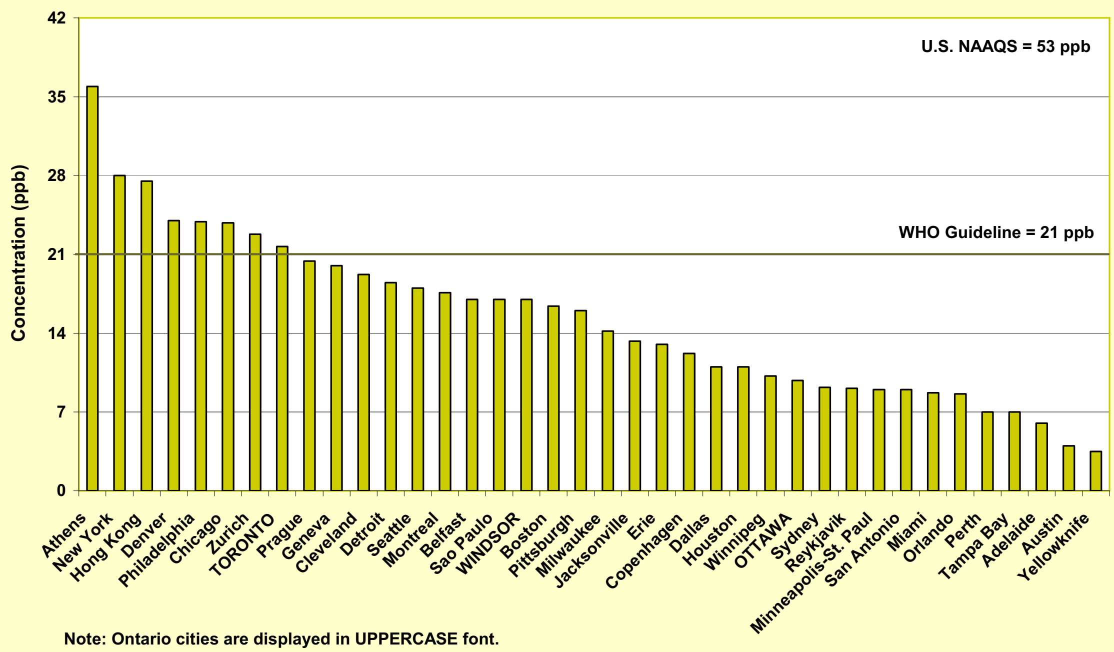
Figure 4.3 displays the NO_2 annual mean concentrations in 2005 for 38 cities world-wide (see Figure 1.2 for city locations). Athens reported the highest NO_2 annual mean of 35.9 ppb. Eight sites, including Toronto, exceeded the WHO guideline of 21 ppb. Yellowknife recorded the lowest NO_2 annual mean of 3.5 ppb. Large urban centres typically experience higher NO_2 levels due to increased energy use and motor vehicle emissions.

Figure 4.2
Range of Nitrogen Dioxide Annual Means in Ontario
(1975 - 2005)



Note: Annual composite mean based on 16 ambient sites operated over 31 years.

Figure 4.3
Nitrogen Dioxide Annual Means for Selected Cities World-wide
(2005)



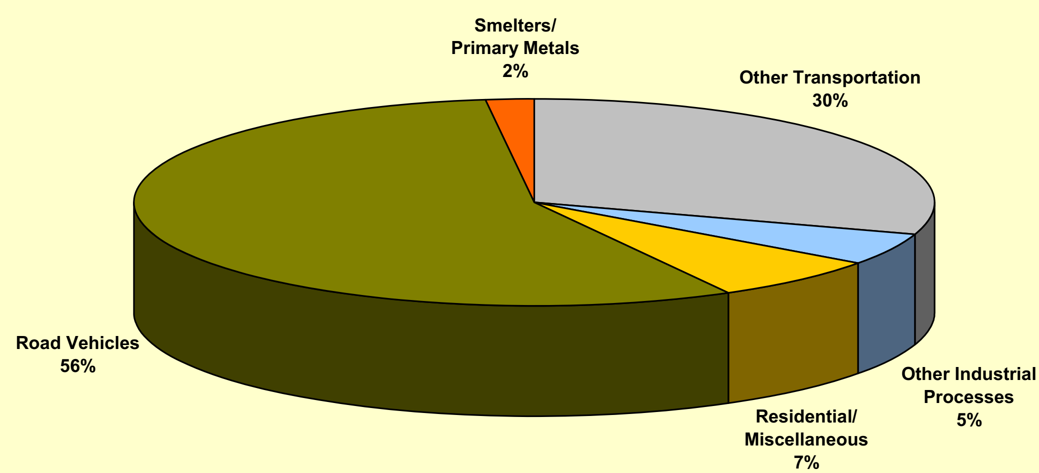
Note: Ontario cities are displayed in UPPERCASE font.

CARBON MONOXIDE

Characteristics, sources and effects

Carbon monoxide is a colourless, odourless, tasteless, and, at high concentrations, a 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. Exposure to high CO levels is linked with the impairment of vision, work capacity, learning ability and performance of complex tasks. Carbon monoxide is produced primarily by the incomplete combustion of fossil fuels. As displayed in Figure 4.4, the transportation sector accounted for 86 per cent of all CO emissions from point, area and transportation sources.

Figure 4.4
Ontario Carbon Monoxide Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2002 Estimates)



Note: 2002 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

Monitoring results for 2005

In 2005, the highest annual mean of 0.44 parts per million (ppm) was recorded at the Ottawa site. The highest one-hour and eight-hour maximum CO values, 2.65 ppm and 1.66 ppm were measured at the Toronto West site. Typically, the higher CO concentrations are recorded in urban centres as a result of vehicle emissions. Ontario's one-hour (30 ppm) and eight-hour (13 ppm) ambient air quality criteria for CO have not been exceeded at any of the monitoring sites in Ontario since 1991.

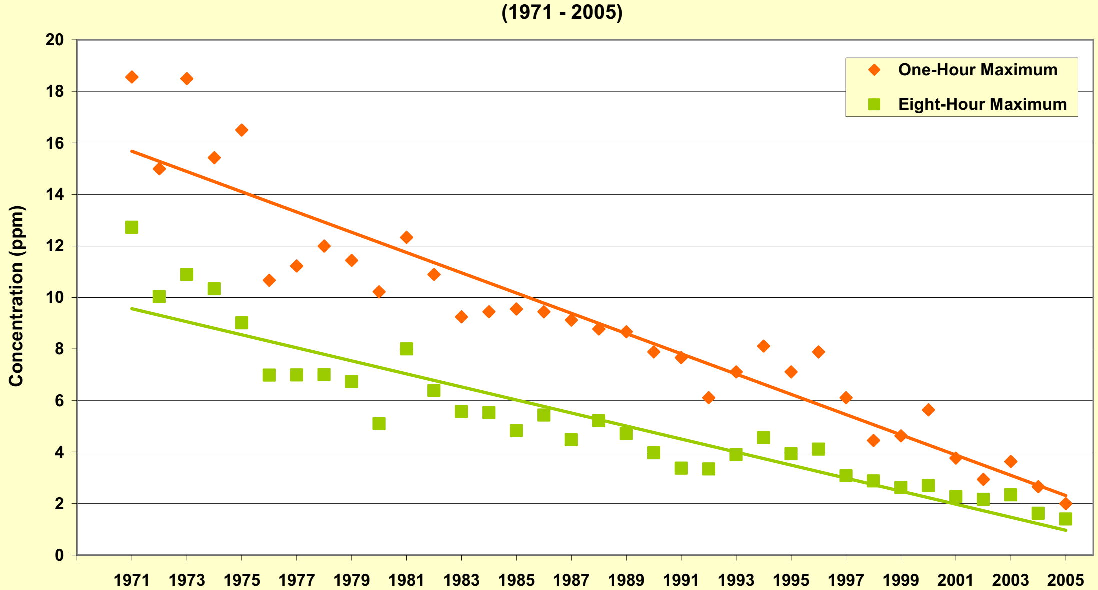
Trends

The trends in provincial averaged one-hour and eight-hour maximum CO concentrations from 1971 to 2005 are shown in Figure 4.5. Ambient CO concentrations, as measured by the composite average of the one-hour and eight-hour maximums, decreased by approximately 86 per cent and 90 per cent, respectively, over this 35-year period. The CO composite annual mean in 2005 was 92 per cent lower than the corresponding 1971 composite mean; however, there was approximately 49 per cent decrease in average CO concentrations over the last decade, 1996 to 2005.

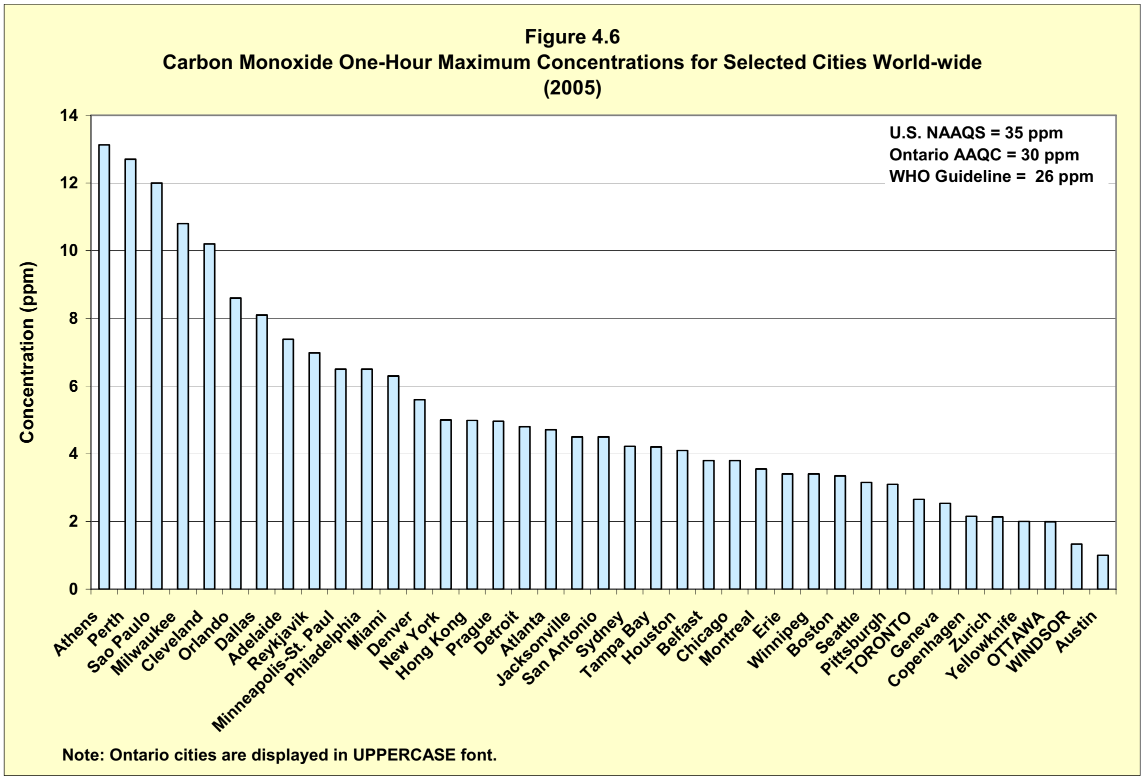
International perspective

Figure 4.6 displays the CO one-hour maximum concentrations in 2005 for 39 cities world-wide (see Figure 1.2 for city locations). Athens, Perth and Sao Paulo reported the three highest CO one-hour maximums between 12 ppm and 13 ppm. Austin recorded the lowest CO maximums of 1 ppm, followed closely by Windsor and Ottawa. There were no exceedances of the one-hour WHO guideline, the Ontario AAQC or the U.S. NAAQS at any of the cities examined in 2005.

Figure 4.5
Trends of Carbon Monoxide One-Hour and Eight-Hour Maximums in Ontario
(1971 - 2005)



Note: Data are based on nine ambient CO sites operated over 35 years.
Ontario's one-hour AAQC = 30 ppm.
Ontario's eight-hour AAQC = 13 ppm.



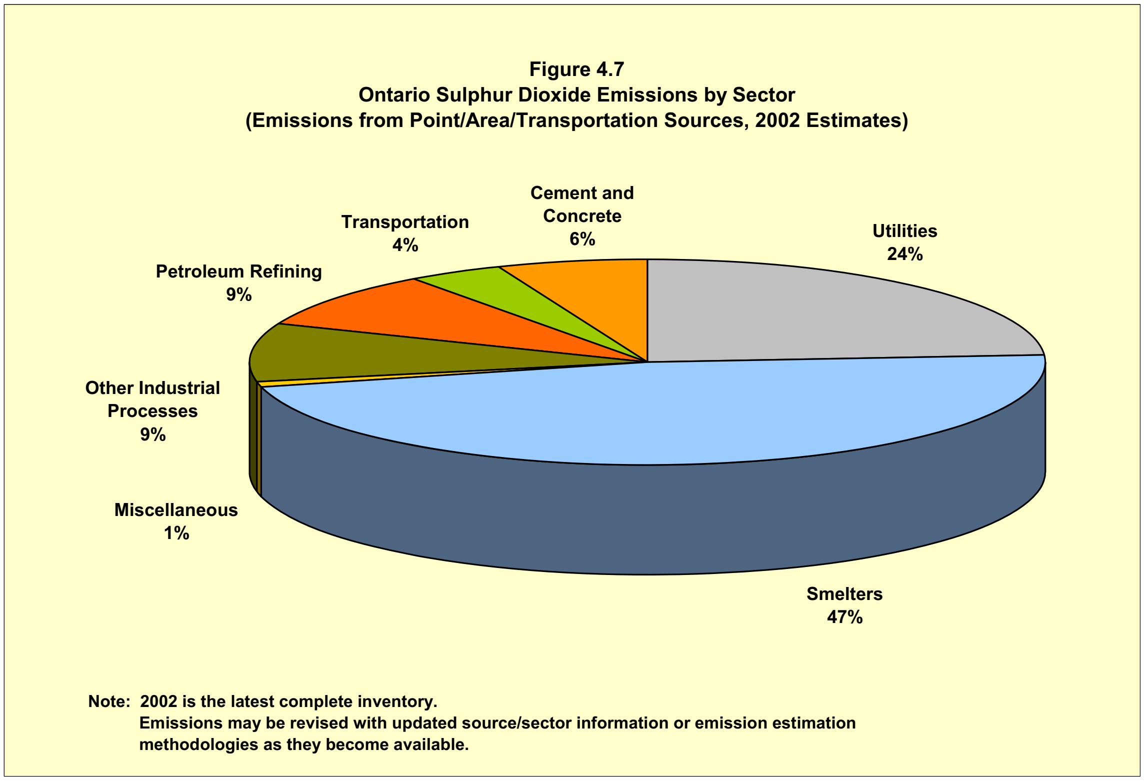
SULPHUR DIOXIDE

Characteristics, sources and effects

Sulphur dioxide is a colourless gas that smells like burnt matches. Sulphur dioxide can also be oxidized to form sulphuric acid aerosols. In addition, sulphur dioxide is a precursor to sulphates, which are one of the main components of airborne fine particulate matter.

Approximately 71 per cent of the SO_2 emitted in Ontario comes from smelters and utilities as shown in Figure 4.7. Other industrial sources include petroleum refineries, iron and steel mills, and pulp and paper mills. Lesser sources of SO_2 include transportation, and residential, commercial and industrial heating.

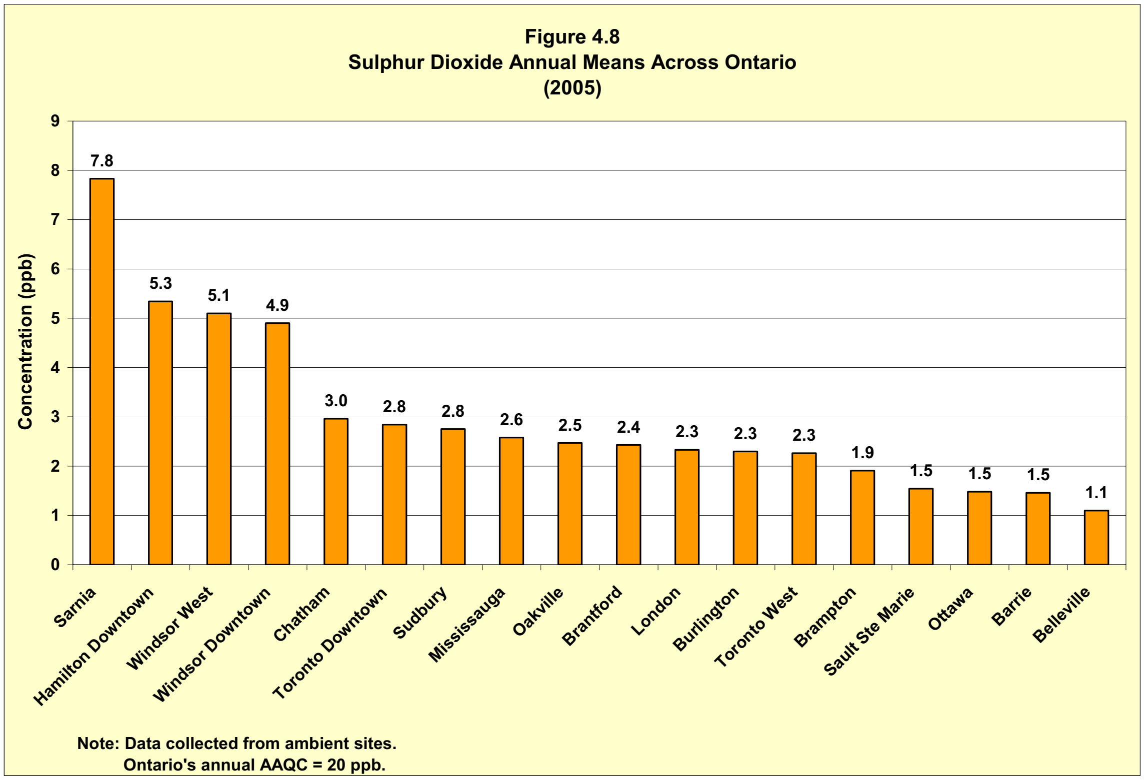
Health effects caused by exposure to high levels of SO_2 include breathing problems, respiratory illness, and the exacerbation of respiratory and cardiovascular disease. People with asthma, chronic lung disease or heart disease are the most sensitive to SO_2. Sulphur dioxide also damages trees and crops. Sulphur dioxide, like NO_2, is also a precursor of acid rain, which contributes to the acidification of soils, lakes and streams, accelerated corrosion of buildings, and reduced visibility. Sulphur dioxide also causes the formation of microscopic acid aerosols, which have serious health implications and contribute to climate change.



Monitoring results for 2005

Sarnia recorded the highest annual mean (7.8 ppb) and 24-hour maximum concentration (73 ppb) of SO_2 during 2005. Sudbury recorded the highest one-hour concentration (253 ppb). The highest concentrations of SO_2 historically have been recorded in the vicinity of large industrial facilities such as smelters and utilities. The provincial one-hour criterion for SO_2 of 250 ppb was only exceeded at the Sudbury site for one hour; however, the 24-hour criterion (100 ppb) for SO_2 was not exceeded at any of the ambient air monitoring sites in 2005.

The SO_2 annual means at ambient AQI sites across Ontario are displayed in Figure 4.8. As mentioned previously, Sarnia recorded the highest annual mean in 2005. The annual levels across the province ranged from a low of 1.1 ppb in Belleville to a high of 7.8 ppb in Sarnia. The annual criterion of 20 ppb for SO_2 was not exceeded at any site in Ontario during 2005.



Trends

The trend of the composite annual means for ambient SO_2 concentrations shows a decreasing trend of approximately 88 per cent from 1971 to 2005, as depicted in Figure 4.9. Control orders on smelting operations and the Countdown Acid Rain program resulted in significant decreases of SO_2 emissions prior to the early 1990s. Based on relatively low concentrations over the last decade and a linear trend, there has been approximately 35 per cent decrease in SO_2 concentrations from 1996 to 2005.

International perspective

Figure 4.10 displays the SO_2 annual mean concentrations in 2005 for 35 cities world-wide (see Figure 1.2 for city locations). Erie reported the highest annual mean (11 ppb) whereas Reykjavik, Sydney and Yellowknife all recorded the lowest SO_2 annual means (less than 1.0 ppb) in 2005. The Ontario cities included here, Windsor, Toronto and Ottawa, reported annual mean levels of 5.0 ppb, 2.6 ppb and 1.5 ppb, respectively. All reported cities were below the Ontario annual AAQC of 20 ppb and the U.S. annual NAAQS of 30 ppb.

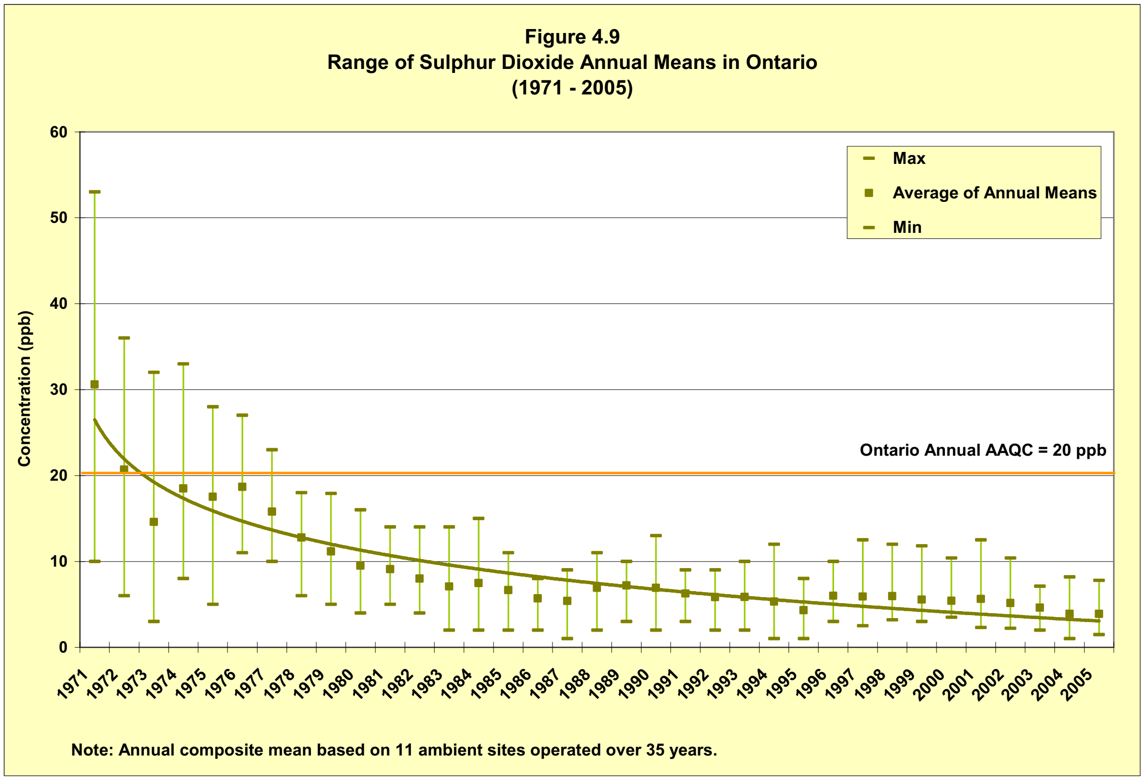


Figure 4.9
Range of Sulphur Dioxide Annual Means in Ontario
(1971 - 2005)
Concentration (ppb)
60
50
40
30
20
10
0
Max
Average of Annual Means
Min
Ontario Annual AAQC = 20 ppb
1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005
Note: Annual composite mean based on 11 ambient sites operated over 35 years.

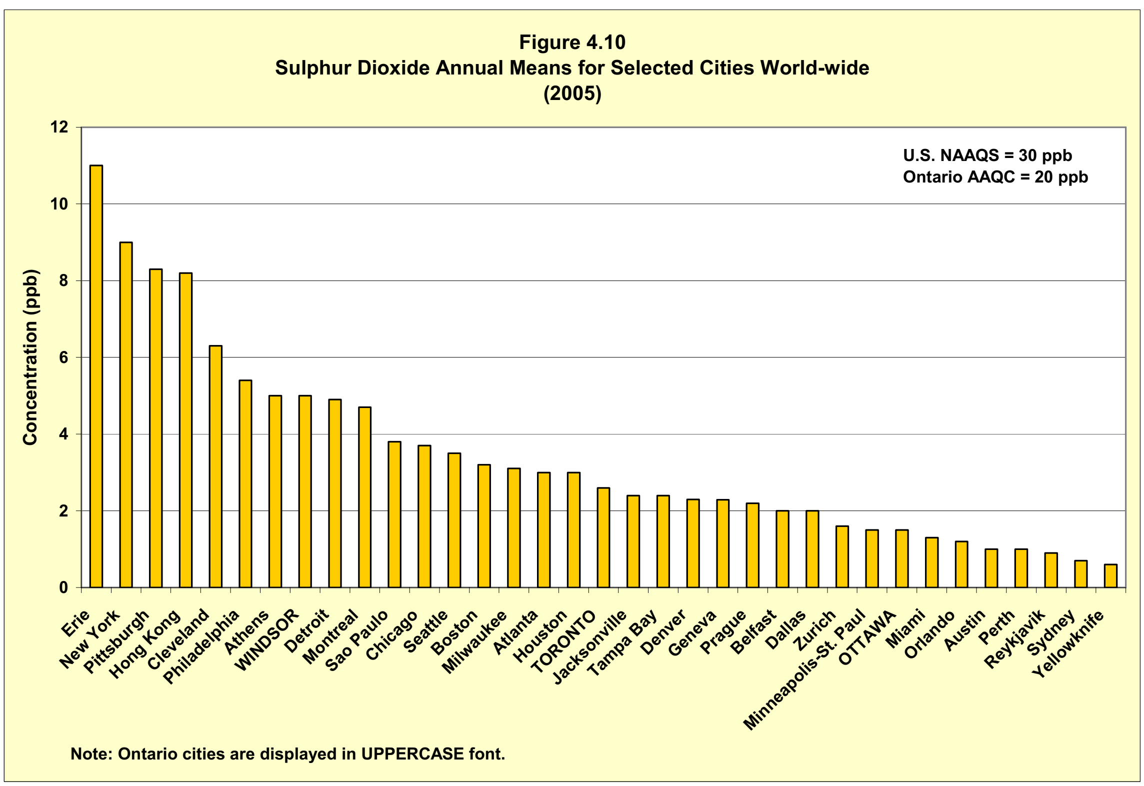


Figure 4.10
Sulphur Dioxide Annual Means for Selected Cities World-wide
(2005)
Concentration (ppb)
12
10
8
6
4
2
0
U.S. NAAQS = 30 ppb
Ontario AAQC = 20 ppb
Erie
New York
Pittsburgh
Hong Kong
Cleveland
Philadelphia
Athens
WINDSOR
Detroit
Montreal
Sao Paulo
Chicago
Seattle
Boston
Milwaukee
Atlanta
Houston
TORONTO
Jacksonville
Tampa Bay
Denver
Geneva
Prague
Belfast
Dallas
Zurich
Minneapolis-St. Paul
OTTAWA
Miami
Orlando
Austin
Perth
Reykjavik
Sydney
Yellowknife
Note: Ontario cities are displayed in UPPERCASE font.

Chapter 5

Air Quality Indices, Smog Alert Program and Smog Episodes

Air Quality Indices

The Ministry of the Environment operates an extensive network of air quality monitoring sites across the province. In 2005, 38 of these sites, in 24 urban centres and six rural areas, formed the basis of the AQI network. In 2005, Chatham was added to the AQI network in replacement of Merlin in southwestern Ontario, and Morrisburg was added in eastern Ontario. The Air Quality Office of the Environmental Monitoring and Reporting Branch continuously obtains data for criteria air pollutants from these 38 sites.

The AQI network, shown in Figure 5.1, provides the public with air quality information, in near real-time, from across the province. The AQI is based on pollutants that have adverse effects on human health and the environment. The pollutants are ozone, fine particulate matter $PM_{2.5}$, nitrogen dioxide, carbon monoxide, sulphur dioxide, and total reduced sulphur compounds. At the end of each hour, the concentration of each pollutant measured at each site is converted into a number ranging from zero upwards using a common scale or index. The calculated number for each pollutant is referred to as a sub-index.

At a given site, the highest sub-index for any given hour becomes the AQI reading for that location. The index is a relative scale, in that, the lower the index, the better the air quality. The index values, corresponding categories, and potential health and environmental effects, are shown in Table 5.1.

If the AQI value is below 32, the air quality is categorized as good. For AQI values in the 32-49 range (moderate category), there may be some adverse effects for very sensitive people. For index values in the 50-99 range (poor category), the air quality may have adverse effects for sensitive members of human and animal populations, and may cause significant damage to vegetation and property. With an AQI value of 100 or more (very poor category), the air quality may have adverse effects for a large proportion of those exposed.

Figure 5.1
Air Quality Index (AQI) Monitoring Sites in Ontario (2005)

Table 5.1: Air Quality Index Pollutants and Their Impacts*

Index	Category	Ozone (O_3)	Fine Particulate Matter ($PM_{2.5}$)	Nitrogen Dioxide (NO_2)	Carbon Monoxide (CO)	Sulphur Dioxide (SO_2)	Total Reduced Sulphur (TRS) Compounds
0-15	Very good	No health effects are expected in healthy people	Sensitive populations may want to exercise caution	No health effects are expected in healthy people	No health effects are expected in healthy people	No health effects are expected in healthy people	No health effects are expected in healthy people
16-31	Good	No health effects are expected in healthy people	Sensitive populations may want to exercise caution	Slight odour	No health effects are expected in healthy people	Damages some vegetation in combination with ozone	Slight odour
32-49	Moderate	Respiratory irritation in sensitive people during vigorous exercise; people with heart/lung disorders at some risk; damages very sensitive plants	People with respiratory disease at some risk	Odour	Blood chemistry changes, but no noticeable impairment	Damages some vegetation	Odour
50-99	Poor	Sensitive people may experience irritation when breathing and possible lung damage when physically active; people with heart/lung disorders at greater risk; damages some plants	People with respiratory disease should limit prolonged exertion; general population at some risk	Air smells and looks brown; some increase in bronchial reactivity in asthmatics	Increased symptoms in smokers with heart disease	Odour; increasing vegetation damage	Strong odour
100-over	Very poor	Serious respiratory effects, even during light physical activity; people with heart/lung disorders at high risk; more vegetation damage	Serious respiratory effects even during light physical activity; people with heart disease, the elderly and children at high risk; increased risk for general population	Increasing sensitivity for asthmatics and people with bronchitis	Increasing symptoms in non-smokers with heart diseases; blurred vision; some clumsiness	Increasing sensitivity for asthmatics and people with bronchitis	Severe odour; some people may experience nausea and headaches

* Please note that the information in this table is subject to change.

Computed AQI values and air quality forecasts are released to the public and news media at set times each day. The public can access the index values by calling the ministry's air quality information Integrated Voice Response (IVR). To access an English recording, call 1-800-387-7768, or in Toronto, call 416-246-0411. For a French recording, call 1-800-221-8852. The AQI values can also be obtained from the ministry's website at www.airqualityontario.com. Air quality forecasts, based on regional meteorological conditions and current pollution levels in Ontario and bordering U.S. states, are also provided daily on this website.

Table 5.2 shows the percentage distribution of hourly AQI readings for the 38 monitoring sites by the AQI descriptive category and the number of days with at least one hour AQI reading greater than 49. On average, the AQI sites in 2005 reported air quality in the very good and good categories approximately 87 per cent of the time and moderate to poor categories about 13 per cent of the time.

Table 5.2: Air Quality Index Summary (2005)

City/Town	Valid Hours	Percentage of Valid Hours AQI in Range					No. of Days At Least 1 Hour > 49
		Very Good 0-15	Good 16-31	Moderate 32-49	Poor 50-99	Very Poor 100+	
Windsor Downtown	8735	35.5	46.2	16.2	2.1	0	37
Windsor West	8672	37.4	43.8	16.7	2.1	0	37
Chatham	8605	28.7	53.3	16.5	1.6	0	26
Sarnia	8729	29.9	50.5	16.9	2.6	<0.1	34
Grand Bend	8717	24.0	61.5	13.1	1.4	0	27
London	8749	31.9	51.3	16.1	0.8	0	18
Port Stanley	8727	22.0	59.8	15.8	2.3	0	30
Tiverton	8638	23.7	65.9	9.7	0.6	0	9
Brantford	8724	31.7	52.7	14.6	0.9	0	20
Kitchener	8719	30.5	53.3	14.9	1.3	0	20
St. Catharines	8739	36.8	48.6	13.9	0.7	0	20
Guelph	8718	30.1	54.7	14.0	1.2	0	23
Hamilton Downtown	8625	42.1	43.7	13.2	1.0	0	20
Hamilton Mountain	8732	31.6	52.6	14.4	1.4	0	24
Hamilton West	8754	43.3	44.5	11.7	0.5	0	15
Toronto Downtown	8691	43.6	43.8	11.4	1.3	0	20
Toronto East	8722	48.7	39.9	10.4	1.1	0	22
Toronto North	8706	37.6	48.5	12.3	1.6	0	20
Toronto West	8729	49.7	36.7	12.1	1.5	0	25
Burlington	8689	41.1	45.5	12.7	0.7	0	16
Oakville	8707	33.7	52.0	13.2	1.1	0	20
Oshawa	8675	35.1	52.7	11.0	1.2	0	19
Brampton	8750	34.5	50.9	13.5	1.2	0	24
Mississauga	8742	42.9	42.7	13.1	1.3	0	24
Barrie	8735	34.4	53.7	11.1	0.8	0	14
Newmarket	8744	26.3	59.7	13.0	1.0	0	21
Parry Sound	8744	23.3	62.0	13.6	1.1	0	17
Dorset	8673	25.9	62.1	11.3	0.7	0	13
Ottawa	8739	43.6	47.6	7.6	1.2	0	13
Kingston*	8721*	48.3*	45.3*	6.1*	0.4*	0*	9*
Belleville	8689	31.4	55.9	11.7	1.1	0	19
Morrisburg	8747	33.1	56.3	9.7	0.8	0	15
Cornwall	8742	31.6	57.1	10.4	1.0	0	14
Peterborough	8697	27.5	59.3	12.0	1.3	0	18
Thunder Bay	8514	50.6	46.7	2.7	<0.1	0	1
Sault Ste. Marie	8742	30.5	59.2	10.1	0.3	0	5
North Bay	8707	35.8	54.4	9.3	0.5	0	10
Sudbury	8743	30.3	59.8	9.5	0.4	0	12

*Note: The above AQI Summary statistics for Kingston do not include $PM_{2.5}$ data.

Air quality in the very good and good categories at individual sites ranged from approximately 80 per cent at Sarnia to 97 per cent at Thunder Bay. Of the 1.1 per cent of poor air quality in Ontario during 2005, 55 per cent was due to fine particulate matter and 45 per cent due to ozone. Thunder Bay was the only monitoring station that did not report air quality in the poor category due to ozone; Thunder Bay's poor air quality hours were all due to fine particulate matter. Ninety five per cent of the exceedances of the poor threshold at Ottawa were due to fine particulate matter, and five per cent were due to ozone. At Windsor Downtown, 68 per cent of the exceeding hours of the poor threshold was due to ozone. The only incident of very poor air quality was due to fine particulate matter, and this was recorded in Sarnia on February 5, 2005 for four hours during a winter fine particulate matter episode that blanketed northeastern U.S. and southern and eastern Ontario. (This unique episode will be discussed later in this chapter).

Three years of data have been compiled since the introduction of fine particulate matter into the air quality index system in August 2002. Table 5.3 shows the number of days that poor air quality was recorded for at least one hour at major cities in southern Ontario and also North Bay in northeastern Ontario during the period 2003-2005.

Table 5.3 Number of Days at Least One Hour AQI > 49 (2003-2005)

City/Town	2003	2004	2005
Windsor Downtown	17	7	37
Hamilton Downtown	22	12	20
Toronto Downtown	12	6	20
Ottawa	5	1	13
North Bay	7	0	10

The significant difference between the number of days recorded during 2004 and 2005 is due primarily to prevailing meteorology. In 2004, May to August were generally cool and wet while September was unseasonably warm and dry. Record-breaking hot and humid conditions dominated the weather across Ontario in 2005, especially for the months of June and July. In 2005, Windsor Downtown recorded the highest number of days (37) with at least one hour of poor air quality. On some days, both ozone and fine particulate matter caused the AQI to exceed the poor threshold of 49. Table 5.4 shows the number of days when ozone, fine particulate matter and both pollutants resulted in the poor category for at least one hour during 2005.

Table 5.4 Number of Days that Ozone, Fine Particulate Matter, and Both Pollutants Resulted in at Least One Hour AQI > 49 (2005)

City/Town	No. of Days At Least 1 Hour > 49 Due to O_3 only	No. of Days At Least 1 hour > 49 Due to FPM only	No. of Days At Least 1 hour > 49 Due to O_3 and FPM	Total Number of Days AQI > 49
Windsor	30	14	7	37
Hamilton	8	14	2	20
Toronto	9	13	2	20
Ottawa	1	12	0	13
North Bay	6	6	2	10

Figures 5.2a-e display the daily maximum AQI values at Windsor Downtown, Sarnia, Hamilton Downtown, Toronto Downtown and Ottawa, respectively, for 2005. All five figures show the winter smog episode that occurred during the period February 4-8, 2005 with elevated daily maximum AQI values due to $PM_{2.5}$. In fact, four out of the five sites reported daily maximum AQI values in the poor category (AQI>49) during that period; Toronto Downtown was the only exception. In Figure 5.2a, ozone dominated the daily maximum AQI values over the entire year, accounting for approximately 69 per cent in Windsor Downtown; 31 per cent were due to $PM_{2.5}$. During the summer months (May to September), ozone was even more dominant in Windsor, with approximately 80 per cent of daily maximum AQI readings due to ozone.

In Sarnia, Figure 5.2b, approximately 55 per cent of daily maximums, for the entire year, were as a result of ozone, and 45 per cent were due to $PM_{2.5}$. During the summer months, Sarnia showed a similar trend to Windsor with approximately 70 per cent of daily maximum AQI readings due to ozone.

As shown in Figure 5.2c, ozone accounted for approximately 65 per cent of the daily maximum AQI readings at Hamilton Downtown, and 35 per cent were due to $PM_{2.5}$. On days when the maximum AQI was in the moderate or poor category (AQI>31), approximately 63 per cent were due to $PM_{2.5}$ and 37 per cent were due to ozone. This indicates that even though the daily maximum AQI readings in Hamilton Downtown were dominated by ozone for the year, as AQI values increase, the maximums became dominated by $PM_{2.5}$.

Figure 5.2a
Daily Maximum AQI Values in Windsor Downtown
(2005)

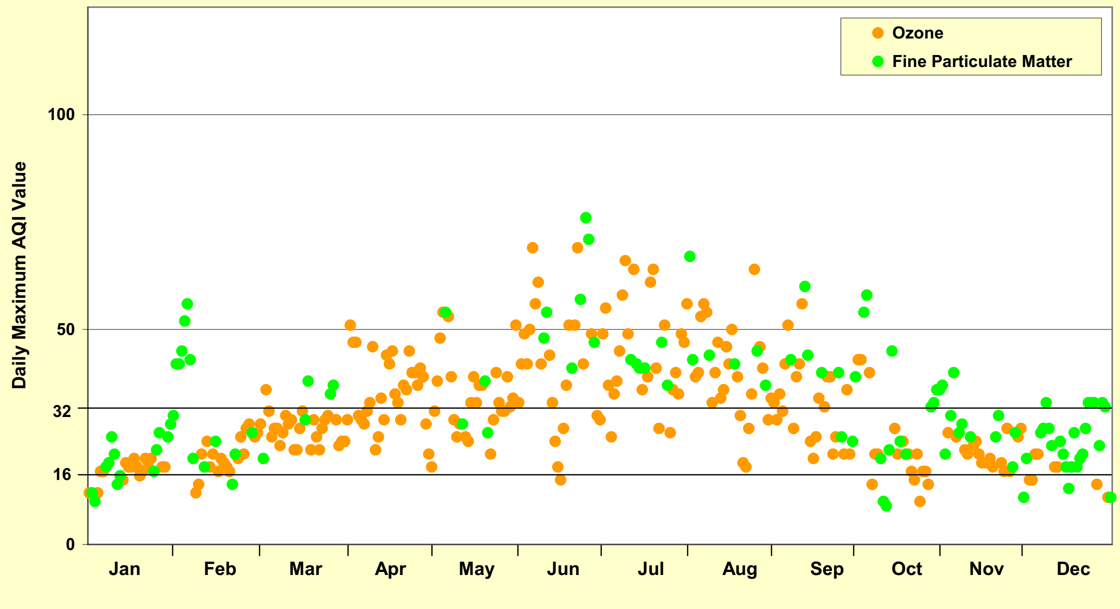


Figure 5.2b
Daily Maximum AQI Values in Sarnia
(2005)

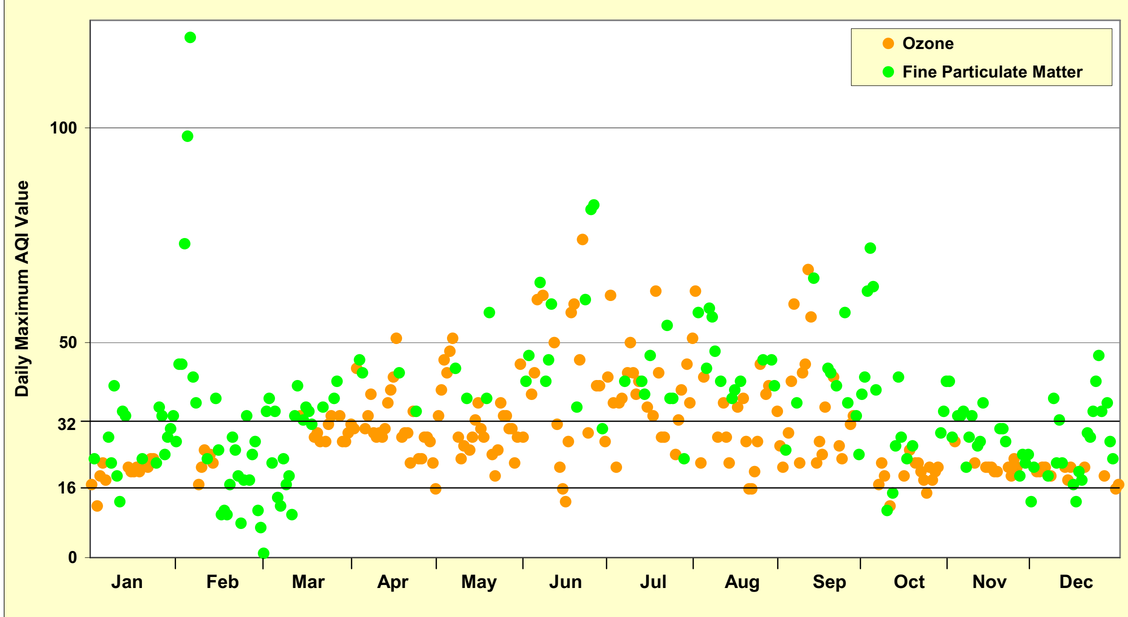


Figure 5.2c
Daily Maximum AQI Values in Hamilton Downtown
(2005)

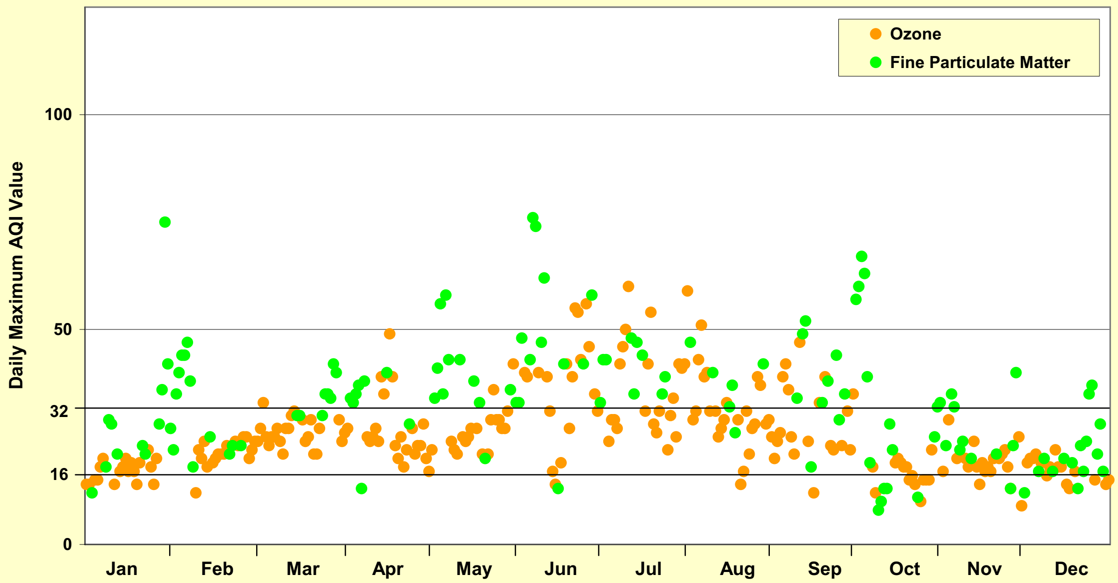
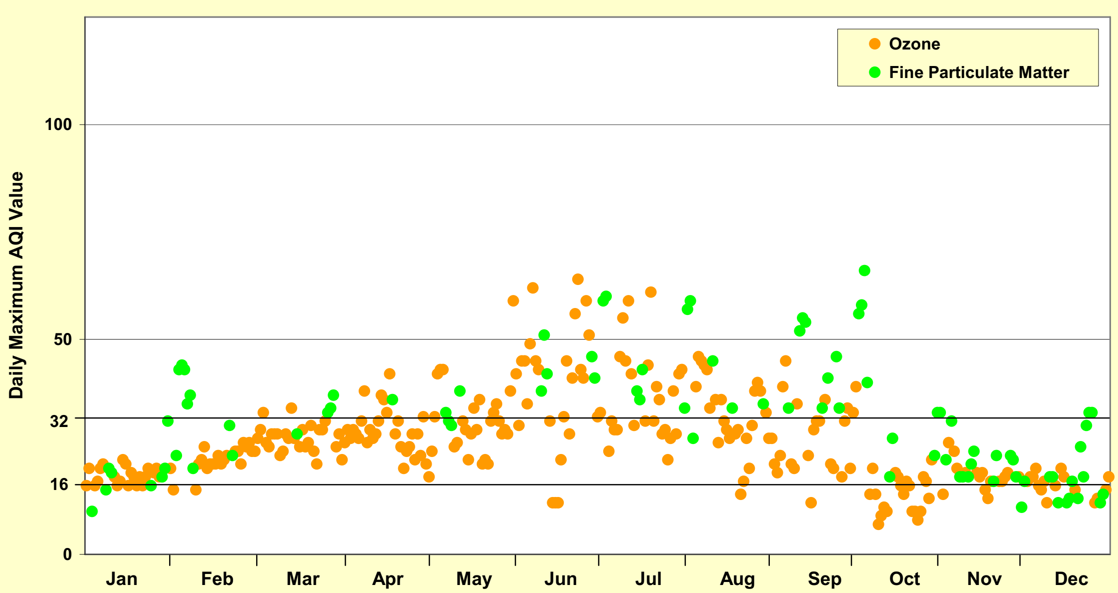
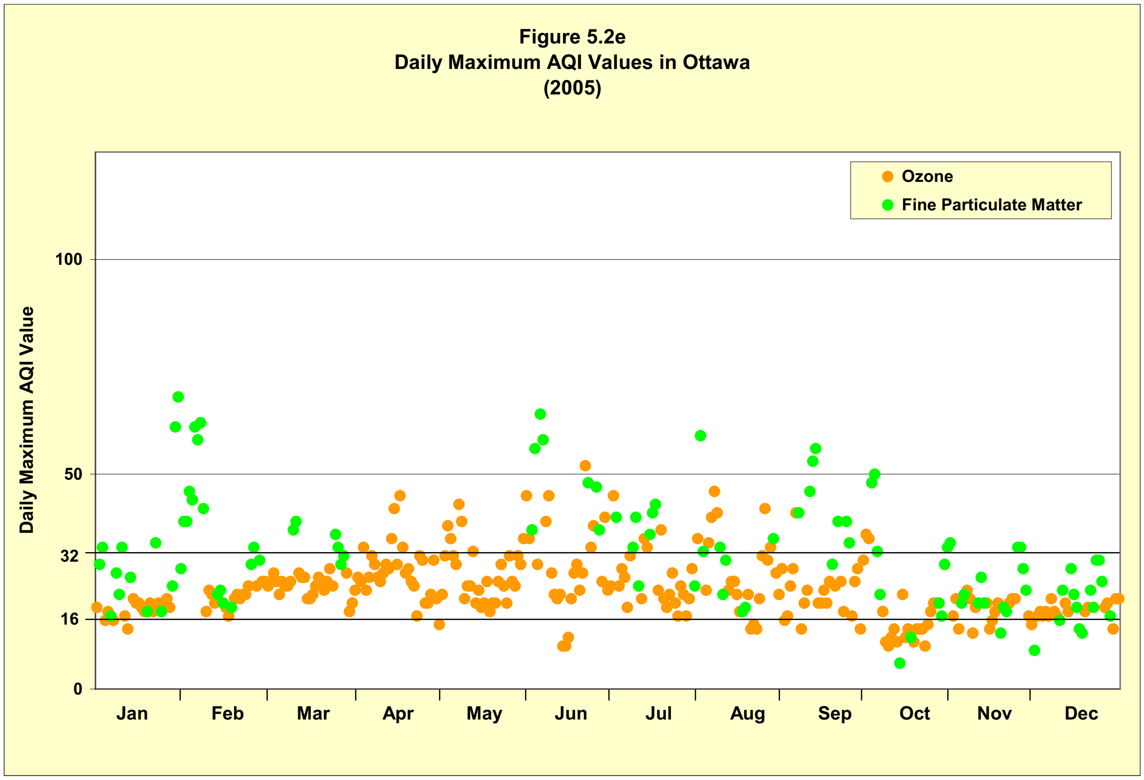


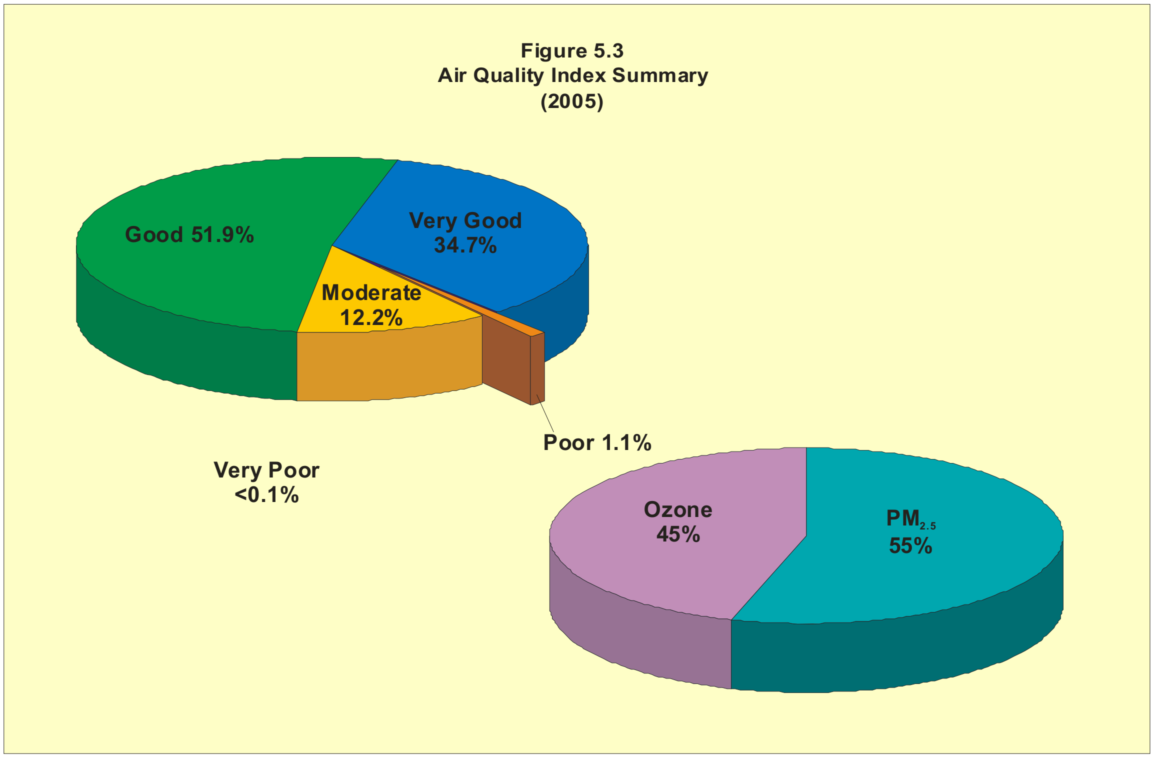
Figure 5.2d
Daily Maximum AQI Values in Toronto Downtown
(2005)





At Toronto Downtown, Figure 5.2d, daily maximum AQI values were again clearly dominated by ozone, with approximately 76 per cent of readings due to ozone, and 24 per cent due to $PM_{2.5}$. In Ottawa, Figure 5.2e, approximately 72 per cent of the reported daily maximum AQI readings were due to ozone, and 28 per cent were due to $PM_{2.5}$. Ozone was clearly dominant, however 12 of the 13 poor days (days with at least one hour in the poor category) were due to $PM_{2.5}$, and only one day was due to ozone.

Figure 5.3 shows the composite pie diagrams of the percentages of very good, good, moderate and poor air quality recorded at sites across the province in 2005. The pie diagram on the top left shows category percentages. The pie diagram on the bottom right breaks down the poor air quality into percentages of pollutants associated with the AQI above 49. Fifty five per cent of the poor AQI values were due to fine particulate matter, and the remaining 45 per cent were due to O_3. By way of contrast, 79 per cent of the poor AQI values were due to fine particulate matter, and 21 per cent due to O_3 in 2004 (not shown).



Smog alert program

The ministry began issuing smog advisories in 1993 under the Air Quality Advisory program, and then expanded to the Smog Alert program in 2000. The program is a joint effort between the Ontario Ministry of the Environment and Environment Canada. Smog advisories are issued to the public when widespread, elevated (AQI values greater than 49) and persistent smog (O_3 and $PM_{2.5}$) levels are forecast to occur within the next 24 hours, *or* if elevated smog conditions occur without warning and weather conditions conducive to elevated smog levels are forecast to continue for several hours. The smog advisory program covers southern, eastern and central Ontario where ozone levels are most likely to exceed the one-hour AAQC of 80 ppb and $PM_{2.5}$ levels of 45 $\mu g/m^3$ three-hour running average.

The Smog Alert program provides Ontarians with improved reporting through comprehensive and timely air quality readings and forecasts, and includes the following:

- A two-level air quality forecast that provides a three-day outlook known as a Smog Watch, in addition to the current 24-hour Smog Advisory;
- A Smog Watch is issued when there is a 50 per cent chance that elevated smog levels are forecast within the next three days;

- A Smog Advisory is issued when there is a strong likelihood that elevated smog levels are forecast within the next 24 hours;
- An immediate Smog Advisory issued if widespread, elevated smog levels occur without warning and weather conditions conducive to the persistence of such levels are forecast to continue for several hours;
- A public website, www.airqualityontario.com, where current AQI readings, smog forecasts and other air quality information are available;
- Direct e-mails of smog alerts to everyone who subscribes to the ministry's Smog Alert network at the above website;
- Toll-free numbers by which anyone at anytime can get updated information on air quality (1-800-387-7768 in English and 1-800-221-8852 in French).

Co-operative activities with Michigan and Quebec

Since May 2000, during the traditional smog season from May to September, air quality and meteorological discussions between Michigan and Ontario meteorologists are held twice per week or more frequently if there is potential for a Smog Advisory in Ontario or an ozone action day in Michigan. Although ozone action days in Michigan and smog advisories in Ontario are not linked to the same air quality standards, the weather conditions conducive to high levels of smog are often common to both airsheds, particularly in the Detroit-Windsor area. This arrangement was expanded in 2004 to also include year round discussions under Lake Michigan Air Director's Consortium (LADCO) on the issuance and harmonizing of smog alerts and ozone action days during the summer, as well as $PM_{2.5}$ forecasting for the Great Lakes transboundary area.

The issuance of smog advisories in Ontario under the Smog Alert program and in Quebec under their Info-Smog program during the smog season is also harmonized through discussions when required between Ontario meteorologists and the Meteorological Services of Canada, Quebec Region meteorologists for border regions such as Ottawa, Ontario and Gatineau, Quebec.

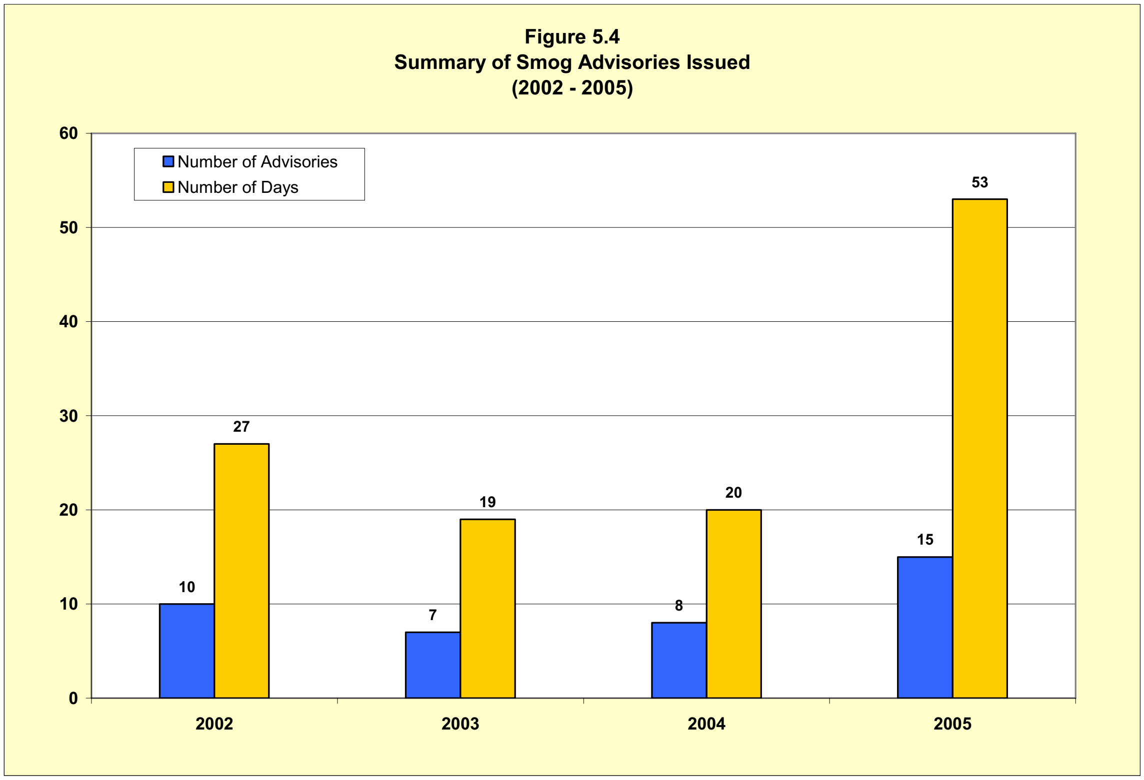
2005 smog advisories

For the 2005 traditional smog season (May 1 to September 30 inclusive), Ontarians experienced 12 smog advisories covering 42 days. Over the entire calendar year, 15 smog advisories, covering 53 days, were issued, as displayed in Table 5.5.

Table 5.5 Smog Advisory Statistics for Ontario (2005)

Advisory	Advisory Period	Duration of Advisory
1	February 4-8	5 days
2	April 19-20	2 days
3	May 8-10	3 days
4	June 2-4	3 days
5	June 5-6	2 days
6	June 7-14	8 days
7	June 24-30	7 days
8	July 4-5	2 days
9	July 10-15	6 days
10	July 20	1 day
11	July 21	1 day
12	August 2-4	3 days
13	August 8-10	3 days
14	September 12-14	3 days
15	October 3-6	4 days

In 2005, a record was set for the number of smog advisory days across Ontario for all regions. For the province as a whole, there were 53 smog advisory days in 2005, compared to the previous record of 27 such days in 2002. For the first time since the inclusion of fine particulate matter into the Smog Alert program in August 2002, Ontario experienced an intense winter smog episode in February 2005. This was followed by the issuance of a smog advisory due to ground-level ozone on April 19-20, the earliest date of the year for such an occurrence. A record-breaking number of 20 smog advisory days was then issued in June, a month with many hot days and transboundary flow of polluted air into Ontario. This also included a record-breaking eight-day episode. Another highlight included, for the first time, a widespread autumn fine particulate matter episode across Ontario in October 2005. A history of smog advisories and smog advisory days since 2002 is shown in Figure 5.4.



2005 smog episodes

Smog episodes are defined here as days with widespread and persistent ozone levels greater than the Ontario one-hour ozone AAQC of 80 ppb and/or days with widespread and persistent $PM_{2.5}$ levels greater than the three-hour average Ontario $PM_{2.5}$ reference level of 45 $\mu g/m^3$. Such episodes in the winter in Ontario are due primarily to fine particulate matter, and are typically associated with relatively stagnant conditions and the development of strong temperature inversion conditions overnight. Under normal atmospheric conditions, the temperature of the atmosphere decreases with height, whereas an inversion is formed when the temperature increases with height. Within the inversion layer, the atmosphere is very stable and is therefore unable to mix vertically, and can lead to pollutants being trapped in that layer. During the day, the sun shines on the earth's surface, heating it up, and in turn the air closest to the surface is heated, resulting in normal atmospheric conditions. When the sun sets, the Earth's surface no longer receives radiation from the sun, so it cools rapidly provided the sky is clear (clouds act as insulation). If winds are light, the temperature of the air near the surface decreases faster than the air above it, establishing an inversion.

The first smog episode of the year was recorded during the winter months in February 2005, and was due to $PM_{2.5}$. The incident occurred between February 3 and February 7 with widespread elevated $PM_{2.5}$ levels monitored on February 4 and 5 from Windsor, across the GTA, and eastwards to Ottawa. A relatively stagnant air mass over broad regions of the Great Lakes and St. Lawrence Valley including southern and eastern Ontario during this period resulted in conditions conducive to inversions (clear skies at night and light winds), as well as poor dispersion conditions. These conditions were ideal for the build-up of $PM_{2.5}$ and other pollutants over the entire region and caused AQI readings to reach the poor category at a number of locations. For example, 12 AQI stations reported poor levels on February 4, with a maximum observed three-hour average concentration of 89 $\mu g/m^3$ at Sarnia. On February 5, 11 stations reported poor levels, with a maximum observed three-hour average concentration of 111 $\mu g/m^3$, also at Sarnia. These elevated $PM_{2.5}$ levels in southern and eastern Ontario were likely caused by local emissions in combination with particulate-laden air from neighbouring jurisdictions. During this period, widespread and elevated $PM_{2.5}$ levels (higher than those in Ontario) occurred in neighbouring U.S. states south and west of Ontario. This would have likely impacted areas such as Sarnia, Windsor and London in southwest Ontario. In eastern Ontario, the maximum observed three-hour average concentrations were recorded in Cornwall on February 4, at 62 $\mu g/m^3$, and in Ottawa on February 5, at 56 $\mu g/m^3$. Wood-burning sources of particle pollution in eastern Ontario and adjacent Quebec regions appear to have played a role in these elevated $PM_{2.5}$ levels.

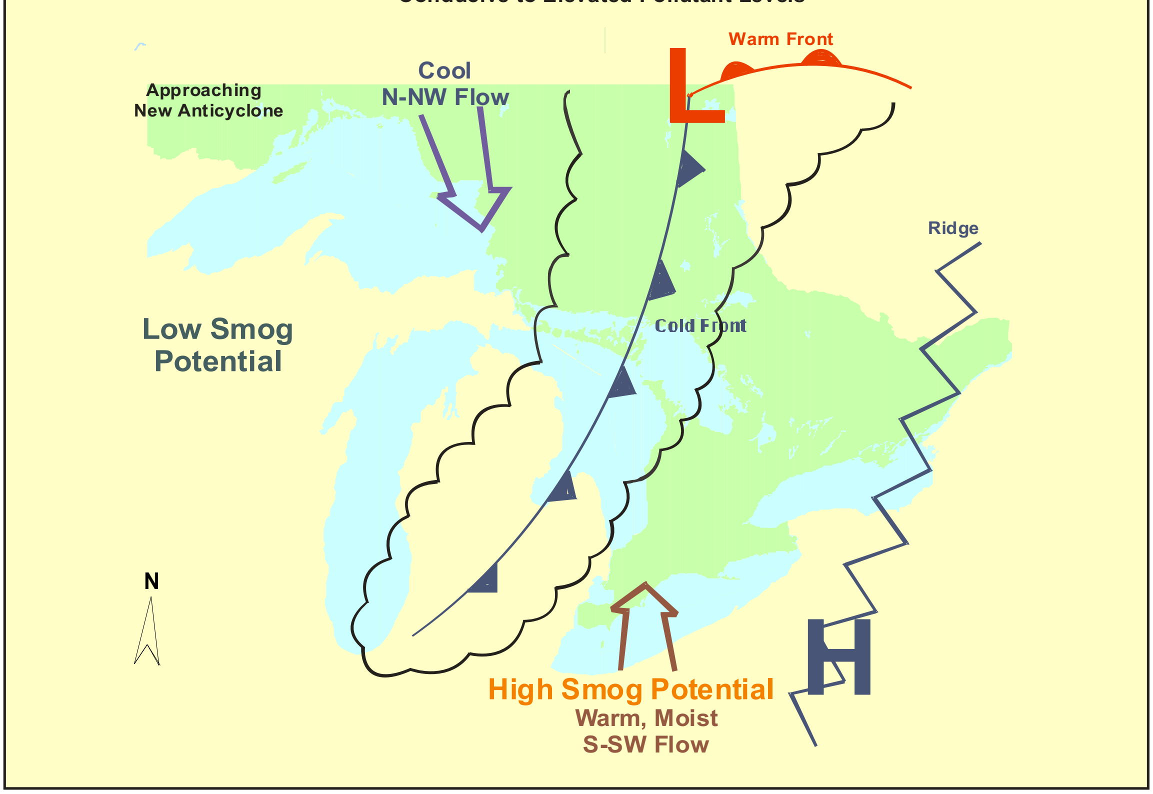
The traditional summer smog season, usually dominated by ground-level ozone, is generally defined as the period between May 1 and September 30. In 2005, however, Ontario experienced for the first time an ozone smog episode in April. Hot sunny conditions with southwesterly winds resulted in the transport of polluted air into Ontario and high smog levels on April 19. Poor air quality due to ground-level ozone occurred at 17 sites in the AQI network over areas of southwestern Ontario, across the GTA, central and eastern Ontario on April 19, and the maximum one-hour level of 100 ppb occurred at Dorset in the cottage country area. Relief arrived overnight as a cold front moved across the regions resulting in cloudiness and precipitation, and cleaner air the next day.

The other episode outside of the traditional smog season occurred in October during the period October 3 to 5 and was the first widespread autumn smog episode due to fine particulate matter. Warm, hazy and humid conditions combined with a light south to southwesterly flow of polluted air from the U.S. and a local build-up of pollutants resulted in elevated levels of fine particulate matter over three days in southwestern and parts of central and eastern Ontario, including the City of Toronto. Twenty-one sites reported poor air quality on October 3 and 30 sites reported poor levels on both October 4 and 5. Elevated fine particulate matter blanketed areas from Windsor to Cornwall, across the GTA and as far north as Sudbury and North Bay during this episode. The highest observed three-hour average concentration was 56 $\mu g/m^3$ on

October 3 (Sarnia), 67 $\mu g/m^3$ on October 4 (Peterborough) and 72 $\mu g/m^3$ on October 5 (Mississauga). Increasing winds along with good mixing and dispersion of pollutants resulted in improved air quality across all affected regions by October 6.

Summer smog episodes in Ontario are often a part of a regional weather condition that prevails over much of northeastern North America. Elevated levels of ozone and $PM_{2.5}$ are typically due to 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. Figure 5.5 is an illustration depicting these typical summer smog episode conditions. The blue "H" just southeast of Lake Erie represents a high pressure system which results in sunny skies and a light south to southwesterly flow of warm moist air across the lower Great Lakes region. The red "L" over northeastern Ontario represents a low pressure system, and has a cold front stretching southwestward across Lake Huron, which results in cloudiness and precipitation. It is the passage of this cold front that typically ends a smog episode and smog advisory. Behind the cold front, another high pressure system approaches from the northwest, causing a north to northwesterly flow of cooler, drier, and cleaner air.

Figure 5.5
Generalized Synoptic Weather Pattern Over Southern Ontario Conducive to Elevated Pollutant Levels



An example of summer smog episode conditions occurred during the event which lasted from August 2 to 4, 2005. On August 2, a high pressure system was centered south of Lake Erie, and a low pressure system was located over northern Saskatchewan, with a cold front stretching southwestward from the low. The high pressure system remained relatively static throughout the episode as the low pressure system and cold front approached. By the afternoon of August 4, the low pressure system had moved to James Bay, with the cold front lying northeast to southwest across Lake Huron, while the high pressure system was southeast of Lake Erie. The cold front moved over the lower Great Lakes region overnight on August 4, resulting in a northwesterly flow of cooler and drier air across the province, ending the episode. During this episode, elevated one-hour ozone concentrations were encountered on August 2 and 3, with a maximum of 116 ppb (Chatham) on August 2, and a maximum of 104 ppb (Grand Bend) on August 3. Elevated $PM_{2.5}$ concentrations were recorded on August 3 and 4, with a maximum three-hour running average of 63 $\mu g/m^3$ (Chatham) on August 3, and a maximum of 59 $\mu g/m^3$ (Toronto North) on August 4.

Elevated ozone and fine particulate matter levels are highly dependent upon weather conditions which vary from year to year. To depict the trend in Ontario, the number of *ozone episode days*, characterized by days with widespread one-hour average ozone levels greater than 80 ppb, for the period 1980 to 2005 is depicted in Figure 5.6. This shows that *ozone episode days*, a total of 22 in 2005, were in marked contrast to the 5 in 2004 and 11 in 2003.

In terms of *smog episode days* (due to ozone and/or $PM_{2.5}$) there were 31 such days in 2005, 15 in 2004, and 12 in 2003. For 2005, most cases occurred in the summertime and were driven by ozone or ozone and fine particles (21 of the 31 cases). In contrast, the events in 2004 were all warm season occurrences and were mainly fine particulate matter or fine particulate matter and ozone driven (10 of the 15 cases). For 2003, the episodes were also all confined to the warm season months and were mainly ozone or ozone and fine particulate matter driven (11 of the 12 cases). These results for the three years are summarized in Table 5.6.

The higher number of *smog advisory days* (Figure 5.4) compared to *smog episode days* (Table 5.6) during the period 2003 to 2005 reflect a number of factors such as the need to capture events over small geographic regions, the need to issue advisories for marginal events to protect populated areas, and limitations in forecasting weather and air quality.

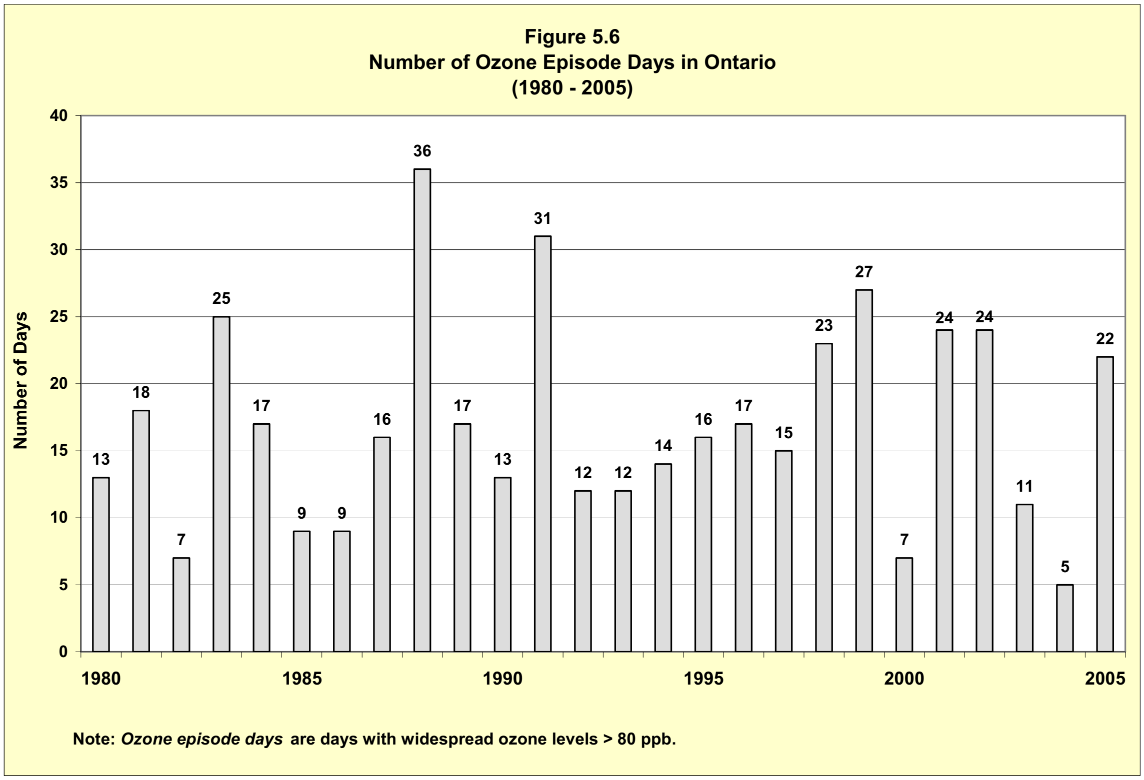


Table 5.6 Smog Episode Days in Ontario (2003 – 2005)

Year	Smog Episode Days Due to		
	Ozone	Ozone and $PM_{2.5}$	$PM_{2.5}$
2003	5	6	1
2004	2	3	10
2005	14	8	9

The air flow into Ontario, as shown with 48-hour back trajectories on the 31 smog episode days during 2005, is depicted in Figure 5.7. This qualitatively confirms the fact that ozone and fine particulate matter episode days in Ontario are typically associated with south to southwesterly flows from the heavily industrialized and urbanized regions of the United States.

Figure 5.7
48-Hour Back Trajectories at 500m Arriving at London, Ontario at 1300 EDT on Smog Episode Days in 2005

Source Contributions on High Ozone Concentration Days in Ontario

The *Transboundary Air Pollution in Ontario* report presented a recent air pollution modelling assessment in Ontario that showed that on high ozone concentration days (days when eight-hour running average ozone concentrations were above the CWS reference level of 65 ppb), Ontario anthropogenic (human-made) emissions contributed, at most, 16 per cent of the local ozone problem. Contributions due to Ontario emissions ranged from about 1 per cent in Windsor, to 9 per cent in the GTA, to 16 per cent downwind of the GTA/Hamilton area, and to 7 per cent in the Kingston area. Ontario's emission contribution to upper New York state and Vermont/New Hampshire was approximately 3 per cent. The implications of these results in terms of transboundary contributions (U.S. and background) are provided below.

Global background mean ozone concentrations in the lower atmosphere vary with the time of the year and with latitude, but are generally very significant at about 40 ppb. If there were no regional anthropogenic emissions of nitrogen oxides and volatile organic compounds, the background ozone aloft would still be available to be mixed down to ground level. At ground level, especially in urban areas, annual average ozone concentrations are affected by global background concentrations but will usually be lower than the background due largely to ozone titration by nitric oxide with limited vertical mixing to replace the depleted ozone at times during the day. In the Ontario context, *background ozone concentrations* refer to the contributions at a given location in Ontario that are primarily the result of anthropogenic and natural emissions from outside North America and natural sources within North America. On high ozone days in Ontario, *background ozone concentrations* are substantial, at about 50 per cent of the eight-hour daily maxima from southwestern Ontario through to areas downwind of the GTA/Hamilton (see Figures 5.8a-c). Regional anthropogenic emissions from upwind U.S. sources contribute about 45 per cent to observed concentrations in southwestern Ontario, whereas the Ontario anthropogenic sources contribute about 5 per cent. For the GTA/Hamilton, the U.S. anthropogenic sources contribute about 40 per cent and the Ontario sources about 10 per cent. Downwind of the GTA/Hamilton, U.S. sources are estimated to contribute about 30-35 per cent and the Ontario sources about 15 per cent.

Based on these findings, it is apparent that while *background ozone concentrations* are very significant on high ozone concentration days in Ontario, the regional anthropogenic sources in the air shed also play a significant and approximately equal role. Moreover, about 90 per cent of the anthropogenic contributions to the observed levels in southwestern Ontario are from upwind regional U.S. sources. Over the GTA/Hamilton, the U.S. anthropogenic contributions are about 80 per cent. For areas immediately to the east and north of the GTA/Hamilton, the U.S. contributions are estimated to be at 60-70 per cent.

Figure 5.8a
Percent Contributions on High Ozone Concentration Days in Ontario
Southwestern Ontario

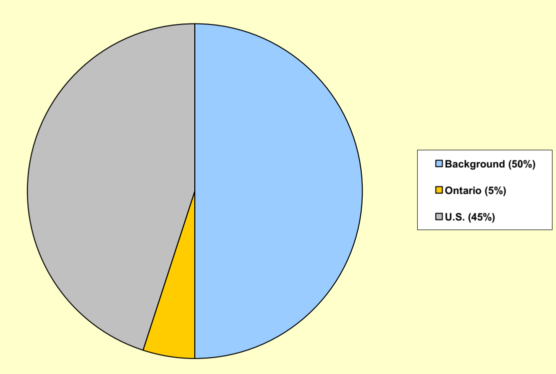


Figure 5.8b
Percent Contributions on High Ozone Concentration Days in Ontario
GTA/Hamilton

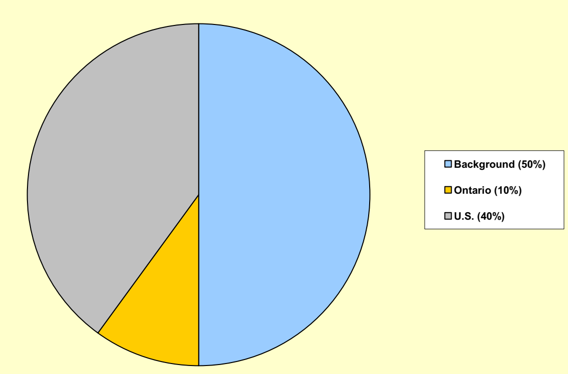
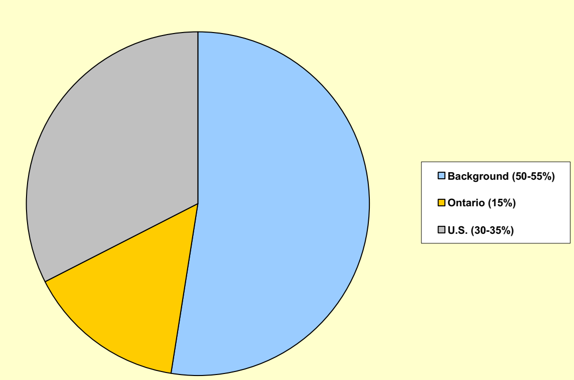


Figure 5.8c
Percent Contributions on High Ozone Concentration Days in Ontario
Immediate Areas Downwind of GTA/Hamilton



On days of low ozone concentrations, contributions from *background ozone concentrations* are expected to dominate as the anthropogenic sources would not be expected to contribute much to the observed levels. Based on the above modelling study, it is estimated that *background ozone concentrations* contributed about 75 per cent to the observed levels in southwestern Ontario on an average day (i.e. when all days are considered over a five month period (spring/summer)). Background contributions were estimated to be about 75-80 per cent for the GTA/Hamilton and 80-85 per cent downwind of GTA/Hamilton.

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GLOSSARY

Acidic deposition	-	refers to wet and dry deposition of a variety of airborne acidic pollutants (acids or acid-forming substances such as sulphates and nitrates) on biota or land or in waters of the Earth's surface.
Air Quality Index	-	real-time information system that provides the public with an indication of air quality in cities, towns and in rural areas across Ontario.
AQI 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.
Airshed	-	a geographical region of influence or spatial extent of the air pollution burden.
Ambient air	-	outdoor or open air.
Carbon monoxide	-	a colourless, odourless, tasteless and at high concentrations, a poisonous gas.
Continuous pollutant	-	pollutants for which a continuous 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.
Detection limit	-	minimum concentration of a contaminant that can be determined.
Diurnal	-	recurring every day; actions that are completed in 24 hours and repeated every 24 hours.

Exceedance	-	violation of the air pollutant concentration levels established by environmental protection criteria or other environmental standards.
Fine Particulate Matter	-	particles smaller than about 2.5 microns 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 $PM_{2.5}$. These are fine enough to penetrate deep into the lungs.
Foliar stomata	-	in the scientific study of plant life, stomata are tiny openings or pores found mostly on the under-surface of a plant leaf, and used for gas exchange.
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.
Global warming	-	long-term rise in the average temperature of the earth's atmosphere; principally due to an increase in the build-up of carbon dioxide and other gases.
Ground-level ozone	-	colourless gas formed from chemical reactions between nitrogen oxides and reactive hydrocarbons in the presence of sunlight near the Earth's surface.
Micron	-	a millionth of a metre.
Nitrogen dioxide	-	a reddish-brown gas with a pungent and irritating odour.
Ozone episode day	-	a day on which widespread (hundreds of kilometres) elevated ozone levels (greater than 80 ppb maximum hourly concentration) occur simultaneously.
Particulate matter	-	refers to all airborne finely divided solid or liquid material with an aerodynamic diameter smaller than 44 microns.
Percentile value	-	percentage of the data set that lies below the stated value; if the 70 percentile value is 0.10 ppm, then 70 per cent of the data are equal to or below 0.10 ppm.
Photochemical oxidation	-	a complex mixture of chemicals produced in the atmosphere; these air pollutants are formed by the action of sunlight on oxides of nitrogen and VOCs.

Glossary continued...

Photochemical smog - see *smog*.

Photochemical reaction - Chemical reaction influenced or initiated by light, particularly ultraviolet light.

Pollution rose - a diagram indicating the frequency of given concentration levels of a pollutant as a function of wind direction.

Primary pollutant - pollutant emitted directly to the atmosphere.

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.

Smog advisory - smog advisories are issued to the public when there is a strong likelihood that widespread, elevated and persistent smog levels are expected.

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 much ultraviolet radiation and prevents it from reaching the Earth.

Sulphur dioxide - a colourless gas that smells like burnt matches.

Toxic deposition - deposition of an airborne toxic pollutant at ground, vegetative or surface levels.

Toxic pollutant - substance that can cause cancer, genetic mutations, organ damage, changes to the nervous system, or even physiological harm as a result of prolonged exposure, even to relatively small amounts.

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

ACRONYMS

AAQC	-	Ambient Air Quality Criteria (Ontario)
AQI	-	Air Quality Index
CCME	-	Canadian Council of Ministers of the Environment
CO	-	carbon monoxide
COPD	-	Chronic obstructive pulmonary disease
CWS	-	Canada-wide Standard
GTA	-	Greater Toronto Area
IVR	-	Integrated Voice Response
MOE	-	Ministry of the Environment
NAAQS	-	National Ambient Air Quality Standard (U.S.)
NAPS	-	National Air Pollution Surveillance (Canada)
NO	-	nitric oxide
NO_2	-	nitrogen dioxide
NO_X	-	nitrogen oxides
O_3	-	ozone
$PM_{2.5}$	-	fine particulate matter
SES (TEOM)	-	Sample Equilibration System
SO_2	-	sulphur dioxide
TEOM	-	Tapered Element Oscillating Microbalance
TRS	-	total reduced sulphur
VOCs	-	volatile organic compounds
WHO	-	World Health Organization
$\mu g/m^3$	-	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

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AIR QUALITY IN ONTARIO 2005 REPORT APPENDIX

AIR MONITORING & REPORTING SECTION
ENVIRONMENTAL MONITORING AND REPORTING BRANCH
ONTARIO MINISTRY OF THE ENVIRONMENT

ACKNOWLEDGEMENTS

This report has been prepared by the staff of the Environmental Monitoring and Reporting Branch of the Ontario Ministry of the Environment. Canada's National Air Pollution Surveillance program is also acknowledged for providing air monitoring instrumentation.

APPENDIX
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INTRODUCTION

This appendix is intended for use in conjunction with the 2005 Annual Air Quality in Ontario report. The first section of the Appendix briefly describes the provincial air monitoring network, quality assurance and quality control procedures and the Ministry of the Environment's air quality database. The second part of the Appendix 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.

MONITORING NETWORK OPERATIONS

Network Description

In 2005, the ambient network comprised of 143 continuous monitoring instruments at 44 sites, including research sites, where 41 real-time $PM_{2.5}$ monitors were operated. During 2005, the Environmental Monitoring and Reporting Branch (EMRB) operated all of the ambient sites. Monitoring site locations for the continuous network are illustrated in Map 1.

Quality Assurance and Quality Control

Day-to-day air monitoring and maintenance of the instruments is administered by staff of the EMRB. 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 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 monthly on-site visits where secondary transfer standards are used to calibrate instrumentation. Station activity is recorded using *FieldWorker Inc.* 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:

- Ozone – TE49C
- Fine Particulate Matter – TEOM 1400AB/SES
- Nitrogen Oxides – TE42C
- Carbon Monoxide – TE48C
- Sulphur Dioxide – TE43C
- Total Reduced Sulphur – TE43C/CDN101

The Environmental Monitoring and Reporting Branch operates a laboratory with gas reference standards that adhere to those of the U.S. National Institute of Standards and Technology (NIST) and the

Pollution Measurement Division of Environment Canada. The secondary transfer standards used by station operators are referenced and certified to EMRB's NIST primary standards on a quarterly basis. Primary weighed filter standards from Thermo Electron Corporation are used to calibrate the TEOM twice a year.

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 staff of the Environmental Monitoring and Reporting Branch. 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 2005 ambient air quality monitoring network had greater than 95 per cent valid data from over 3 million data points.

Data Base

The ambient air quality data used in this report are stored in the ministry's air quality information system (AQUIS). 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, obtained from automated ambient air monitoring instruments that operate continuously, produce an average measurement for every hour for a possible total of 8760 measurements in a given year. Hourly parameters measured include O_3, $PM_{2.5}$, $NO/NO_2/NO_x$, CO, SO_2 and TRS compounds. A valid annual mean requires at least 6570 hourly readings. In addition, the 2nd and 3rd quarters of the year should have 75 per cent valid data for ozone, whereas for $PM_{2.5}$, each quarter of the year should have 75 per cent valid data.

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 1996-2005.

NETWORK DESCRIPTIVE TABLES AND ANNUAL STATISTICS

The ambient continuous (hourly) network for 2005 is summarized in Table 1 and Map 1. 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.

The 2005 statistical data and 10-year trends for various continuous pollutants are provided in Tables 2-15.

Table 1: 2005 Ontario Continuous Ambient Air Monitoring Network

ID	CITY/TOWN	STATION LOCATION	YEAR	LATITUDE	LONGITUDE	AIR INTAKE	TYPE	AQI	O_3	$PM_{2.5}$	NO_2	CO	SO_2	TRS
12008	WINDSOR DOWNTOWN	467 UNIVERSITY AVE.	1969	42°18`59``	83°02`40``	8	A	Y	T	T	T	T	T	.
12016	WINDSOR WEST	COLLEGE/SOUTH ST.	1975	42°17`34``	83°04`24``	4	A	Y	T	T	T	.	T	T
12059	ESSEX	360 FAIRVIEW DR. W.	2004	42°09`36``	82°50`00``	5	R	.	T	T	T	.	T	.
13001	CHATHAM	435 GRAND AVE. W.	2005	42°24`12``	82°12`31``	15	A	Y	T	T	T	T	T	.
14064	SARNIA	FRONT ST./CN TRACKS/CENTENNIAL PARK	1976	42°59`01``	82°24`16``	3	A	Y	T	T	T	.	T	T
15020	GRAND BEND	WATER TREATMENT PLANT	1991	43°20`02``	81°44`20``	10	A	S	T	T	.	.	.	.
15025	LONDON	900 HIGHBURY AVE.	1995	43°00`32``	81°12`34``	4	A	Y	T	T	T	T	T	.
16015	PORT STANLEY	43665 DEXTER LINE/ ELGIN WATER T. PLANT	2002	42°39`36``	81°13`08``	5	A	S	T	T	.	.	.	.
18007	TIVERTON	CONCESSION RD. 2/ LOT A	1979	44°18`50``	81°33`08``	4	A	S	T	T	.	.	.	.
21005	BRANTFORD	324 GRAND RIVER AVE.	2004	43°08`25``	80°17`46``	5	A	Y	T	T	T	.	T	.
22071	SIMCOE	HWY 3/BLUE LINE RD./ EXPERIMENTAL FARM	1975	42°51`08``	80°15`50``	4	R	.	T	T	.	.	.	.
26060	KITCHENER	WEST AVE./HOMEWOOD	1990	43°26`34``	80°30`14``	5	A	Y	T	T	T	.	.	.
27067	ST. CATHARINES	ARGYLE CRES./ PUMP STN.	1987	43°09`38``	79°14`02``	4	A	Y	T	T	T	.	.	.
28028	GUELPH	EXHIBITION ST./CLARK ST.	2000	43°33`09``	80°15`59``	4	A	Y	T	T	.	.	.	.
29000	HAMILTON DOWNTOWN	ELGIN/KELLY	1987	43°15`30``	79°51`41``	4	A	Y	T	T	T	T	T	T
29114	HAMILTON MOUNTAIN	VICKERS RD./E. 18TH ST.	1985	43°13`47``	79°51`43``	3	A	Y	T	T	.	.	.	.
29118	HAMILTON WEST	MAIN ST. W./ HWY 403	1985	43°15`31``	79°54`09``	3	A	Y	T	T	.	.	.	.
31103	TORONTO DOWNTOWN	BAY/WELLESLEY ST.	2000	43°39`51``	79°23`14``	10	A	Y	T	T	T	T	T	.
31190	TORONTO	CN TOWER/ 301 FRONT ST. W.	1989	43°38`26``	79°23`13``	444	R	.	T	.	T	.	.	.
33003	TORONTO EAST	KENNEDY/LAWRENCE	1970	43°44`57``	79°16`30``	4	A	Y	T	T	T	.	.	.
34020	TORONTO NORTH	HENDON/YONGE ST.	1988	43°46`47``	79°24`56``	5	A	Y	T	T	T	.	.	.
35003	ETOBICOKE WEST	ELMCREST RD./CENTENNIAL PARK	1969	43°38`58``	79°35`18``	5	R	.	T	T	T	.	.	.
35033	ETOBICOKE SOUTH	185 JUDSON ST.	1967	43°36`49``	79°30`28``	5	R	.	T	T	T	.	.	.
35125	TORONTO WEST	125 RESOURCES RD.	2003	43°42`40``	79°32`33``	8	A	Y	T	T	T	T	T	.
44008	BURLINGTON	HWY 2/NORTH SHORE BLVD. E.	1979	43°19`08``	79°48`06``	5	A	Y	T	T	T	.	T	.
44017	OAKVILLE	8TH LINE/GLENASHTON DR./ HALTON RESERVOIR	2003	43°29`09``	79°42`08``	12	A	Y	T	T	T	.	T	.
45026	OSHAWA	2200 SIMCOE ST. N./ DURHAM COLLEGE	2005	43°57`06``	78°53`52``	7	A	Y	T	T	T	.	.	.
46089	BRAMPTON	525 MAIN ST. N./ PEEL MANOR	2000	43°41`59``	79°46`41``	5	A	Y	T	T	T	.	T	.
46109	MISSISSAUGA	FRANK McKECHNIE COMM. CTR	2004	43°36`57``	79°39`09``	10	A	Y	T	T	.	.	T	.

Table 1: 2005 Ontario Continuous Ambient Air Monitoring Network

ID	CITY/TOWN	STATION LOCATION	YEAR	LATITUDE	LONGITUDE	AIR INTAKE	TYPE	AQI	O_3	$PM_{2.5}$	NO_2	CO	SO_2	TRS
47045	BARRIE	83 PERRY ST.	2001	44°22`55``	79°42`15``	5	A	Y	T	T	T	.	T	.
48002	STOUFFVILLE	HWY 47/ E. OF HWY 48	1980	43°57`52``	79°15`58``	5	R	.	T	.	.	.	.	.
48006	NEWMARKET	EAGLE ST./McCAFFREY RD.	2001	44°02`38``	79°28`55``	5	A	Y	T	T	T	.	.	.
49005	PARRY SOUND	7 BAY ST.	2001	45°20`21``	80°02`15``	5	A	S	T	T	.	.	.	.
49010	DORSET	HWY 117 / PAINT LAKE RD.	1981	45°13`35``	78°55`08``	3	A	S	T	T	.	.	.	.
51001	OTTAWA	RIDEAU/WURTEMBURG ST.	1971	45°26`00``	75°40`30``	4	A	Y	T	T	T	T	T	.
52020	KINGSTON	133 DALTON ST.	1988	44°15`57``	76°30`06``	5	A	Y	T	.	.	.	.	.
54012	BELLEVILLE	2 SIDNEY ST./ WATER TREATMENT PLANT	2002	44°09`07``	77°23`41``	10	A	Y	T	T	T	.	T	.
56010	MORRISBURG	COUNTY RD. 2/ MORRISBURG WATER TOWER	2005	44°53`23``	75°11`24``	5	A	S	T	T	.	.	.	.
56051	CORNWALL	BEDFORD/THIRD ST.	1970	45°01`05``	74°44`09``	4	A	Y	T	T	.	.	.	.
59006	PETERBOROUGH	10 HOSPITAL DR.	1998	44°18`05``	78°20`51``	10	A	Y	T	T	.	.	.	.
63203	THUNDER BAY	421 JAMES ST. N.	2004	48°22`46``	89°17`25``	15	A	Y	T	T	.	.	.	.
71078	SAULT STE MARIE	SAULT COLLEGE	2004	46°31`59``	84°18`34``	8	A	Y	T	T	T	T	T	T
75010	NORTH BAY	CHIPPAWA ST./ DEPT. NATIONAL DEFENCE	1979	46°18`58``	79°27`01``	4	A	Y	T	T	T	.	.	.
77219	SUDBURY	RAMSEY LAKE RD.	2004	46°28`32``	80°57`47``	3	A	Y	T	T	.	.	T	.

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, R = research
AQI - Air Quality Index site: Y = year-round AQI site (January to December), S = seasonal AQI site (May 1 to September 30)
T - telemetry
O_3 - ground-level ozone
$PM_{2.5}$ - fine particulate matter
NO_2 - nitrogen dioxide
CO - carbon monoxide
SO_2 - sulphur dioxide
TRS - total reduced sulphur

Table 2: 2005 Ozone (O_3) Statistics

Unit: parts per billion (ppb)
O_3 1-hour AAQC is 80 ppb

				PERCENTILES							Maximum		No. of Times Above Criterion
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h
12008	Windsor Downtown	467 University Ave.	8723	3	13	23	33	53	83	26.0	108	70	126
12016	Windsor West	College/South St.	8633	2	13	22	32	54	86	25.6	111	68	150
12059	Essex	360 Fairview Dr. W.	8715	9	19	26	35	51	79	28.6	111	71	65
13001	Chatham	435 Grand Ave. W.	8596	10	21	29	38	54	82	31.0	116	75	99
14064	Sarnia	Front St./CN Tracks, Centennial Park	8058	7	18	26	34	49	79	27.4	115	61	76
15020	Grand Bend	Water Treatment Plant	8687	13	24	32	38	52	82	32.5	131	73	98
15025	London	900 Highbury Ave.	8741	6	17	24	32	48	71	26.1	93	64	14
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plant	8717	15	25	33	40	58	88	34.6	111	79	172
18007	Tiverton	Concession Rd. 2, Lot A	8634	16	25	31	37	47	69	31.8	121	74	22
21005	Brantford	324 Grand River Ave.	8718	6	18	27	35	50	75	27.9	96	65	36
22071	Simcoe	Hwy 3/Blue Line Rd., Experimental Farm	8697	14	25	32	40	55	78	33.6	101	75	61
26060	Kitchener	West Ave./Homewood	8716	6	19	27	35	49	74	28.0	96	67	30
27067	St. Catharines	Argyle Cres., Pump Stn.	8693	3	16	25	33	50	74	26.3	100	68	30
28028	Guelph	Exhibition St./Clark St.	8715	7	19	28	36	50	76	28.6	97	66	48
29000	Hamilton Downtown	Elgin/Kelly	8595	4	14	22	29	44	69	23.2	95	67	23
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8728	7	18	26	35	51	75	28.2	95	73	48
29118	Hamilton West	Main St. W./Hwy 403	8748	1	11	20	28	41	62	21.2	81	61	4
31103	Toronto Downtown	Bay/Wellesley St.	8647	5	14	22	31	46	72	24.5	100	63	36
31190	Toronto	CN Tower, 301 Front St. W.	8410	19	29	37	45	63	87	39.1	122	87	177
33003	Toronto East	Kennedy/Lawrence	8099	3	12	20	28	43	74	22.4	105	59	38
34020	Toronto North	Hendon/Yonge St.	8700	5	14	24	32	45	69	24.5	93	55	17
35003	Etobicoke West	Elmcrest Rd., Centennial Park	8694	2	11	20	30	46	75	22.9	106	68	50
35033	Etobicoke South	185 Judson St.	8671	3	10	19	28	42	66	21.1	97	52	15
35125	Toronto West	125 Resources Rd.	8713	3	8	16	26	43	74	20.3	107	59	49
44008	Burlington	Hwy 2/North Shore Blvd. E.	8674	3	14	22	31	45	69	23.9	91	59	18
44017	Oakville	8th Line/Glenashton Dr., Halton Reservoir	8698	6	18	27	35	49	75	27.7	98	72	47
45026	Oshawa	2200 Simcoe St. N., Durham College	8005	10	19	28	36	47	75	INS	112	62	45
46089	Brampton	525 Main St. N., Peel Manor	8743	5	16	26	35	49	75	26.8	101	64	47
46109	Mississauga	Frank McKechnie Community Center	8732	2	11	21	30	47	76	23.1	102	74	54

Table 2: 2005 Ozone (O_3) Statistics

Unit: parts per billion (ppb)
O_3 1-hour AAQC is 80 ppb

				PERCENTILES							Maximum		No. of Times Above Criterion
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h
47045	Barrie	83 Perry St.	8732	6	18	26	35	46	70	26.9	103	62	24
48002	Stouffville	Hwy 47/E. Of Hwy 48	8695	10	19	26	33	42	67	26.3	89	54	10
48006	Newmarket	Eagle St./McCaffrey Rd.	8734	10	22	31	38	50	76	30.8	114	67	58
49005	Parry Sound	7 Bay St.	8740	14	25	33	40	54	79	33.8	110	78	76
49010	Dorset	Hwy 117/Paint Lake Rd.	8671	14	24	32	39	50	76	32.3	116	61	41
51001	Ottawa	Rideau/Wurtemburg St.	8457	5	15	22	29	40	66	23.3	84	57	5
52020	Kingston	133 Dalton St.	8721	3	15	24	32	45	72	24.8	98	68	33
54012	Belleville	2 Sidney St., Water Treatment Plant	8684	8	21	29	36	50	80	29.4	111	73	83
56010	Morrisburg	County Rd. 2, Morrisburg Water Tower	8747	8	19	28	35	46	68	27.8	97	63	15
56051	Cornwall	Bedford/Third St.	8694	8	20	27	34	47	69	27.7	89	64	18
59006	Peterborough	10 Hospital Dr.	8695	12	22	30	38	50	76	31.2	101	69	53
63203	Thunder Bay	421 James St. N.	8430	4	14	22	29	40	55	22.3	69	54	0
71078	Sault Ste Marie	Sault College	8716	13	22	29	36	48	70	30.2	84	67	2
75010	North Bay	Chippawa St., Dept. National Defence	8663	8	19	28	35	47	70	28.0	103	71	17
77219	Sudbury	Ramsey Lake Road	8739	14	23	30	37	49	73	31.0	100	70	22

Notes:
INS indicates there was insufficient data in the 2nd and/or 3rd quarter to calculate a valid annual mean.
CN Tower Site (station 31190) measurements are taken at 444m above ground-level.

Table 3: 2005 Fine Particulate Matter ($PM_{2.5}$) Statistics

Unit: micrograms per cubic meter (µg/m^3)

				PERCENTILES							Maximum		No. of Times Above Reference Level
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	24h
12008	Windsor Downtown	467 University Ave.	8665	1	4	8	12	24	44	10.4	72	48	12
12016	Windsor West	College/South St.	8643	1	4	8	12	24	42	10.5	74	52	9
12059	Essex	360 Fairview Dr. W.	8702	1	4	6	11	22	43	9.3	72	47	9
13001	Chatham	435 Grand Ave. W.	8246	1	3	6	10	22	42	9.1	67	43	9
14064	Sarnia	Front St./CN Tracks, Centennial Park	8683	3	6	9	15	27	52	12.8	114	54	24
15020	Grand Bend	Water Treatment Plant	8411	0	2	4	8	19	40	7.4	69	46	8
15025	London	900 Highbury Ave.	8672	4	6	9	13	24	43	11.9	71	46	13
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plant	8686	1	3	6	9	21	42	8.6	63	45	12
18007	Tiverton	Concession Rd. 2, Lot A	8360	0	1	3	7	18	40	6.6	69	53	7
21005	Brantford	324 Grand River Ave.	8652	1	3	6	10	22	42	8.9	57	40	10
22071	Simcoe	Hwy 3/Blue Line Rd., Experimental Farm	8666	1	3	6	10	22	42	9.1	68	40	13
26060	Kitchener	West Ave./Homewood	8671	1	3	6	11	24	47	9.5	73	48	14
27067	St. Catharines	Argyle Cres., Pump Stn.	8688	0	3	6	10	22	41	8.6	68	44	11
28028	Guelph	Exhibition St./Clark St.	8630	1	3	6	10	22	44	8.8	66	46	11
29000	Hamilton Downtown	Elgin/Kelly	8610	1	4	7	11	24	45	10.0	72	44	15
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8639	1	4	7	11	23	46	9.8	70	47	15
29118	Hamilton West	Main St. W./Hwy 403	8689	1	4	7	11	23	42	9.6	85	40	15
31103	Toronto Downtown	Bay/Wellesley St.	8662	1	3	5	9	21	45	8.5	65	43	14
33003	Toronto East	Kennedy/Lawrence	8692	1	3	5	9	21	45	8.4	64	44	13
34020	Toronto North	Hendon/Yonge St.	8669	0	3	6	10	24	51	9.4	65	51	19
35003	Etobicoke West	Elmcrest Rd., Centennial Park	8699	1	3	6	10	22	44	9.1	64	43	12
35033	Etobicoke South	185 Judson St.	8643	2	4	7	12	24	48	10.4	72	48	20
35125	Toronto West	125 Resources Rd.	8524	2	4	7	11	24	46	10.0	68	49	15
44008	Burlington	Hwy 2/North Shore Blvd. E.	8665	1	3	6	10	22	42	9.1	58	43	11
44017	Oakville	8th Line/Glenashton Dr., Halton Reservoir	8600	1	3	6	10	21	43	8.8	55	42	10
45026	Oshawa	2200 Simcoe St. N., Durham College	8576	1	3	5	9	20	44	8.1	57	44	12
46089	Brampton	525 Main St. N., Peel Manor	8708	1	3	6	10	22	44	8.8	59	48	12
46109	Mississauga	Frank McKechnie Community Center	8636	1	3	6	10	22	45	9.2	78	47	12
47045	Barrie	83 Perry St.	8721	1	3	5	9	20	44	8.1	68	44	9
48006	Newmarket	Eagle St./McCaffrey Rd.	8736	0	2	4	8	20	42	7.7	65	42	12

Table 3: 2005 Fine Particulate Matter ($PM_{2.5}$) Statistics

Unit: micrograms per cubic meter (µg/m^3)

				PERCENTILES							Maximum		No. of Times Above Reference Level
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	24h
49005	Parry Sound	7 Bay St.	8679	0	1	3	6	16	39	6.1	67	50	8
49010	Dorset	Hwy 117/Paint Lake Rd.	8426	0	2	3	6	15	36	5.8	71	43	6
51001	Ottawa	Rideau/Wurtemburg St.	8471	1	2	5	8	18	46	7.7	66	47	10
54012	Belleville	2 Sidney St., Water Treatment Plant	8670	0	2	4	7	18	41	7.0	65	39	8
56010	Morrisburg	County Rd. 2, Morrisburg Water Tower	8697	0	2	4	8	18	43	7.0	59	39	9
56051	Cornwall	Bedford/Third St.	8723	0	2	5	8	19	44	7.6	76	46	10
59006	Peterborough	10 Hospital Dr.	8680	0	2	4	8	19	45	7.5	70	50	13
63203	Thunder Bay	421 James St. N.	7513	0	1	3	5	11	22	INS	54	29	0
71078	Sault Ste Marie	Sault College	8729	0	1	3	6	14	35	5.4	107	46	2
75010	North Bay	Chippawa St., Dept. National Defence	8690	0	1	3	6	14	38	5.6	67	43	5
77219	Sudbury	Ramsey Lake Road	8571	0	1	3	5	13	36	5.0	69	40	5

Notes:

Measurements taken by Tapered Element Oscillating Microbalance (TEOM) sampler operated at 30 degrees Celsius with a Sample Equilibrium System (SES).

The $PM_{2.5}$ reference level is 30 $\mu g/m^3$ for a 24-hour period (based on CWS).

INS indicates there was insufficient data to calculate a valid annual mean for $PM_{2.5}$ which requires 75% valid data per quarter.

Table 4: 2005 Nitric Oxide (NO) Statistics

Unit: parts per billion (ppb)

				PERCENTILES							Maximum	
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h
12008	Windsor Downtown	467 University Ave.	8541	0	1	2	6	20	82	7.8	184	74
12016	Windsor West	College/South St.	8561	0	1	2	6	20	101	8.3	356	73
12059	Essex	360 Fairview Dr. W.	8710	0	0	0	1	5	20	1.7	87	32
13001	Chatham	435 Grand Ave. W.	8586	0	0	1	2	6	27	2.5	132	34
14064	Sarnia	Front St./CN Tracks, Centennial Park	8704	0	1	1	3	8	45	3.8	174	51
15025	London	900 Highbury Ave.	8540	0	1	2	4	10	66	5.5	405	99
21005	Brantford	324 Grand River Ave.	8610	0	1	1	2	8	48	3.8	187	36
26060	Kitchener	West Ave./Homewood	8715	0	0	1	2	8	79	4.4	199	91
27067	St. Catharines	Argyle Cres., Pump Stn.	6910	0	1	1	3	13	76	5.5	202	52
29000	Hamilton Downtown	Elgin/Kelly	8551	0	1	3	7	22	119	9.9	393	168
31103	Toronto Downtown	Bay/Wellesley St.	8664	1	1	3	5	16	77	7.2	222	100
31190	Toronto	CN Tower, 301 Front St. W.	8352	0	0	0	1	3	19	1.4	95	21
33003	Toronto East	Kennedy/Lawrence	8704	2	3	6	12	31	132	14.4	479	146
34020	Toronto North	Hendon/Yonge St.	8585	0	1	3	9	29	104	10.8	340	108
35003	Etobicoke West	Elmcrest Rd., Centennial Park	8617	0	1	2	7	31	152	12.2	387	138
35033	Etobicoke South	185 Judson St.	8525	2	5	10	20	60	189	23.3	423	164
35125	Toronto West	125 Resources Rd.	8709	1	4	11	25	68	208	26.1	414	156
44008	Burlington	Hwy 2/North Shore Blvd. E.	8585	1	2	4	8	26	160	12.3	392	168
44017	Oakville	8th Line/Glenashton Dr., Halton Reservoir	8607	0	1	1	3	11	73	5.2	188	60
45026	Oshawa	2200 Simcoe St. N., Durham College	4901	1	1	2	3	9	34	INS	113	20
46089	Brampton	525 Main St. N., Peel Manor	8747	0	1	3	5	20	115	8.9	339	113
47045	Barrie	83 Perry St.	8517	1	1	2	3	12	105	7.1	409	79
48006	Newmarket	Eagle St./McCaffrey Rd.	8155	0	0	1	1	6	60	3.5	254	66
51001	Ottawa	Rideau/Wurtemburg St.	8009	0	0	0	2	8	50	3.2	149	47
54012	Belleville	2 Sidney St., Water Treatment Plant	8563	1	1	2	3	8	59	4.5	192	77
71078	Sault Ste Marie	Sault College	6132	0	0	1	2	3	13	INS	112	9
75010	North Bay	Chippawa St., Dept. National Defence	8677	0	0	1	2	8	55	3.7	129	32

Notes:

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

CN Tower Site (station 31190) measurements are taken at 444m above ground-level.

Table 5: 2005 Nitrogen Dioxide (NO_2) Statistics

Unit: parts per billion (ppb)
NO_2 1-hour AAQC is 200 ppb
NO_2 24-hour AAQC is 100 ppb

				PERCENTILES							Maximum		No. of Times Above Criteria	
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h	24h
12008	Windsor Downtown	467 University Ave.	8541	5	9	14	21	33	50	16.9	66	53	0	0
12016	Windsor West	College/South St.	8561	4	9	15	22	33	51	17.1	71	58	0	0
12059	Essex	360 Fairview Dr. W.	8710	2	3	5	8	15	30	7.1	51	39	0	0
13001	Chatham	435 Grand Ave. W.	8586	3	6	9	13	22	40	11.0	69	48	0	0
14064	Sarnia	Front St./CN Tracks, Centennial Park	8704	3	6	10	16	25	45	12.7	76	50	0	0
15025	London	900 Highbury Ave.	8540	4	8	11	17	28	49	14.1	69	51	0	0
21005	Brantford	324 Grand River Ave.	8610	3	5	7	11	21	39	10.0	57	37	0	0
26060	Kitchener	West Ave./Homewood	8715	4	6	9	14	27	51	12.9	68	50	0	0
27067	St. Catharines	Argyle Cres., Pump Stn.	6910	4	7	10	16	27	44	13.1	62	34	0	0
29000	Hamilton Downtown	Elgin/Kelly	8551	7	12	16	23	36	55	19.3	77	63	0	0
31103	Toronto Downtown	Bay/Wellesley St.	8664	8	13	18	25	37	55	20.6	75	60	0	0
31190	Toronto	CN Tower, 301 Front St. W.	8352	1	3	5	8	14	30	6.6	60	26	0	0
33003	Toronto East	Kennedy/Lawrence	8704	6	12	17	24	37	58	20.1	104	65	0	0
34020	Toronto North	Hendon/Yonge St.	8585	5	10	17	25	37	55	19.2	89	58	0	0
35003	Etobicoke West	Elmcrest Rd., Centennial Park	8617	5	9	15	23	38	60	18.6	94	57	0	0
35033	Etobicoke South	185 Judson St.	8525	11	18	24	33	49	70	27.6	99	68	0	0
35125	Toronto West	125 Resources Rd.	8705	10	18	25	32	45	65	26.6	88	65	0	0
44008	Burlington	Hwy 2/North Shore Blvd. E.	8585	4	10	15	21	33	55	17.2	67	56	0	0
44017	Oakville	8th Line/Glenashton Dr., Halton Reservoir	8607	4	7	11	17	29	50	14.5	67	47	0	0
45026	Oshawa	2200 Simcoe St. N., Durham College	4901	2	5	7	10	14	25	INS	46	19	0	0
46089	Brampton	525 Main St. N., Peel Manor	8747	5	8	13	21	36	58	16.9	89	54	0	0
47045	Barrie	83 Perry St.	8517	4	7	10	15	29	55	13.8	85	56	0	0
48006	Newmarket	Eagle St./McCaffrey Rd.	8155	2	3	5	9	19	45	8.5	73	47	0	0
51001	Ottawa	Rideau/Wurtemburg St.	8009	1	4	7	12	22	44	9.8	60	47	0	0
54012	Belleville	2 Sidney St., Water Treatment Plant	8563	2	3	5	8	18	42	8.2	57	38	0	0
71078	Sault Ste Marie	Sault College	6132	0	1	2	5	10	21	INS	38	14	0	0
75010	North Bay	Chippawa St., Dept. National Defence	8677	0	1	3	7	19	41	6.7	56	29	0	0

Notes:
INS indicates there was insufficient data to calculate a valid annual mean.
CN Tower Site (station 31190) measurements are taken at 444m above ground-level.

Table 6: 2005 Nitrogen Oxides (NO_x) Statistics

Unit: parts per billion (ppb)

				PERCENTILES							Maximum	
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h
12008	Windsor Downtown	467 University Ave.	8541	6	11	17	28	52	125	24.9	225	128
12016	Windsor West	College/South St.	8561	6	11	18	27	52	142	25.6	422	132
12059	Essex	360 Fairview Dr. W.	8710	2	4	6	10	20	46	9.3	130	72
13001	Chatham	435 Grand Ave. W.	8586	4	7	10	15	27	63	13.5	194	82
14064	Sarnia	Front St./CN Tracks, Centennial Park	8704	4	8	12	19	33	87	16.8	233	97
15025	London	900 Highbury Ave.	8540	5	9	13	20	37	107	19.4	472	134
21005	Brantford	324 Grand River Ave.	8610	4	6	9	14	28	81	13.7	236	72
26060	Kitchener	West Ave./Homewood	8715	5	7	11	17	34	122	17.4	260	141
27067	St. Catharines	Argyle Cres., Pump Stn.	6910	5	8	12	19	40	106	18.8	247	85
29000	Hamilton Downtown	Elgin/Kelly	8551	10	15	21	30	58	165	30.0	470	233
31103	Toronto Downtown	Bay/Wellesley St.	8664	10	16	22	30	52	127	28.2	293	161
31190	Toronto	CN Tower, 301 Front St. W.	8352	1	3	5	8	16	47	7.5	152	43
33003	Toronto East	Kennedy/Lawrence	8704	9	17	25	37	67	181	34.7	574	212
34020	Toronto North	Hendon/Yonge St.	8585	6	13	22	34	63	152	30.4	427	160
35003	Etobicoke West	Elmcrest Rd., Centennial Park	8617	6	12	19	30	66	203	31.0	480	195
35033	Etobicoke South	185 Judson St.	8525	13	23	34	53	106	246	49.9	509	224
35125	Toronto West	125 Resources Rd.	8705	12	24	38	56	109	258	52.4	486	215
44008	Burlington	Hwy 2/North Shore Blvd. E.	8585	5	12	19	30	59	212	29.3	456	217
44017	Oakville	8th Line/Glenashton Dr., Halton Reservoir	8607	5	8	12	20	40	116	19.5	246	106
45026	Oshawa	2200 Simcoe St. N., Durham College	4901	3	7	10	14	23	52	INS	139	34
46089	Brampton	525 Main St. N., Peel Manor	8747	6	10	16	26	56	164	25.9	428	164
47045	Barrie	83 Perry St.	8517	5	9	12	19	42	150	20.9	493	127
48006	Newmarket	Eagle St./McCaffrey Rd.	8155	2	4	7	11	25	103	12.2	324	110
51001	Ottawa	Rideau/Wurtemburg St.	8009	2	5	8	14	30	90	13.7	202	95
54012	Belleville	2 Sidney St., Water Treatment Plant	8563	3	5	7	11	26	95	12.6	243	114
71078	Sault Ste Marie	Sault College	6132	1	2	3	6	13	30	INS	131	21
75010	North Bay	Chippawa St., Dept. National Defence	8677	1	3	5	10	28	94	11.2	177	58

Notes:

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

CN Tower Site (station 31190) measurements are taken at 444m above ground-level.

Table 7: 2005 Carbon Monoxide (CO) Statistics

Unit: parts per million (ppm)
CO 1-hour AAQC is 30 ppm
CO 8-hour AAQC is 13 ppm

				PERCENTILES							Maximum		No. of Times Above Criteria	
ID	**City**	**Location**	**Valid h**	**10%**	**30%**	**50%**	**70%**	**90%**	**99%**	**Mean**	**1h**	**8h**	**1h**	**8h**
12008	Windsor Downtown	467 University Ave.	7867	0.04	0.11	0.16	0.22	0.38	0.80	0.19	1.33	1.12	0	0
13001	Chatham	435 Grand Ave. W.	8434	0.08	0.14	0.18	0.23	0.32	0.54	0.19	1.39	0.78	0	0
15025	London	900 Highbury Ave.	8663	0.02	0.09	0.14	0.20	0.32	0.67	0.17	2.40	1.24	0	0
29000	Hamilton Downtown	Elgin/Kelly	7786	0.11	0.19	0.26	0.35	0.56	1.03	0.30	2.58	1.45	0	0
31103	Toronto Downtown	Bay/Wellesley St.	8058	0.09	0.19	0.31	0.41	0.55	0.88	0.32	1.59	1.15	0	0
35033	Etobicoke South	185 Judson St.	4471	0.12	0.19	0.25	0.31	0.44	0.82	INS	1.83	1.04	0	0
35125	Toronto West	125 Resources Rd.	8684	0.16	0.25	0.32	0.42	0.63	1.41	0.38	2.65	1.66	0	0
51001	Ottawa	Rideau/Wurtemburg St.	8627	0.17	0.33	0.44	0.53	0.69	0.97	0.44	1.99	1.48	0	0
71078	Sault Ste Marie	Sault College	8406	0.16	0.26	0.33	0.41	0.54	0.85	0.35	2.07	1.23	0	0

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

Table 8: 2005 Sulphur Dioxide (SO_2) Statistics

Unit: parts per billion (ppb)
SO_2 1-hour AAQC is 250 ppb
SO_2 24-hour AAQC is 100 ppb
SO_2 1-year AAQC is 20 ppb

				PERCENTILES							Maximum		No. of Times Above Criteria		
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h	24h	1y
12008	Windsor Downtown	467 University Ave.	8387	0	1	2	5	13	37	4.9	127	20	0	0	0
12016	Windsor West	College/South St.	8584	0	1	2	5	14	35	5.1	98	22	0	0	0
12059	Essex	360 Fairview Dr. W.	8695	0	0	1	3	7	23	2.9	72	29	0	0	0
13001	Chatham	435 Grand Ave. W.	8594	1	1	2	3	7	17	3.0	40	17	0	0	0
14064	Sarnia	Front St./CN Tracks, Centennial Park	8709	0	0	2	4	20	105	7.8	231	73	0	0	0
15025	London	900 Highbury Ave.	8699	0	1	1	3	5	11	2.3	31	10	0	0	0
21005	Brantford	324 Grand River Ave.	8717	0	1	1	3	6	14	2.4	32	10	0	0	0
29000	Hamilton Downtown	Elgin/Kelly	8494	0	1	2	5	14	41	5.3	93	25	0	0	0
31103	Toronto Downtown	Bay/Wellesley St.	8668	1	1	2	3	6	12	2.8	48	11	0	0	0
35125	Toronto West	125 Resources Rd.	8721	0	1	1	2	5	13	2.3	54	12	0	0	0
44008	Burlington	Hwy 2/North Shore Blvd. E.	8605	0	1	1	2	5	14	2.3	52	14	0	0	0
44017	Oakville	8th Line/Glenashton Dr., Halton Reservoir	8597	0	1	1	2	6	16	2.5	46	14	0	0	0
46089	Brampton	525 Main St. N., Peel Manor	8746	0	0	1	2	5	12	1.9	69	10	0	0	0
46109	Mississauga	Frank McKechnie Community Center	8739	1	1	2	2	5	12	2.6	66	9	0	0	0
47045	Barrie	83 Perry St.	8733	0	1	1	2	3	8	1.5	31	8	0	0	0
51001	Ottawa	Rideau/Wurtemburg St.	8665	0	0	1	2	4	12	1.5	70	13	0	0	0
54012	Belleville	2 Sidney St., Water Treatment Plant	8001	0	0	1	1	3	7	1.1	28	6	0	0	0
71078	Sault Ste Marie	Sault College	8442	0	0	1	1	3	18	1.5	73	17	0	0	0
77219	Sudbury	Ramsey Lake Road	8717	0	0	1	1	4	46	2.8	253	31	1	0	0

Table 9: 2005 Total Reduced Sulphur (TRS) Compounds Statistics

Unit: parts per billion (ppb)
TRS 1-hour AAQC is 27 ppb

				PERCENTILES							Maximum		No. of Times Above Criterion
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h	1h
12016	Windsor West	College/South St.	8342	0	0	0	1	1	4	0.4	20	3	0
14064	Sarnia	Front St./CN Tracks, Centennial Park	8705	0	0	0	0	0	1	0.1	10	1	0
29000	Hamilton Downtown	Elgin/Kelly	7416	0	0	0	1	1	4	0.5	17	3	0
71078	Sault Ste Marie	Sault College	8407	0	0	0	0	0	1	0.1	3	1	0

Table 10: 10-Year Trend for O_3

Annual Mean (ppb)

ID	City	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
12008	Windsor Downtown	20.3	20.7	21.4	21.7	18.6	20.5	21.9	22.9	20.2	26.0
12016	Windsor West	20.8	17.9	18.7	18.9	17.0	19.0	20.2	22.8	22.6	25.6
14064	Sarnia	25.2	24.5	26.1	26.5	24.3	25.6	26.5	24.7	23.8	27.4
15020	Grand Bend	31.9	31.2	31.2	32.5	32.6	31.6	29.8	30.7	25.8	32.5
15025	London	23.1	22.8	25.1	25.8	21.1	24.2	25.3	26.9	23.6	26.1
18007	Tiverton	32.0	32.5	32.2	INS	32.3	34.7	34.7	33.2	28.1	31.8
22071	Simcoe	29.9	28.6	31.1	31.3	n/a	31.0	33.5	33.9	30.5	33.6
26060	Kitchener	23.8	23.4	25.4	25.2	23.0	25.7	27.3	28.1	24.8	28.0
27067	St. Catharines	20.3	20.9	20.8	21.7	18.9	21.2	24.1	25.3	23.6	26.3
29000	Hamilton Downtown	17.3	18.1	19.1	19.5	17.0	18.8	20.4	21.7	20.1	23.2
29114	Hamilton Mountain	20.8	22.2	24.1	24.1	22.6	24.2	27.7	28.4	24.6	28.2
29118	Hamilton West	17.3	18.6	19.3	20.0	16.9	18.6	20.5	22.0	19.2	21.2
31103	Toronto Downtown	12.2	INS	17.8	20.2	19.7	22.0	24.0	23.6	22.8	24.5
31190	Toronto	n/a	37.3	INS	40.3	34.2	37.2	37.4	36.9	36.0	39.1
33003	Toronto East	18.9	18.0	20.6	21.5	19.6	21.7	21.0	21.8	19.9	22.4
34020	Toronto North	16.4	21.6	22.0	22.8	20.6	23.4	25.1	23.6	22.5	24.5
35033	Etobicoke South	17.0	17.2	18.4	21.5	17.4	19.9	20.2	19.2	18.9	21.1
44008	Burlington	22.4	21.7	22.5	26.2	23.4	24.6	26.3	22.8	21.0	23.9
44017	Oakville	21.1	20.8	21.8	22.4	21.0	22.9	25.1	INS	24.6	27.7
45026	Oshawa	21.9	23.2	23.1	25.0	21.2	23.4	23.2	24.1	23.3	28.6
46109	Mississauga	19.3	20.0	20.8	22.2	19.9	22.4	23.1	24.8	20.7	23.1
48002	Stouffville	26.4	30.1	31.4	31.2	27.5	30.5	30.6	29.4	27.3	26.3
49010	Dorset	28.6	30.9	30.6	31.0	29.3	31.0	32.4	30.1	28.8	32.3
51001	Ottawa	18.9	20.5	19.1	21.2	19.9	25.0	24.9	24.7	21.7	23.3
52020	Kingston	21.0	20.1	21.5	21.5	19.1	20.7	23.0	24.0	22.5	24.8
56051	Cornwall	20.9	22.8	24.2	25.8	24.0	29.0	24.8	25.9	23.8	27.7
59006	Peterborough	26.0	INS	INS	31.4	28.1	30.7	30.5	29.7	27.1	31.2
63203	Thunder Bay	21.0	23.9	21.5	22.5	22.6	24.4	23.4	26.1	22.0	22.3
71078	Sault Ste. Marie	22.8	24.9	22.3	24.1	24.8	25.2	24.2	26.8	27.0	30.2
75010	North Bay	25.4	26.6	27.4	29.1	22.1	26.6	26.8	27.0	25.2	28.0
77219	Sudbury	28.1	28.0	29.1	30.7	26.1	29.1	29.2	28.5	27.7	31.0

Notes:
n/a indicates pollutant not monitored.
INS indicates there was insufficient data in the 2^{nd} and/or 3^{rd} quarter to calculate a valid annual mean.
CN Tower Site (Station 31190) measurements taken at 444 m above ground-level.
Station 31103 was relocated in 1996 and represented by station 31303.
Station 35033 was relocated in 2001.
Station 44017 replaced station 44015 as the Oakville site in 2003.
Station 45026 replaced station 45025 as the Oshawa site in 2005.
Station 46109 replaced station 46110 as the Mississauga site in 2004.
Station 63203 replaced station 63200 as the Thunder Bay site in 2004.
Station 71078 replaced station 71068 as the Sault Ste. Marie site in 2004.
Station 77219 replaced station 77203 as the Sudbury site in 2004.

Table 11: 10-Year Trend for NO

Annual mean (ppb)

ID	City	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
12008	Windsor Downtown	15.7	15.9	16.3	13.3	13.9	11.0	10.9	INS	10.5	7.8
14064	Sarnia	6.6	7.0	6.9	7.1	8.9	6.7	7.1	5.0	3.7	3.8
26060	Kitchener	7.4	5.5	6.9	6.6	7.4	5.7	3.8	INS	4.9	4.4
29000	Hamilton Downtown	15.4	10.8	12.6	12.0	14.7	11.5	10.4	11.7	9.6	9.9
29118	Hamilton West	25.1	22.1	28.3	23.4	22.6	18.5	16.0	17.2	n/a	n/a
31103	Toronto Downtown	41.9	INS	24.3	15.8	14.4	10.0	8.2	8.7	7.6	7.2
33003	Toronto East	23.2	24.9	23.2	20.7	23.0	17.9	16.1	17.0	16.0	14.4
34020	Toronto North	17.4	16.3	16.5	16.5	16.8	14.3	12.4	12.4	INS	10.8
35033	Etobicoke South	39.4	33.8	29.8	27.1	34.6	25.0	23.3	26.7	24.5	23.3
44008	Burlington	11.7	12.2	14.1	22.6	21.8	13.2	11.8	15.5	11.1	12.3
45026	Oshawa	15.2	16.4	15.6	15.1	14.2	13.7	10.0	9.3	8.2	INS

Notes:
n/a indicates pollutant not monitored.
INS indicates there was insufficient data to calculate a valid annual mean.
Station 31103 was relocated in 1996 and represented by station 31303.
Station 35033 was relocated in 2001.
Station 45026 replaced station 45025 as the Oshawa site in 2005.

Table 12: 10-Year Trend for NO_2

Annual Mean (ppb)

ID	City	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
12008	Windsor Downtown	25.5	23.8	23.8	22.9	21.6	19.4	19.1	INS	18.3	16.9
14064	Sarnia	16.4	16.9	18.0	16.7	16.3	16.8	17.5	13.0	11.7	12.7
26060	Kitchener	12.9	13.7	16.5	14.0	14.7	14.1	11.9	INS	13.1	12.9
29000	Hamilton Downtown	21.6	18.6	22.4	21.6	21.8	22.5	20.9	21.3	16.8	19.3
29118	Hamilton West	19.7	19.5	23.4	21.8	21.0	19.5	19.0	18.0	n/a	n/a
31103	Toronto Downtown	33.9	INS	27.7	26.9	26.8	27.1	23.3	23.1	20.1	20.6
33003	Toronto East	22.9	23.4	25.5	24.6	23.7	22.9	22.0	21.3	19.8	20.1
34020	Toronto North	21.9	20.2	23.4	24.3	22.7	22.0	21.0	20.3	17.3	19.2
35033	Etobicoke South	31.6	29.2	29.7	28.4	28.2	26.1	26.1	26.6	26.1	27.6
44008	Burlington	10.6	13.2	16.6	22.9	20.3	16.5	17.9	17.3	15.3	17.2
45026	Oshawa	19.3	18.6	20.0	21.5	19.7	19.0	17.2	16.2	14.2	INS

Notes:
n/a indicates pollutant not monitored.
INS indicates there was insufficient data to calculate a valid annual mean.
Station 31103 was relocated in 1996 and represented by station 31303.
Station 35033 was relocated in 2001.
Station 45026 replaced station 45025 as the Oshawa site in 2005.

Table 13: 10-Year Trend for NO_x

Annual Mean (ppb)

ID	City	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
12008	Windsor Downtown	39.1	39.3	38.5	37.0	36.0	30.5	29.2	INS	29.3	24.9
14064	Sarnia	23.5	24.9	25.1	23.5	25.0	23.6	24.6	18.1	15.7	16.8
26060	Kitchener	28.5	19.2	23.9	20.5	21.9	19.5	15.5	INS	18.2	17.4
29000	Hamilton Downtown	25.5	29.5	34.7	34.0	37.0	34.4	31.4	33.3	27.7	30.0
29118	Hamilton West	44.0	42.1	52.1	45.1	43.5	38.4	35.3	35.3	n/a	n/a
31103	Toronto Downtown	45.4	INS	51.6	41.9	40.4	36.6	31.5	32.1	28.1	28.2
33003	Toronto East	38.9	47.5	48.3	44.9	46.3	40.3	37.7	37.9	36.3	34.7
34020	Toronto North	47.2	36.7	39.9	40.7	39.3	36.2	33.4	33.0	28.3	30.4
35033	Etobicoke South	47.4	62.1	59.9	56.6	63.1	51.0	49.3	53.1	49.4	49.9
44008	Burlington	33.2	25.6	30.7	45.4	42.2	29.0	28.4	32.5	26.1	29.3
45026	Oshawa	34.5	34.9	35.1	35.8	33.6	32.6	27.2	25.5	22.5	INS

Notes:
n/a indicates pollutant not monitored.
INS indicates there was insufficient data to calculate a valid annual mean.
Station 31103 was relocated in 1996 and represented by station 31303.
Station 35033 was relocated in 2001.
Station 45026 replaced station 45025 as the Oshawa site in 2005.

Table 14: 10-Year Trend for CO

Annual Mean (ppm)

ID	City	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
12008	Windsor Downtown	0.8	0.6	0.7	0.6	0.3	0.3	0.5	INS	0.5	0.2
26060	Kitchener	0.4	0.2	0.3	0.4	0.4	0.4	0.3	0.6	n/a	n/a
29000	Hamilton Downtown	1.0	0.7	1.1	0.8	0.8	0.7	INS	INS	0.4	0.3
29118	Hamilton West	0.8	0.6	0.6	0.6	0.5	0.4	0.5	0.6	n/a	n/a
35033	Etobicoke South	1.1	1.1	0.9	1.3	1.7	0.9	0.9	0.6	n/a	INS
44008	Burlington	0.5	0.4	0.3	0.7	1.4	0.5	0.8	0.4	0.4	n/a
44017	Oakville	0.7	0.3	0.2	0.2	0.4	0.4	0.6	INS	0.5	n/a
51001	Ottawa	0.7	0.4	1.1	0.8	0.7	0.6	0.7	0.6	0.5	0.4
63203	Thunder Bay	0.2	0.3	0.1	0.5	0.8	0.7	0.5	0.5	INS	n/a

Notes:
n/a indicates pollutant not monitored.
INS indicates there was insufficient data to calculate a valid annual mean.
Station 35033 was relocated in 2001.
Station 44017 replaced station 44015 as the Oakville site in 2003.
Station 63203 replaced station 63200 as the Thunder Bay site in 2004.

Table 15: 10-Year Trend for SO_2

Annual Mean (ppb)
SO_2 1-year AAQC is 20 ppb

ID	City	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
12008	Windsor Downtown	9.8	6.7	7.4	6.7	6.2	6.1	5.7	5.9	4.8	4.9
12016	Windsor West	9.1	12.5	12.0	9.6	8.8	9.3	7.9	6.3	4.6	5.1
14064	Sarnia	7.4	8.7	10.3	11.8	10.4	12.5	10.4	7.1	8.2	7.8
15025	London	2.7	2.5	3.2	4.9	3.5	3.5	2.2	INS	2.2	2.3
29000	Hamilton Downtown	6.6	5.8	6.3	6.6	5.1	6.0	4.9	5.0	4.0	5.3
44008	Burlington	4.3	5.1	3.2	4.9	5.2	4.9	5.9	2.5	2.4	2.3
44017	Oakville	5.1	4.8	5.1	4.0	4.8	3.7	4.3	INS	2.8	2.5
51001	Ottawa	4.8	6.3	3.4	4.2	4.1	2.3	2.9	INS	1.0	1.5
71078	Sault Ste. Marie	2.2	2.1	1.9	1.9	2.0	2.0	1.7	2.0	0.9	1.5
77219	Sudbury	4.6	3.5	5.2	3.0	4.2	2.6	3.1	2.0	INS	2.8

Notes:
INS indicates there was insufficient data to calculate a valid annual mean.
Station 44017 replaced station 44015 as the Oakville site in 2003.
Station 63203 replaced station 63200 as the Thunder Bay site in 2004.
Station 71078 replaced station 71068 as the Sault Ste. Marie site in 2004.
Station 77219 replaced station 77203 as the Sudbury site in 2004.

Map 1: Locations of Ambient Air Monitoring Stations in Ontario (2005)