Air Quality in Ontario

2007 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 to the province of Ontario.

PIBS 6930e

2007 Report Findings

- The 2007 air quality report marks 37 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 37 years, especially for nitrogen dioxide (NO_2), carbon monoxide (CO) and sulphur dioxide (SO_2). However, ozone (O_3) and fine particulate matter ($PM_{2.5}$), both major components of smog, continue to exceed the ambient air quality criteria and Canada-wide Standards (CWS) and thus, remain the pollutants of most concern.

- There were 13 smog advisories covering 39 days issued in 2007. In contrast to the low number of smog advisories in 2006 (6 smog advisories covering 17 days), the year 2007 was the second highest since $PM_{2.5}$ was included in the Smog Alert Program in 2002.

- Analysis of smog and weather data strongly indicates that the U.S. Midwest and Ohio Valley Region of the U.S. continue to be significant contributors to elevated O_3 and $PM_{2.5}$ concentrations in southern Ontario during the smog season.

- The provincial ambient air quality criteria (AAQC) for NO_2 and CO were not exceeded at any of the air monitoring sites in 2007. The one-hour AAQC for SO_2 was exceeded at the Sudbury site for one hour; however, the 24-hour criterion for SO_2 was not exceeded.

- In 2007, Ontario's AAQC for ozone was exceeded at 38 of the 40 air monitoring sites on at least one occasion. Sault Ste. Marie and Thunder Bay were the only sites that did not record any hours of ozone above the one-hour AAQC of 80 parts per billion (ppb).

- All but one of the 20 designated CWS reporting sites recorded 8-hour ozone averages above the CWS of 65 ppb for ozone in 2007. The one exception was Thunder Bay where the CWS calculated ozone value was 57 ppb.

- Two of the 20 designated CWS reporting sites in 2007 recorded 24-hour $PM_{2.5}$ averages above the CWS of 30 micrograms per cubic metre ($\mu g/m^3$).

- A comparison of air quality at 40 cities world-wide was conducted for 2007. Overall, the air quality of the three Ontario cities, Windsor, Toronto and Ottawa, was generally better than the other cities used in this analysis for the parameters compared.

- The Border Air Quality Study, conducted in the summer of 2007, confirmed air parcels containing elevated pollutant levels were most likely brought into Ontario from the U.S. during the study period.

- The Ottawa Study, a 15-month project (September 2007 to December 2008), is underway and the ministry continues to provide technical support, including provision of air quality data from the two AQI sites, Ottawa Downtown and Ottawa Central. Also, the ministry has provided temporary AQI sites at Glen Cairn and Orleans using two mobile air monitoring units.

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Chapter 1

Overview

Air pollution is of concern to many people who live in Ontario. Although the average levels for many air pollutants in Ontario have decreased over the last several decades, smog remains an important issue, especially in southern Ontario. 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, for example, soils and vegetation.

Many pollutants, including those that are associated with smog (ozone and fine particulate matter) remain in the atmosphere for significant 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 communities far removed from their original sources.

The release of pollutants into the atmosphere and removal of pollutants from the atmosphere are ongoing processes. Pollutant levels are

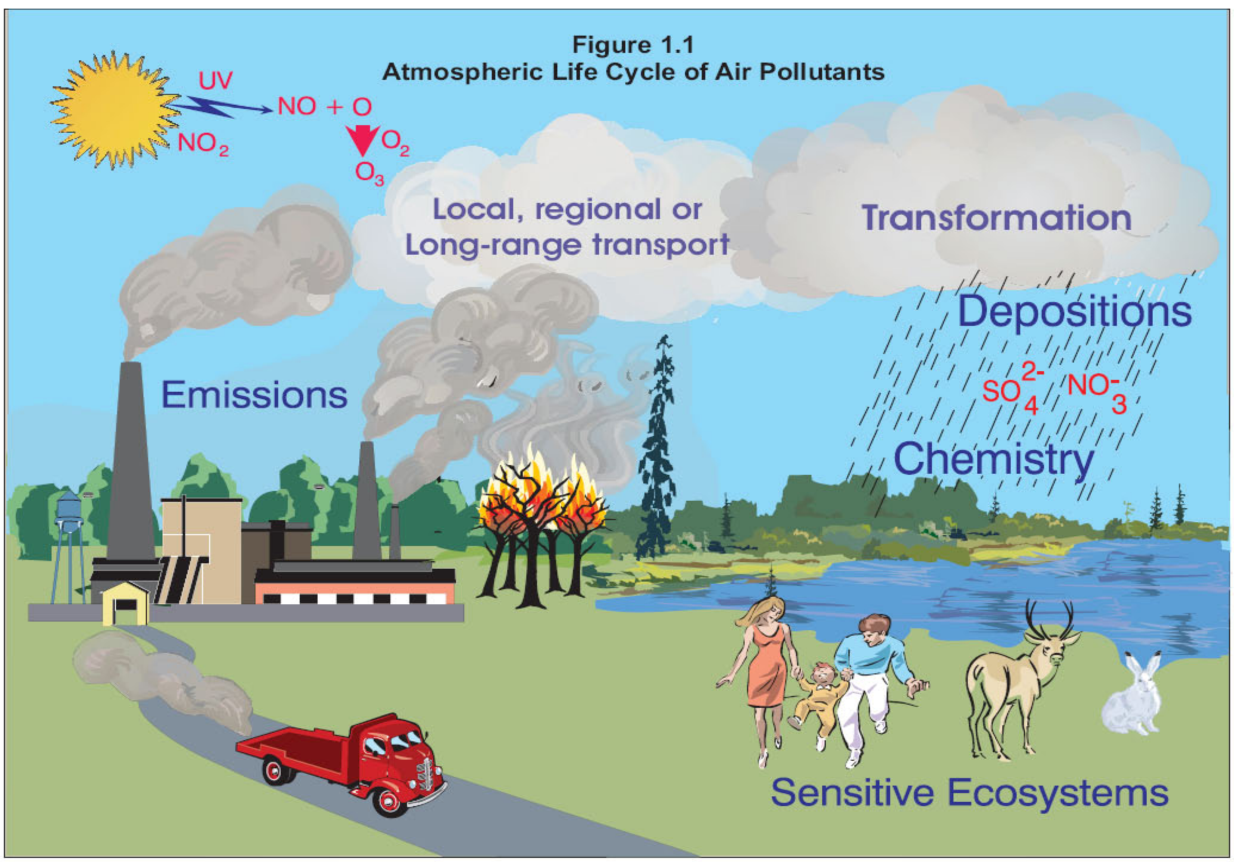


Figure 1.1
Atmospheric Life Cycle of Air Pollutants

affected by the amount emitted, sunlight, moisture, clouds, winds, precipitation, geography, and regional and local weather conditions.

This report focuses on ambient air quality based on measurements of key criteria pollutants in order to assess the state of air quality in the province of Ontario during 2007 and over the last several decades.

The Ontario Ministry of the Environment operates 40 Air Quality Index (AQI) monitoring sites across the province. The data, which are collected continuously at these sites, 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 effectiveness of ministry policies and programs. Ambient air monitoring provides information on the ambient concentrations of selected pollutants in communities across Ontario. Table 1.1 shows the relationship between monitored air pollutants and current air issues.

The Ministry of the Environment continues to monitor air quality across Ontario and uses this information to:

- ❖ inform the public about Ontario's air quality;
- ❖ assess Ontario's air quality and evaluate long-term trends;
- ❖ identify areas where criteria and standards are exceeded;
- ❖ provide the basis for air policy/program development;
- ❖ provide quantitative measurements to enable abatement of specific sources;
- ❖ determine the contribution from U.S. sources and other provinces on Ontario's air quality;
- ❖ provide scientists with air quality data to link environmental and human health effects to pollution levels; and
- ❖ provide smog advisories for public health protection.

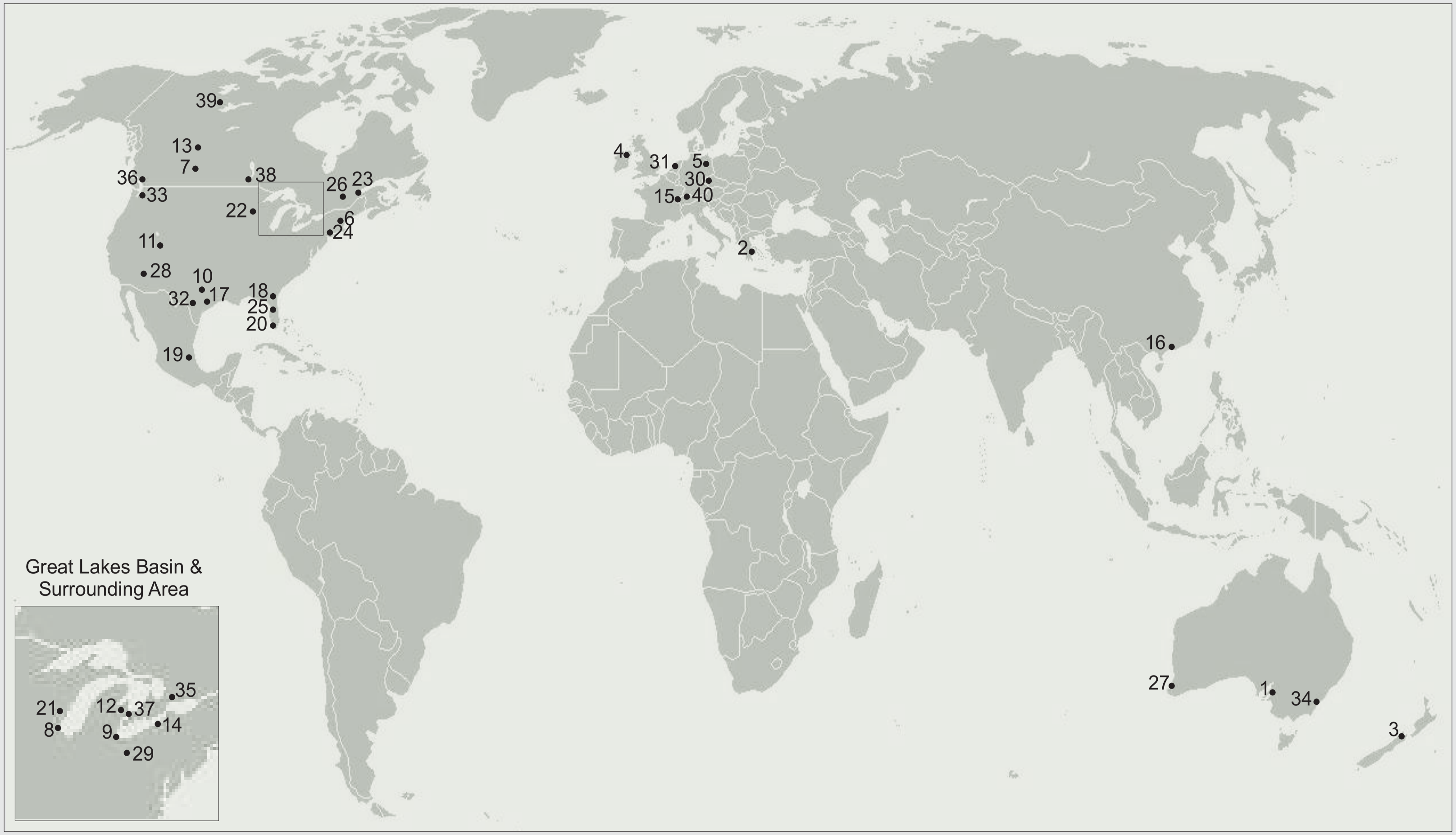
This annual report, the 37th in a series, summarizes the state of ambient air quality in Ontario during 2007 and examines trends over time. It covers the measured levels of six common contaminants: ozone (O_3), fine particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur dioxide (SO_2) and total reduced sulphur (TRS) compounds.

Air pollutant concentrations from selected Ontario cities have been compared to the information available in other cities from around the world (see Figures 2.9, 3.7, 4.3, 4.6, and 4.10). The cities included in this comparative study are depicted in Figure 1.2. City populations, a factor in ambient pollution levels, ranged from approximately 19,000 (Yellowknife, Canada) to 17,000,000 (Mexico

Table 1.1: Linkages between Air Pollutants and Current Air Issues

Pollutant	Smog	Climate Change	Acid Deposition	Odour	Visibility/ Soiling
Ozone	Yes	Yes	Yes	No	No
Sulphur Dioxide	Yes	Yes	Yes	Yes	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

Figure 1.2
Selected Cities Around the World Used for 2007 Air Quality Comparison



1. Adelaide, AUS; 2. Athens, GRE; 3. Auckland, NZL; 4. Belfast, IRL; 5. Berlin, GER; 6. Boston, USA; 7. Calgary, CAN; 8. Chicago, USA; 9. Cleveland, USA; 10. Dallas, USA; 11. Denver, USA; 12. Detroit, USA; 13. Edmonton, CAN; 14. Erie, USA; 15. Geneva, SUI; 16. Hong Kong, CHN; 17. Houston, USA; 18. Jacksonville, USA; 19. Mexico City, MEX; 20. Miami, USA; 21. Milwaukee, USA; 22. Minneapolis-St. Paul, USA; 23. Montreal, CAN; 24. New York City, USA; 25. Orlando, USA; 26. Ottawa, CAN; 27. Perth, AUS; 28. Phoenix, USA; 29. Pittsburgh, USA; 30. Prague, CZE; 31. Rotterdam, NED; 32. San Antonio, USA; 33. Seattle, USA; 34. Sydney, AUS; 35. Toronto, CAN; 36. Vancouver, CAN; 37. Windsor, CAN; 38. Winnipeg, CAN; 39. Yellowknife, CAN; 40. Zurich, SUI.

City, Mexico). 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. Furthermore, air quality standards for the chosen criteria pollutants in this study may vary from country to country. 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 and special studies of air quality that were undertaken in 2007: the Border Air Quality Study, and the Ottawa Study.

The main focus of the 2007 publication is to report on the state of Ontario's ambient air quality from the analysis of data recorded at the 40 AQI sites. The annual statistics and 10- and 20-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 40 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.

Reduce Smog, Reduce the Risk

Whenever we burn fuel, we create the pollutants necessary to form smog. We burn oil and gas to power our cars and to heat and cool our homes. It is important to remember that much of Ontario's electricity is generated by burning fossil fuels, so reducing your energy consumption helps prevent smog.

How can I protect my kids?

If a smog advisory is issued in your community:

- While exercise is important for your kids, reduce outdoor activity levels by choosing less vigorous activities when smog levels are high.
- Avoid or reduce exercising near areas of heavy traffic because motor vehicles are a primary source of air pollution.
- If your child suffers from asthma or other respiratory or cardiac illness, it is essential that you speak to your physician about how to best manage their condition.
- Make sure your child's teachers, coaches and camp directors are aware of the health risks of air pollution, and have policies in place to protect the kids when air quality is unhealthy.

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, generally between noon and early evening.

The diurnal variation of ozone and its relationship with NO_x are displayed in Figure 2.1. The increase in NO_x concentrations, measured as nitric oxide (NO) and nitrogen dioxide (NO_2), during the morning rush-hour is mainly the result of vehicular traffic; however, the ozone concentrations can decrease over the same period due to the scavenging effect of NO. By the late morning, ground-level ozone starts to be produced as a result of chemical reactions of VOCs and NO_x in the presence of sunlight. Ozone concentrations continue to increase and peak by mid- to late afternoon when the sunlight is still relatively intense. As the sun goes down, ozone concentrations typically decrease.

Figure 2.2 shows the 2006 estimates of Ontario's VOC emissions from point, area and transportation sources. Transportation sectors accounted for approximately 38 per cent of VOC emissions. Printing/surface coating and general solvent use were the second and third largest sources of VOC emissions, accounting for approximately 19 per cent and 18 per cent, respectively.

Figure 2.3 shows the 2006 estimates of Ontario's NO_x emissions from point, area and transportation sources. Transportation sectors accounted for approximately two-thirds or 68 per cent of NO_x emissions. Other industrial processes were the second largest source of NO_x emissions, accounting for approximately 11 per cent.

Spare the Air Tips!

- Reduce energy use in your home.
- Turn off your lights when you do not need them.
- Learn more about alternative energy resources.
- Don't use oil-based products such as paints, solvents or cleaners if you can avoid them. They contain volatile organic compounds (VOCs), which contribute to smog.

Figure 2.1
Diurnal Variation of Ozone and Its Relationship with NO_x

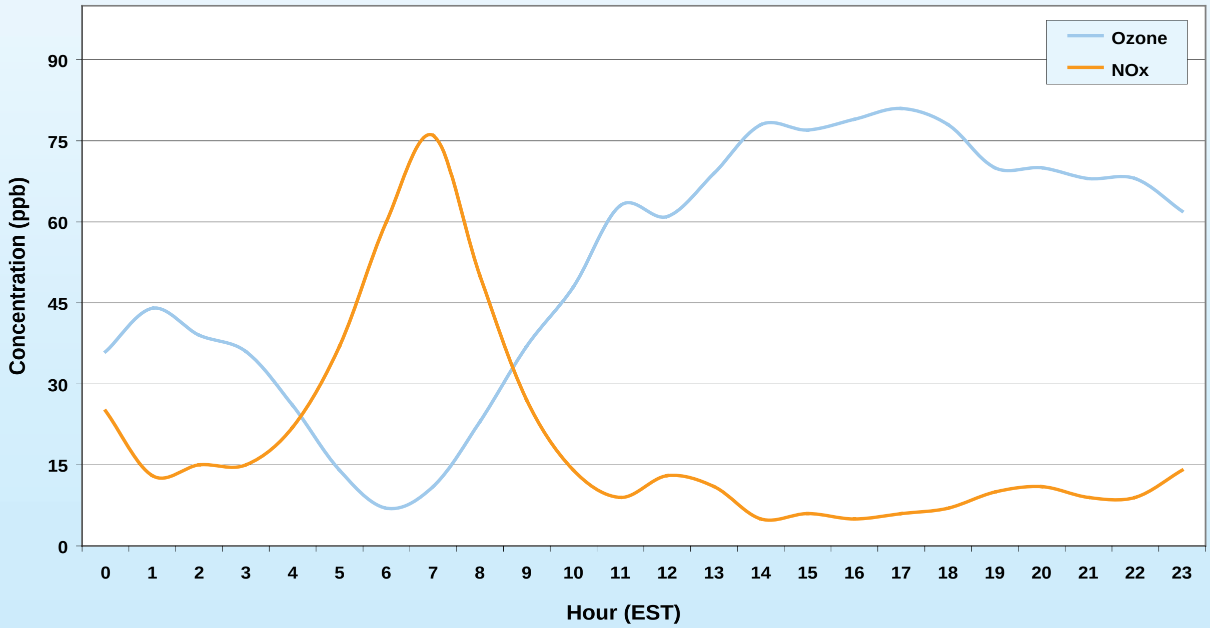
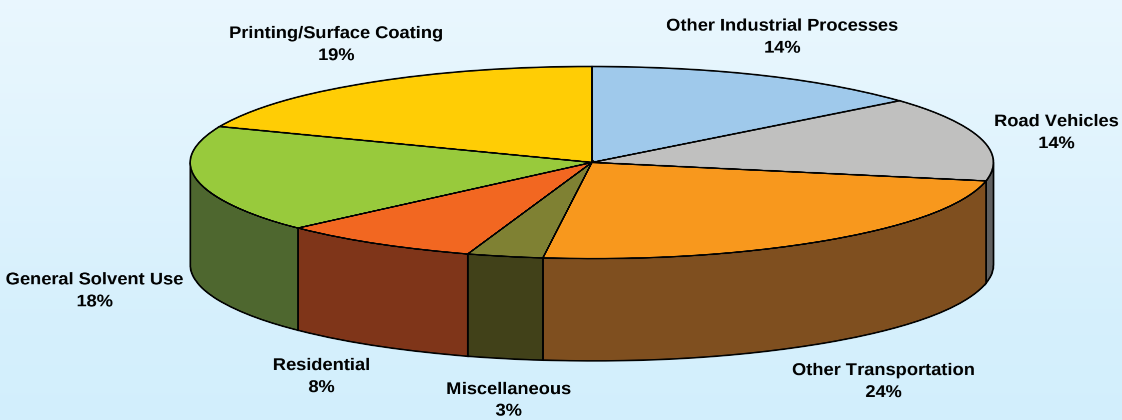
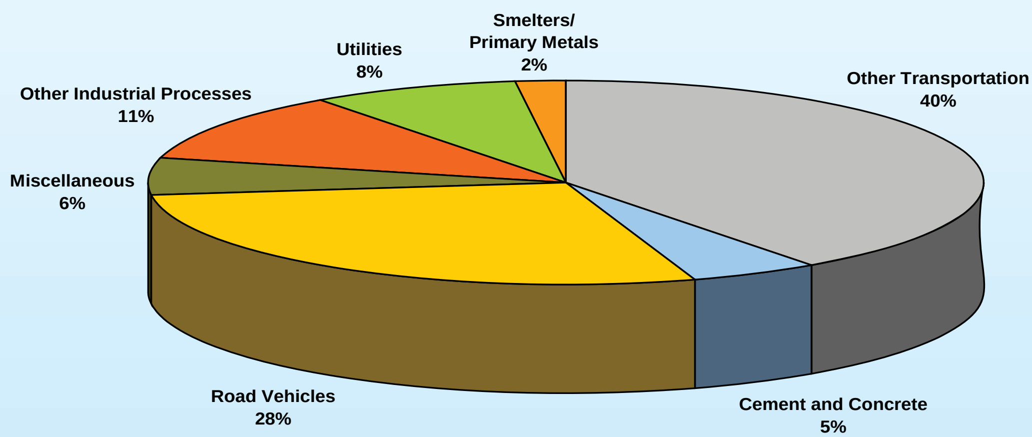


Figure 2.2
Ontario Volatile Organic Compounds Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2006 Estimates)



Note: 2006 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, 2006 Estimates)



**Note: 2006 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.

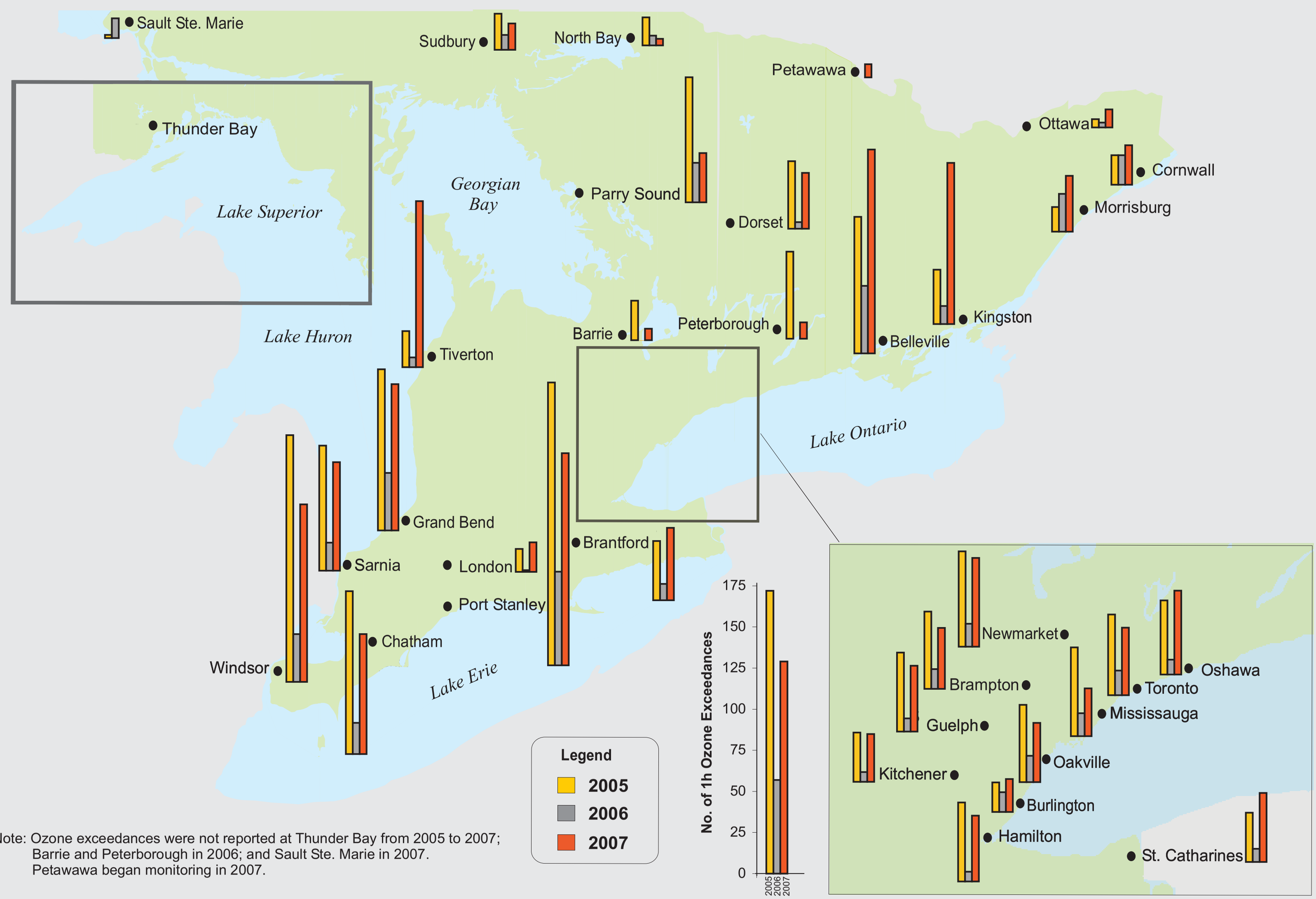
Monitoring results for 2007

During 2007, ground-level ozone was monitored at all 40 Ontario Ministry of the Environment AQI monitoring stations. The highest annual mean was 34.3 parts per billion (ppb), measured at both Port Stanley and Tiverton. These two rural locations are considered to be transboundary-influenced sites situated on the shores of Lake Erie and Lake Huron, respectively. The lowest annual mean, 21.1 ppb, was measured at Toronto West, a site located near Highway 401 and impacted directly by local nitric oxide emissions. Generally, ozone concentrations are lower in urban areas because ozone is reduced by reaction with nitric oxide emitted by vehicles and other local combustion sources.

Ground-level ozone concentrations continued to exceed the provincial one-hour AAQC of 80 ppb across the province. In 2007, Ontario's one-hour AAQC for ozone was exceeded at 38 of the 40 AQI stations on at least one occasion.

The maximum one-hour ozone concentrations ranged from 67 ppb recorded in Thunder Bay to 136 ppb recorded at Windsor West. Port Stanley, a site impacted significantly by U.S. emissions, recorded the most instances (129) when ozone exceeded Ontario's one-hour AAQC. Sault Ste. Marie and Thunder Bay were the only sites that did not record any hours of ozone above 80 ppb in 2007.

Figure 2.4
Geographical Distribution of Number of One-Hour Ozone Exceedances Across Ontario (2005 - 2007)



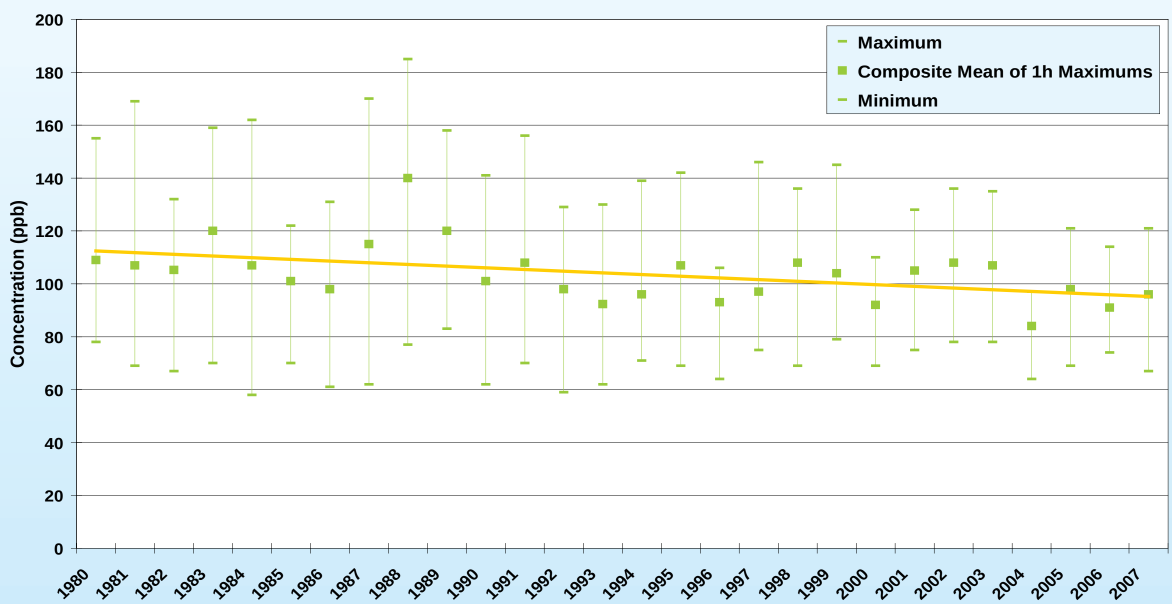
Note: Ozone exceedances were not reported at Thunder Bay from 2005 to 2007; Barrie and Peterborough in 2006; and Sault Ste. Marie in 2007. Petawawa began monitoring in 2007.

The geographical distribution of the number of ozone exceedances across Ontario for 2005 to 2007 is shown in Figure 2.4. Higher numbers of one-hour ozone exceedances were recorded on the northern shores of Lake Erie and Lake Ontario and the eastern shores of Lake Huron and 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 to potentially impact various areas of the province during a smog episode. In contrast, London reported significantly less exceedances than its surrounding sites in southwestern Ontario. London is affected by lake breezes from both Lake Huron and Lake Erie. The subsequent convergence zone causes the air to rise which leads to the development of clouds and precipitation resulting in lower ozone levels. As shown in Figure 2.4, for most sites, the number of ozone exceedances in 2007 was lower than those recorded in 2005. Tiverton, Belleville and Kingston all recorded a significant increase in ozone exceedances in 2007 due to weather conditions that are more conducive to the build-up and transport of smog in these areas. In 2006, Ontario experienced significantly less transboundary polluted air compared to that in 2005 and 2007 as the weather conditions upwind, in the U.S., were often cloudy, unstable and wet, thus smog formation and subsequent transport occurred less frequently.

Trends

The range of the annual one-hour maximum ozone concentrations is shown for the 28-year period of 1980 to 2007 in Figure 2.5. For this period, the annual composite mean of the one-hour maximum concentrations ranges from a low of 84 ppb, recorded in 2004, to a high of 140 ppb, recorded in 1988. The data show random fluctuations year-to-year but an overall decreasing trend (15 per cent) in the annual composite means of the one-hour maximum ozone concentrations from 1980 to 2007 is evident. Over the past 10 years (1998 to 2007), the annual composite means of the

Figure 2.5
Range of Ozone One-Hour Maximum Concentrations in Ontario
(1980 - 2007)



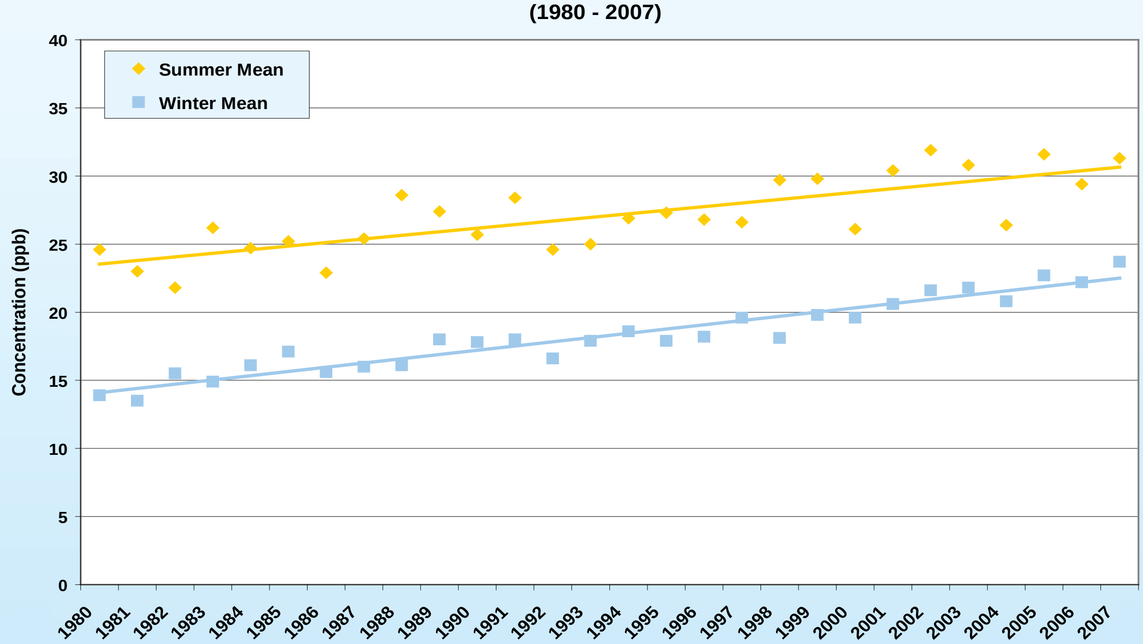
Note: Based on data from 20 ambient ozone sites operated over 28 years.
Ontario 1h AAQC = 80 ppb.

one-hour maximum concentrations of ozone have decreased by approximately 12 per cent on average; most of this change has occurred over the last four years. This decrease is partly due to weather conditions less conducive for ozone production, and the reductions of NO_x emissions in Ontario and the U.S.

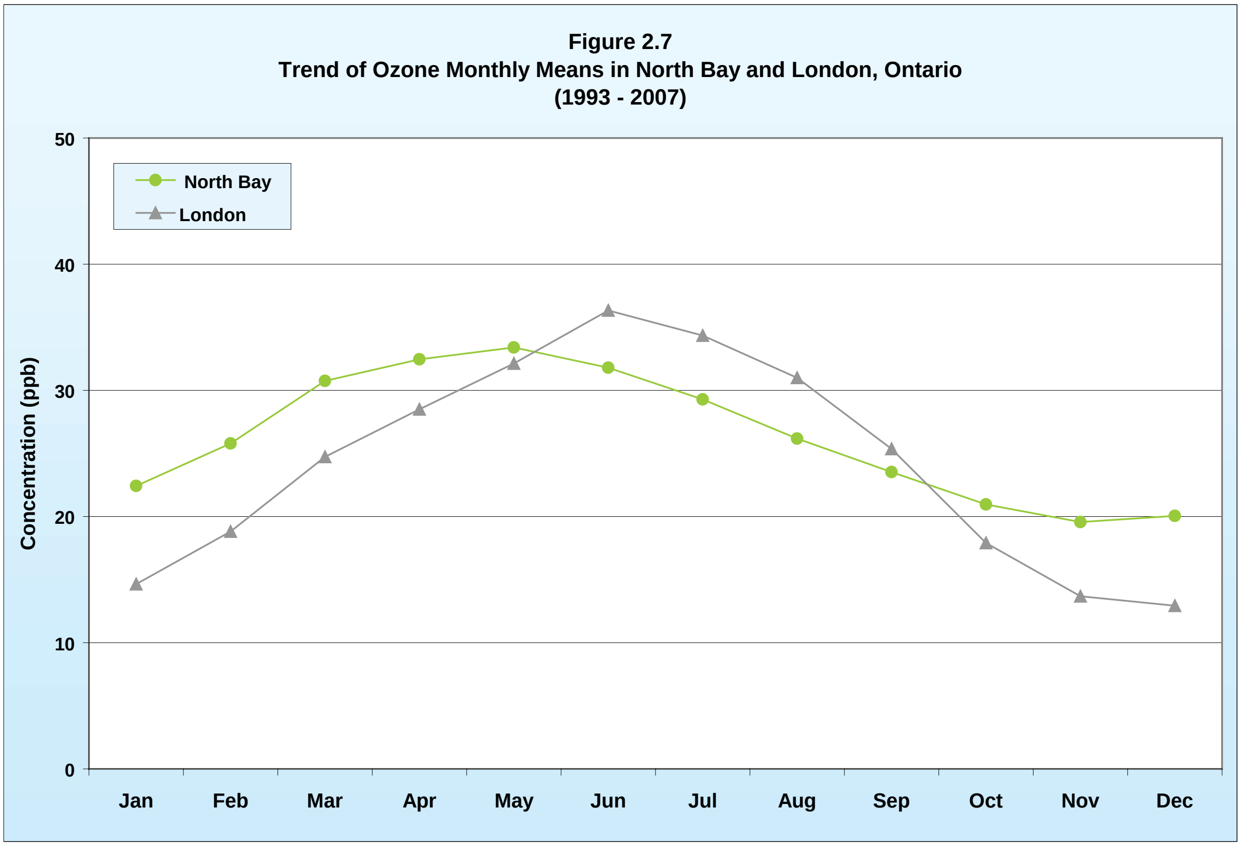
The trend of the ozone seasonal composite means (summer and winter) as recorded at 19 long-term ozone sites for the period 1980 to 2007 is shown in Figure 2.6. It shows that there has been an increasing trend in the ozone seasonal composite means during the 28-year period where the ozone summer composite means have increased by approximately 30 per cent and the winter composite means by approximately 60 per cent. For the 10-year period, 1998 to 2007, summer composite means increased by approximately 5 per cent and winter composite means increased by approximately 24 per cent. The increases in summer and winter ozone composite means appear to be largely related to the reductions in NO_x emissions and the rising global background ozone concentrations. Potential contributions to the increases in the summer composite means may also be related to meteorological factors and long-range transport of ozone and its precursors from the U.S.

In Figure 2.7, the ozone monthly means are compared for two locations for the period 1993 to 2007. This figure shows the typical behaviour of ozone levels 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 from October through to May. For the month of January, the ozone mean concentration in North Bay is approximately 8 ppb 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 4 to 5 ppb greater

Figure 2.6
Trend of Ozone Seasonal Means at Sites Across Ontario
(1980 - 2007)



Note: Based on data from 19 ozone sites operated over 28 years.
Seasonal definitions - Summer (May to September); Winter (January to April, October to December).



than those reported in North Bay. It is more common for ozone and/or its precursors to be transported into southern Ontario from the mid-western U.S. during the summer months.

The Canada-wide Standard for ozone

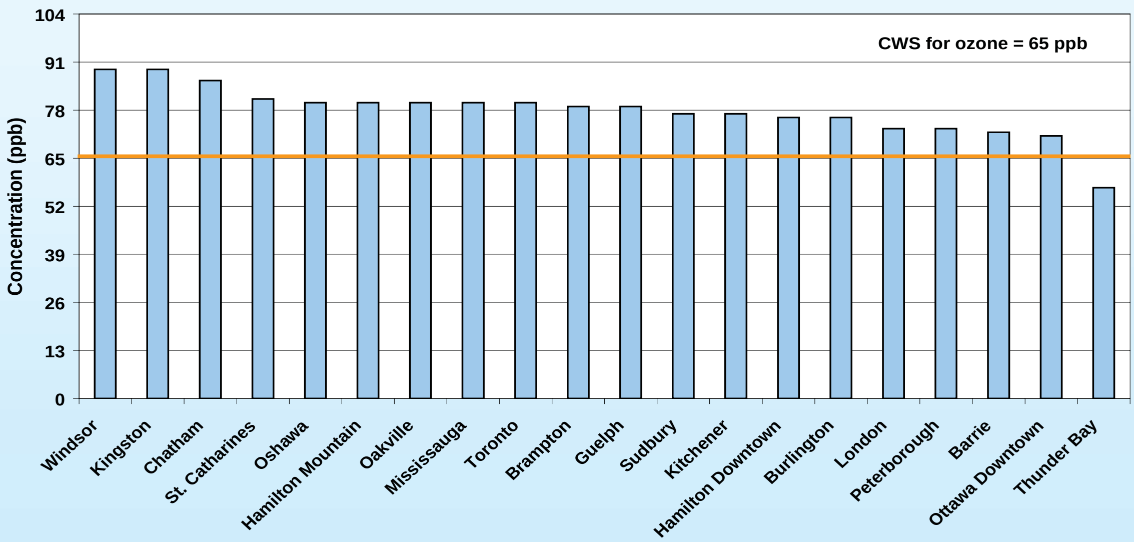
In 2000, the Canadian Council of Ministers of the Environment (CCME) developed a Canada-wide Standard (CWS) for ozone as a result of the pollutant's adverse effects on human health and the environment. As referenced in the *Guidance Document on Achievement Determination,* the CWS for ozone is 65 ppb, eight-hour running average time, based on the 4^{th} 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 2.8 displays the 2007 concentrations for ozone based on the 4^{th} highest ozone eight-hour daily maximum for designated sites across Ontario. (The 2007 ozone concentrations in Figure 2.8 consist of an average over a three-year period, 2005 to 2007). All of the sites exceeded the CWS of 65 ppb for ozone, with the exception of Thunder Bay where its 2007 ozone concentration, based on the CWS metric, was 57 ppb.

How do Ontario cities compare world-wide?

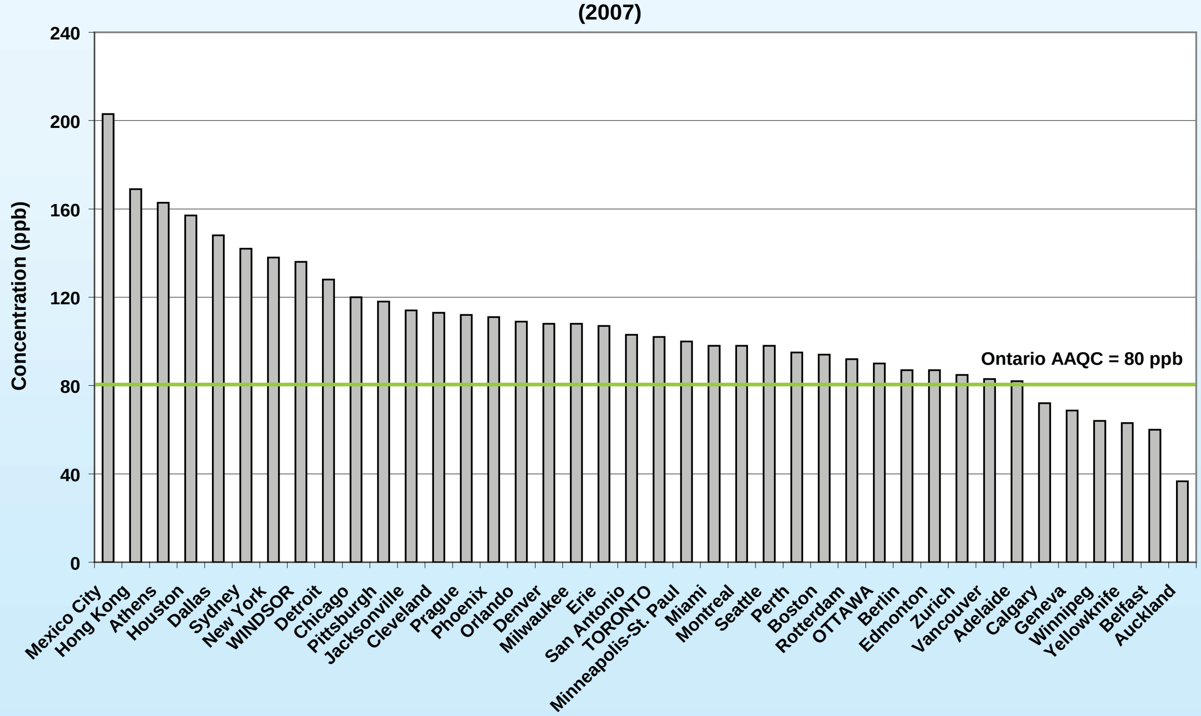
Figure 2.9 displays the ozone one-hour maximum concentrations in 2007 for 40 cities around the world (see Figure 1.2 for city locations). Mexico City recorded the highest ozone one-hour maximum reaching 203 ppb, followed by Hong Kong and Athens at 169 ppb and 163 ppb, respectively. Auckland, in New Zealand, reported the lowest ozone one-hour maximum at 37 ppb. The Ontario one-hour AAQC of 80 ppb was exceeded at 34 of the cities examined here, including Windsor, Toronto and Ottawa.

Figure 2.8
Ozone Levels at Designated CWS Sites Across Ontario
Based on the CWS for Ozone
(2005 - 2007)



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 (2005 - 2007).
The value displayed for Kingston is based on a 2-year average (2006-2007).

Figure 2.9
Ozone One-Hour Maximum Concentrations for Selected Cities World-wide
(2007)



Note: Ontario cities are displayed in UPPERCASE font.

CHAPTER 3

PARTICULATE MATTER IN THE AIR

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.

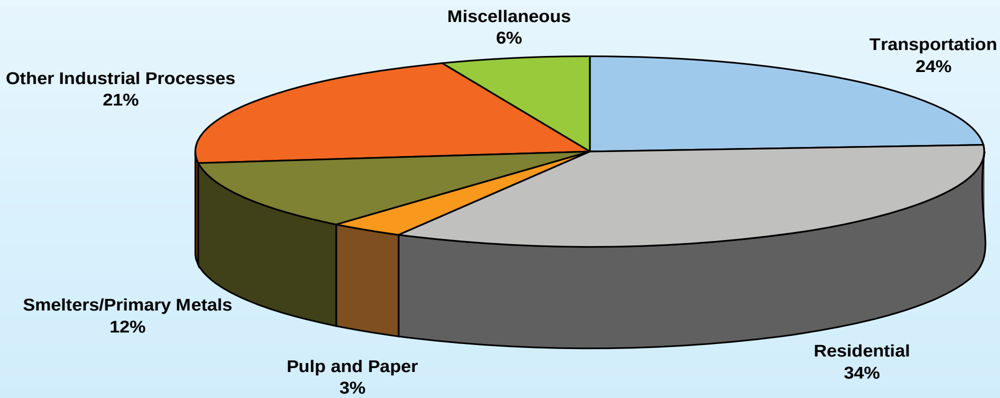
Characteristics, sources and effects

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. The residential and transportation sectors accounted for 34 per cent and 24 per cent of $PM_{2.5}$ emissions, respectively, while other industrial processes accounted for 21 per cent.

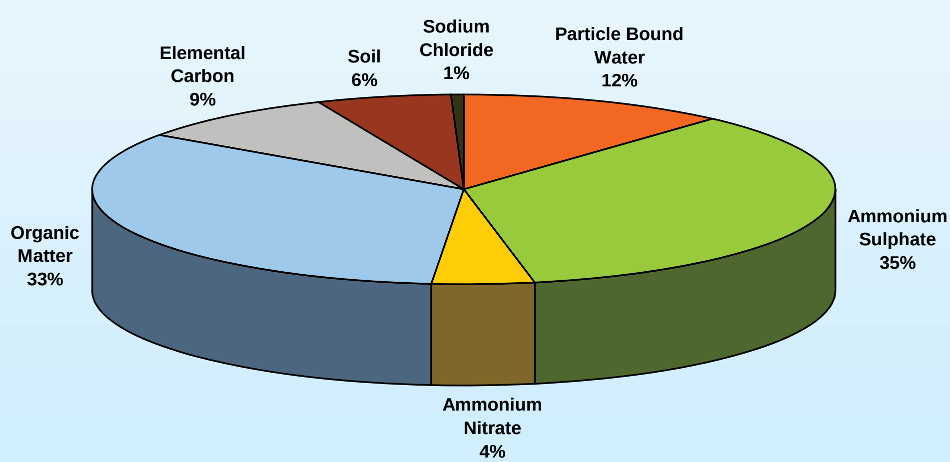
The composition of the total $PM_{2.5}$ mass at Toronto during the summer and winter months from 2004 to 2008 are displayed in Figures 3.2a-b. In the summer months, April to September, fine particles are mainly composed of ammonium sulphate (35 per cent) and organic matter (33 per cent); whereas in the winter months, October to March, the composition of $PM_{2.5}$ mainly consists of ammonium nitrate

Figure 3.1
Ontario $PM_{2.5}$ Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2006 Estimates)



Note: 2006 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

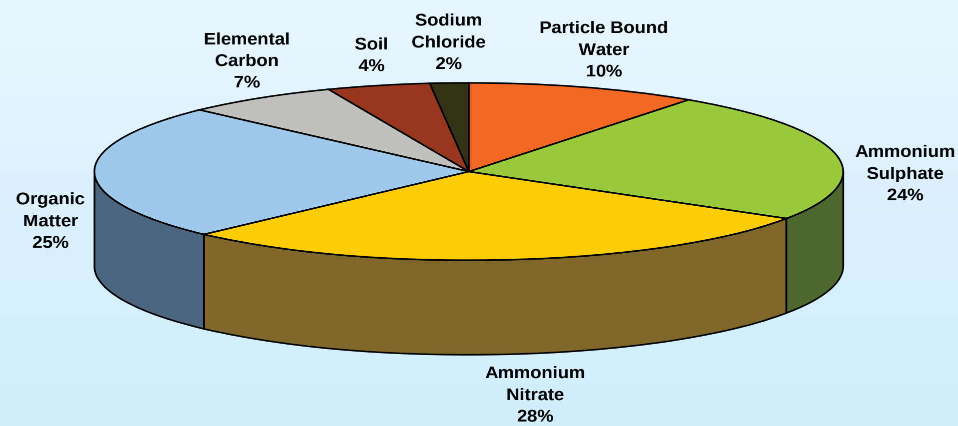
Figure 3.2a
Composition of the Total $PM_{2.5}$ Mass at Toronto
Summer 2004-2008



Note: Summer denotes the months April to September.

Source: Environment Canada, based on measurements at University of Toronto, Gage Institute.

Figure 3.2b
Composition of the Total $PM_{2.5}$ Mass at Toronto
Winter 2004-2008



Note: Winter denotes the months October to March.

Source: Environment Canada, based on measurements at University of Toronto, Gage Institute.

(28 per cent), organic matter (25 per cent) and ammonium sulphate (24 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 to 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 on the eastern shore of Georgian Bay.

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 2007

In 2007, each of Ontario's ambient air monitoring sites operated a Tapered Element Oscillating Microbalance (TEOM) instrument at 30°C with a Sample Equilibration System (SES) to measure the $PM_{2.5}$ concentrations on an hourly basis. The 2007 annual summary statistics for 24-hour $PM_{2.5}$ for sites across Ontario are shown in Figure 3.3. The annual mean concentrations ranged from 4.0 micrograms per cubic metre

Figure 3.3
Annual Statistics for 24-Hour Average $PM_{2.5}$ Across Ontario (2007)

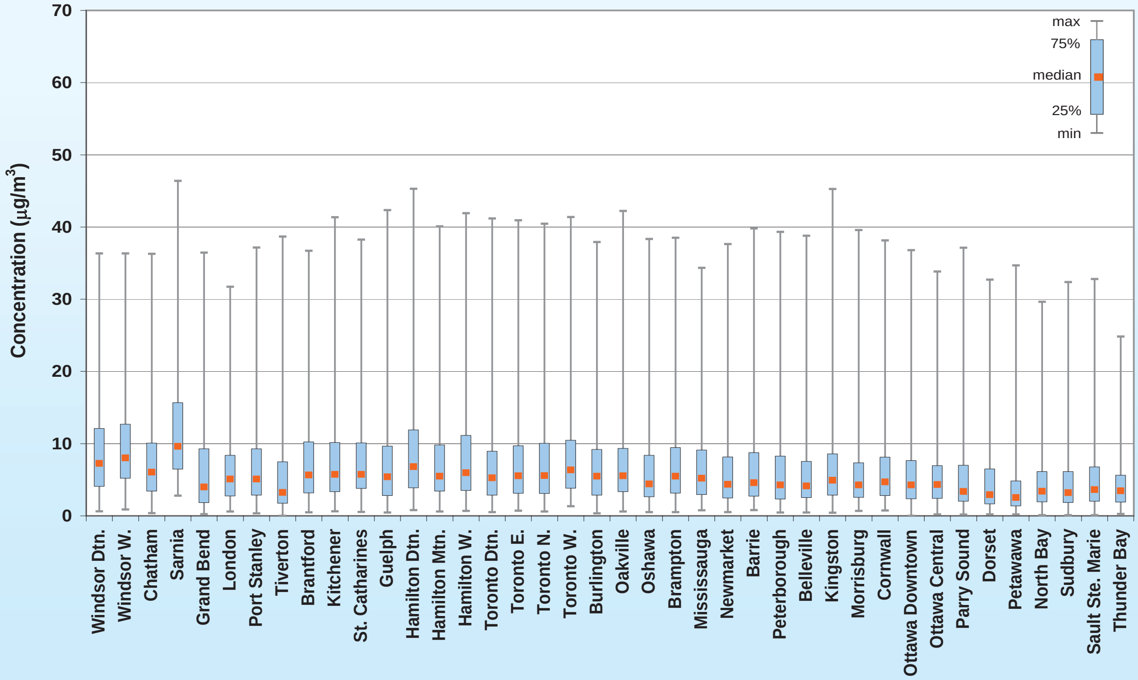
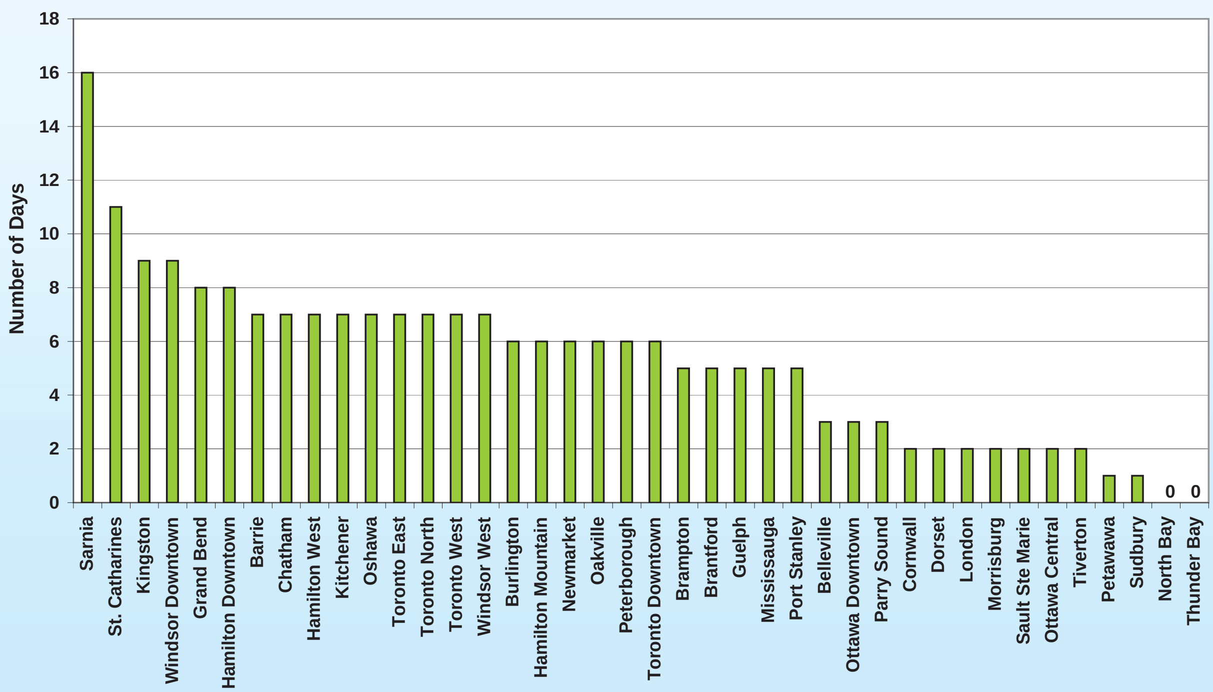


Figure 3.4
Number of Days $PM_{2.5}$ 24-Hour Concentrations > 30 $\mu g/m^3$ Across Ontario (2007)



($\mu g/m^3$) in Petawawa to 12.2 $\mu g/m^3$ in Sarnia. The 24-hour $PM_{2.5}$ maximum concentrations measured at urban sites ranged from 25 $\mu g/m^3$ in Thunder Bay to 46 $\mu g/m^3$ in Sarnia; and at rural sites ranged from 33 $\mu g/m^3$ in Dorset to 40 $\mu g/m^3$ in Morrisburg.

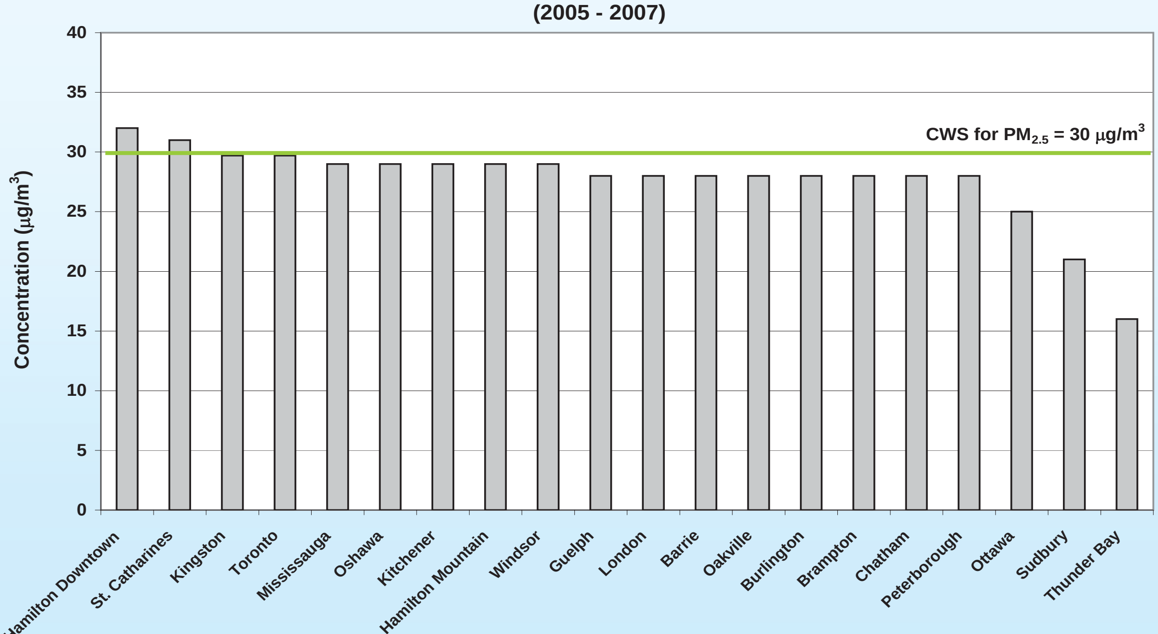
Figure 3.4 shows the number of days when $PM_{2.5}$ 24-hour concentrations were greater than 30 $\mu g/m^3$ across Ontario. The $PM_{2.5}$ reference level of 30 $\mu g/m^3$ for a 24-hour period was exceeded at 38 of the 40 sites in 2007. Sarnia recorded the highest number of days (16) in Ontario with 24-hour $PM_{2.5}$ concentrations greater than 30 $\mu g/m^3$, whereas North Bay and Thunder Bay were the two locations that did not record a 24-hour average $PM_{2.5}$ concentration above 30 $\mu g/m^3$. The provincial average for $PM_{2.5}$ during 2007 was 7.0 $\mu g/m^3$ which is a decrease of approximately 1 $\mu g/m^3$ when compared to 2006.

The Canada-wide Standard for $PM_{2.5}$

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 $\mu g/m^3$, 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 2007 concentrations for $PM_{2.5}$ based on the 98th percentile of the daily average for 20 designated sites across Ontario.

Figure 3.5
$PM_{2.5}$ Levels at Designated CWS Sites Across Ontario
Based on the CWS for $PM_{2.5}$
(2005 - 2007)



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 $\mu g/m^3$) is based on the 24-hour, 98th percentile, annual ambient measurement averaged over 3 years (2005-2007).
The values displayed for Kingston and Thunder Bay are based on 2-year averages (2006-2007).

Did you know...

- One poorly tuned vehicle can emit as much pollution as 20 properly tuned cars.
- A well-maintained car runs better and pollutes less. Shut the engine off, even for short stops. One minute of idling uses more fuel than restarting your engine.

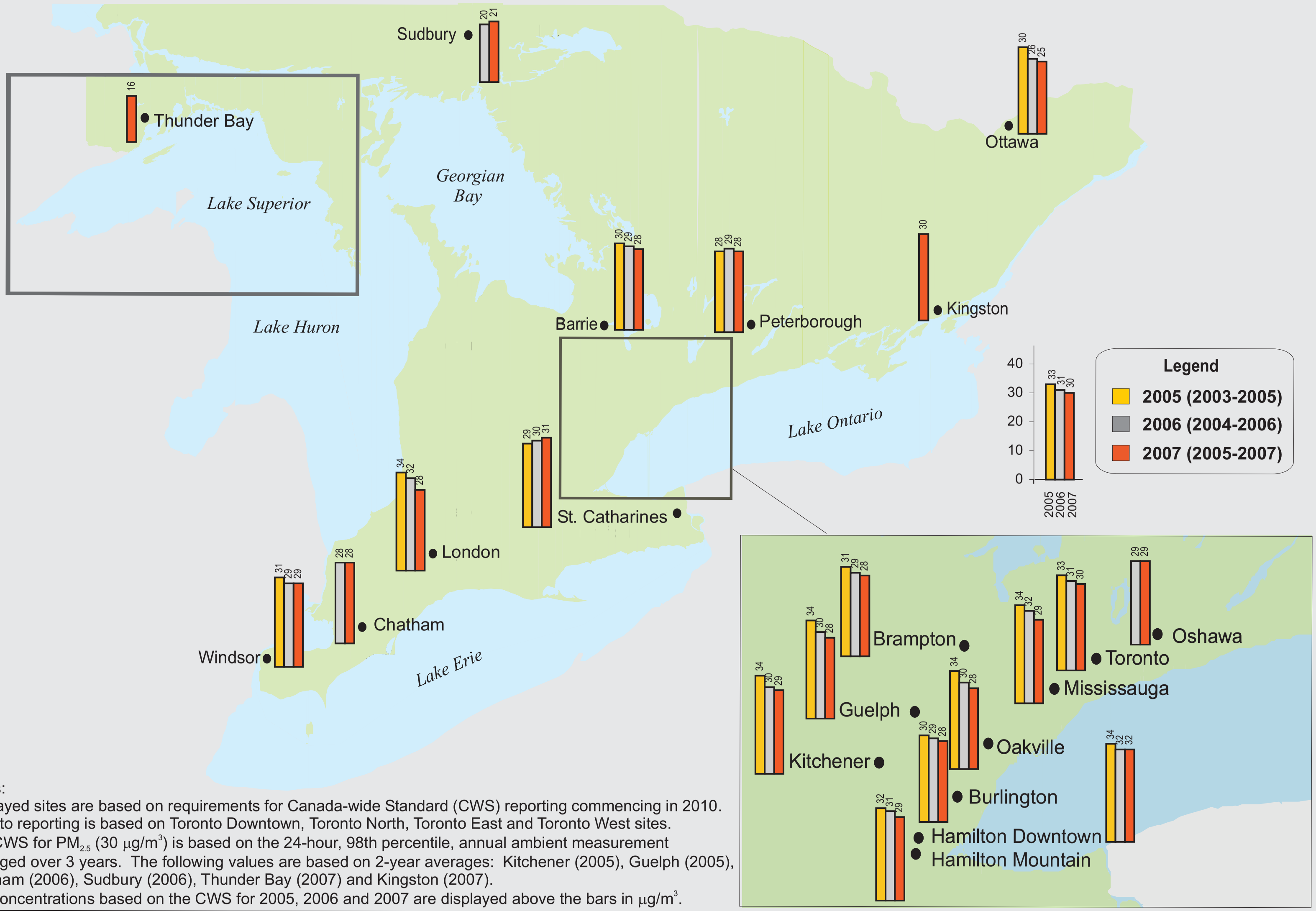
(The 2007 $PM_{2.5}$ concentrations in Figure 3.5 consist of an average over a three-year period, 2005 to 2007). The concentrations, based on the CWS metric for $PM_{2.5}$, ranged from 32 µg/m^3 in Hamilton Downtown to 16 µg/m^3 in Thunder Bay, which was based on a two-year average. Only two sites (Hamilton Downtown and St. Catharines) of the 20 designated sites exceeded the CWS target of 30 µg/m^3.

Figure 3.6 displays the geographical distribution of $PM_{2.5}$ levels, based on the CWS metric calculated for 2005 to 2007, at designated CWS sites across Ontario. The majority of $PM_{2.5}$ levels reported in 2007 are lower than those reported in 2005, with the exception of St. Catharines. The $PM_{2.5}$ three-year averages for St. Catharines have increased by 1 µg/m^3 annually from 29 µg/m^3 in 2005 to 30 µg/m^3 in 2006, to exceeding the CWS in 2007 at 31 µg/m^3. This increase is comparable with concentrations measured on the other side of the border, specifically in Niagara Falls, New York, and therefore may be attributed to the flow and impact of polluted air from the U.S.

How do Ontario cities compare world-wide?

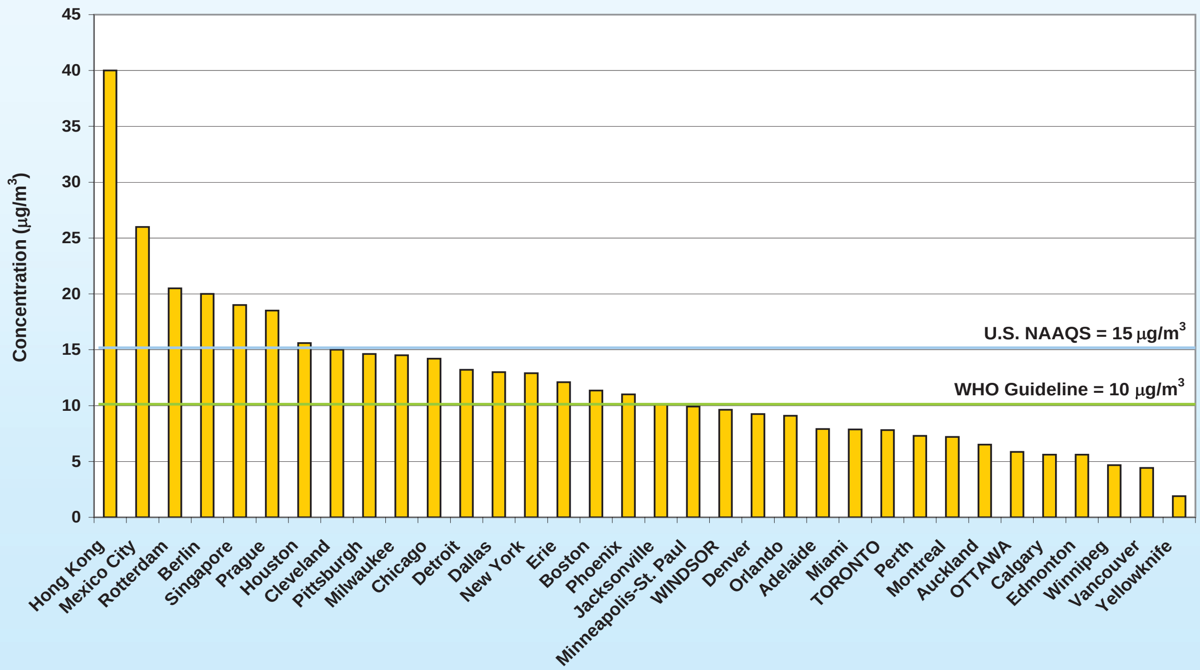
Figure 3.7 displays the $PM_{2.5}$ annual means in 2007 for 34 cities from around the world (see Figure 1.2 for city locations). The $PM_{2.5}$ annual means are based on both continuous and non-continuous measurements. Monitoring methods and instrument operations may vary between cities; therefore, comparisons among cities are not intended to be used as a comprehensive ranking. Hong Kong reported the highest annual mean $PM_{2.5}$ concentration (40 µg/m^3) for 2007 and Yellowknife recorded the lowest annual mean $PM_{2.5}$ concentration of 1.9 µg/m^3. Seven cities (none which were located in Canada) exceeded the annual U.S. NAAQS of 15 µg/m^3. Of the 34 selected cities world-wide, 18 exceeded the WHO guideline of 10 µg/m^3. The Ontario cities recorded measurements below the U.S. NAAQS and WHO guideline.

Figure 3.6
Geographical Distribution of $PM_{2.5}$ Levels at Designated CWS Sites Across Ontario (2005 - 2007)



Notes:
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/m^3) is based on the 24-hour, 98th percentile, annual ambient measurement averaged over 3 years. The following values are based on 2-year averages: Kitchener (2005), Guelph (2005), Chatham (2006), Sudbury (2006), Thunder Bay (2007) and Kingston (2007).
The concentrations based on the CWS for 2005, 2006 and 2007 are displayed above the bars in μg/m^3.

Figure 3.7
$PM_{2.5}$ Annual Means for Selected Cities World-wide
(2007)



Note: Ontario sites are displayed in UPPERCASE font.

CHAPTER 4

OTHER AIR POLLUTANTS

Characteristics, sources and effects of nitrogen dioxide, carbon monoxide and sulphur dioxide are discussed in this chapter, as well as their ambient concentrations during 2007 and, where appropriate, trends over time. 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 atmosphere 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 compounds, 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 by sector 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 2007

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 (22.1 ppb) for NO_2 during 2007. 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 Oakville air monitoring station recorded the highest 24-hour average concentration (51 ppb), whereas the Toronto East site recorded the highest one-hour concentration (77 ppb) in 2007. 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 2007.

Trends

The trend of the composite annual means for ambient NO_2 concentrations shows a decreasing trend from 1975 to 2007 as displayed in Figure 4.2. Average concentrations decreased by approximately 36 per cent over the 33-year period. Average NO_2 concentrations decreased approximately 27 per cent from 1975 to 1997 and 30 per cent over the last decade, 1998 to 2007, as well.

How do Ontario cities compare world-wide?

Figure 4.3 displays the NO_2 annual mean concentrations in 2007 for 40 cities world-wide (see Figure 1.2 for city locations). Mexico City reported the highest NO_2 annual mean of 58.0 ppb, which exceeded the U.S. NAAQS of 53 ppb.

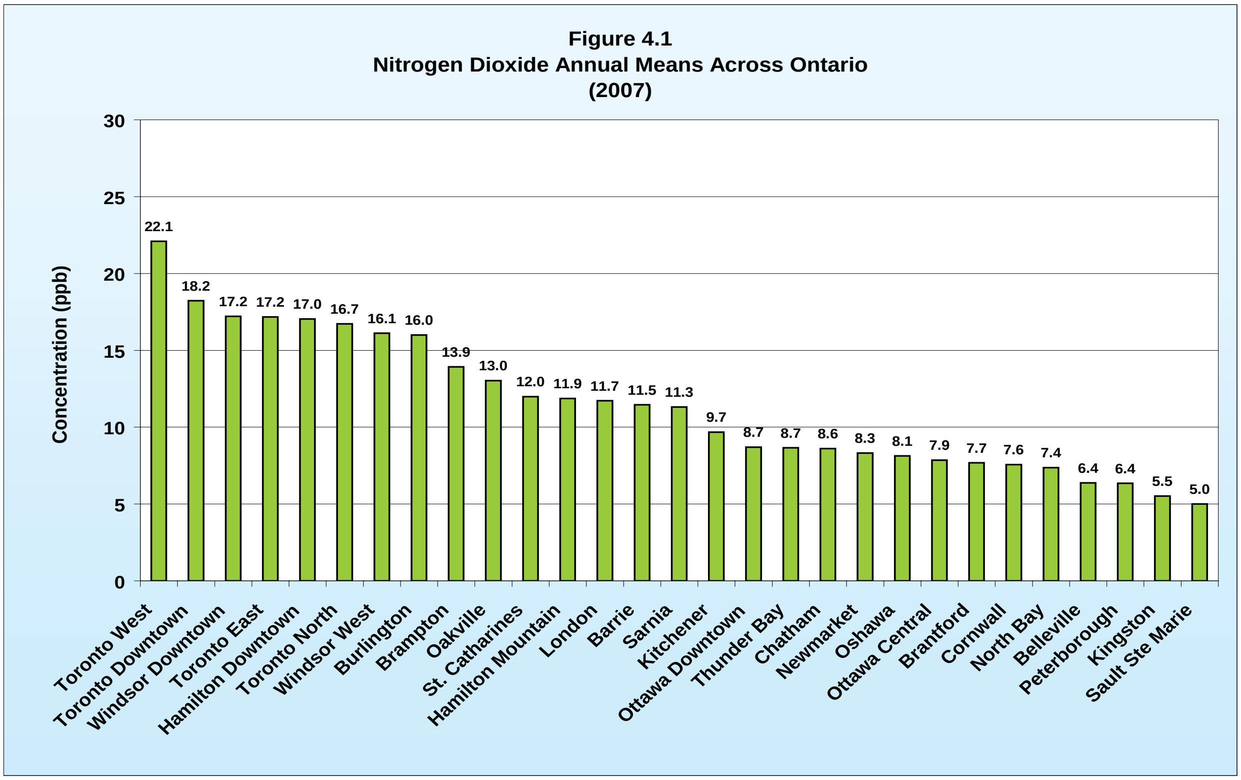


Figure 4.1
Nitrogen Dioxide Annual Means Across Ontario
(2007)
Concentration (ppb)
0
5
10
15
20
25
30
22.1
18.2
17.2
17.2
17.0
16.7
16.1
16.0
13.9
13.0
12.0
11.9
11.7
11.5
11.3
9.7
8.7
8.7
8.6
8.3
8.1
7.9
7.7
7.6
7.4
6.4
6.4
5.5
5.0
Toronto West
Toronto Downtown
Windsor Downtown
Toronto East
Hamilton Downtown
Toronto North
Windsor West
Burlington
Brampton
Oakville
St. Catharines
Hamilton Mountain
London
Barrie
Sarnia
Kitchener
Ottawa Downtown
Thunder Bay
Chatham
Newmarket
Oshawa
Ottawa Central
Brantford
Cornwall
North Bay
Belleville
Peterborough
Kingston
Sault Ste Marie

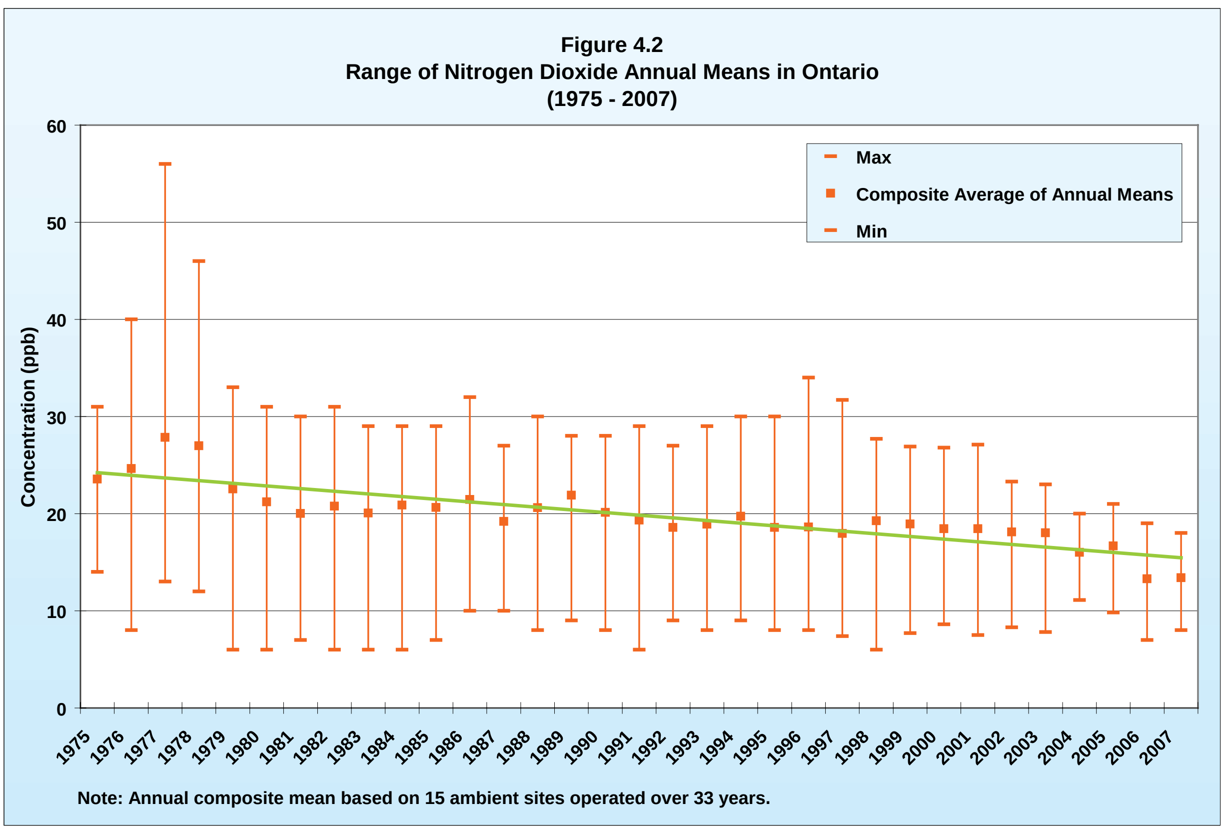
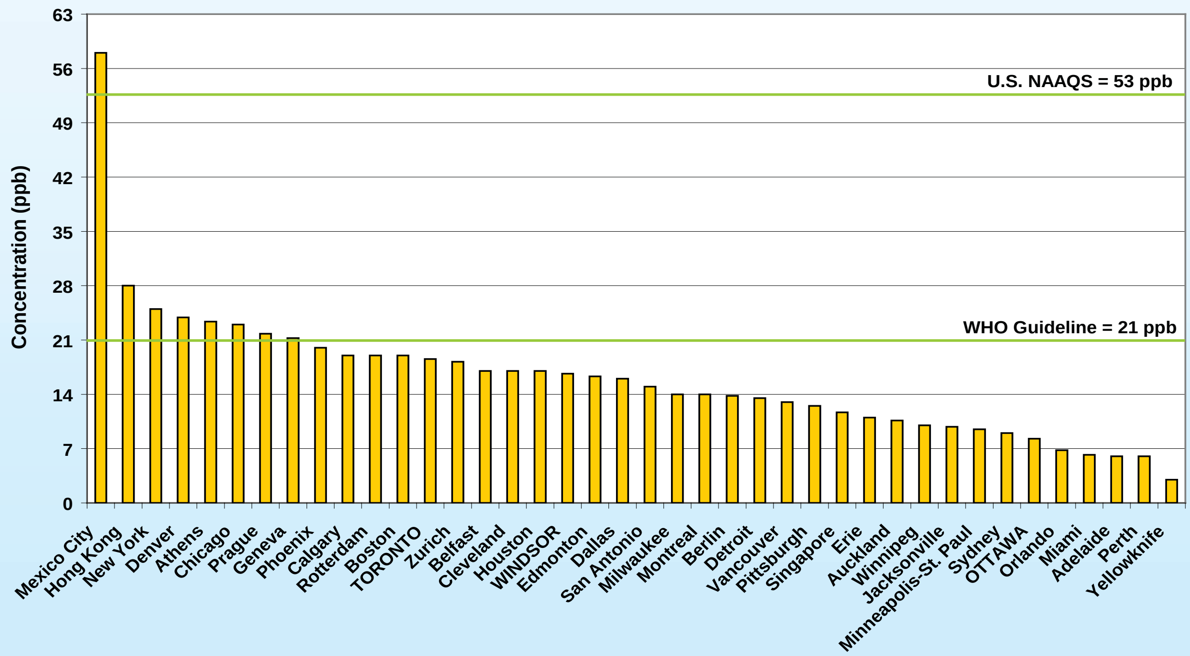


Figure 4.2
Range of Nitrogen Dioxide Annual Means in Ontario
(1975 - 2007)
Concentration (ppb)
0
10
20
30
40
50
60
Max
Composite Average of Annual Means
Min
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
Note: Annual composite mean based on 15 ambient sites operated over 33 years.

Figure 4.3
Nitrogen Dioxide Annual Means for Selected Cities World-wide
(2007)



Note: Ontario cities are displayed in UPPERCASE font.

Eight sites, including Mexico City, exceeded the WHO guideline of 21 ppb. Toronto, Windsor and Ottawa reported NO_2 annual means of 18.6 ppb, 16.7 ppb and 8.3 ppb, respectively. Yellowknife recorded the lowest NO_2 annual mean of 3.0 ppb. Large urban centres typically experience higher NO_2 levels due to increased energy use and motor vehicle emissions.

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 85 per cent of all CO emissions.

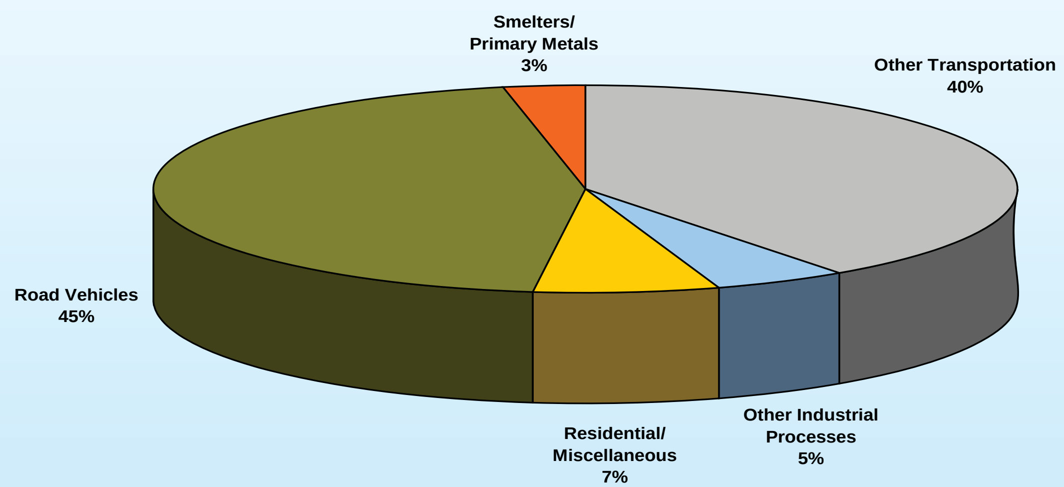
Monitoring results for 2007

In 2007, the highest one-hour and eight-hour maximum CO values, 5.97 ppm and 1.75 ppm were measured at the Hamilton Downtown site. Typically, 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

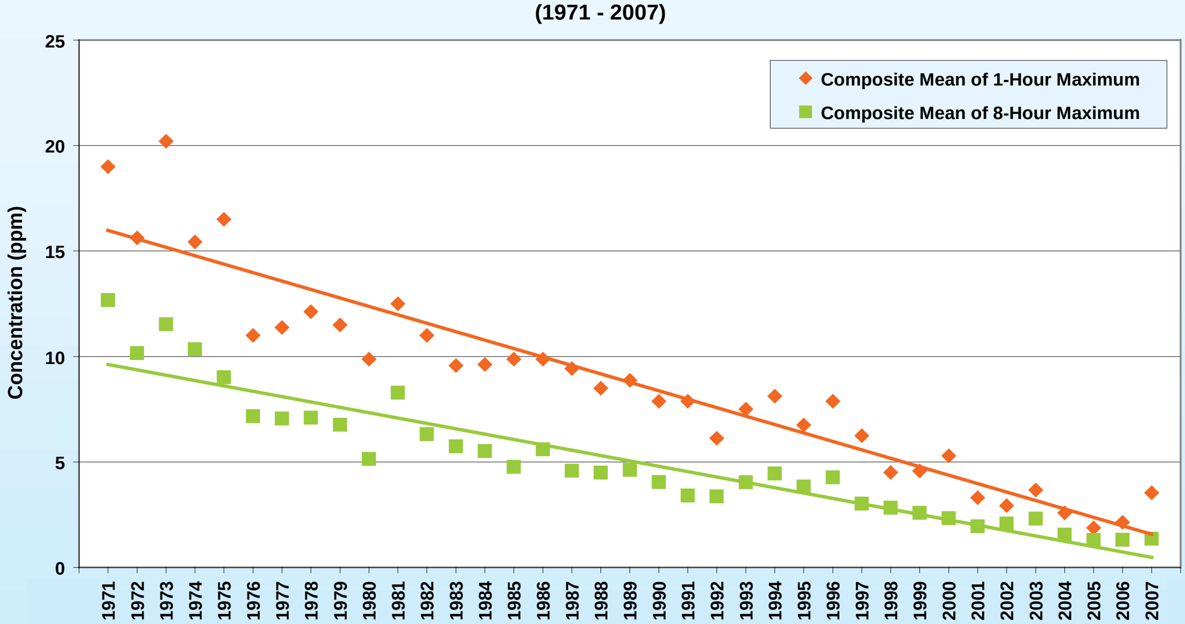
The trends in provincial composite mean of one-hour and eight-hour maximum CO concentrations from 1971 to 2007 are shown in Figure 4.5. Ambient CO concentrations, as measured by the composite mean of the one-hour and eight-hour maximums, decreased by approximately 90 per cent and 95 per cent, respectively, over this 37-year period.

Figure 4.4
Ontario Carbon Monoxide Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2006 Estimates)



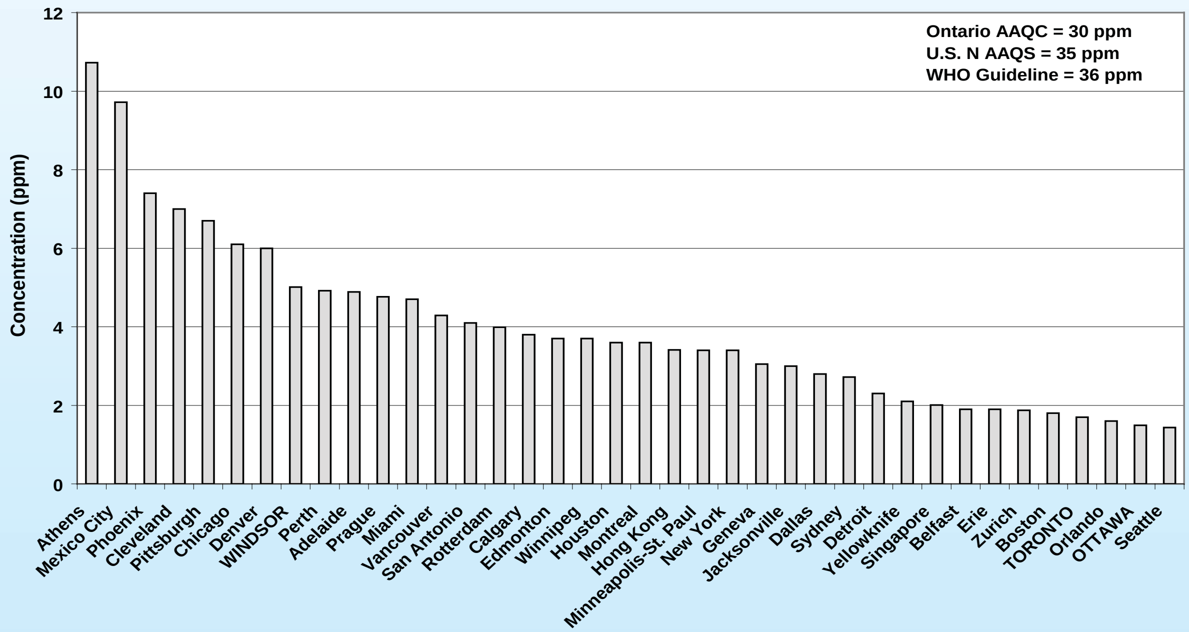
Note: 2006 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

Figure 4.5
Trends of Carbon Monoxide One-Hour and Eight-Hour Maximums in Ontario
(1971 - 2007)



Note: Data are based on eight ambient CO sites operated over 37 years.
Ontario's 1-hour AAQC = 30 ppm.
Ontario's 8-hour AAQC = 13 ppm.

Figure 4.6
Carbon Monoxide One-Hour Maximum Concentrations for Selected Cities World-wide (2007)



Note: Ontario cities are displayed in UPPERCASE font.

How do Ontario cities compare world-wide?

Figure 4.6 displays the CO one-hour maximum concentrations in 2007 for 38 cities world-wide (see Figure 1.2 for city locations). Athens and Mexico City reported the two highest CO one-hour maximums at 10.7 ppm and 9.7 ppm, respectively. Seattle recorded the lowest CO maximum of 1 ppm, followed closely by Ottawa, Orlando and Toronto. 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 2007.

SULPHUR DIOXIDE

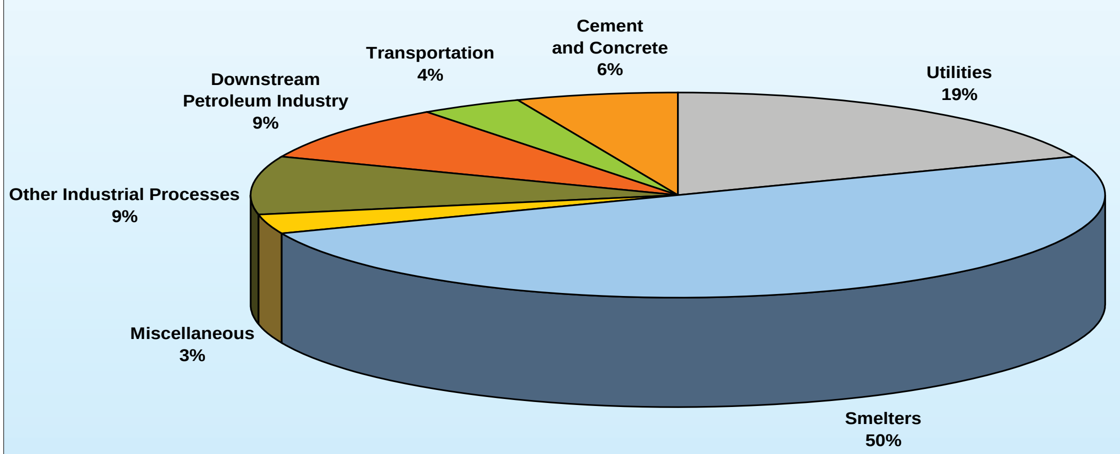
Characteristics, sources and effects

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 69 per cent of the SO_2 emitted in Ontario comes from smelters and utilities as shown in Figure 4.7. Downstream petroleum industry and other industrial processes each accounted for approximately 9 per cent of SO_2 emissions. Lesser sources of SO_2 include transportation, cement and concrete, and miscellaneous.

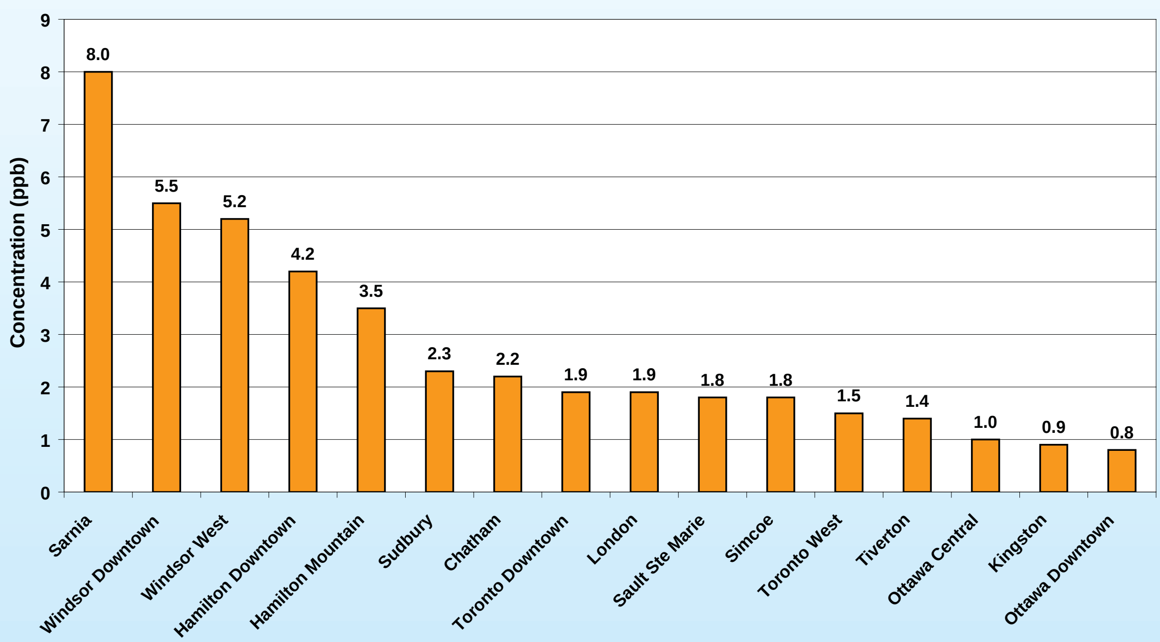
Health effects caused by exposure to high levels of SO_2 include breathing problems, respiratory illness, and the exacerbation of respiratory and cardiovascular disease. People with asthma, chronic lung disease or heart disease are the most sensitive to SO_2. Sulphur dioxide also damages trees and crops. 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 leads to the formation of microscopic particles, which have serious health implications and contribute to climate change.

Figure 4.7
Ontario Sulphur Dioxide Emissions by Sector
(Emissions from Point/Area/Transportation Sources, 2006 Estimates)



Note: 2006 is the latest complete inventory.
Emissions may be revised with updated source/sector information or emission estimation methodologies as they become available.

Figure 4.8
Sulphur Dioxide Annual Means Across Ontario
(2007)



Note: Data collected from ambient sites.
Ontario's annual AAQC = 20 ppb.

Monitoring results for 2007

Sarnia recorded the highest annual mean (8.0 ppb) and 24-hour maximum concentration (87 ppb) of SO_2 during 2007. Sudbury recorded the highest one-hour concentration (352 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 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 2007.

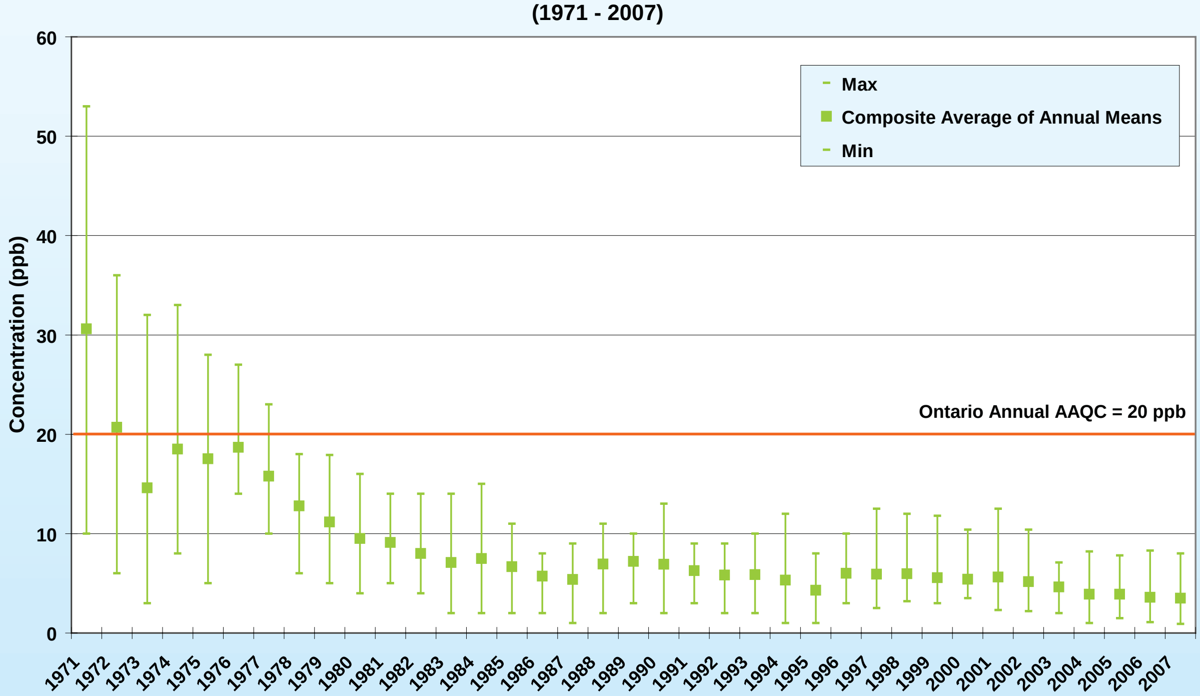
The SO_2 annual means at ambient AQI sites across Ontario are displayed in Figure 4.8. As mentioned previously, Sarnia recorded the highest annual mean in 2007. The annual levels across the province ranged from a low of 0.9 ppb in Ottawa to a high of 8.0 ppb in Sarnia. The annual criterion of 20 ppb for SO_2 was not exceeded at any site in Ontario during 2007.

How can I help?

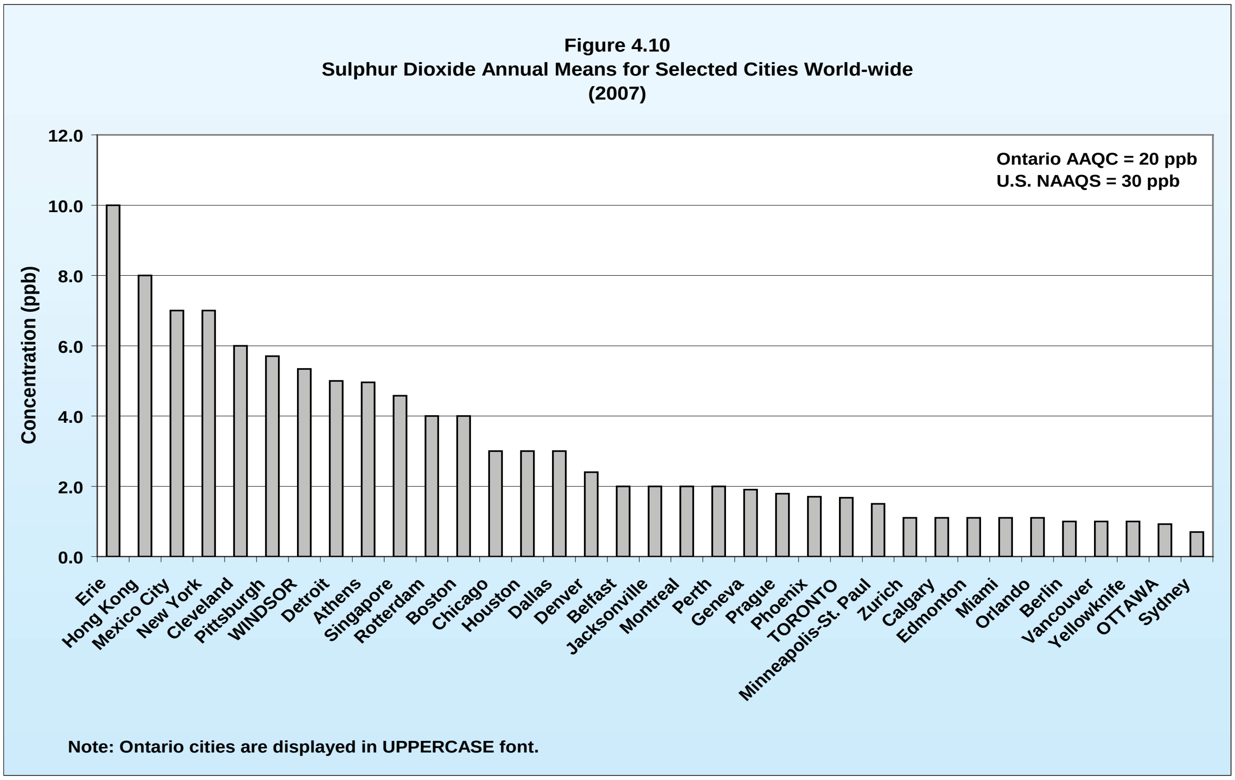
Smog-causing pollutants come from many sources including the burning of fossil fuels to run our vehicles and produce energy. The easiest ways to reduce our contribution to smog are to reduce our use of gas-powered vehicles and conserve our energy use.

- When possible, use public transportation instead of your car. You could also walk or ride your bicycle, as long as smog levels are not too high.
- Look for alternatives to gas-powered machines and vehicles. Try a rowboat or sailboat instead of a motorboat or a push-type lawnmower instead of one that runs on gasoline.
- Consider fuel efficiency when you buy a vehicle. Keep all vehicles well maintained and tires properly inflated.
- Consider joining a citizens' committee to advocate for cleaner air in your community.
- Spend time talking with your children about the importance of a sustainable lifestyle.

Figure 4.9
Range of Sulphur Dioxide Annual Means in Ontario
(1971 - 2007)



Note: Annual composite mean based on 10 ambient sites operated over 37 years.



Trends

Figure 4.9 shows the composite annual means for ambient SO_2 concentrations from 1971 to 2007. The composite annual mean for SO_2 in 2007 is 89 per cent lower than the 1971 value. 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, there has been a decrease of approximately 44 per cent in SO_2 concentrations from 1998 to 2007.

How do Ontario cities compare world-wide?

Figure 4.10 displays the SO_2 annual mean concentrations in 2007 for 35 cities world-wide (see Figure 1.2 for city locations). Erie, Pennsylvania reported the highest annual mean (10 ppb) whereas Sydney and Ottawa recorded the lowest SO_2 annual means (less than 1 ppb) in 2007. The remaining Ontario cities included here, Windsor and Toronto, reported annual mean levels of 5.3 ppb and 1.7 ppb, respectively. All reported cities were below the Ontario annual AAQC of 20 ppb and the U.S. annual NAAQS of 30 ppb.

How can I protect my kids?

Listen and watch for smog alerts on the radio or TV especially during the traditional smog season (from May to September). You can also subsribe to Ontario's Smog Alert Network at www.airqualityontario.com and receive free smog notifications by email.

Chapter 5

Air Quality Index, Smog Alert Program and Smog Episodes

This chapter focuses on the Air Quality Index (AQI), Smog Alert program and briefly examines smog episodes in 2007. The ministry's AQI program was established in 1988, and was originally based on five pollutants – ozone, NO_2, SO_2, CO, and total reduced sulphur (TRS) compounds. On August 23, 2002, the ministry added $PM_{2.5}$ to the AQI, making Ontario the first province in Canada to do so. In association with the AQI program, the ministry launched the Air Quality Advisory Program in 1993. In 2000, this program was expanded to the Smog Alert program under which smog advisories are issued today.

Air Quality Indices

The Ministry of the Environment operates an extensive network of air quality monitoring sites across the province. In 2007, 40 of these sites formed the basis of the AQI network. Two new sites, Ottawa Central and Petawawa, were added to the network in 2007. The Air Quality Office of the Environmental Monitoring and Reporting Branch continuously obtains data for criteria air pollutants from these 40 sites.

The AQI network, shown in Figure 5.1, provides the public with air quality information, every hour, 24 hours a day, 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, 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 hour. 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.

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.

Figure 5.1
Air Quality Index (AQI) Monitoring Sites in Ontario
2007

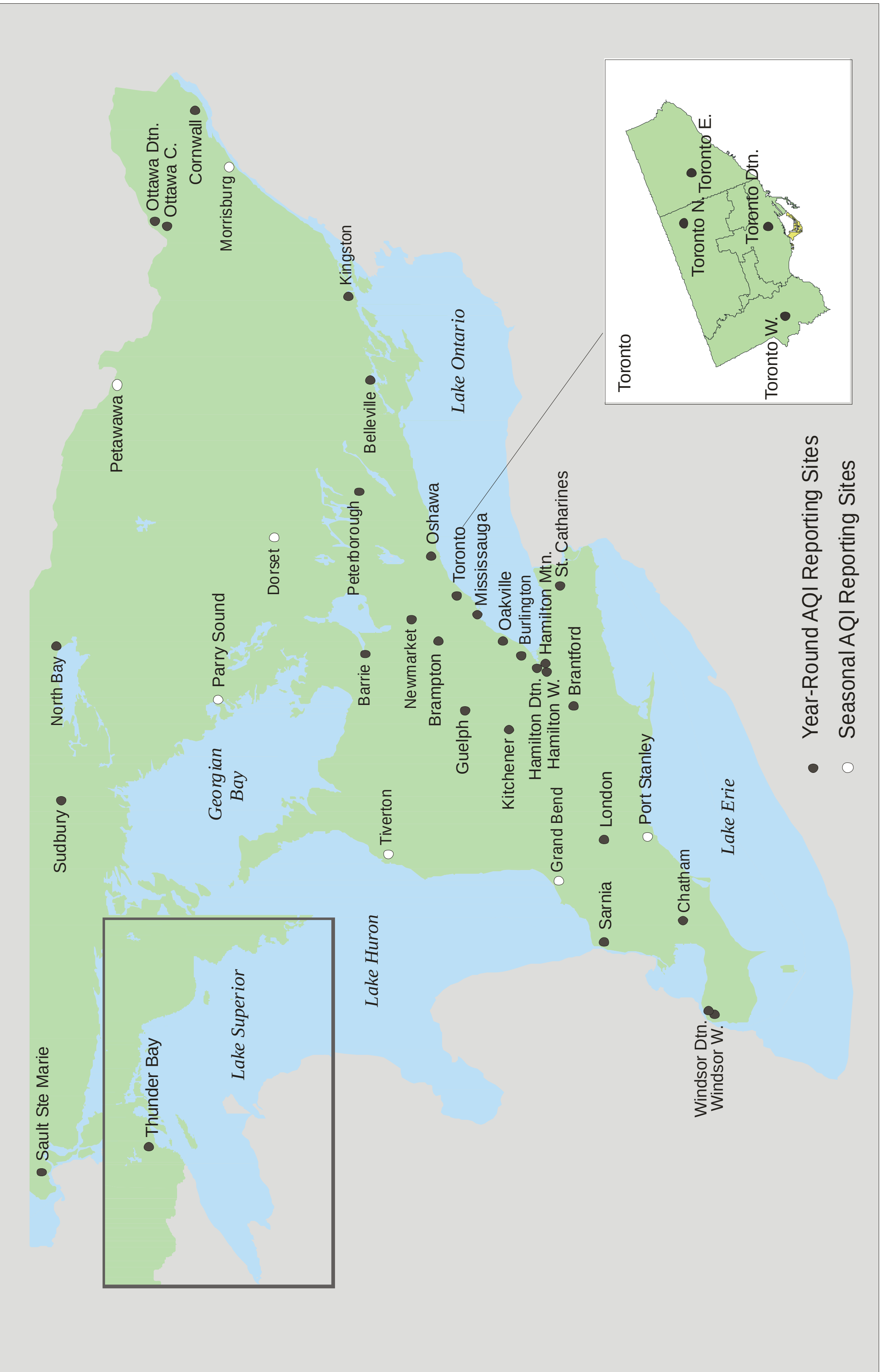


Table 5.1: Air Quality Index Pollutants and Their Impacts*

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.

Table 5.2 shows the percentage distribution of hourly AQI readings for the 40 monitoring sites by the AQI descriptive category and the number of days with at least one hour AQI reading greater than 49. Air quality in the very good and good categories ranged from approximately 86 per cent at Sarnia to 98 per cent at Thunder Bay. On average, the AQI sites in 2007 reported air quality in the very good and good categories approximately 90 per cent of the time and moderate to poor categories about 10 per cent of the time. The highest percentage of hours in the moderate to poor categories was reported in southwestern Ontario. Sarnia recorded approximately 16 percent of the reported hours in the moderate to poor categories. There were 28 poor days in Sarnia (days with at least one hour in the poor category), which was the highest number of days recorded in the province during 2007. In contrast, the London site recorded approximately nine percent of air quality in the moderate to poor categories and six poor days. This was the least number of poor days recorded at cities in southern Ontario. In eastern Ontario, Ottawa Downtown recorded seven poor days, and the Ottawa Central site and Petawawa each recorded poor air quality on two days. Kingston recorded 24 days of poor air quality largely due to transboundary flow of pollutants from the United States. In northern Ontario, Thunder Bay and Sault Ste. Marie did not record any hours of air quality in the poor category.

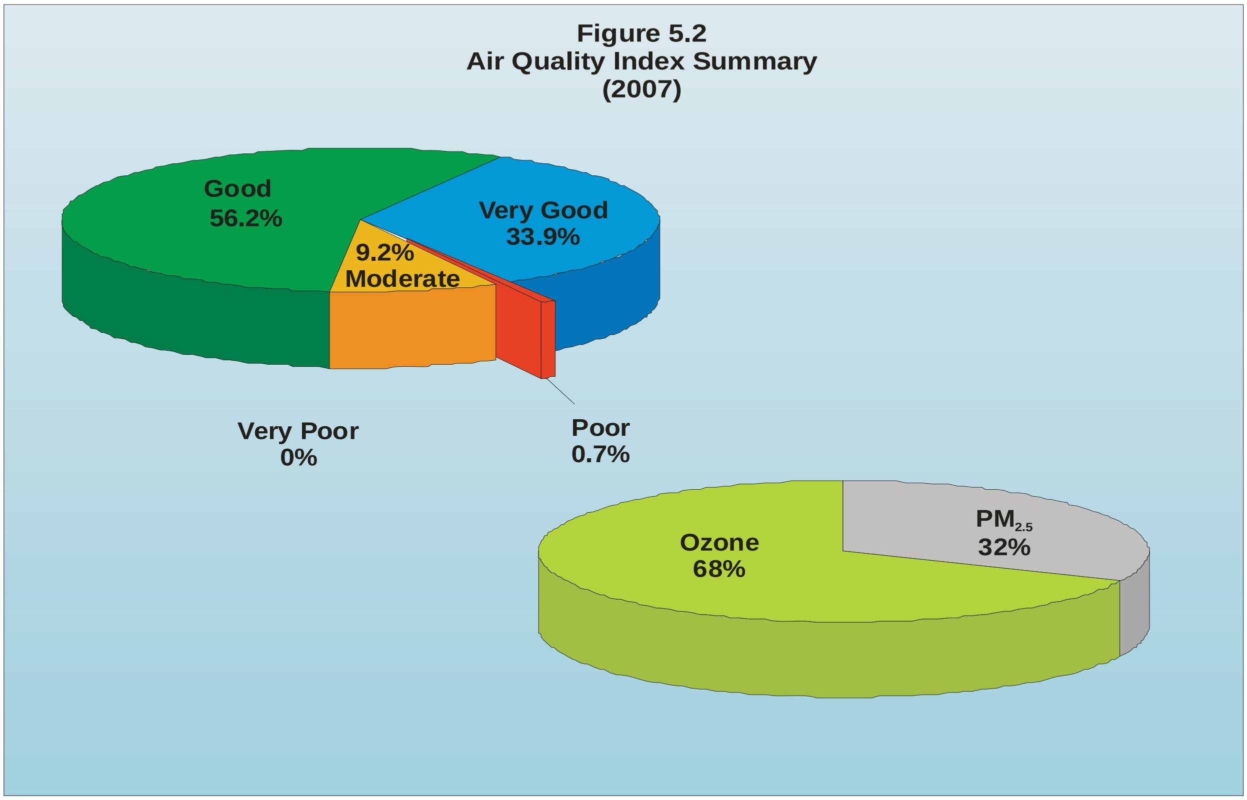
At Sarnia, approximately 64 per cent of the poor hours occurred when the AQI was driven by fine particulate matter. In contrast, at Windsor Downtown, approximately 80 per cent of hours with air quality in the poor category were due to ozone. Approximately 63 per cent of the hours of poor air quality were due to fine particulate matter at Hamilton Downtown. In the Greater Toronto Area approximately 55 per cent of the poor hours were due to fine particulate matter and 45 per cent due to ozone. The four Toronto AQI sites averaged approximately 0.8 per cent of the monitored hours in the poor category with

Table 5.2: Air Quality Index Summary (2007)

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	8755	36.5	48.6	13.5	1.4	0	21
Windsor West	8755	36.4	50.3	12.1	1.2	0	19
Chatham	8757	30.3	56.6	12.2	0.9	0	18
Port Stanley	8616	22.9	62.8	12.8	1.5	0	24
London	8757	38.8	52.2	8.8	0.2	0	6
Sarnia	8754	21.1	63.2	13.9	1.9	0	28
Grand Bend	8702	25.9	62.9	10.1	1.2	0	22
Tiverton	8733	19.3	69.6	9.8	1.2	0	20
Brantford	8758	31.4	56.1	11.8	0.7	0	15
Kitchener	8756	30.6	58.2	10.5	0.8	0	12
Guelph	8749	33.4	56.4	9.5	0.7	0	16
St. Catharines	8722	33.4	54.4	11.5	0.7	0	15
Hamilton Mountain	8722	31.1	56.7	11.3	0.8	0	14
Hamilton West	8758	42.4	48.3	8.8	0.5	0	11
Hamilton Downtown	8757	40.2	48.6	10.5	0.8	0	17
Burlington	8757	42.2	48.7	8.5	0.5	0	13
Oakville	8748	34.6	55.8	9.0	0.6	0	13
Mississauga	8758	47.0	44.1	8.6	0.4	0	9
Brampton	8754	35.1	55.5	8.9	0.5	0	11
Toronto West	8693	50.3	40.5	8.5	0.8	0	15
Toronto Downtown	8760	42.6	47.6	9.1	0.7	0	13
Toronto North	8649	40.4	50.4	8.3	0.8	0	15
Toronto East	8754	46.6	44.3	8.3	0.9	0	17
Oshawa	8698	33.1	58.2	7.8	0.9	0	14
Newmarket	8758	26.3	62.2	10.8	0.7	0	16
Barrie	8752	36.5	56.1	7.2	0.2	0	8
Peterborough	8718	33.0	60.0	6.6	0.4	0	9
Belleville	8750	26.2	62.8	9.5	1.5	0	26
Kingston	8745	19.7	67.0	11.6	1.6	0	24
Morrisburg	8753	30.9	60.5	8.1	0.5	0	10
Cornwall	8751	31.8	60.2	7.6	0.4	0	7
Ottawa Central	8750	37.9	56.6	5.3	0.1	0	2
Ottawa Downtown	8757	44.7	49.9	5.1	0.3	0	7
Petawawa	8752	33.9	61.8	4.2	0.1	0	2
Dorset	8752	30.1	62.6	6.8	0.4	0	12
Parry Sound	8750	24.2	66.3	9.1	0.4	0	10
North Bay	8757	37.3	56.8	5.8	0.0	0	2
Sudbury	8754	35.1	59.7	5.0	0.2	0	5
Sault Ste. Marie	8604	28.9	64.1	7.0	0.0	0	0
Thunder Bay	8757	43.2	54.6	2.2	0.0	0	0

approximately 52 per cent of these hours due to ozone. At Kingston, 63 per cent of the poor air quality hours were due to ozone, whereas at Belleville 95 per cent of the hours of poor air quality were due to ozone. Sudbury was the only site in the province to record poor air quality due to sulphur dioxide, which was for only one hour. Similarly, Hamilton Downtown recorded the only hour of poor air quality due to total reduced sulphur compounds. There were no hours of very poor air quality recorded at any site in Ontario during 2007.

Figure 5.2 shows the provincial average for the percentages of very good, good, moderate and poor air quality as recorded by all sites



across the province in 2007. The pie diagram at top shows the category percentages. The pie diagram at the bottom right breaks down the poor air quality into percentages of pollutants associated with the AQI above 49. Sixty-eight per cent of the poor AQI values were due to ozone, and the remaining 32 per cent were due to fine particulate matter.

Table 5.3 displays the number of days that poor air quality was recorded for at least one hour at selected cities in Ontario during the period 2003 to 2007. The large variability from year to year in the number of days of poor air quality in these cities is due primarily to prevailing meteorological conditions. During the relatively hot, humid conditions of 2005, there was a large number of poor air quality days, whereas during the relatively cooler and more cloudy summers of 2004 and 2006, less days of poor air quality were recorded.

Table 5.3 Number of Days with at Least One Hour AQI > 49 (2003-2007)

City	2003	2004	2005	2006	2007
Windsor Downtown	17	7	37	7	21
Hamilton Downtown	22	12	20	5	16
Toronto Downtown	12	6	20	9	13
Ottawa	5	1	13	1	7
North Bay	7	0	10	3	3

Table 5.4 Number of Days that Ozone, $PM_{2.5}$, and Both Pollutants Resulted in at Least One Hour AQI > 49 (2007)

City	No. of days at least 1hour AQI > 49 due to Ozone only	No. of days at least 1hour AQI > 49 due to $PM_{2.5}$ only	No. of days at least 1hour AQI > 49 due to Ozone and $PM_{2.5}$	Total no. of days AQI > 49
Windsor Dtn.	15	1	5	21
Sarnia	7	9	12	28
London	6	0	0	6
Hamilton Dtn.	6	7	3	16
Toronto Dtn.	7	2	4	13
Kingston	16	2	6	24
Ottawa	1	4	2	7

In 2007, Sarnia recorded the highest number of days (28) 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 poor air quality for at least one hour during 2007 at selected cities in southern Ontario.

Figures 5.3a-c display the daily maximum AQI values on poor days (days with at least one hour in the poor category) at Windsor Downtown, Toronto Downtown, and Ottawa Downtown, respectively, for 2007. The maximum AQI recorded at each of the three sites were 79 at Windsor Downtown, 61 at Toronto Downtown and 58 at Ottawa Downtown.

Figure 5.3a
Daily Maximum AQI Values in the Poor Category at Windsor Downtown (2007)

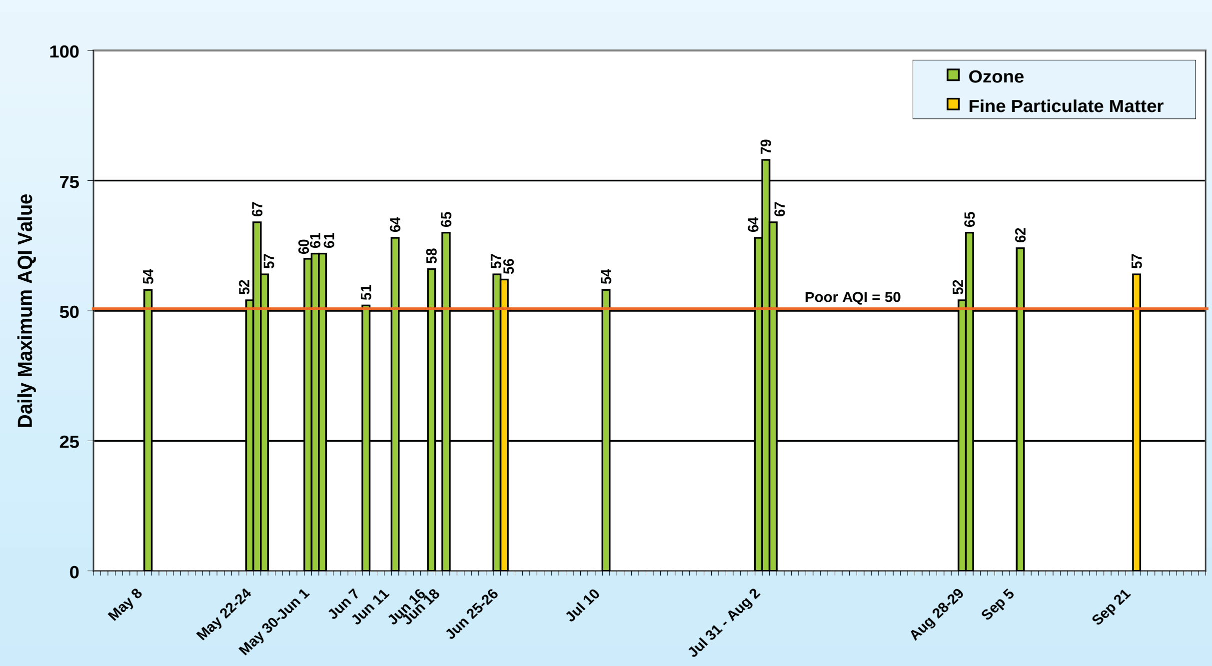


Figure 5.3b
Daily Maximum AQI Values in the Poor Category at Toronto Downtown (2007)

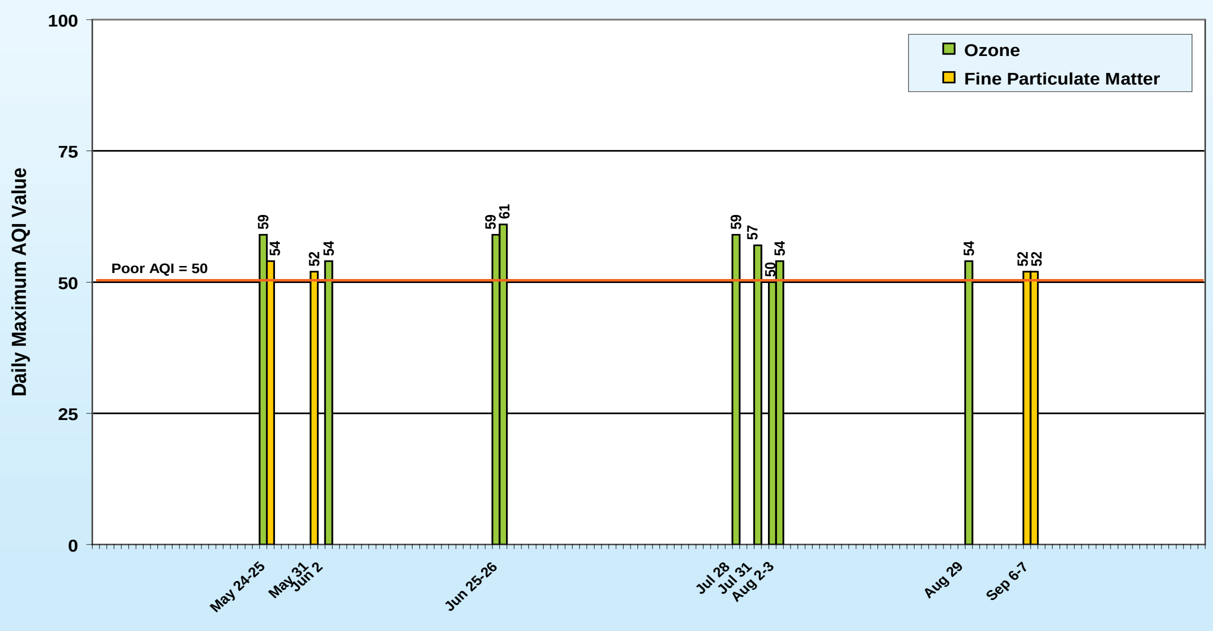
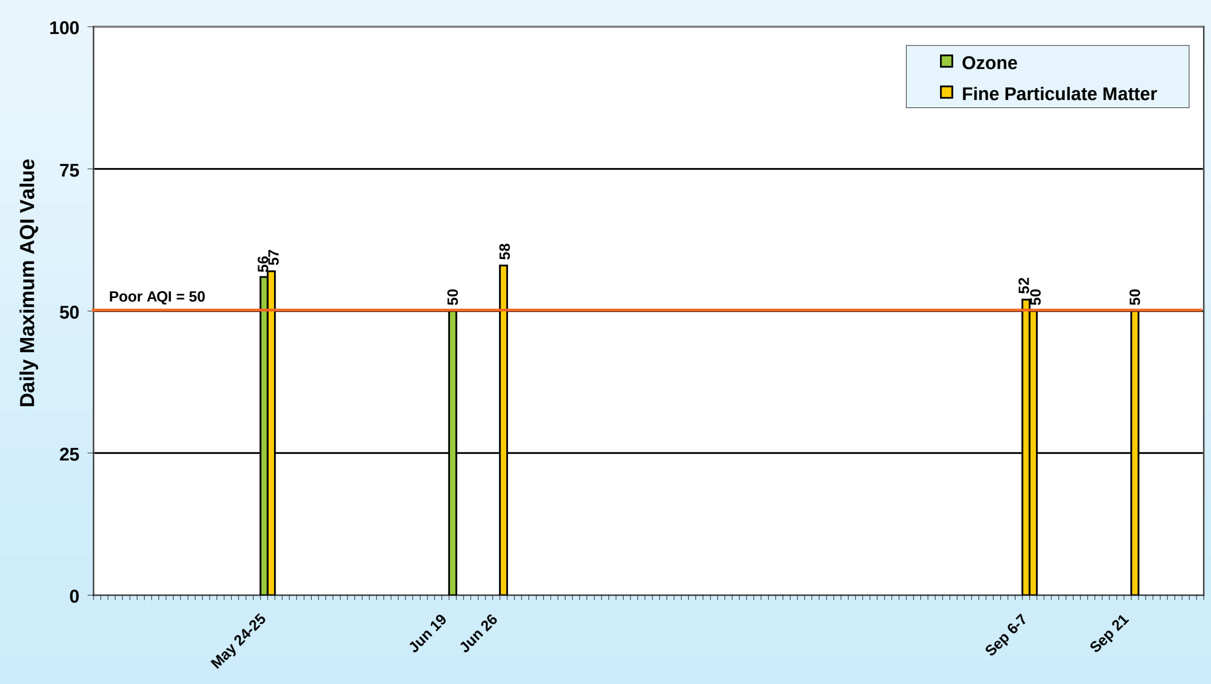


Figure 5.3c
Daily Maximum AQI Values in the Poor Category at Ottawa Downtown (2007)



The number of poor days, and the key pollutant on those days varied between each of the three sites. Windsor Downtown recorded 21 poor days, whereas Toronto Downtown and Ottawa Downtown recorded 13 and seven poor days, respectively. For Windsor, there were 19 poor days due to ozone, and two poor days due to $PM_{2.5}$. For Toronto, ozone was the key pollutant for nine poor days, and $PM_{2.5}$ was the key pollutant for the other four poor days. For Ottawa, ozone was the main pollutant for two poor days, and $PM_{2.5}$ was the main pollutant for five poor days.

Smog Alert program

Smog advisories are issued to the public when widespread, elevated (AQI values greater than 49) and persistent smog (O_3 and/or $PM_{2.5}$) 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 pollutant concentrations are most likely to exceed the one-hour AAQC of 80 ppb for ozone and the Ontario three-hour benchmark of 45 µg/m^3 for $PM_{2.5}$.

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 is 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 in the National Capital Region.

Did you know...

- Every day, the average adult breathes about 15,000 to 20,000 litres of air.

2007 smog advisories

For 2007, Ontarians experienced 13 smog advisories covering 39 days, and 12 of these events occurred during the traditional smog season (May 1 to September 30 inclusive). The remaining one smog advisory covering 2 days was issued in October 2007. The details of these smog advisories are shown in Table 5.5.

In contrast to the low number of smog advisories and smog advisory days in 2006 (6 smog advisories covering 17 days), the year 2007 was the second highest since fine particulate matter was included in the Smog Alert program in 2002, a total of 13 smog advisory days covering 39 days. The number of smog advisory days issued in May 2007 was notable for that month, a total of 10 days. In comparison, the number of smog advisory days in May ranged from 0 to 5 during the previous five years. A history of smog advisories and smog advisory days since 2002 is shown in Figure 5.4.

2007 smog episodes

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

Table 5.5 Smog Advisory Statistics for Ontario (2007)

Advisory	Advisory Period	Duration of Advisory
1	May 8-10	3 days
2	May 15	1 day
3	May 23-25	3 days
4	May 29-June 3	6 days
5	June 7	1 day
6	June 11-19	9 days
7	June 25-27	3 days
8	July 9-11	3 days
9	July 3-August 3	4 days
10	August 29	1 day
11	September 6-7	2 days
12	September 19	1 day
13	October 5-6	2 days

Figure 5.4
Summary of Smog Advisories Issued
(2002 - 2007)

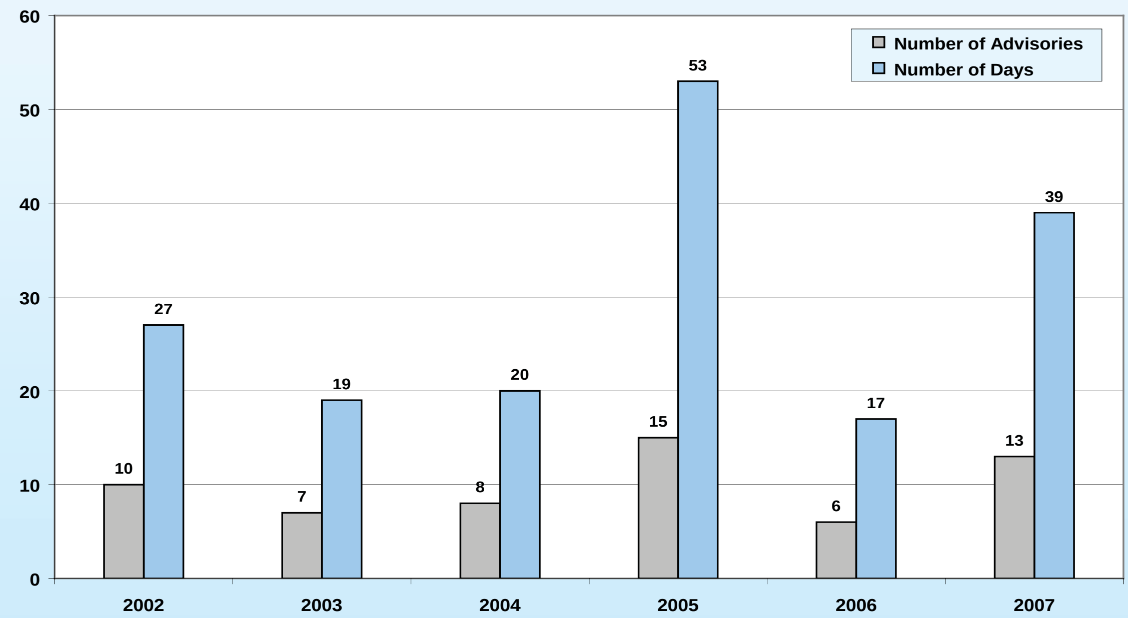
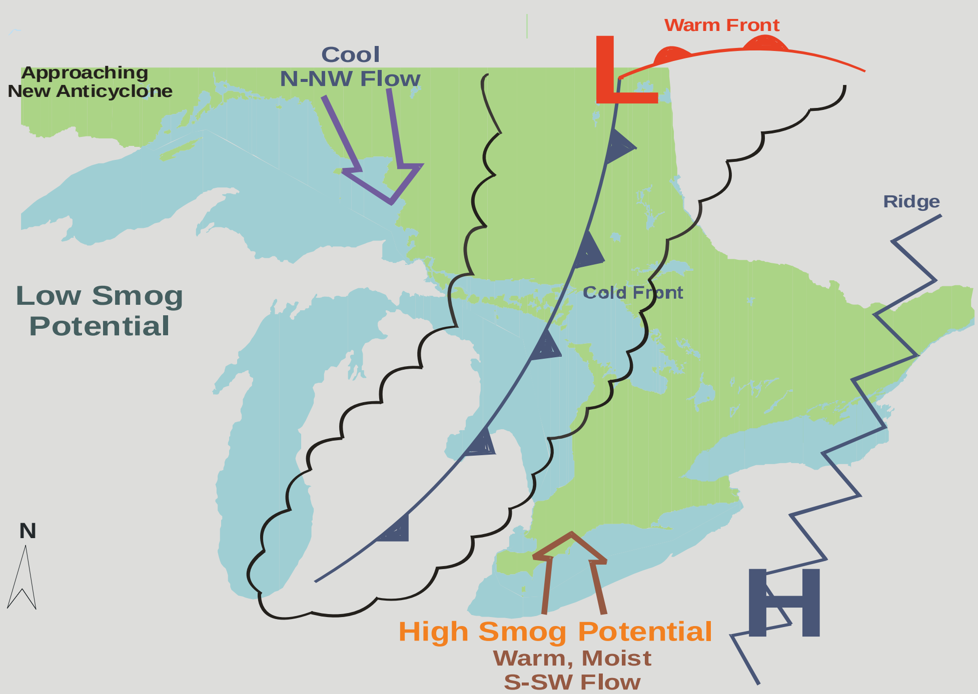


Figure 5.5
Generalized Synoptic Weather Pattern Over Southern Ontario
Conducive to Elevated Pollutant Levels



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.

Smog episodes in the winter in Ontario are due primarily to fine particulate matter, and are typically associated with relatively stagnant conditions, the development of strong temperature inversion conditions overnight, and the trapping of air pollutants near the ground.

In 2007, Ontario experienced significantly more transboundary polluted air as the conditions upwind often favoured the opportunity for smog formation there and subsequent transport into southern regions of the province. Temperature conditions were also more conducive in 2007 compared to that of 2006 for the development of elevated smog levels across southern Ontario. For example, in 2007 Windsor recorded 35 hot days (days on which the maximum temperature was greater than 30°C) and was in marked contrast to the 16 hot days in 2006. These contrasting weather conditions between 2006 and 2007 resulted in significantly more smog incidences in 2007 compared to those in 2006.

Ways to reduce smog...

At home:

- Restrict your use of gasoline-powered equipment. Avoid mowing the lawn when air quality is poor.

At work:

- If possible, take public transit, or walk to work.
- If you use a car, don’t travel alone, encourage and facilitate carpooling.
- Consider teleconferencing instead of travelling to meetings.

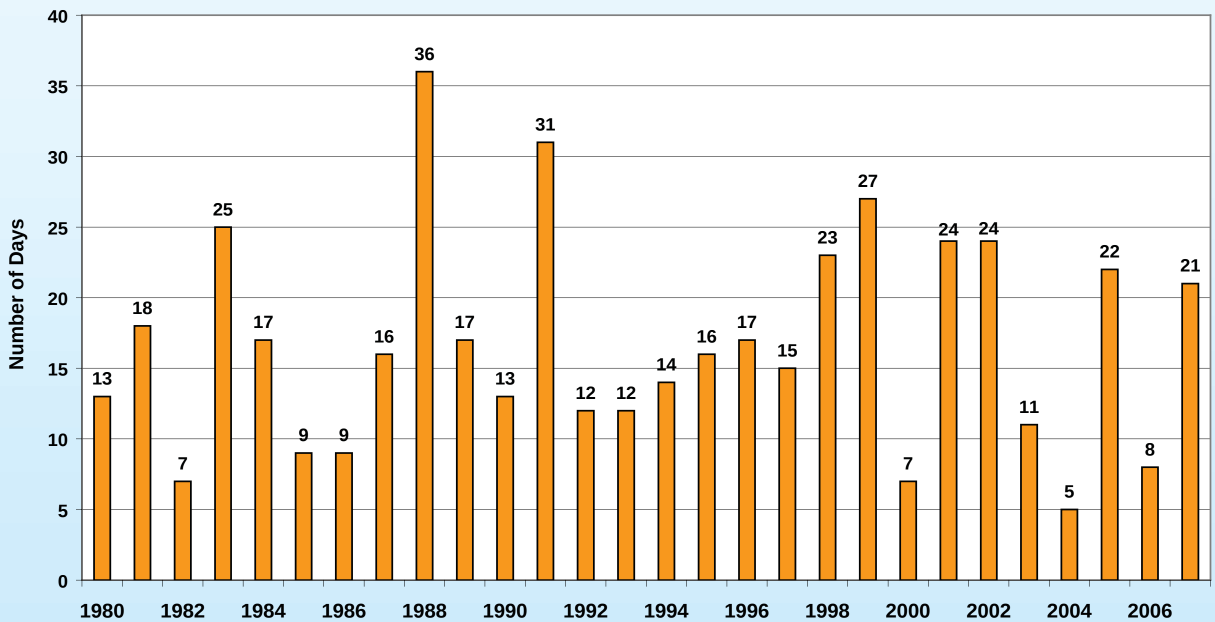
Smog episodes in 2007 were typically of one or two- day durations, and these events were dominated by ozone or ozone and fine particulate matter. There was one three-day episode (May 23-25, 2007) which was the most widespread event (described below) and one four-day event (May 30-June 2, 2007) which was the most persistent. A description is also included below of the two day event on September 21-22, 2007 which was primarily driven by particles.

The most extensive smog event of the season occurred during the period May 23 to May 25, 2007. On May 23, hot, hazy, humid and sunny conditions combined with a southerly flow of polluted air from the U.S. and local build-up of pollutants began to impact areas of southwestern, central and parts of northern and eastern Ontario. Poor air quality due to ground-level ozone occurred at 15 sites, and the maximum one-hour level of 125 ppb (the third highest hourly ozone value recorded in 2007) occurred at Grand Bend, a rural site on the eastern shores of Lake Huron. By May 24, the hot, sunny conditions coupled with a southwesterly flow of polluted air had invaded all of southern, central and parts of eastern and northern Ontario. On this day, 38 of the 40 AQI sites across Ontario recorded poor air quality due to ground-level ozone, and the maximum one-hour level of 113 ppb occurred at Port Stanley, on the northern shores of Lake Erie. The second highest maximum one-hour level of 110 ppb on this day occurred at Belleville, located near the north shore of Lake Ontario. Poor air quality due to fine particulate matter was also reported at 22 sites on May 24 with the maximum three-hour average concentration of 54 $\mu g/m^3$ recorded at Sarnia and Grand Bend. By mid- morning of May 25, cloudiness and west to northwesterly winds covered northern Ontario as a cold front tracked southeastward. Elsewhere, hot, hazy and humid conditions and elevated smog levels persisted over southern, central and eastern Ontario much of the day until the cold front swept through the area that evening. Twenty-six sites recorded poor air quality and of these, 13 had poor levels due to ozone and 20 had poor levels due to fine particulate matter. The maximum one-hour ozone reading was 101 ppb, and this occurred at Belleville, located near the north shore of Lake Ontario. For fine particulate matter, the maximum three-hour average concentration on May 25 was 56 µg/m^3, and this occurred at Sarnia. This was followed closely by 55 µg/m^3 at Toronto West.

The two-day episode on September 21 and 22, 2007 occurred over southern and parts of eastern Ontario as a southwesterly flow of hot, humid and polluted air moved unexpectedly into the province in advance of a delayed weather system of cleaner air from the west. This occurred primarily during the late afternoon, evening and night of September 21 and the early morning of September 22 before a cold front moved over the region. Elevated levels of ozone and fine particles were experienced on September 21; only concentrations of fine particles were elevated in the early morning on September 22. On September 21, twelve sites, primarily in the southwest regions of the province, recorded poor levels due to ozone in the afternoon and evening. Twenty-four sites in the southern and eastern regions recorded high levels of fine particulate matter overnight. The maximum one-hour ozone reading was 93 ppb, and this occurred at Chatham in southwestern Ontario and Belleville located near the north shore of Lake Ontario. The maximum three-hour average concentrations of fine particulate matter reached 71 µg/m^3 at Burlington and 70 µg/m^3 at Hamilton Mountain and Guelph. On September 22, nine sites had levels in the poor range due to fine particulate matter with the maximum three-hour average concentrations of 65 µg/m^3 at Oakville and 64 µg/m^3 at Brampton. These particle levels were among the highest recorded in 2007.

Occurrences of elevated ozone and fine particulate matter 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 2007 is depicted in Figure 5.6. This

Figure 5.6
Number of Ozone Episode Days in Ontario
(1980 - 2007)



Note: ***Ozone episode days*** **are days with widespread ozone levels > 80 ppb.**

shows that the number of *ozone episode days* in 2007 was relatively high, a total of 21, and was in marked contrast to the total of 8 such days in 2006.

The second highest number of smog episode days (due to ozone and/or $PM_{2.5}$) over the past five years occurred in 2007. There were 22 such days in 2007, 11 such days in 2006, 31 in 2005, 15 in 2004, and 12 in 2003. For 2007, all cases occurred in the summertime and were driven by ozone or ozone and fine particles (21 of the 22 cases). There was one episode day that was dominated by fine particles only. Of the five years, smog episode days were dominated by fine particulate matter in only one year, namely, 2004 (10 of the 15 days). The results for the five years are summarized in Table 5.6.

The air flow into Ontario, as shown with 48-hour back trajectories on smog episode days during 2007, is depicted in Figure 5.7. The fine particulate matter episode that occurred on September 22 took place in the early morning. This figure 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.

Table 5.6 Smog Episode Days in Ontario (2003 – 2007)

Year	Smog Episode Days Due to			Total Number of Smog Episode Days
	Ozone	Ozone and $PM_{2.5}$	$PM_{2.5}$	
2003	5	6	1	12
2004	2	3	10	15
2005	14	8	9	31
2006	5	4	2	11
2007	13	8	1	22

Figure 5.7
48-Hour Back Trajectories at 500m Arriving at London, Ontario at 1300 EDT on Smog Episode Days in 2007

Chapter 6

Special Studies

This chapter examines two separate studies conducted in the province of Ontario in 2007. The first study was designed to assist in the characterization of the airshed in the U.S.-Canada border region of southwestern Ontario and explore the regional transport of air pollution. The second study was initiated to support the City of Ottawa in the development of an operational mapping service for the National Capital Region with a focus on the spatial distribution of air pollutants. The results of these two studies have been analysed and summarised below.

BORDER AIR QUALITY STUDY – AN AMBIENT AIR QUALITY OVERVIEW FOR SOUTHWESTERN ONTARIO

Introduction

The purpose of the Border Air Quality Study (BAQS) was to gain insight into the sources of air pollution, in addition to the impacts of the transboundary flow of pollutants and lake effects during smog episodes in southwestern Ontario. Air quality data were collected from three temporary sites – Harrow, Pelee Island and Ridgetown – located in the U.S.-Canada border region, and compared to nine fixed air monitoring stations from Ontario's network over the study period, June 20, 2007 to July 10, 2007. The monitoring site locations during the study period are displayed in Figure 6.1.

Data Analysis

The air pollutants monitored during the study period include ozone, $PM_{2.5}$, NO_2, SO_2 and CO. The summary statistics for one-hour ozone are shown in Figure 6.2. Monitoring sites located along the northern shore of Lake Erie and the southern shores of Lake Huron recorded the maximum one-hour and eight-hour ozone concentrations. The highest one-hour and eight-hour ozone concentrations were 131 ppb and 96 ppb, respectively, measured at Grand Bend on June 25, 2007. London, the site located furthest inland, recorded the lowest maximum concentration for both one-hour and eight-hour ozone, 76 and 68 ppb, respectively. All sites exceeded the ozone one-hour criterion of 80 ppb, with the exception of London. The number of exceedances was higher at stations located on the shores of Lake Erie and Lake Huron, such as Port Stanley, Harrow and Grand Bend, and Pelee Island located in Lake Erie. Harrow recorded the most number of days (5) that exceeded Ontario's one-hour AAQC.

How to protect yourself

- Check the Air Quality Index in your community, especially during the traditional smog season (from May to September). If a smog advisory is issued in your community, tailor your activities accordingly.
- Avoid or reduce strenuous physical outdoor activities when smog levels are high, especially during the late afternoon when ground-level ozone reaches its peak. Try not to exert yourself outdoors.
- Avoid or reduce exercising near areas of heavy traffic, especially during rush hour, because motor vehicles are a primary source of air pollution.
- If you have a heart or lung condition, talk to your doctor about additional ways to protect your health when smog levels are high.

Figure 6.1
2007 Border Air Quality Study and Surrounding Ministry Monitoring Sites

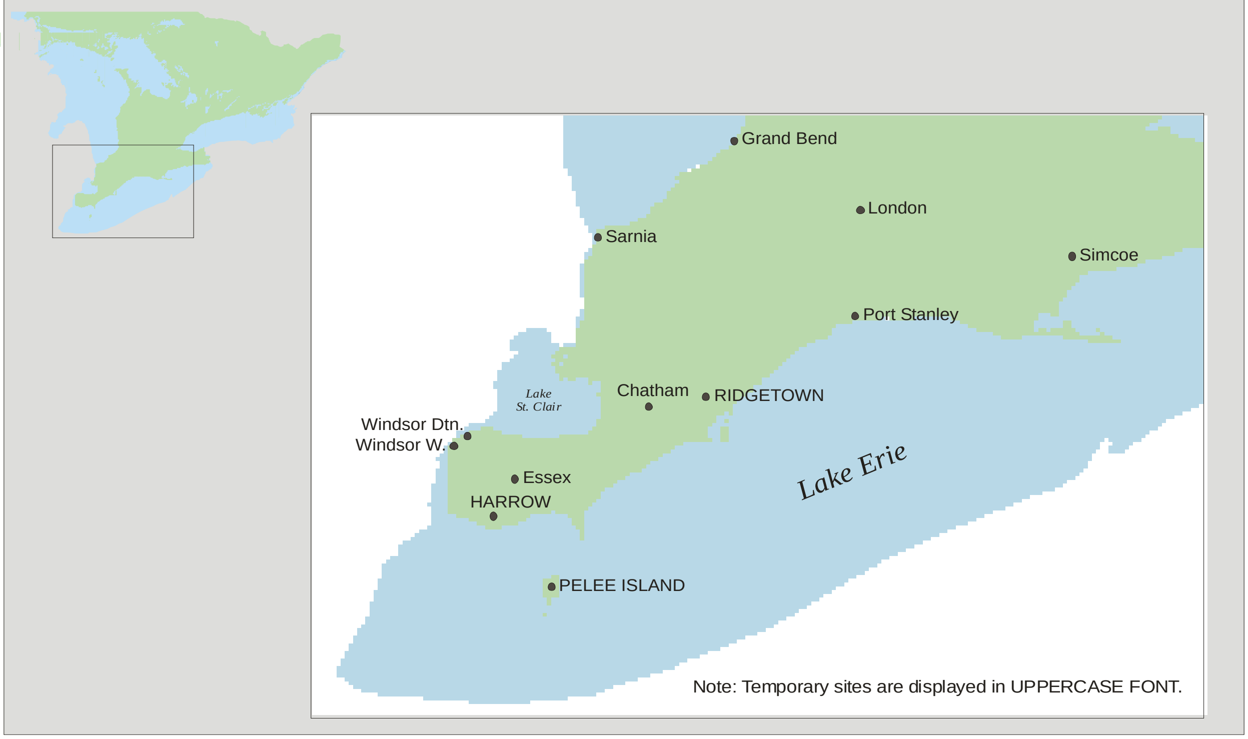


Figure 6.2
Summary Statistics for One-Hour Ozone
at Ministry Sites Across Southwestern Ontario During the Study Period
June 20 - July 10, 2007

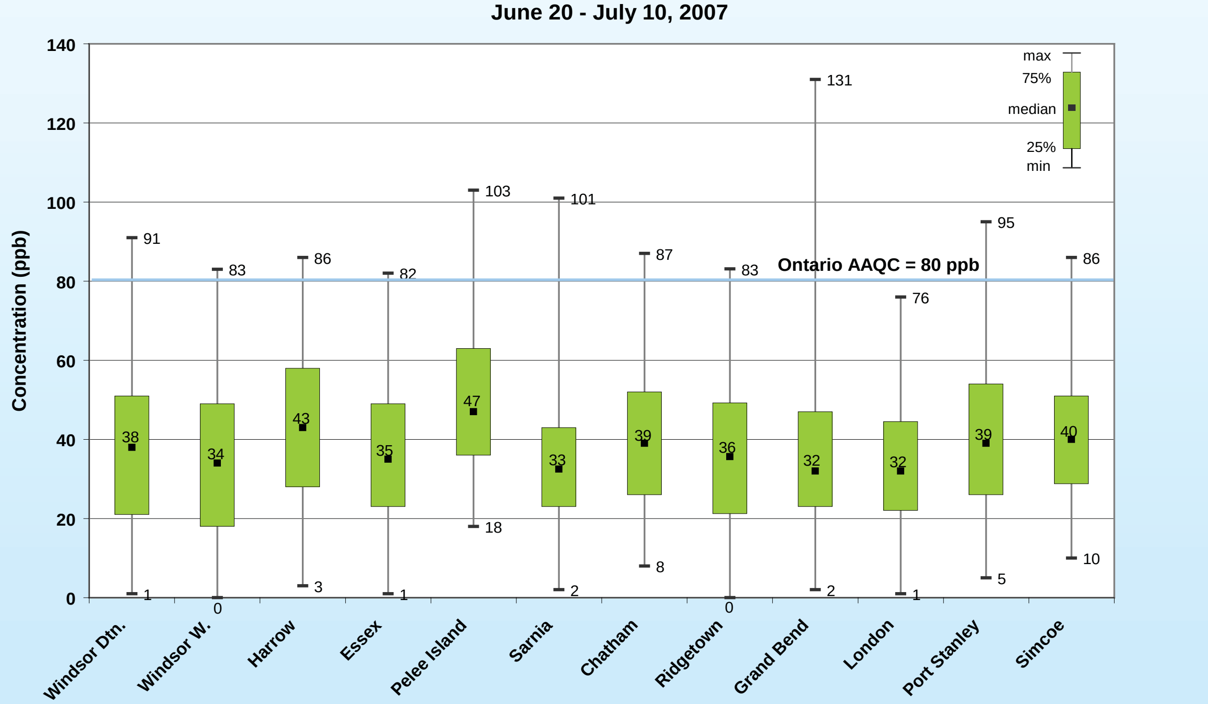


Figure 6.3 displays the summary statistics for 24-hour $PM_{2.5}$ concentrations. The maximum 24-hour $PM_{2.5}$ concentration was 36 µg/m³, measured at both Windsor Downtown and Sarnia, on June 25, 2007. In general, median $PM_{2.5}$ concentrations were higher at urban sites due to local $PM_{2.5}$ in addition to the background concentration, and were also higher at sites in close proximity to the U.S.-Canada border region. Six of the 11 ambient air monitoring sites exceeded the 24-hour reference level of 30 µg/m³.

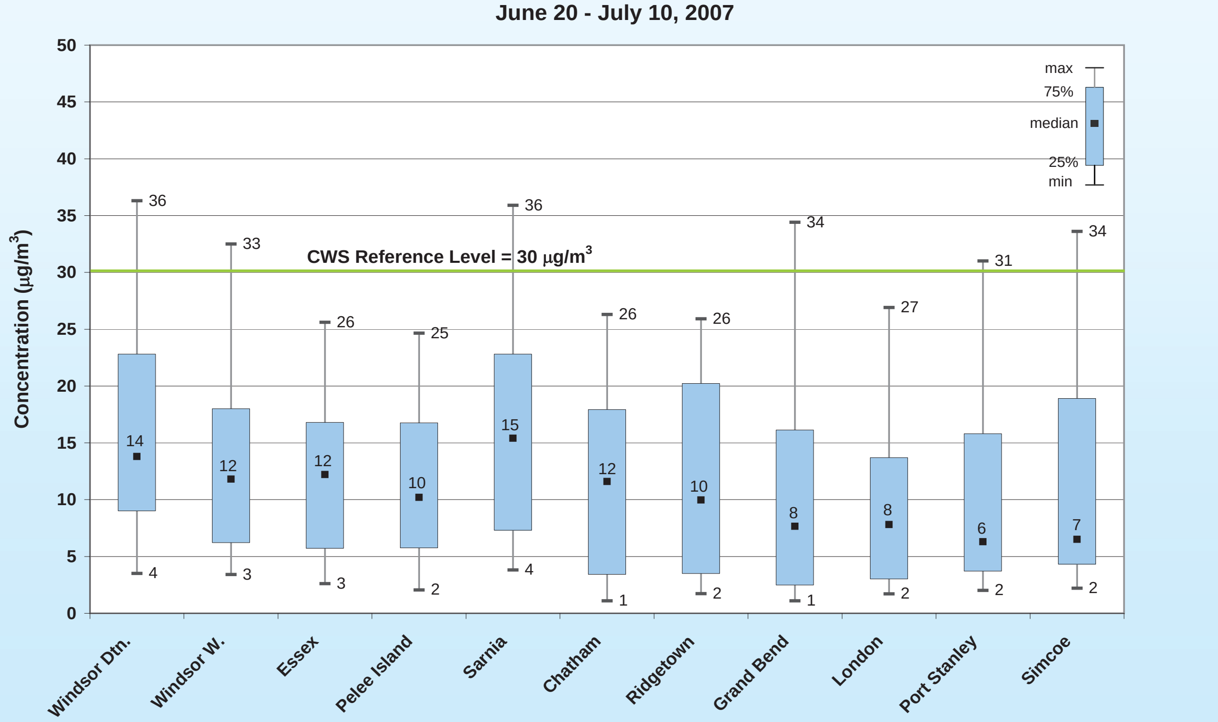
The study also examined black carbon (BC), as part of the $PM_{2.5}$ composition, at Windsor West, Pelee Island and Ridgetown. BC is composed of elemental carbon and is released from the combustion of fuels (most notably diesel), and biomass burning, including forest fires. The highest BC concentrations were recorded at Windsor West, an urban site that is surrounded by industrial sources in the Windsor/Detroit airshed; therefore, the local sources plus the transboundary sources of BC result in the higher concentrations measured at this site.

Both rural sites, Pelee Island and Ridgetown, provide indications of transboundary impact of BC levels in the air mass.

Windsor West measured the highest one-hour NO_2 concentration (51 ppb) and Windsor Downtown recorded the maximum 24-hour NO_2 concentration (22 ppb). In the rural areas of the study, maximum one-hour NO_2 concentrations ranged between 15 ppb to 20 ppb. Generally, higher NO_2 concentrations are recorded in large urbanized areas influenced by vehicular traffic. 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 sites during the study period.

Windsor Downtown measured the highest maximum one-hour CO concentration (1.01 ppm) and eight-hour CO concentration (0.49 ppm) from June 20, 2007 to July 10, 2007. The maximum CO concentrations recorded during the study period were below the provincial one-hour (30 ppm) and eight-hour (13 ppm) AAQC.

Figure 6.3
Summary Statistics for 24-Hour Average Fine Particulate Matter at Ministry Sites Across Southwestern Ontario During the Study Period June 20 - July 10, 2007



Sarnia recorded the highest one-hour SO_2 concentration of 134 ppb on July 10 when the winds were southwesterly. High SO_2 concentrations in Sarnia generally result from emissions of the utilities and petroleum-based industries. Relatively high concentrations were also recorded at Windsor Downtown, Windsor West and Essex, indicating the influence of industrial sources in the Windsor/Detroit airshed. Ontario's one-hour AAQC for SO_2 (250 ppb) was not exceeded during the study period.

Conclusion

The examination of the air pollutant concentration measurements in the U.S.-Canada border region, combined with observations from back trajectories, concludes air parcels containing elevated pollutant levels were most likely brought into Ontario from the U.S. during the study period, June 20, 2007 to July 10, 2007. The polluted air from the U.S. combined with local contributions resulted in the elevated pollutant concentrations therefore exceeding the one-hour AAQC for ozone and the 24-hour reference level for $PM_{2.5}$. The AAQC for NO_2, CO and SO_2 were not exceeded at any of the study sites. The complete Border Air Quality Study report can be accessed via the ministry web site (www.ene.gov.on.ca).

CITY OF OTTAWA STUDY – NATIONAL CAPITAL REGION INTEGRAL AIR QUALITY MAPPING SERVICE

The City of Ottawa study is a 15-month project (September 2007 to December 2008) to map air quality concentrations across the municipality as a basis for future environmental decisions and public health protection. The project is sponsored by GeoConnections, a program of Natural Resources Canada. The Ontario Ministry of the Environment is providing technical support for the project, as are Environment Canada, Transport Canada and the Ottawa Macdonald-Cartier International Airport. The study consists of data from a satellite monitoring system, two permanent provincial AQI stations (Ottawa Downtown and Ottawa Central), and three mobile monitoring units, including one from the ministry, recording week-long measurements on a rotational basis at select sites throughout Ottawa. The following discussion will focus on the measurements recorded by the ministry from September 13, 2007 to October 30, 2007, during the first phase of the project.

The ministry collected data from the two AQI sites, Ottawa Downtown and Ottawa Central, in addition to data measured by two mobile air quality units (mobile AQI unit and mobile PM unit) sited in Glen Cairn and Orleans during the study period. The land-use representation of the local surroundings of study locations are displayed in Figure 6.4. The sampling locations and sampling periods are presented in Table 6.1. The pollutants measured for the study include ozone, $PM_{2.5}$, NO_2, CO and SO_2.

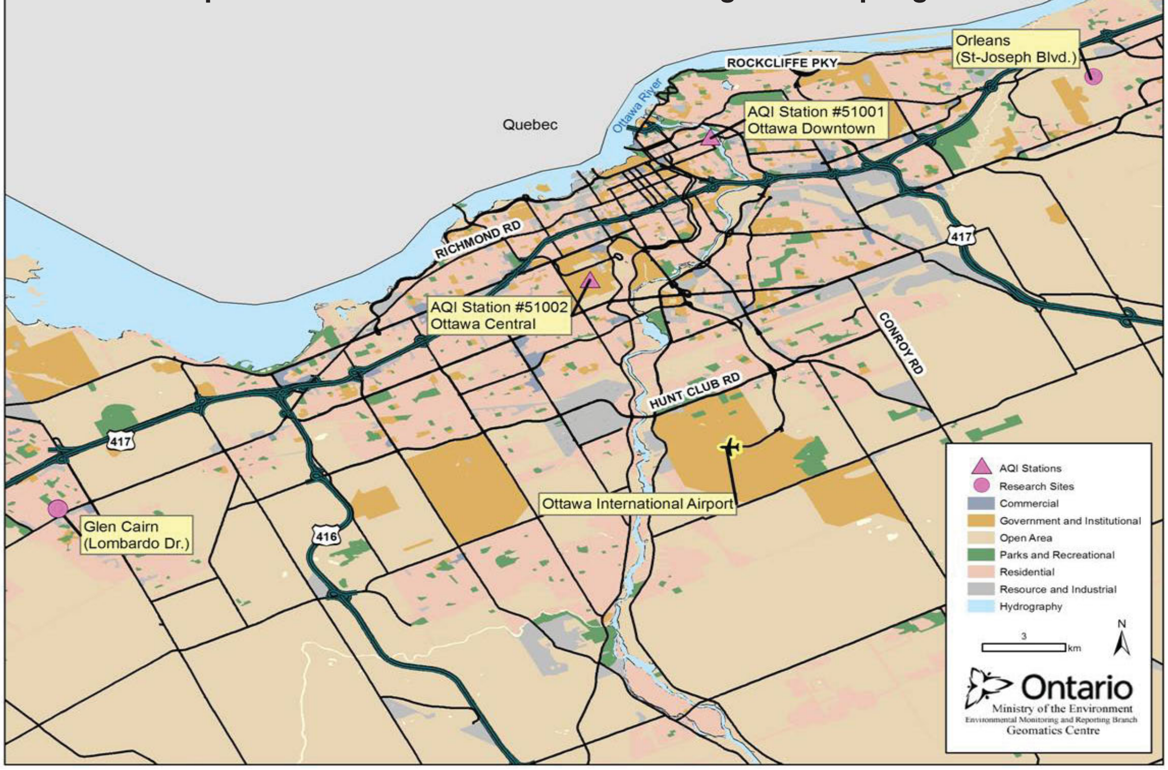
Figure 6.5 displays the daily one-hour maximum ozone concentrations recorded at the ministry sites during the Ottawa Study. There are no significant differences between the daily one-hour maximum ozone concentrations. No one site was more dominant than the others in terms of ambient ozone levels. Ottawa Central recorded the highest one-hour ozone maximum concentration (72 ppb); however, it was below Ontario's one-hour AAQC of 80 ppb.

Figure 6.6 displays the running three-hour average $PM_{2.5}$ concentrations at the ministry sites during the study period. There was no significant difference between the $PM_{2.5}$ concentrations measured at the four sites. Ottawa Downtown was the only site to exceed the Ontario three-hour benchmark of 45 $\mu g/m^3$ which is the threshold for poor air quality based on $PM_{2.5}$. This site recorded poor air quality for a duration of two consecutive hours.

Similar to the ozone and $PM_{2.5}$ measurements, concentrations of NO_2, CO and SO_2 were comparable and far below their associated provincial criteria. The measurements obtained throughout the study confirm that there is no significant difference between observed levels.

These data provided by the ministry during the 2007 study period will assist the City of Ottawa with the mapping of air quality concentrations

Figure 6.4
Land-use Representation of the Local Surroundings of Sampling Site Locations



over an extensive area. Details on the spatial and temporal distribution of air pollution and the ability to forecast such levels over an urban area are becoming of increasing importance in the characterization of urban air quality. Such information is essential for the interpretation of impacts and in the development of appropriate control strategies. This project by the City of Ottawa to establish an operational mapping service of the spatial distribution of air pollutants in the National Capital Region is made possible by complimentary approaches to studying air quality: stationary and mobile air monitoring, air modelling and satellite remote sensing of air pollutant concentrations. The ministry will continue to participate in the Ottawa project throughout 2008.

Table 6.1: Ministry Sampling Locations and Sampling Periods for Ottawa Study

Sampling Location	Station No./Monitoring Unit	Sampling Period
Ottawa Downtown	51001	September 13 – October 30, 2007
Ottawa Central	51002	September 13 – October 30, 2007
Glen Cairn	AQI Mobile Unit	September 13 – October 10, 2007
Orleans	PM Mobile Unit AQI Mobile Unit	September 18 – October 11, 2007 October 13 – October 16, 2007

Figure 6.5
Daily One-Hour Maximum Ozone Concentrations at Ministry Sites for the Ottawa Study (September 13 - October 16, 2007)

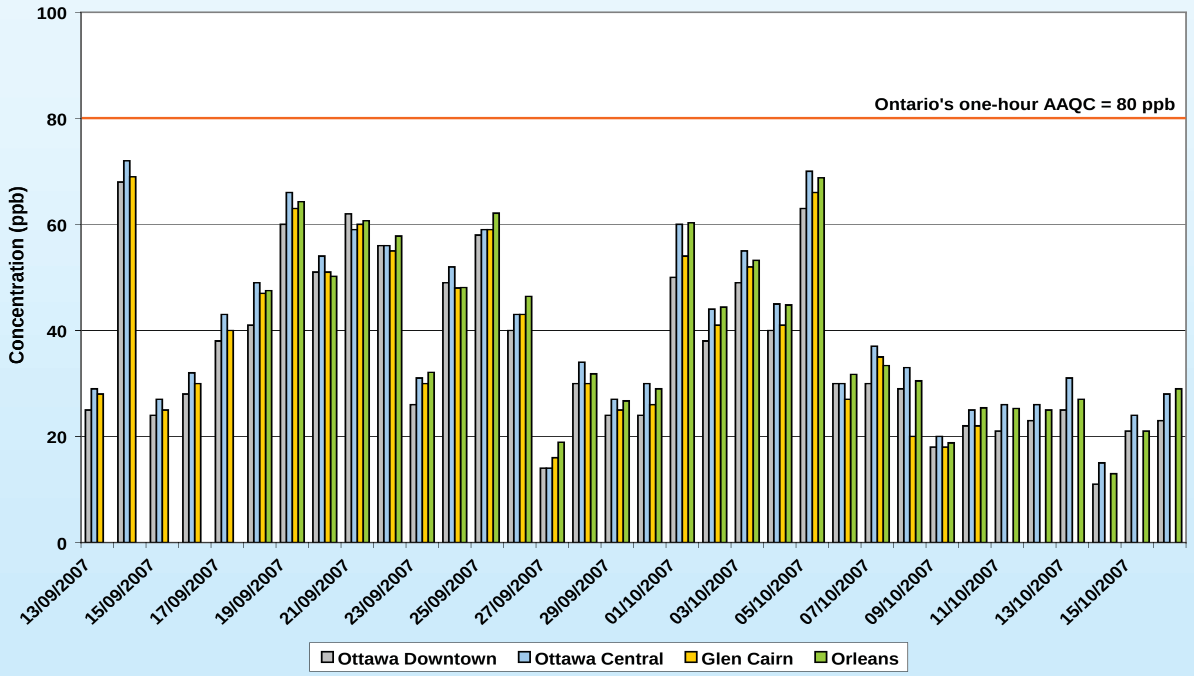
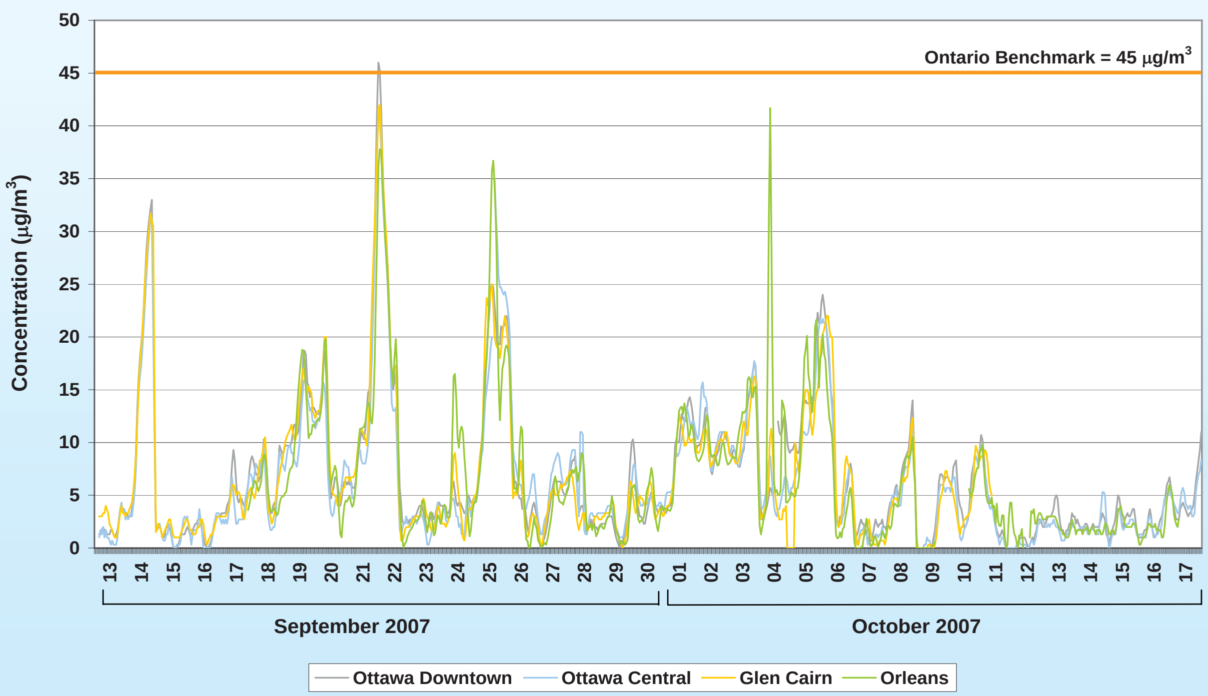


Figure 6.6
Three-Hour Average $PM_{2.5}$ Concentrations at Ministry Sites for the Ottawa Study (September 13 - October 17, 2007)



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 pollutants	-	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.
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 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 $PM_{2.5}$ or respirable particles. These are fine enough to penetrate deep into the lungs.

Fossil fuels - natural gas, petroleum, coal and any form of solid, liquid or gaseous fuel derived from organic materials for the purpose of generating heat.

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.

Photochemical smog - see *smog*.

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

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.
Smog episode day	-	A day with widespread and persistent ozone levels greater than the Ontario one-hour AAQC of 80 ppb and/or a day with widespread and persistent $PM_{2.5}$ levels greater than the three-hour average of 45 $\mu g/m^3$.
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
BAQS	-	Border Air Quality Study
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
LADCO	-	Lake Michigan Air Director's Consortium
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	-	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
2007 REPORT

APPENDICES

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 to the province of Ontario.

APPENDICES
TABLE OF CONTENTS

INTRODUCTION

The Appendices are intended for use in conjunction with the 2007 Annual Air Quality in Ontario report. The Appendices briefly describe the provincial Air Quality Index (AQI) network, quality assurance and quality control procedures and the Ministry of the Environment's air quality database. It also includes a series of tables displaying station locations and a listing of the summary statistics including means, maximums, percentile values and the number of exceedances of the Ontario ambient air quality criteria (AAQC) for each pollutant. In addition, trends for select pollutants are displayed for 10- and 20-year periods.

MONITORING NETWORK OPERATIONS

Network Description

In 2007, the AQI network was comprised of 139 continuous monitoring instruments at 40 sites. These instruments have the capability of recording minute data (approximately 73.1 million data points per year) that are used to scan and validate the continuous hourly data. During 2007, the Environmental Monitoring and Reporting Branch (EMRB) operated all of the ambient air monitoring sites. Monitoring site locations for the AQI 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 2007 ambient air quality monitoring network had greater than 98 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 8,760 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 6,570 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.

NETWORK DESCRIPTIVE TABLE, ANNUAL STATISTICS AND TRENDS

The AQI network for 2007 is summarized in Table 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 2007 statistical data and 10-year trends for various continuous pollutants are provided in Appendices A and B, respectively. 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 1998-2007.

The 20-year trends for ozone, NO_2, CO and SO_2 are provided in Appendices C-F. To be included in the 20-year trend analysis, a site must have valid annual means for a minimum of 15 years over the 20-year period from 1988-2007.


Map 1: Locations of Air Quality Index Stations in Ontario (2007)
Sault Ste. Marie
Sudbury
North Bay
Petawawa
Ottawa Dtn.
Ottawa C.
Cornwall
Morrisburg
Thunder Bay
Lake Superior
Georgian Bay
Parry Sound
Dorset
Kingston
Peterborough
Belleville
Barrie
Lake Huron
Tiverton
Newmarket
Oshawa
Brampton
Toronto
Lake Ontario
Guelph
Mississauga
Oakville
Kitchener
Burlington
Hamilton Dtn.
Hamilton W.
Hamilton Mtn.
St. Catharines
Grand Bend
Brantford
Sarnia
London
Port Stanley
Windsor Dtn.
Windsor W.
Lake Erie
Permanent AQI Sites
Seasonal AQI Sites
Toronto
Toronto N.
Toronto E.
Toronto Dtn.
Toronto W.

Table 1: 2007 Ontario Air Quality Index 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`56.8``	-83°02`37.21``	8	A/C/N	Y	T	T	T	T	T	.
12016	WINDSOR WEST	COLLEGE/SOUTH ST.	1975	42°17`34.43``	-83°04`23.25``	4	A/N	Y	T	T	T	.	T	T
13001	CHATHAM	435 GRAND AVE. W.	2005	42°24`13.33``	-82°12`29.92``	15	A/C/N	Y	T	T	T	T	T	.
14064	SARNIA	FRONT ST./CN TRACKS/CENTENNIAL PARK	1976	42°58`56.23``	-81°24`18.32``	3	A/N	Y	T	T	T	.	T	T
15020	GRAND BEND	WATER TREATMENT PLANT	1991	43°19`59.1``	-81°44`34.4``	10	A/N	S	T	T	.	.	.	.
15025	LONDON	900 HIGHBURY AVE.	1995	43°00`24.19``	-81°12`23.12``	4	A/C/N	Y	T	T	T	T	T	.
16015	PORT STANLEY	43665 DEXTER LINE/ ELGIN WATER T. PLANT	2002	42°40`19.5``	-81°09`46.36``	5	A/N	S	T	T	.	.	.	.
18007	TIVERTON	CONCESSION RD. 2/ LOT A	1979	44°18`52.1``	-81°32`58.96``	4	A/N	S	T	T	T	.	T	.
21005	BRANTFORD	324 GRAND RIVER AVE.	2004	43°08`18.97``	-80°17`33.52``	5	A/N	Y	T	T	T	.	.	.
26060	KITCHENER	WEST AVE./HOMEWOOD	1990	43°26`37.8``	-80°30`13.7``	5	A/C/N	Y	T	T	T	.	.	.
27067	ST. CATHARINES	ARGYLE CRES./ PUMP STN.	1987	43°09.36`16``	-79°14`5.13``	4	A/C/N	Y	T	T	T	.	.	.
28028	GUELPH	EXHIBITION ST./CLARK ST.	2000	43°33`05.8``	-80°15`51.0``	4	A/C/N	Y	T	T	.	.	.	.
29000	HAMILTON DOWNTOWN	ELGIN/KELLY	1987	43°15`27.99``	-79°51`42.04``	4	A/C/N	Y	T	T	T	T	T	T
29114	HAMILTON MOUNTAIN	VICKERS RD./E. 18TH ST.	1985	43°13`45.31``	-79°51`44.1``	3	A/C/N	Y	T	T	T	.	T	.
29118	HAMILTON WEST	MAIN ST. W./ HWY 403	1985	43°15`26.81``	-79°54`27.85``	3	A	Y	T	T	.	.	.	.
31103	TORONTO DOWNTOWN	BAY/WELLESLEY ST.	2000	43°39`46.72``	-79°23`17.24``	10	A/C/N	Y	T	T	T	T	T	.
33003	TORONTO EAST	KENNEDY/LAWRENCE	1970	43°44`52.52``	-79°16`26.61``	4	A/C/N	Y	T	T	T	.	.	.
34020	TORONTO NORTH	HENDON/YONGE ST.	1988	43°46`53.76``	-79°25`03.80``	5	A/C/N	Y	T	T	T	.	.	.
35125	TORONTO WEST	125 RESOURCES RD.	2003	43°42`33.97``	-79°32`36.57``	8	A/C/N	Y	T	T	T	T	T	.
44008	BURLINGTON	HWY 2/NORTH SHORE BLVD. E.	1979	43°18`54.37``	-79°48`09.52``	5	A/C/N	Y	T	T	T	.	.	.
44017	OAKVILLE	8TH LINE/GLENASHTON DR./ HALTON RESERVOIR	2003	43°29`12.9``	-79°42`08.2``	12	A/C/N	Y	T	T	T	.	.	.
45026	OSHAWA	2200 SIMCOE ST. N./ DURHAM COLLEGE	2005	43°56`45.35``	-78°53`41.69``	7	A/C/N	Y	T	T	T	.	.	.
46089	BRAMPTON	525 MAIN ST. N./ PEEL MANOR	2000	43°41`55.47``	-79°46`51.27``	5	A/C/N	Y	T	T	T	.	.	.
46109	MISSISSAUGA	FRANK McKECHNIE COMM. CTR	2004	43°36`57``	-79°39`09``	10	A/C/N	Y	T	T	.	.	.	.
47045	BARRIE	83 PERRY ST.	2001	44°22`56.47``	-79°42`8.32``	5	A/C/N	Y	T	T	T	.	.	.
48006	NEWMARKET	EAGLE ST./McCAFFREY RD.	2001	44°02`39.49``	-79°28`59.65``	5	A/N	Y	T	T	T	.	.	.
49005	PARRY SOUND	7 BAY ST.	2001	45°20`16.34``	-80°02`17.37``	5	A/N	S	T	T	.	.	.	.
49010	DORSET	HWY 117 / PAINT LAKE RD.	1981	45°13`27.41``	-78°55`58.64``	3	A/N	S	T	T	.	.	.	.
51001	OTTAWA DOWNTOWN	RIDEAU/WURTEMBURG ST.	1971	45°26`03.59``	-75°40`33.6``	4	A/C/N	Y	T	T	T	T	T	.

Table 1: 2007 Ontario Air Quality Index Network

ID	CITY/TOWN	STATION LOCATION	YEAR	LATITUDE	LONGITUDE	AIR INTAKE	TYPE	AQI	O_3	$PM_{2.5}$	NO_2	CO	SO_2	TRS
51002	OTTAWA CENTRAL	960 CARLING AVE.	2007	45°22`57.08``	-75°42`51.05``	5	A/N	Y	T	T	T	T	T	.
51010	PETAWAWA	PETAWAWA RESEARCH FOREST FACILITY	2007	45°59`48.18``	-77°26`28.27``	6	A/N	S	T	T	.	.	.	.
52022	KINGSTON	752 KING ST. W.	2006	44°12`58.54``	-76°31`41.94``	13	A/C/N	Y	T	T	T	T	T	.
54012	BELLEVILLE	2 SIDNEY ST./ WATER TREATMENT PLANT	2002	44°09`01.9``	-77°23`43.8``	10	A/N	Y	T	T	T	.	.	.
56010	MORRISBURG	COUNTY RD. 2/ MORRISBURG WATER TOWER	2005	44°53`59.09``	-75°11`23.80``	5	A/N	S	T	T	.	.	.	.
56051	CORNWALL	BEDFORD/THIRD ST.	1970	45°01`4.67``	-74°44`6.84``	4	A/N	Y	T	T	T	.	.	.
59006	PETERBOROUGH	10 HOSPITAL DR.	1998	44°18`06.88``	-78°20`46.35``	10	A/C/N	Y	T	T	T	.	.	.
63203	THUNDER BAY	421 JAMES ST. N.	2004	48°22`45.75``	-89°17`24.56``	15	A/C/N	Y	T	T	T	.	.	.
71078	SAULT STE MARIE	SAULT COLLEGE	2004	46°31`59.53``	-84°18`35.67``	8	A/N	Y	T	T	T	T	T	T
75010	NORTH BAY	CHIPPAWA ST./ DEPT. NATIONAL DEFENCE	1979	46°19`23.52``	-79°26`57.43``	4	A/N	Y	T	T	T	.	.	.
77219	SUDBURY	RAMSEY LAKE RD.	2004	46°28`32.48``	-80°57`46.62``	3	A/C/N	Y	T	T	.	.	T	.

Note:
A single CWS metric for Toronto is produced using data from four sites (Toronto Downtown, Toronto North, Toronto East and Toronto West) according to the procedure laid out in the Guidance Document on Achievement Determination.

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, C = CWS, N = NAPS
AQI - Air Quality Index site: Y = year-round AQI site (January to December), S = seasonal rural 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

AIR QUALITY IN ONTARIO
2007 REPORT

APPENDIX A
2007 ANNUAL STATISTICS

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

ACKNOWLEDGEMENTS

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Table A1: 2007 Ozone (O_3) Statistics

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

ID	City	Location	Valid h	PERCENTILES 10%	30%	50%	70%	90%	99%	Mean	Maximum 1h	24h	No. of Times Above Criterion 1h
12008	Windsor Downtown	467 University Ave.	8705	5	16	25	34	50	83	27.0	121	66	107
12016	Windsor West	College/South St.	8710	4	14	23	32	48	82	25.3	136	63	98
13001	Chatham	435 Grand Ave. W.,	8672	13	22	29	37	52	79	30.9	99	69	73
14064	Sarnia	Front St./Cn Tracks, Centennial Park	8690	10	20	28	35	47	78	28.6	106	64	66
15020	Grand Bend	Water Treatment Plant	8662	14	24	31	37	49	81	31.7	131	67	89
15025	London	900 Highbury Ave.	8743	9	19	26	33	46	71	27.2	85	61	18
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plt	8587	17	25	32	39	54	85	34.3	113	81	129
18007	Tiverton	Concession Rd. 2, Lot A	8711	18	27	33	39	51	82	34.3	108	78	101
21005	Brantford	324 Grand River Ave.	8747	8	20	28	36	50	76	28.9	102	58	44
26060	Kitchener	West Ave./Homewood	8743	9	20	28	35	48	75	28.6	95	68	29
27067	St. Catharines	Argyle Cres., Pump Stn.	8702	7	19	27	34	50	75	28.1	101	63	42
28028	Guelph	Exhibition St./Clark St.	8588	8	20	28	35	47	75	28.1	96	55	40
29000	Hamilton Downtown	Elgin/Kelly	8696	5	16	23	31	45	71	24.8	100	61	24
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8697	10	21	28	35	50	75	29.2	103	65	40
29118	Hamilton West	Main St. W./ Hwy 403	8747	3	14	22	29	42	66	23.0	91	54	11
31103	Toronto Downtown	Bay/Wellesley St.	8725	7	17	24	32	45	72	25.7	97	62	41
33003	Toronto East	Kennedy/Lawrence	8740	3	14	22	30	42	69	23.2	102	55	35
34020	Toronto North	Hendon/Yonge St.	8587	4	15	24	32	44	69	24.5	98	60	37
35125	Toronto West	125 Resources Rd.	8646	3	11	19	27	42	70	21.1	98	54	33
44008	Burlington	Hwy 2/North Shore Blvd. E.	8739	5	16	23	32	44	68	24.6	94	55	20
44017	Oakville	8th Line/Glenashton Dr., Halton Reserv.	8733	8	19	27	34	46	73	27.5	95	61	36
45026	Oshawa	2200 Simcoe St. N., Durham College	8684	9	20	28	34	44	74	28.0	103	59	51
46089	Brampton	525 Main St. N., Peel Manor	8718	5	18	27	34	46	72	26.8	106	60	37
46109	Mississauga	Frank Mckechnie Comm. Ctr	8564	3	14	22	30	44	71	23.3	95	60	29
47045	Barrie	83 Perry St.	8723	7	18	26	32	43	64	25.9	84	57	7
48006	Newmarket	Eagle St./Mccaffrey Rd.	8666	13	24	32	38	50	77	31.7	104	70	54
49005	Parry Sound	7 Bay St.	8741	15	25	32	37	48	72	31.8	92	66	30
49010	Dorset	Hwy 117 / Paint Lake Rd.	8667	12	23	30	36	46	70	29.9	96	65	34
51001	Ottawa Downtown	Rideau/Wurtemburg St.	8520	8	17	24	30	41	66	24.7	90	61	11
51002	Ottawa Central	960 Carling Ave.	8492	8	20	27	33	42	65	26.5	83	61	2

Table A1: 2007 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
51010	Petawawa	Petawawa Research Forest Facility	8738	12	22	28	34	43	63	28.3	89	67	8
52022	Kingston	752 King St. W.	8729	17	26	32	39	53	82	33.9	99	74	98
54012	Belleville	2 Sidney St., Water Treatment Plant	8720	13	24	31	37	50	84	32.0	124	77	124
56010	Morrisburg	County Rd. 2, Morrisburg Water Tower	8741	11	22	29	35	47	74	29.2	89	71	34
56051	Cornwall	Bedford/Third St.	8738	9	21	28	34	46	73	28.3	95	75	24
59006	Peterborough	10 Hospital Dr.	8707	11	21	28	33	42	66	27.6	101	57	10
63203	Thunder Bay	421 James St. S.	8746	6	17	25	31	40	53	24.2	67	56	0
71078	Sault Ste Marie	Sault College	8593	14	23	29	35	45	65	29.7	80	66	0
75010	North Bay	Chippawa St., Dept. National Defence	8745	10	20	27	33	44	64	27.1	83	53	4
77219	Sudbury	Ramsey Lake Road	8626	13	21	28	33	43	64	28.1	91	76	16

Table A2: 2007 Fine Particulate Matter ($PM_{2.5}$) Statistics

Unit: micrograms per cubic metre ($\mu g/m^3$)

				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.	8659	1	4	7	11	22	39	9.5	64	36	9
12016	Windsor West	College/South St.	8676	2	5	8	12	21	38	9.8	177	36	7
13001	Chatham	435 Grand Ave. W.,	8655	1	3	5	9	18	36	7.9	61	36	7
14064	Sarnia	Front St./Cn Tracks, Centennial Park	8706	4	6	9	14	25	48	12.2	104	46	16
15020	Grand Bend	Water Treatment Plant	8590	0	2	4	8	18	38	6.7	66	36	8
15025	London	900 Highbury Ave.	8669	0	2	5	8	15	31	6.5	48	32	2
16015	Port Stanley	43665 Dexter Line, Elgin Water T. Plt	8545	1	3	5	8	17	36	7.2	51	37	5
18007	Tiverton	Concession Rd. 2, Lot A	8656	0	2	3	6	14	32	5.6	56	39	2
21005	Brantford	324 Grand River Ave.	8688	1	3	5	9	18	37	7.7	57	37	5
26060	Kitchener	West Ave./Homewood	8683	1	3	6	9	18	41	8.0	62	41	7
27067	St. Catharines	Argyle Cres., Pump Stn.	8638	1	3	6	9	19	39	8.2	59	38	11
28028	Guelph	Exhibition St./Clark St.	8708	1	3	5	8	17	39	7.5	74	42	5
29000	Hamilton Downtown	Elgin/Kelly	8725	1	4	6	10	20	41	8.9	71	45	8
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8691	1	3	5	9	18	39	7.8	74	40	6
29118	Hamilton West	Main St. W./ Hwy 403	8690	1	3	6	10	19	39	8.3	73	42	7
31103	Toronto Downtown	Bay/Wellesley St.	8715	1	3	5	8	17	38	7.3	51	41	6
33003	Toronto East	Kennedy/Lawrence	8711	1	3	5	9	17	41	7.8	95	41	7
34020	Toronto North	Hendon/Yonge St.	8582	1	3	5	9	18	42	7.8	60	40	7
35125	Toronto West	125 Resources Rd.	8653	2	4	6	10	18	40	8.4	78	41	7
44008	Burlington	Hwy 2/North Shore Blvd. E.	8679	1	3	5	8	17	38	7.3	73	38	6
44017	Oakville	8th Line/Glenashton Dr., Halton Reserv.	8655	1	3	5	9	17	38	7.6	68	42	6
45026	Oshawa	2200 Simcoe St. N., Durham College	8659	1	2	4	7	16	39	6.8	53	38	7
46089	Brampton	525 Main St. N., Peel Manor	8706	1	3	5	8	17	37	7.4	65	39	5
46109	Mississauga	Frank Mckechnie Comm. Ctr	8701	1	3	5	8	17	36	7.2	55	34	5
47045	Barrie	83 Perry St.	8714	1	2	4	8	16	38	6.9	58	40	7
48006	Newmarket	Eagle St./Mccaffrey Rd.	8735	1	2	4	7	16	37	6.6	54	38	6
49005	Parry Sound	7 Bay St.	8693	0	2	3	6	13	33	5.5	50	37	3
49010	Dorset	Hwy 117 / Paint Lake Rd.	8656	0	1	3	5	12	31	5.0	48	33	2

Table A2: 2007 Fine Particulate Matter ($PM_{2.5}$) Statistics

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

ID	City	Location	Valid h	PERCENTILES 10%	30%	50%	70%	90%	99%	Mean	Maximum 1h	24h	No. of Times Above Reference Level 24h
51001	Ottawa Downtown	Rideau/Wurtemburg St.	8617	0	2	4	7	14	33	6.0	57	37	3
51002	Ottawa Central	960 Carling Ave.	8348	0	2	4	6	13	31	5.8	51	34	2
51010	Petawawa	Petawawa Research Forest Facility	8607	0	1	2	4	9	26	4.0	49	35	1
52022	Kingston	752 King St. W.	8723	1	3	5	8	18	44	7.5	57	45	9
54012	Belleville	2 Sidney St., Water Treatment Plant	8703	1	2	4	7	14	37	6.2	52	39	3
56010	Morrisburg	County Rd. 2, Morrisburg Water Tower	8698	1	2	4	7	14	35	6.2	52	40	2
56051	Cornwall	Bedford/Third St.	8687	1	2	4	7	15	33	6.4	52	38	2
59006	Peterborough	10 Hospital Dr.	8690	1	2	4	7	15	38	6.4	53	39	6
63203	Thunder Bay	421 James St. S.	8733	0	1	3	5	11	21	4.4	51	25	0
71078	Sault Ste Marie	Sault College	8487	0	2	3	6	13	30	5.3	50	33	2
75010	North Bay	Chippawa St., Dept. National Defence	8679	0	2	3	5	12	31	5.0	46	30	0
77219	Sudbury	Ramsey Lake Road	8465	0	2	3	5	12	31	4.9	46	32	1

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 µg/m^3 for a 24-hour period (based on CWS).

Table A3: 2007 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.	8742	0	1	2	5	15	67	6.4	321	55
12016	Windsor West	College/South St.	8715	0	1	2	4	14	83	6.5	307	76
13001	Chatham	435 Grand Ave. W.,	8344	1	1	1	2	5	17	2.4	70	18
14064	Sarnia	Front St./Cn Tracks, Centennial Park	8011	0	1	2	3	7	29	3.2	123	32
15025	London	900 Highbury Ave.	8721	0	1	1	3	7	47	3.6	132	47
18007	Tiverton	Concession Rd. 2, Lot A	6824	0	0	0	0	0	3	0.2	17	3
21005	Brantford	324 Grand River Ave.	8745	0	0	1	1	4	23	1.8	81	21
26060	Kitchener	West Ave./Homewood	8692	0	0	1	1	5	46	2.7	211	46
27067	St. Catharines	Argyle Cres., Pump Stn.	8699	1	1	2	3	8	57	4.5	211	41
29000	Hamilton Downtown	Elgin/Kelly	8695	1	1	3	5	18	82	7.7	213	69
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8709	0	1	1	2	7	38	3.2	105	38
31103	Toronto Downtown	Bay/Wellesley St.	8687	1	2	3	5	12	54	5.9	260	44
33003	Toronto East	Kennedy/Lawrence	8740	1	2	5	9	23	97	10.8	380	90
34020	Toronto North	Hendon/Yonge St.	8632	0	1	3	6	21	79	8.3	287	61
35125	Toronto West	125 Resources Rd.	8635	1	3	7	16	46	138	17.5	290	80
44008	Burlington	Hwy 2/North Shore Blvd. E.	8738	1	2	3	6	20	93	8.8	251	90
44017	Oakville	8th Line/Glenashton Dr., Halton Reserv.	8620	0	1	1	2	8	47	3.9	146	34
45026	Oshawa	2200 Simcoe St. N., Durham College	8602	0	1	1	3	7	32	3.2	86	30
46089	Brampton	525 Main St. N., Peel Manor	8676	0	1	2	4	14	66	6.0	227	46
47045	Barrie	83 Perry St.	8726	1	1	2	3	10	71	5.5	217	39
48006	Newmarket	Eagle St./Mccaffrey Rd.	8634	0	0	1	1	4	29	2.2	142	18
51001	Ottawa Downtown	Rideau/Wurtemburg St.	8708	0	1	1	2	6	39	3.4	160	42
51002	Ottawa Central	960 Carling Ave.	8649	0	0	0	1	4	42	2.4	185	77
52022	Kingston	752 King St. W.	8731	0	0	0	0	1	9	0.6	36	8
54012	Belleville	2 Sidney St., Water Treatment Plant	8668	0	1	2	3	6	33	3.2	162	44
56051	Cornwall	Bedford/Third St.	8734	1	1	1	2	4	62	3.5	223	42
59006	Peterborough	10 Hospital Dr.	8705	0	1	1	2	4	26	2.3	86	19
63203	Thunder Bay	421 James St. S.	8544	0	1	1	3	14	60	5.4	204	95
71078	Sault Ste Marie	Sault College	8591	0	0	1	1	3	13	1.4	59	8
75010	North Bay	Chippawa St., Dept. National Defence	8748	0	1	1	2	7	46	3.5	147	40

Table A4: 2007 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

ID	City	Location	Valid h	PERCENTILES 10%	30%	50%	70%	90%	99%	Mean	Maximum 1h	Maximum 24h	No. of Times Above Criteria 1h	No. of Times Above Criteria 24h
12008	Windsor Downtown	467 University Ave.	8742	6	10	15	21	32	46	17.2	66	37	0	0
12016	Windsor West	College/South St.	8715	6	10	14	20	30	44	16.1	66	39	0	0
13001	Chatham	435 Grand Ave. W.,	8344	3	5	7	10	16	27	8.6	40	26	0	0
14064	Sarnia	Front St./Cn Tracks, Centennial Park	8011	3	6	9	14	23	36	11.3	58	33	0	0
15025	London	900 Highbury Ave.	8721	3	6	9	14	23	38	11.7	56	30	0	0
18007	Tiverton	Concession Rd. 2, Lot A	6824	0	1	2	3	7	16	2.9	34	14	0	0
21005	Brantford	324 Grand River Ave.	8745	2	4	6	9	16	31	7.7	49	35	0	0
26060	Kitchener	West Ave./Homewood	8692	3	5	7	11	20	37	9.7	52	32	0	0
27067	St. Catharines	Argyle Cres., Pump Stn.	8699	4	7	10	14	23	39	12.0	61	33	0	0
29000	Hamilton Downtown	Elgin/Kelly	8695	6	10	14	20	32	48	17.0	64	50	0	0
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8709	4	6	9	14	24	43	11.9	60	44	0	0
31103	Toronto Downtown	Bay/Wellesley St.	8687	7	11	16	22	33	50	18.2	75	46	0	0
33003	Toronto East	Kennedy/Lawrence	8740	6	10	15	21	33	50	17.2	77	46	0	0
34020	Toronto North	Hendon/Yonge St.	8632	4	8	14	22	33	48	16.7	63	43	0	0
35125	Toronto West	125 Resources Rd.	8635	9	14	20	27	38	53	22.1	72	48	0	0
44008	Burlington	Hwy 2/North Shore Blvd. E.	8738	5	9	14	20	31	48	16.0	67	50	0	0
44017	Oakville	8th Line/Glenashton Dr., Halton Reserv.	8620	3	6	10	16	28	46	13.0	58	51	0	0
45026	Oshawa	2200 Simcoe St. N., Durham College	8602	2	4	6	9	17	33	8.1	44	31	0	0
46089	Brampton	525 Main St. N., Peel Manor	8676	4	6	11	17	30	46	13.9	62	38	0	0
47045	Barrie	83 Perry St.	8726	3	6	8	13	24	43	11.5	73	36	0	0
48006	Newmarket	Eagle St./Mccaffrey Rd.	8634	2	3	6	10	18	36	8.3	50	32	0	0
51001	Ottawa Downtown	Rideau/Wurtemburg St.	8708	1	3	6	11	21	37	8.7	53	37	0	0
51002	Ottawa Central	960 Carling Ave.	8649	2	3	5	9	18	38	7.9	52	36	0	0
52022	Kingston	752 King St. W.	8731	2	3	4	6	11	25	5.5	38	27	0	0
54012	Belleville	2 Sidney St., Water Treatment Plant	8668	1	3	4	7	15	32	6.4	50	26	0	0
56051	Cornwall	Bedford/Third St.	8734	2	4	5	8	16	34	7.6	52	31	0	0
59006	Peterborough	10 Hospital Dr.	8705	1	3	4	7	14	29	6.4	42	27	0	0
63203	Thunder Bay	421 James St. S.	8544	2	4	6	10	20	36	8.7	51	34	0	0
71078	Sault Ste Marie	Sault College	8591	1	2	3	5	11	25	5.0	42	17	0	0
75010	North Bay	Chippawa St., Dept. National Defence	8748	1	3	5	8	17	38	7.4	57	28	0	0

Table A5: 2007 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.	8742	7	12	18	26	46	107	23.6	384	89
12016	Windsor West	College/South St.	8715	7	11	17	24	42	120	22.6	367	103
13001	Chatham	435 Grand Ave. W.,	8344	4	7	9	12	20	40	11.0	92	44
14064	Sarnia	Front St./Cn Tracks, Centennial Park	8011	4	7	11	17	29	60	14.5	169	60
15025	London	900 Highbury Ave.	8721	4	8	11	17	30	80	15.3	188	78
18007	Tiverton	Concession Rd. 2, Lot A	6824	0	1	2	3	7	17	3.0	43	15
21005	Brantford	324 Grand River Ave.	8745	3	4	7	10	19	47	9.5	122	48
26060	Kitchener	West Ave./Homewood	8692	3	5	8	13	25	73	12.4	239	68
27067	St. Catharines	Argyle Cres., Pump Stn.	8699	5	8	11	17	32	90	16.5	245	61
29000	Hamilton Downtown	Elgin/Kelly	8695	8	13	17	26	49	120	24.7	258	109
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8709	4	7	10	16	31	74	15.1	156	82
31103	Toronto Downtown	Bay/Wellesley St.	8687	9	14	19	27	45	96	24.2	334	81
33003	Toronto East	Kennedy/Lawrence	8740	7	14	20	30	55	141	28.0	456	131
34020	Toronto North	Hendon/Yonge St.	8632	5	10	18	28	53	121	25.0	349	100
35125	Toronto West	125 Resources Rd.	8635	10	19	29	44	81	182	39.6	335	121
44008	Burlington	Hwy 2/North Shore Blvd. E.	8738	6	11	17	27	51	134	24.8	308	134
44017	Oakville	8th Line/Glenashton Dr., Halton Reserv.	8620	4	7	11	18	37	85	16.9	194	83
45026	Oshawa	2200 Simcoe St. N., Durham College	8602	3	5	8	12	23	62	11.3	114	59
46089	Brampton	525 Main St. N., Peel Manor	8676	5	8	13	21	44	103	19.9	282	84
47045	Barrie	83 Perry St.	8726	5	7	11	16	34	107	17.0	280	69
48006	Newmarket	Eagle St./Mccaffrey Rd.	8634	2	4	6	11	22	62	10.4	184	51
51001	Ottawa Downtown	Rideau/Wurtemburg St.	8708	2	4	7	13	26	69	12.0	213	79
51002	Ottawa Central	960 Carling Ave.	8649	2	3	6	9	23	76	10.2	236	113
52022	Kingston	752 King St. W.	8731	2	3	4	6	12	32	6.3	70	35
54012	Belleville	2 Sidney St., Water Treatment Plant	8668	2	4	6	9	20	61	9.6	188	70
56051	Cornwall	Bedford/Third St.	8734	3	5	6	10	21	88	11.0	251	56
59006	Peterborough	10 Hospital Dr.	8705	2	4	6	9	18	51	8.6	118	45
63203	Thunder Bay	421 James St. S.	8544	2	5	8	14	32	94	14.1	233	125
71078	Sault Ste Marie	Sault College	8591	1	3	4	7	14	35	6.4	101	24
75010	North Bay	Chippawa St., Dept. National Defence	8748	2	4	6	10	24	81	10.9	193	68

Table A6: 2007 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.	8593	0.04	0.14	0.21	0.28	0.43	0.88	0.23	5.01	1.48	0	0
13001	Chatham	435 Grand Ave. W.,	8711	0.09	0.15	0.19	0.23	0.30	0.44	0.20	2.03	0.85	0	0
15025	London	900 Highbury Ave.	8552	0.02	0.08	0.16	0.21	0.29	0.52	0.16	1.21	0.65	0	0
29000	Hamilton Downtown	Elgin/Kelly	8664	0.00	0.10	0.20	0.28	0.45	0.89	0.22	5.97	1.75	0	0
31103	Toronto Downtown	Bay/Wellesley St.	7514	0.04	0.12	0.19	0.25	0.36	0.63	0.20	1.70	1.08	0	0
35125	Toronto West	125 Resources Rd.	8635	0.10	0.18	0.24	0.30	0.44	0.79	0.26	1.42	0.88	0	0
51001	Ottawa Downtown	Rideau/Wurtemburg St.	8413	0.17	0.24	0.28	0.34	0.44	0.76	0.30	1.49	1.14	0	0
51002	Ottawa Central	960 Carling Ave.	7209	0.09	0.16	0.20	0.25	0.34	0.67	0.21	1.29	1.00	0	0
52022	Kingston	752 King St. W.	8603	0.12	0.16	0.2	0.24	0.31	0.44	0.2	0.59	0.51	0	0
71078	Sault Ste Marie	Sault College	8258	0.13	0.17	0.21	0.25	0.33	0.56	0.2	1.22	0.64	0	0

Table A7: 2007 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.	8739	1	1	3	5	14	39	5.5	93	27	0	0	0
12016	Windsor West	College/South St.	8700	0	1	2	5	14	34	5.2	67	21	0	0	0
13001	Chatham	435 Grand Ave. W.,	8745	0	1	1	2	5	14	2.2	45	12	0	0	0
14064	Sarnia	Front St./Cn Tracks, Centennial Park	8735	0	1	2	4	19	97	8.0	183	87	0	0	0
15025	London	900 Highbury Ave.	8741	0	1	1	2	5	11	1.9	24	12	0	0	0
18007	Tiverton	Concession Rd. 2, Lot A	8707	0	0	1	1	4	11	1.4	26	9	0	0	0
29000	Hamilton Downtown	Elgin/Kelly	8696	0	1	2	4	11	33	4.2	70	30	0	0	0
29114	Hamilton Mountain	Vickers Rd./E. 18th St.	8708	0	1	2	4	8	22	3.5	58	15	0	0	0
31103	Toronto Downtown	Bay/Wellesley St.	8743	0	1	1	2	5	12	1.9	39	13	0	0	0
35125	Toronto West	125 Resources Rd.	8678	0	0	1	2	4	10	1.5	26	11	0	0	0
51001	Ottawa Downtown	Rideau/Wurtemburg St.	8642	0	0	0	1	2	8	0.9	28	7	0	0	0
51002	Ottawa Central	960 Carling Ave.	7919	0	0	0	1	3	7	1.0	22	7	0	0	0
52022	Kingston	752 King St. W.	8514	0	0	0	1	2	7	0.9	29	8	0	0	0
71078	Sault Ste Marie	Sault College	8594	0	0	1	2	3	18	1.8	82	11	0	0	0
77219	Sudbury	Ramsey Lake Road	8743	0	0	1	1	4	38	2.3	352	31	1	0	0

Table A8: 2007 Total Reduced Sulphur (TRS) Compounds Statistics

Unit: parts per billion (ppb)

				PERCENTILES							Maximum	
ID	City	Location	Valid h	10%	30%	50%	70%	90%	99%	Mean	1h	24h
12016	Windsor West	College/South St.	8423	0	0	1	1	1	5	0.7	14	3
14064	Sarnia	Front St./Cn Tracks, Centennial Park	8657	0	0	0	0	0	1	0.1	11	1
29000	Hamilton Downtown	Elgin/Kelly	8691	0	0	0	0	1	4	0.3	32	4
71078	Sault Ste Marie	Sault College	8581	0	0	0	1	1	2	0.4	5	2

AIR QUALITY IN ONTARIO
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APPENDIX B
10-YEAR POLLUTANT TRENDS

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 to the province of Ontario.

Table B1: 10-Year Trend for O_3

Annual Mean (ppb)

ID	City	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
12008	Windsor Downtown	21.4	21.7	18.6	20.5	21.9	22.9	20.2	26.0	24.6	27.0
12016	Windsor West	18.7	18.9	17.0	19.0	20.2	22.8	22.6	25.6	24.3	25.3
14064	Sarnia	26.1	26.5	24.3	25.6	26.5	24.7	23.8	27.4	26.7	28.6
15020	Grand Bend	31.2	32.5	32.6	31.6	29.8	30.7	25.8	32.5	29.7	31.7
15025	London	25.1	25.8	21.1	24.2	25.3	26.9	23.6	26.1	25.1	27.2
18007	Tiverton	32.2	INS	32.3	34.7	34.7	33.2	28.1	31.8	28.9	34.3
26060	Kitchener	25.4	25.2	23.0	25.7	27.3	28.1	24.8	28.0	26.6	28.6
27067	St. Catharines	20.8	21.7	18.9	21.2	24.1	25.3	23.6	26.3	26.2	28.1
29000	Hamilton Downtown	19.1	19.5	17.0	18.8	20.4	21.7	20.1	23.2	23.2	24.8
29114	Hamilton Mountain	24.1	24.1	22.6	24.2	27.7	28.4	24.6	28.2	27.5	29.2
29118	Hamilton West	19.3	20.0	16.9	18.6	20.5	22.0	19.2	21.2	20.9	23.0
31103	Toronto Downtown	17.8	20.2	19.7	22.0	24.0	23.6	22.8	24.5	22.6	25.7
33003	Toronto East	20.6	21.5	19.6	21.7	21.0	21.8	19.9	22.4	22.0	23.2
34020	Toronto North	22.0	22.8	20.6	23.4	25.1	23.6	22.5	24.5	23.3	24.5
44008	Burlington	22.5	26.2	23.4	24.6	26.3	22.8	21.0	23.9	23.4	24.6
44017	Oakville	21.8	22.4	21.0	22.9	25.1	INS	24.6	27.7	26.1	27.5
45026	Oshawa	23.1	25.0	21.2	23.4	23.2	24.1	23.3	28.6	25.1	28.0
46109	Mississauga	20.8	22.2	19.9	22.4	23.1	24.8	20.7	23.1	22.4	23.3
49010	Dorset	30.6	31.0	29.3	31.0	32.4	30.1	28.8	32.3	28.9	29.9
51001	Ottawa Downtown	19.1	21.2	19.9	25.0	24.9	24.7	21.7	23.3	23.6	24.7
56051	Cornwall	24.2	25.8	24.0	29.0	24.8	25.9	23.8	27.7	27.5	28.3
59006	Peterborough	INS	31.4	28.1	30.7	30.5	29.7	27.1	31.2	24.9	27.6
63203	Thunder Bay	21.5	22.5	22.6	24.4	23.4	26.1	22.0	22.3	23.5	24.2
71078	Sault Ste. Marie	22.3	24.1	24.8	25.2	24.2	26.8	27.0	30.2	29.1	29.7
75010	North Bay	27.4	29.1	22.1	26.6	26.8	27.0	25.2	28.0	26.7	27.1
77219	Sudbury	29.1	30.7	26.1	29.1	29.2	28.5	27.7	31.0	28.4	28.1

Notes:

n/a indicates pollutant not monitored.

INS indicates there was insufficient data in the 2nd and/or 3rd quarter to calculate a valid annual mean.

Station 31103 replaced station 31303 as the Toronto Downtown site in 1998.

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 B2: 10-Year Trend for NO

Annual mean (ppb)

ID	City	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
12008	Windsor Downtown	16.3	13.3	13.9	11.0	10.9	INS	10.5	7.8	7.2	6.4
14064	Sarnia	6.9	7.1	8.9	6.7	7.1	5.0	3.7	3.8	3.7	3.2
15025	London	9.1	8.5	8.0	6.6	INS	INS	6.0	5.5	4.4	3.6
26060	Kitchener	6.9	6.6	7.4	5.7	3.8	INS	4.9	4.4	3.5	2.7
29000	Hamilton Downtown	12.6	12.0	14.7	11.5	10.4	11.7	9.6	9.9	8.0	7.7
31103	Toronto Downtown	24.3	15.8	14.4	10.0	8.2	8.7	7.6	7.2	6.9	5.9
33003	Toronto East	23.2	20.7	23.0	17.9	16.1	17.0	16.0	14.4	12.5	10.8
34020	Toronto North	16.5	16.5	16.8	14.3	12.4	12.4	INS	10.8	10.0	8.3
44008	Burlington	14.1	22.6	21.8	13.2	11.8	15.5	11.1	12.3	9.8	8.8
44017	Oakville	15.8	13.0	16.2	11.9	INS	INS	5.3	5.2	4.3	3.9
45026	Oshawa	15.6	15.1	14.2	13.7	10.0	9.3	8.2	INS	3.8	3.2
51001	Ottawa Downtown	7.9	14.8	11.0	7.3	INS	5.8	3.2	3.3	3.0	3.4

Table B3: 10-Year Trend for NO_2

Annual Mean (ppb)

ID	City	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
12008	Windsor Downtown	23.8	22.9	21.6	19.4	19.1	INS	18.3	16.9	17.2	17.2
14064	Sarnia	18	16.7	16.3	16.8	17.5	13.0	11.7	12.7	11.0	11.3
15025	London	17.7	19.4	17.4	17.3	INS	INS	13.7	14.1	12.3	11.7
26060	Kitchener	16.5	14.0	14.7	14.1	11.9	INS	13.1	12.9	10.8	INS
29000	Hamilton Downtown	22.4	21.6	21.8	22.5	20.9	21.3	16.8	19.3	17.0	17.0
31103	Toronto Downtown	27.7	26.9	26.8	27.1	23.3	23.2	20.0	20.7	19.1	18.2
33003	Toronto East	25.5	24.6	23.7	22.9	22.0	21.3	19.8	20.1	17.4	17.2
34020	Toronto North	23.4	24.3	22.7	22.0	21.0	20.4	INS	19.2	17.4	16.7
44008	Burlington	16.6	22.9	20.3	16.5	17.9	17.3	15.3	17.2	16.2	16.0
44017	Oakville	17.1	17.2	17.2	16.2	INS	INS	13.5	14.5	12.4	13.0
45026	Oshawa	20	21.5	19.7	19	17.2	16.2	14.15	INS	8.9	8.1
51001	Ottawa Downtown	12.4	12.2	13.8	14.3		13.7	11.1	9.8	8.6	8.7

Notes:

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

Station 31103 replaced station 31303 as the Toronto Downtown site in 1998.

Station 44017 replaced station 44015 as the Oakville site in 2003.

Station 45026 replaced station 45025 as the Oshawa site in 2005.

Table B4: 10-Year Trend for NO_x

Annual Mean (ppb)

ID	City	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
12008	Windsor Downtown	38.5	37.0	36.0	30.5	29.2	INS	29.3	24.9	24.4	23.6
14064	Sarnia	25.1	23.5	25.0	23.6	24.6	18.1	15.7	16.8	14.7	14.5
15025	London	25.8	25.9	24.7	23.1	INS	INS	19.4	19.4	16.7	15.3
26060	Kitchener	23.9	20.5	21.9	19.5	15.5	INS	18.2	17.4	14.3	12.4
29000	Hamilton Downtown	34.7	34.0	37.0	34.4	31.4	33.3	27.7	30.0	24.9	24.7
31103	Toronto Downtown	51.6	41.9	40.4	36.6	31.5	32.1	28.1	28.2	26.1	24.2
33003	Toronto East	48.3	44.9	46.3	40.3	37.7	37.9	36.3	34.7	29.9	28.0
34020	Toronto North	39.9	40.7	39.3	36.2	33.4	33.0	28.3	30.4	27.5	25.0
44008	Burlington	30.7	45.4	42.2	29.0	28.4	32.5	26.1	29.3	26.0	24.8
44017	Oakville	30.0	29.6	33.0	27.8	INS	INS	18.3	19.5	16.7	16.9
45026	Oshawa	35.1	35.8	33.6	32.6	27.2	25.5	22.5	INS	12.7	11.3
51001	Ottawa Downtown	22.8	27.5	24.4	21.0	INS	20.1	14.7	13.7	11.5	12.0

Notes:
INS indicates there was insufficient data to calculate a valid annual mean.
Station 31103 replaced station 31303 as the Toronto Downtown site in 1998.
Station 44017 replaced station 44015 as the Oakville site in 2003.
Station 45026 replaced station 45025 as the Oshawa site in 2005.

Table B5: 10-Year Trend for CO

1h Maximum (ppm)

ID	City	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
12008	Windsor Downtown	6.0	6.7	11.8	4.9	4.3	4.3	2.3	1.3	2.9	5.0
15025	London	3.0	3.0	2.5	3.5	2.3	2.4	2.3	2.4	1.8	1.2
29000	Hamilton Downtown	6.0	5.5	7.3	3.7	2.3	3.1	4.0	2.6	2.8	6.0
31103	Toronto Downtown	4.0	3.2	3.6	3.2	2.9	2.4	1.9	1.6	1.5	1.7
51001	Ottawa Downtown	1.1	0.8	0.7	0.6	0.7	0.6	0.5	0.4	0.3	1.5

Notes:
n/a indicates pollutant not monitored.
INS indicates there was insufficient data to calculate a valid annual mean.

Table B6: 10-Year Trend for SO_2

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

ID	City	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
12008	Windsor Downtown	7.4	6.7	6.2	6.1	5.7	5.9	4.8	4.9	5.0	5.5
12016	Windsor West	12.0	9.6	8.8	9.3	7.9	6.3	4.6	5.1	4.9	5.2
14064	Sarnia	10.3	11.8	10.4	12.5	10.4	7.1	8.2	7.8	8.3	8.0
15025	London	3.2	4.9	3.5	3.5	2.2	INS	2.2	2.3	1.9	1.9
29000	Hamilton Downtown	6.3	6.6	5.1	6.0	4.9	5.0	4.0	5.3	4.8	4.2
29114	Hamilton Mountain	6.6	5.5	5.8	5.3	4.8	5.3	n/a	n/a	3.32	3.5
31103	Toronto Downtown	4.0	INS	4.7	5.0	4.0	3.2	2.2	2.8	1.9	1.9
44008	Burlington	3.2	4.9	5.2	4.9	5.9	2.5	2.4	2.3	2.0	n/a
44017	Oakville	5.1	4.0	4.8	3.7	4.3	INS	2.8	2.5	2.0	n/a
51001	Ottawa	3.4	4.2	4.1	2.3	2.9	INS	1.0	1.5	1.1	0.9
71078	Sault Ste. Marie	1.9	1.9	2.0	2.0	1.7	2.0	0.9	1.5	1.4	1.8
77219	Sudbury	5.2	3.0	4.2	2.6	3.1	2.0	INS	2.8	2.4	2.3

Notes:
n/a indicates pollutant not monitored.
INS indicates there was insufficient data to calculate a valid annual mean.
Station 44017 replaced station 44015 as the Oakville site in 2003.
Station 71078 replaced station 71068 as the Sault Ste. Marie site in 2004.
Station 77219 replaced station 77203 as the Sudbury site in 2004.

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APPENDIX C
20-YEAR OZONE TRENDS

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 to the province of Ontario.

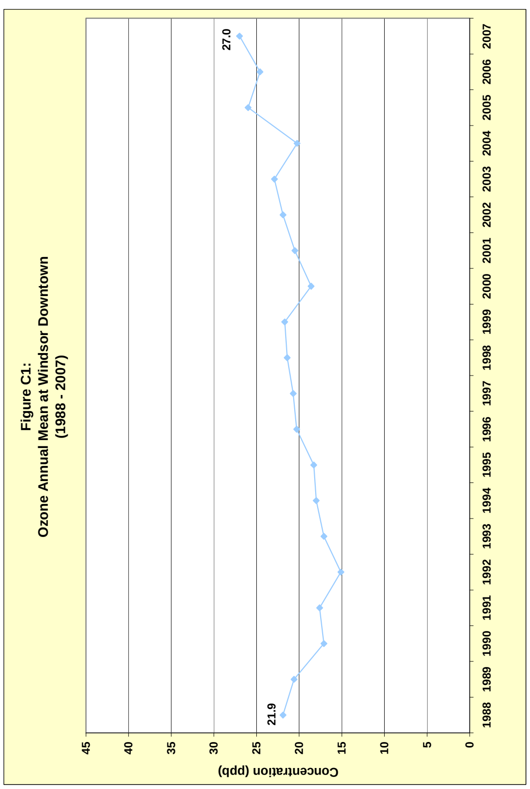

Figure C1:
Ozone Annual Mean at Windsor Downtown
(1988 - 2007)
Concentration (ppb)
0
5
10
15
20
25
30
35
40
45
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
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2006
2007
21.9
27.0

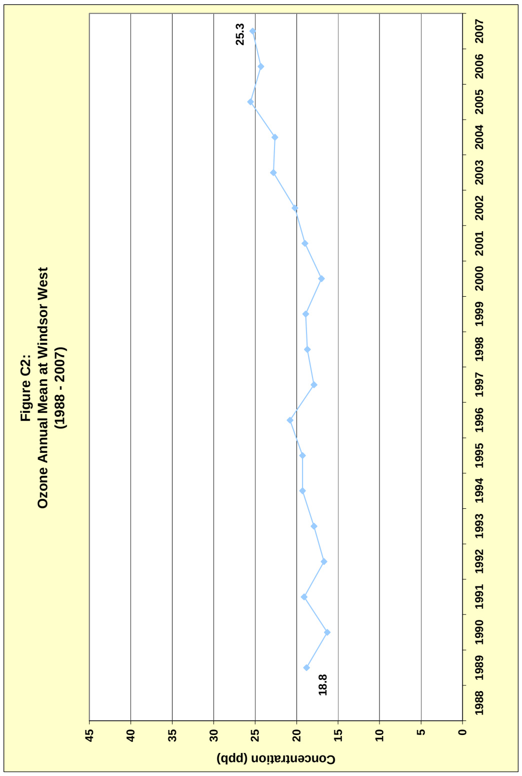

Figure C2:
Ozone Annual Mean at Windsor West
(1988 - 2007)
Concentration (ppb)
0
5
10
15
20
25
30
35
40
45
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
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2006
2007
18.8
25.3

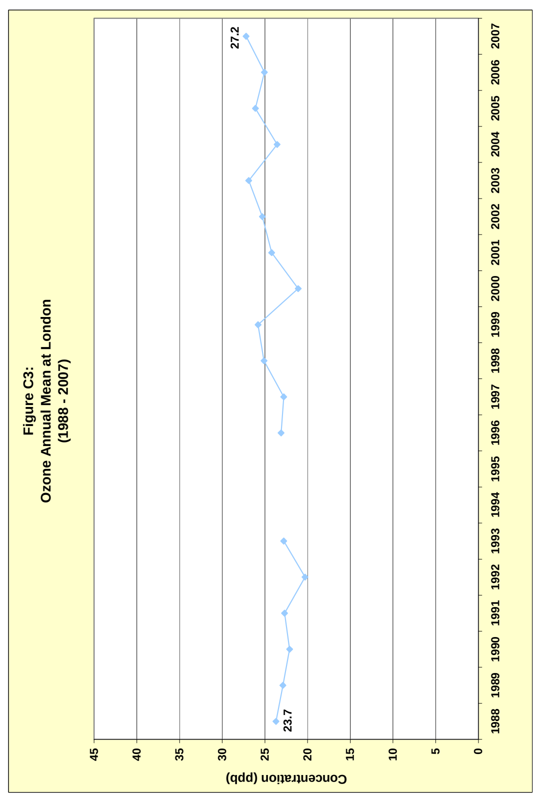

Figure C3:
Ozone Annual Mean at London
(1988 - 2007)
Concentration (ppb)
0
5
10
15
20
25
30
35
40
45
1988
1989
1990
1991
1992
1993
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1996
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1998
1999
2000
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2006
2007
23.7
27.2

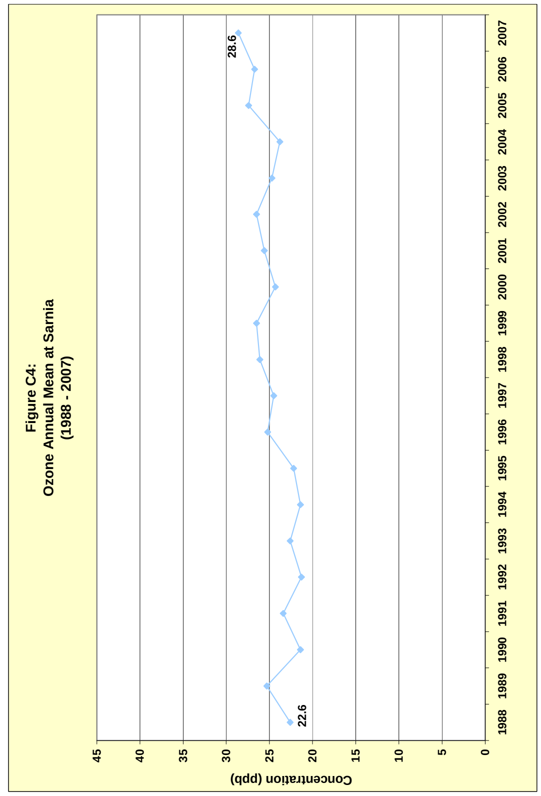


Figure C4:
Ozone Annual Mean at Sarnia
(1988 - 2007)
Concentration (ppb)
0
5
10
15
20
25
30
35
40
45
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
22.6
28.6

Figure C5:
Ozone Annual Mean at Grand Bend
(1988 - 2007)

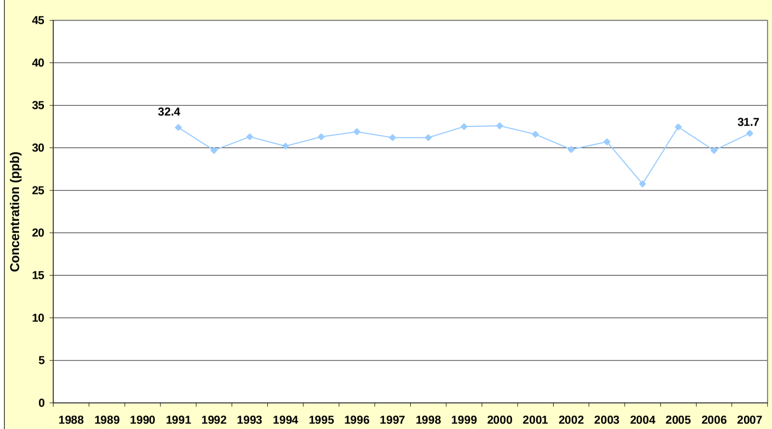


Figure C6:
Ozone Annual Mean at Tiverton
(1988 - 2007)

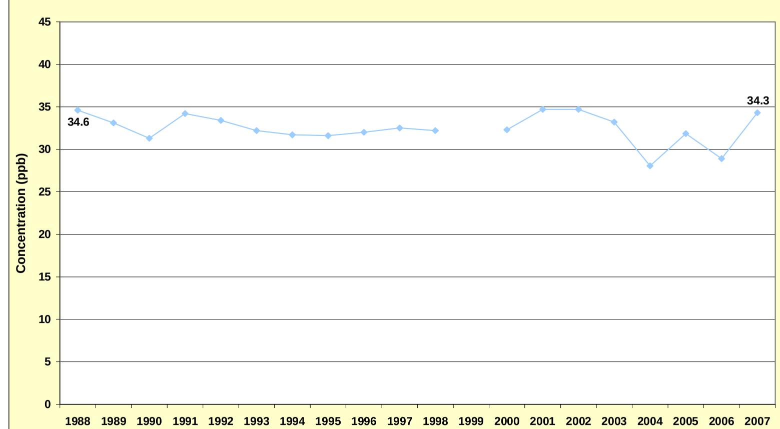


Figure C7:
Ozone Annual Mean at Kitchener
(1988 - 2007)

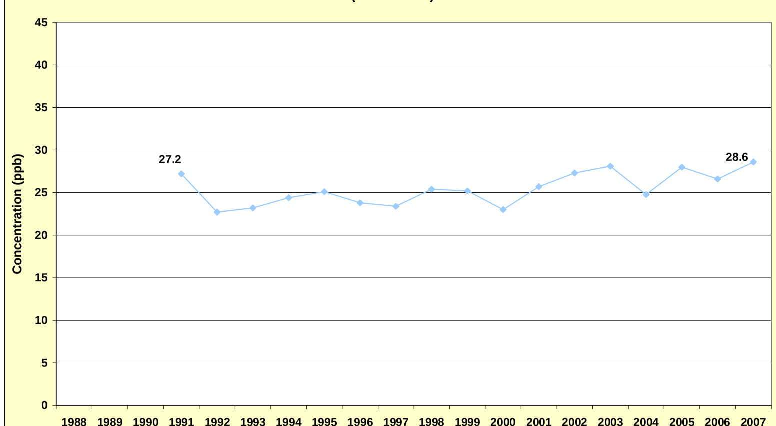
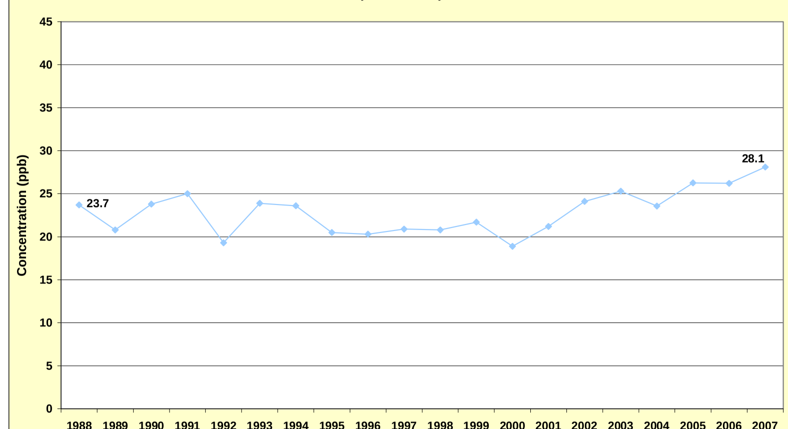


Figure C8:
Ozone Annual Mean at St. Catharines
(1988 - 2007)



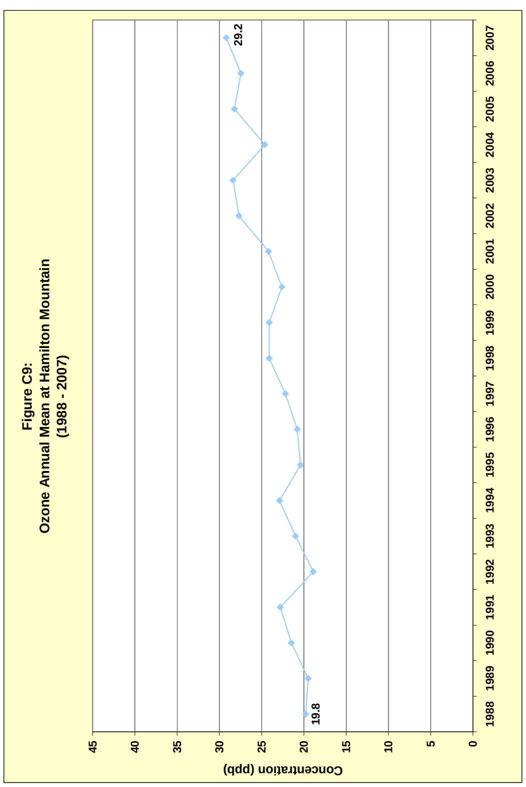


Figure C9:
Ozone Annual Mean at Hamilton Mountain
(1988 - 2007)
Concentration (ppb)
19.8
29.2

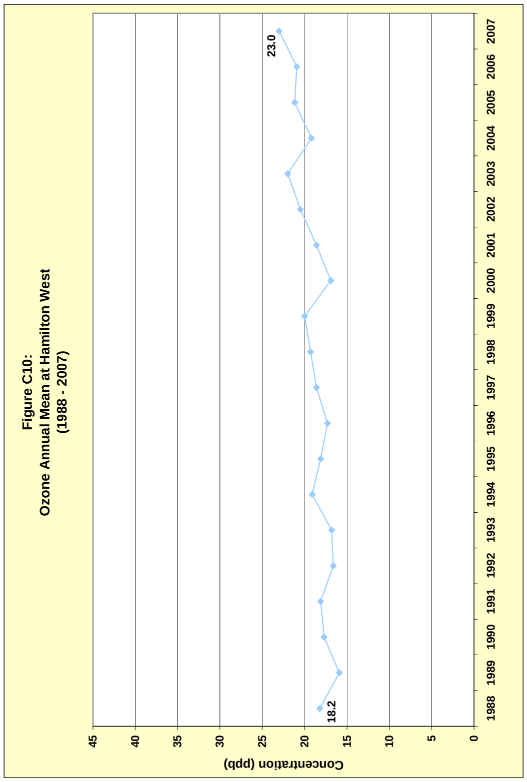


Figure C10:
Ozone Annual Mean at Hamilton West
(1988 - 2007)
Concentration (ppb)
18.2
23.0

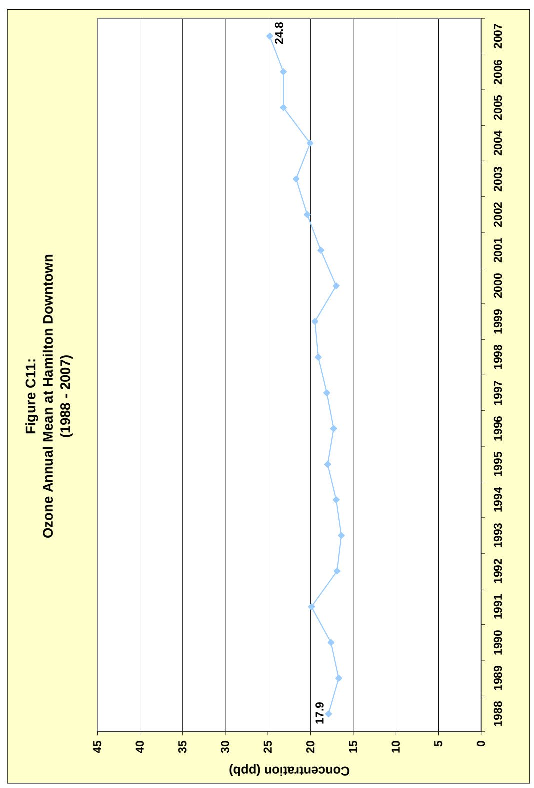


Figure C11:
Ozone Annual Mean at Hamilton Downtown
(1988 - 2007)
Concentration (ppb)
17.9
24.8

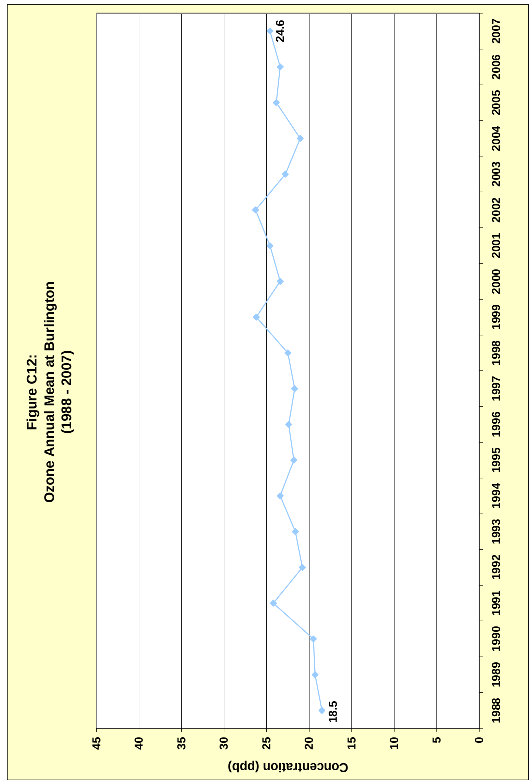


Figure C12:
Ozone Annual Mean at Burlington
(1988 - 2007)
Concentration (ppb)
18.5
24.6

Figure C13:
Ozone Annual Mean at Oakville
(1988 - 2007)

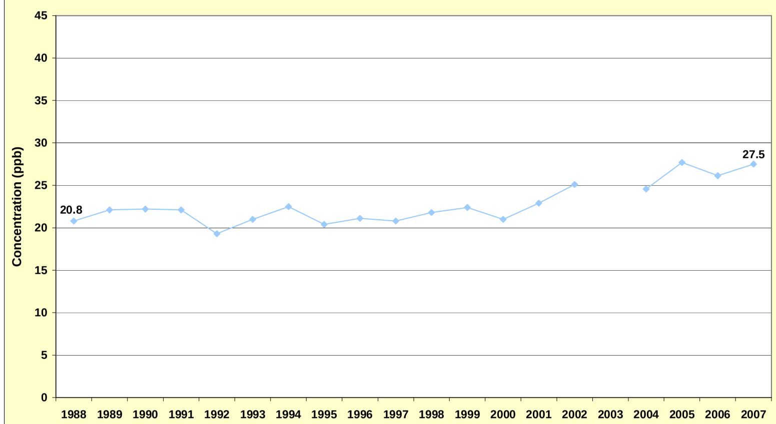


Figure C14:
Ozone Annual Mean at Mississauga
(1988 - 2007)

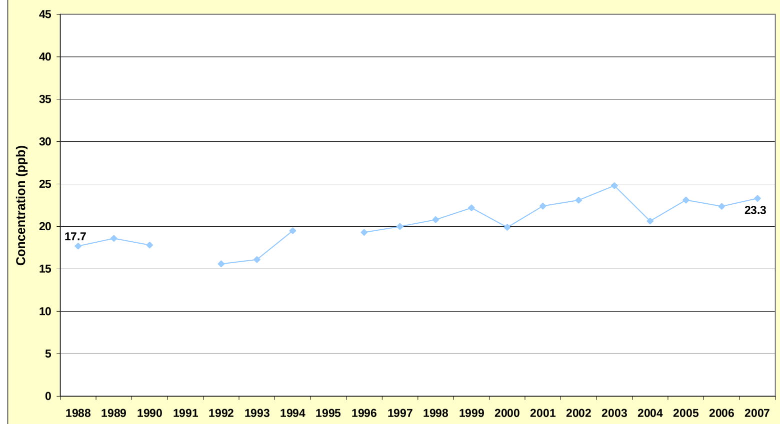


Figure C15:
Ozone Annual Mean at Toronto Downtown
(1988 - 2007)

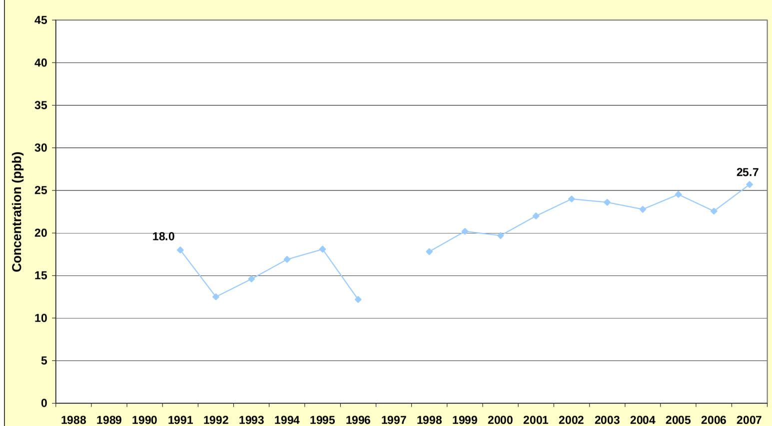


Figure C16:
Ozone Annual Mean at Toronto North
(1988 - 2007)

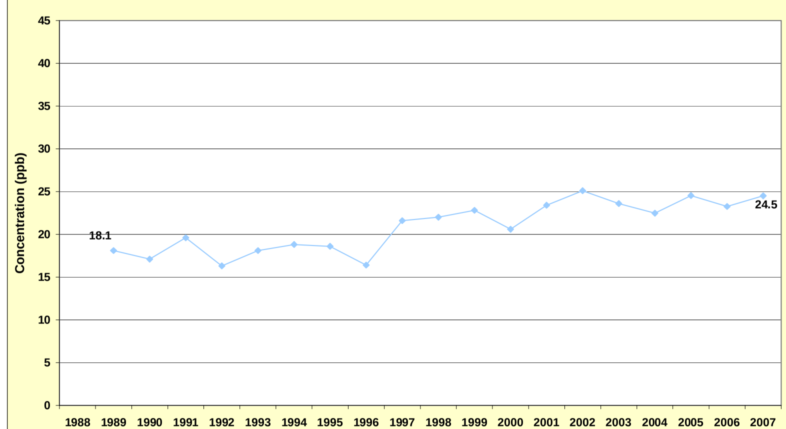


Figure C17:
Ozone Annual Mean at Toronto East
(1988 - 2007)

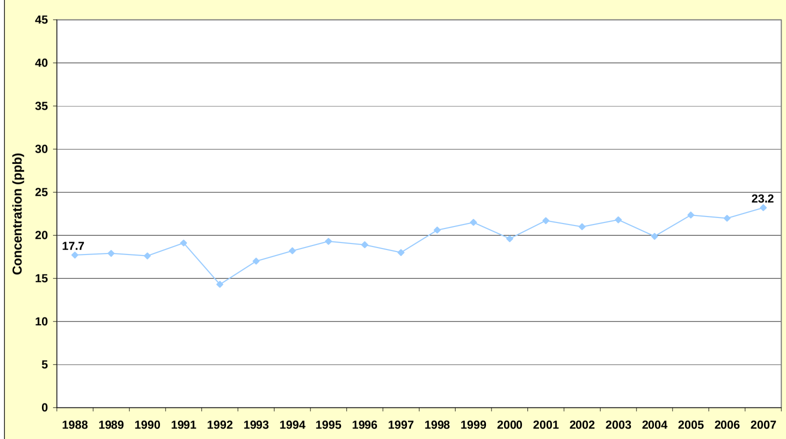


Figure C18:
Ozone Annual Mean at Oshawa
(1988 - 2007)

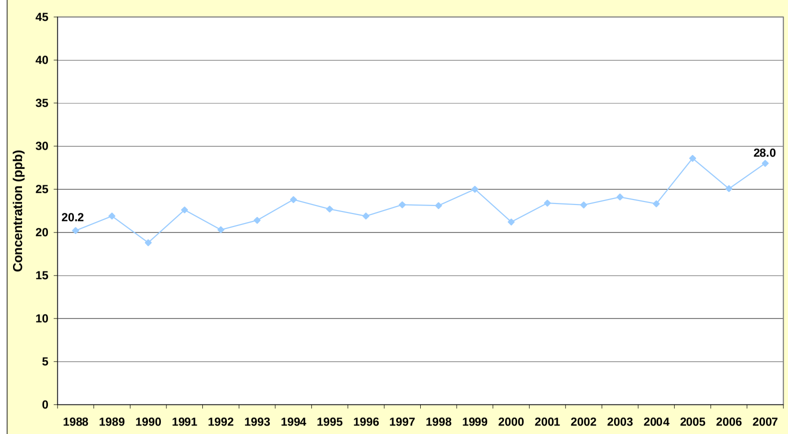


Figure C19:
Ozone Annual Mean at Peterborough
(1998 - 2007)

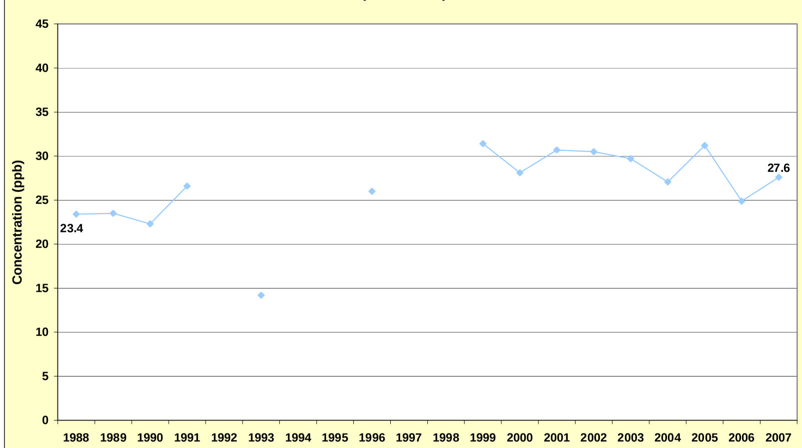
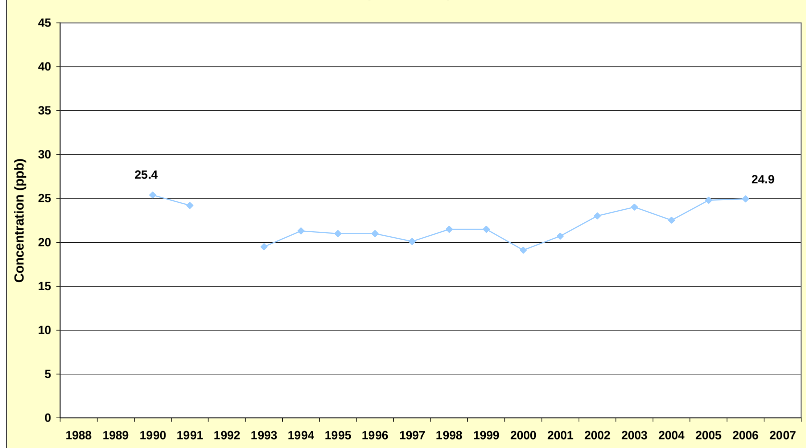


Figure C20:
Ozone Annual Mean at Kingston
(1998 - 2007)



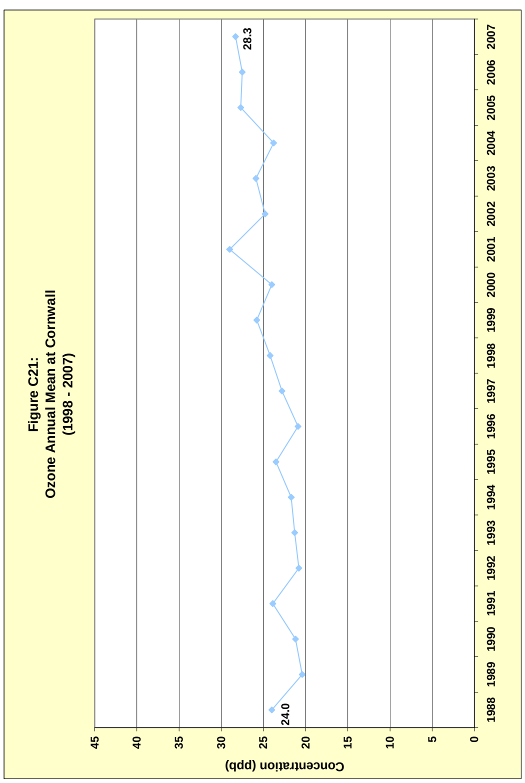


Figure C21:
Ozone Annual Mean at Cornwall
(1998 - 2007)

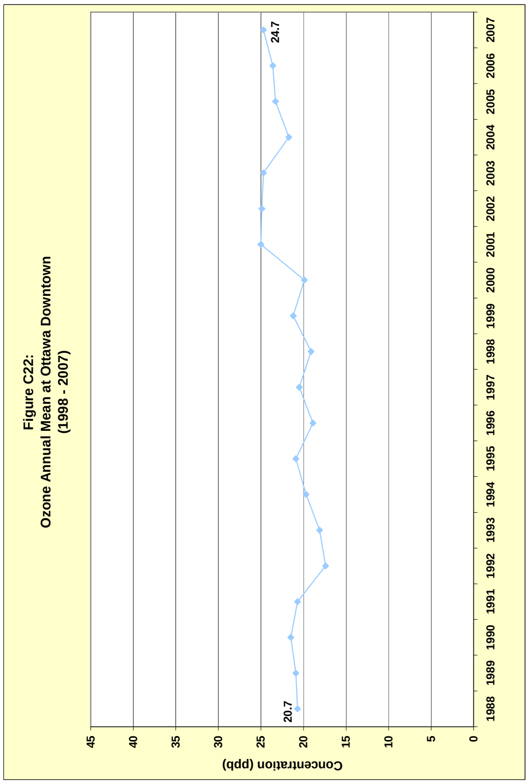


Figure C22:
Ozone Annual Mean at Ottawa Downtown
(1998 - 2007)

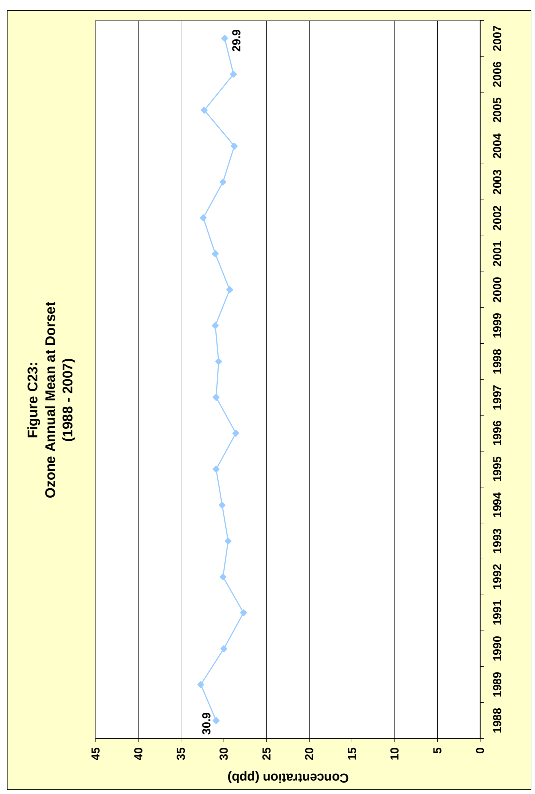


Figure C23:
Ozone Annual Mean at Dorset
(1988 - 2007)

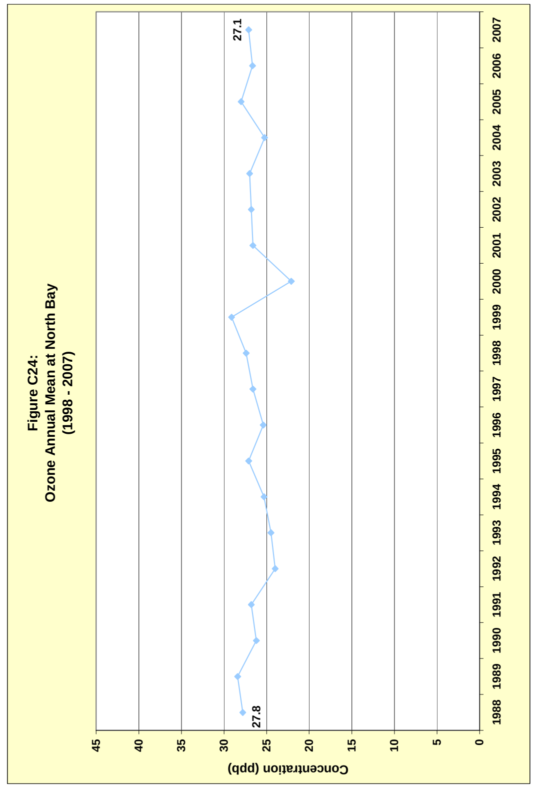


Figure C24:
Ozone Annual Mean at North Bay
(1998 - 2007)

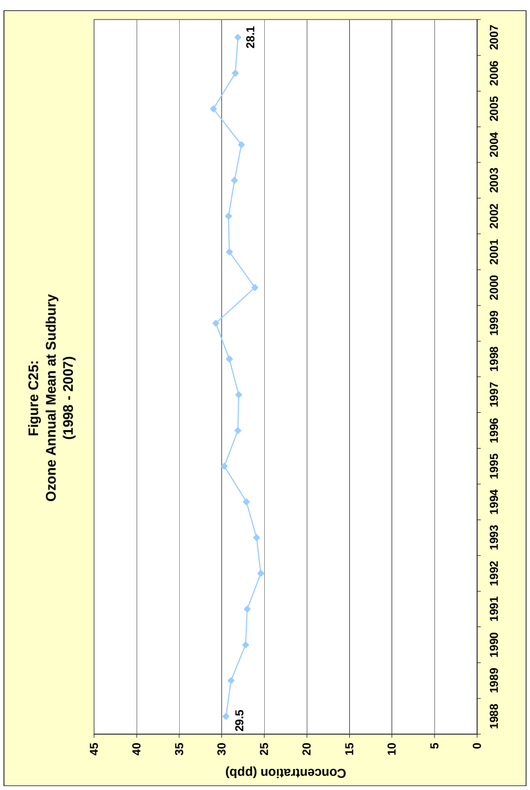


Figure C25:
Ozone Annual Mean at Sudbury
(1998 - 2007)
Concentration (ppb)
45
40
35
30
25
20
15
10
5
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
29.5
28.1

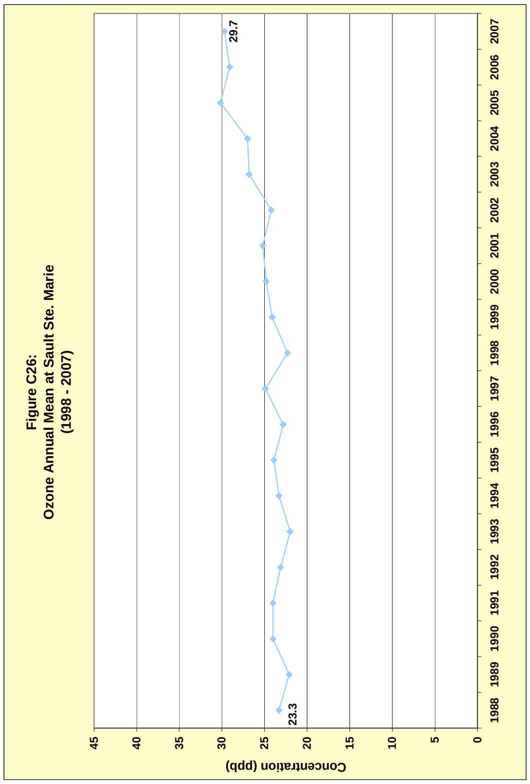


Figure C26:
Ozone Annual Mean at Sault Ste. Marie
(1998 - 2007)
Concentration (ppb)
45
40
35
30
25
20
15
10
5
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
23.3
29.7

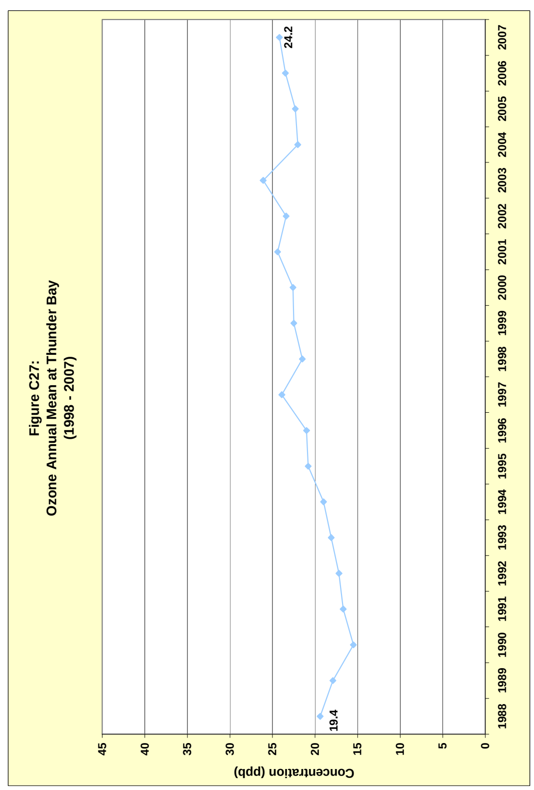


Figure C27:
Ozone Annual Mean at Thunder Bay
(1998 - 2007)
Concentration (ppb)
45
40
35
30
25
20
15
10
5
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
19.4
24.2

AIR QUALITY IN ONTARIO
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APPENDIX D
20-YEAR NO_2 TRENDS

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

ACKNOWLEDGEMENTS

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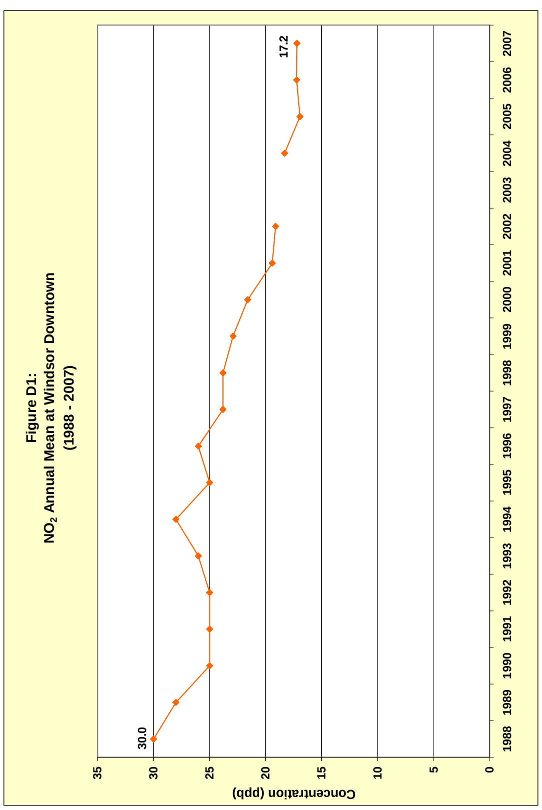


Figure D1:
NO_2 Annual Mean at Windsor Downtown
(1988 - 2007)

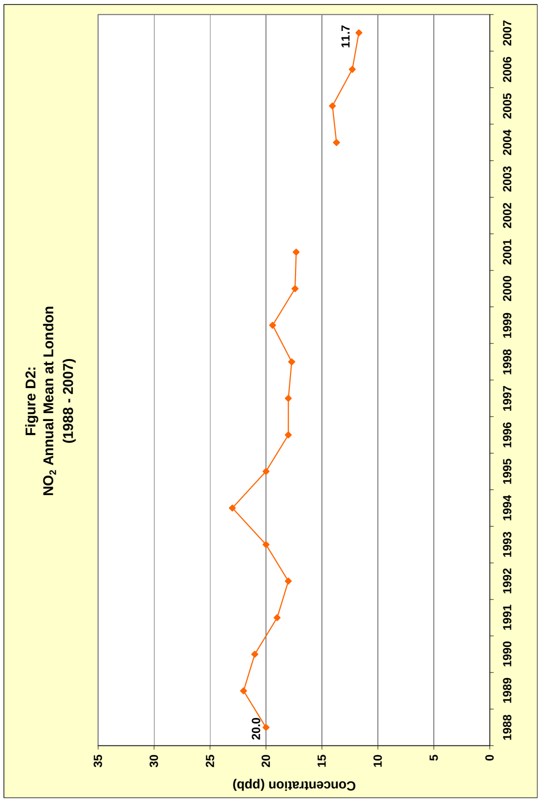


Figure D2:
NO_2 Annual Mean at London
(1988 - 2007)

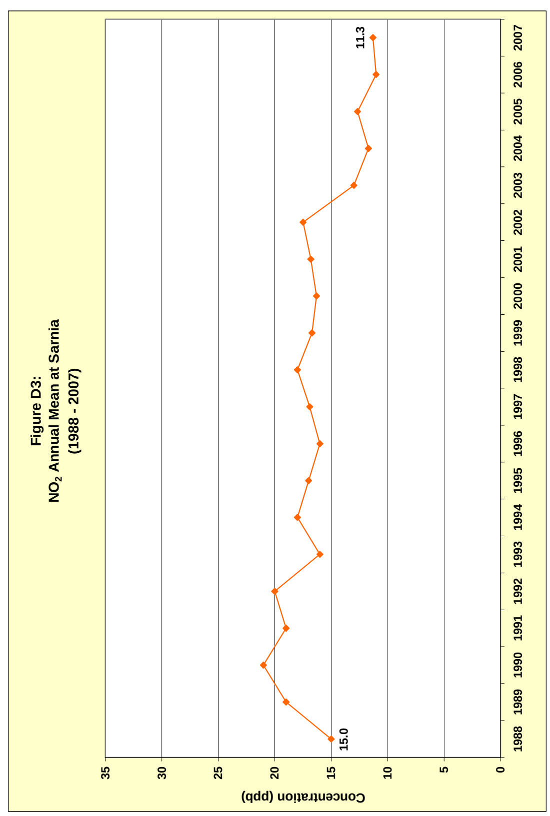


Figure D3:
NO_2 Annual Mean at Sarnia
(1988 - 2007)

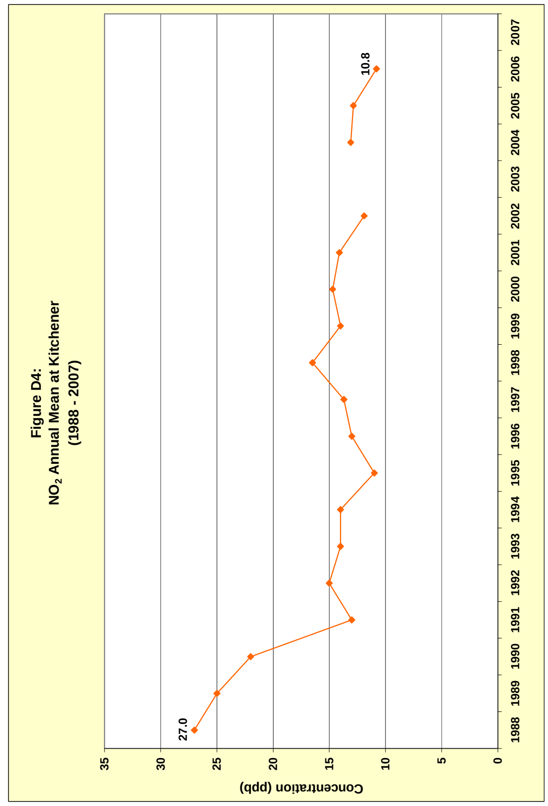


Figure D4:
NO_2 Annual Mean at Kitchener
(1988 - 2007)

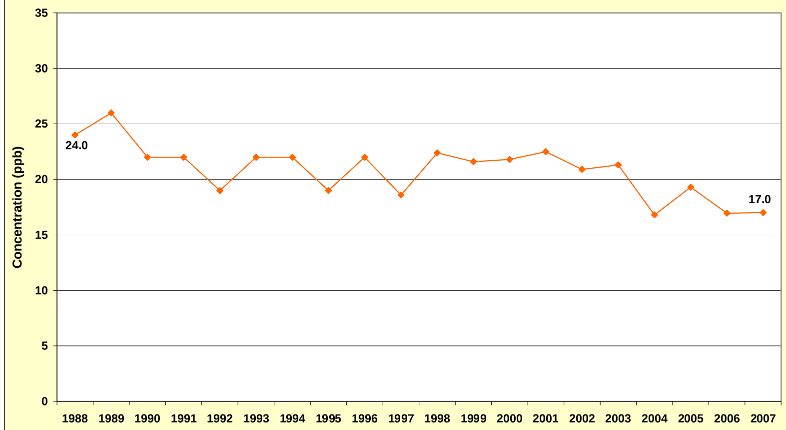


Figure D5:
NO_2 Annual Mean at Hamilton Downtown
(1988 - 2007)

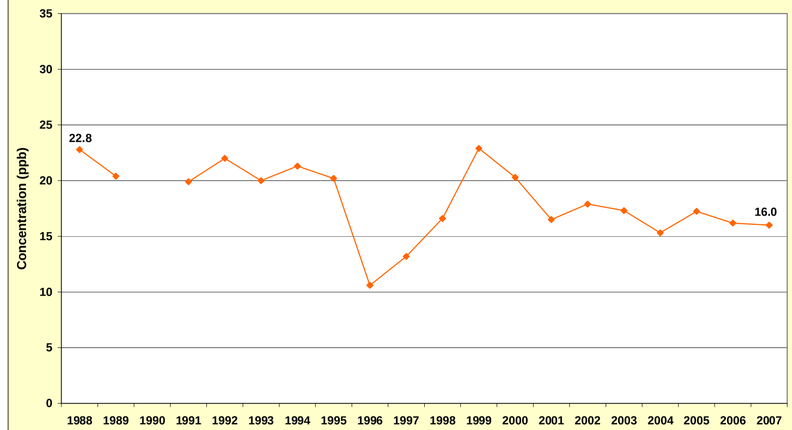


Figure D6:
NO_2 Annual Mean at Burlington
(1988 - 2007)

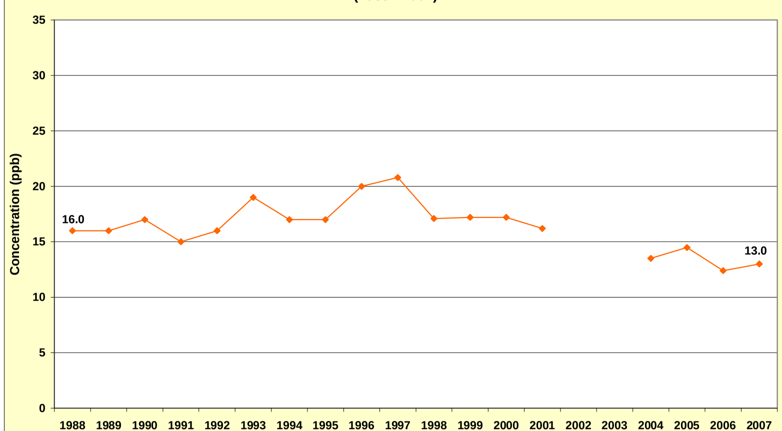


Figure D7:
NO_2 Annual Mean at Oakville
(1988 - 2007)

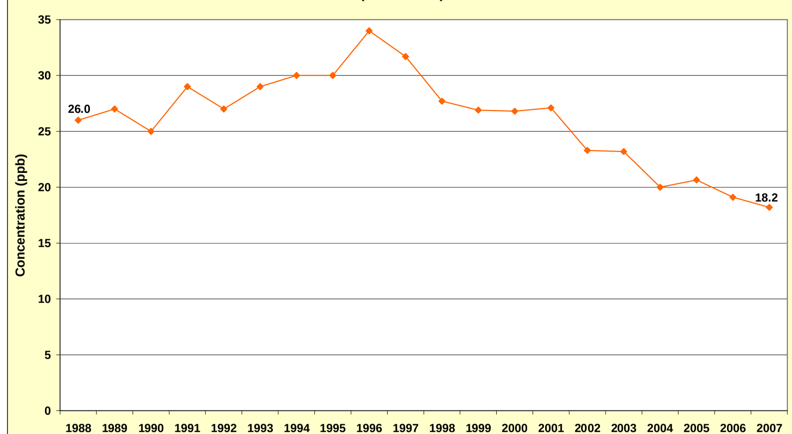


Figure D8:
NO_2 Annual Mean at Toronto Downtown
(1988 - 2007)

Figure D9:
NO_2 Annual Mean at Toronto North
(1988 - 2007)

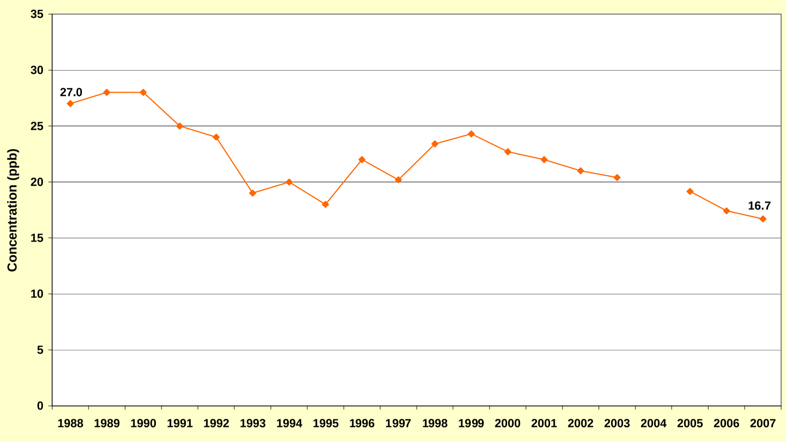


Figure D10:
NO_2 Annual Mean at Toronto East
(1988 - 2007)

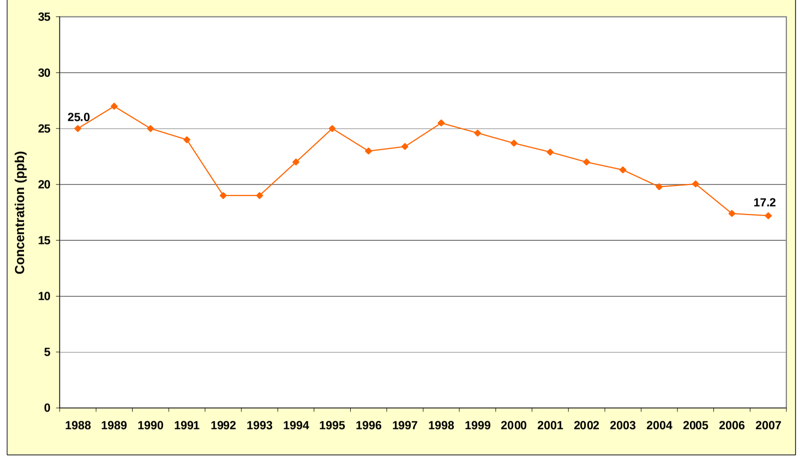


Figure D11:
NO_2 Annual Mean at Oshawa
(1988 - 2007)

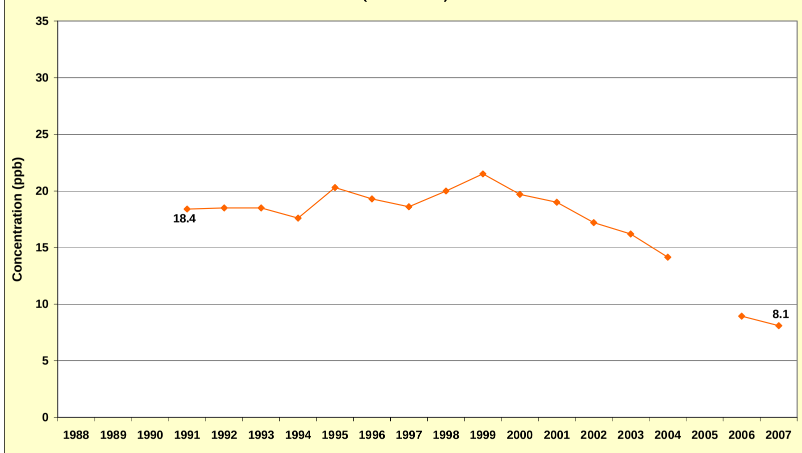
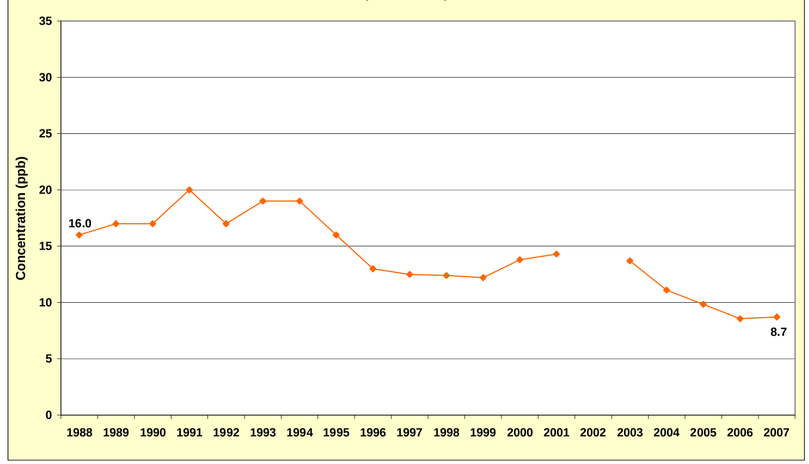


Figure D12:
NO_2 Annual Mean at Ottawa Downtown
(1988 - 2007)



AIR QUALITY IN ONTARIO
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APPENDIX E
20-YEAR CO TRENDS

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

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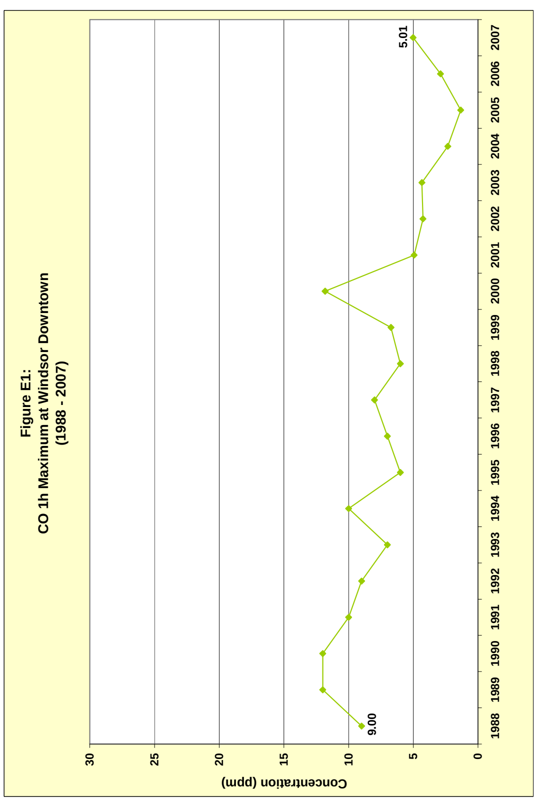

Figure E1:
CO 1h Maximum at Windsor Downtown
(1988 - 2007)

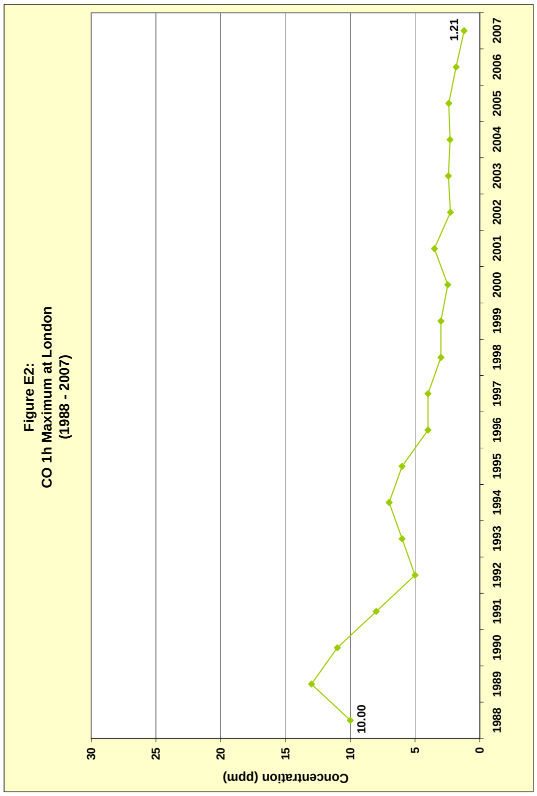

Figure E2:
CO 1h Maximum at London
(1988 - 2007)

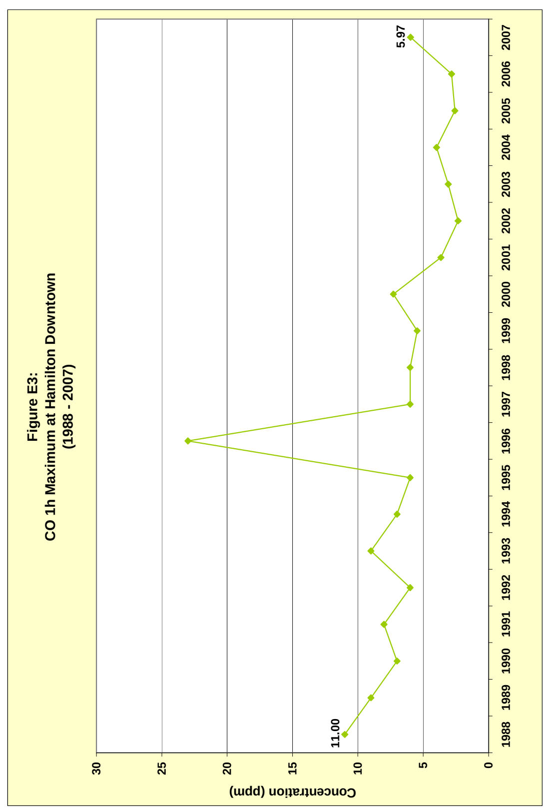

Figure E3:
CO 1h Maximum at Hamilton Downtown
(1988 - 2007)

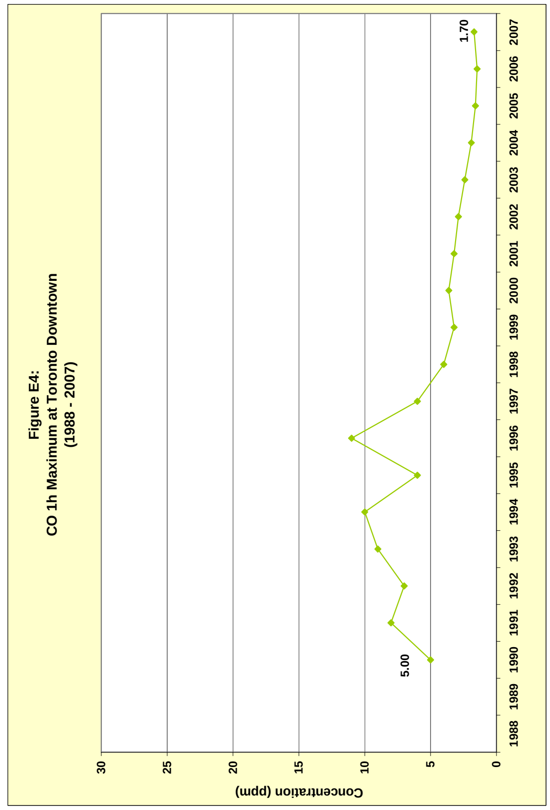

Figure E4:
CO 1h Maximum at Toronto Downtown
(1988 - 2007)

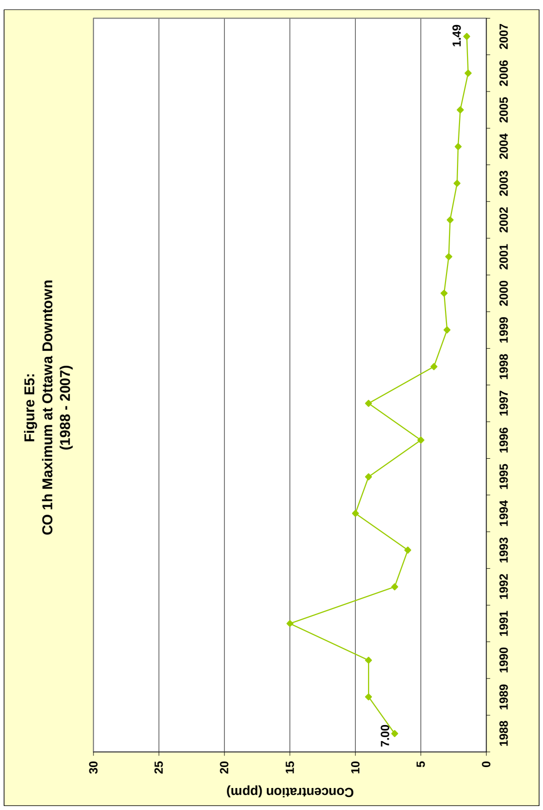

Figure E5:
CO 1h Maximum at Ottawa Downtown
(1988 - 2007)

AIR QUALITY IN ONTARIO
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APPENDIX F
20-YEAR SO_2 TRENDS

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

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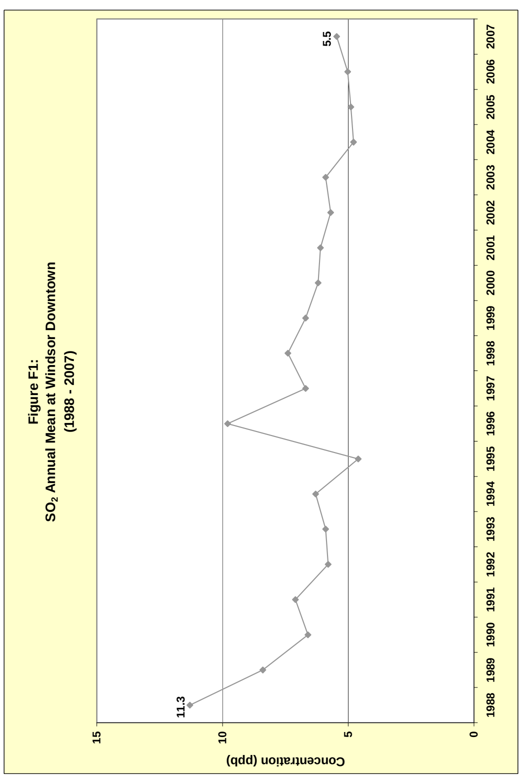

Figure F1:
SO_2 Annual Mean at Windsor Downtown
(1988 - 2007)

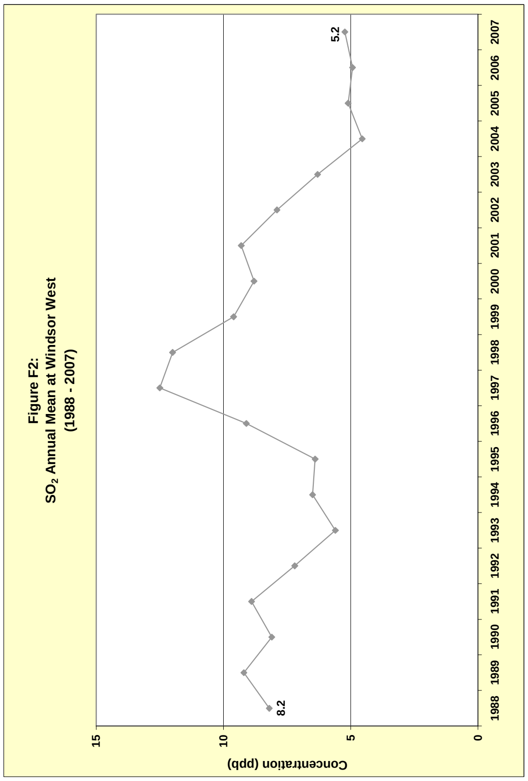

Figure F2:
SO_2 Annual Mean at Windsor West
(1988 - 2007)

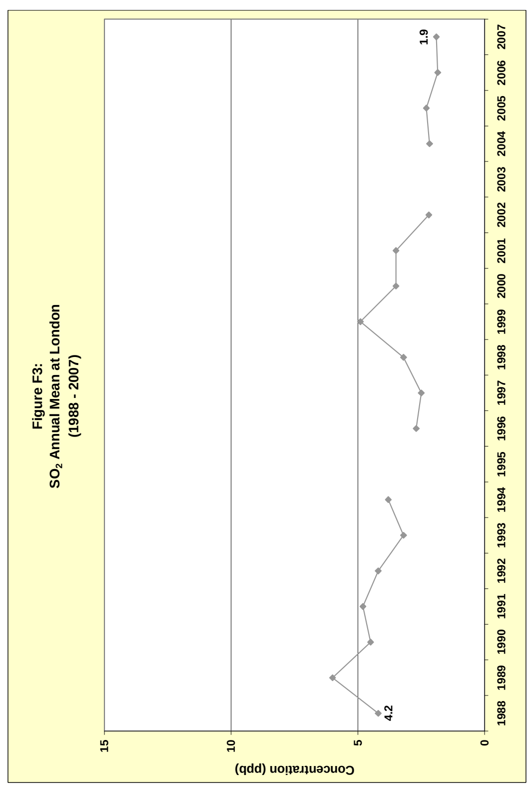

Figure F3:
SO_2 Annual Mean at London
(1988 - 2007)

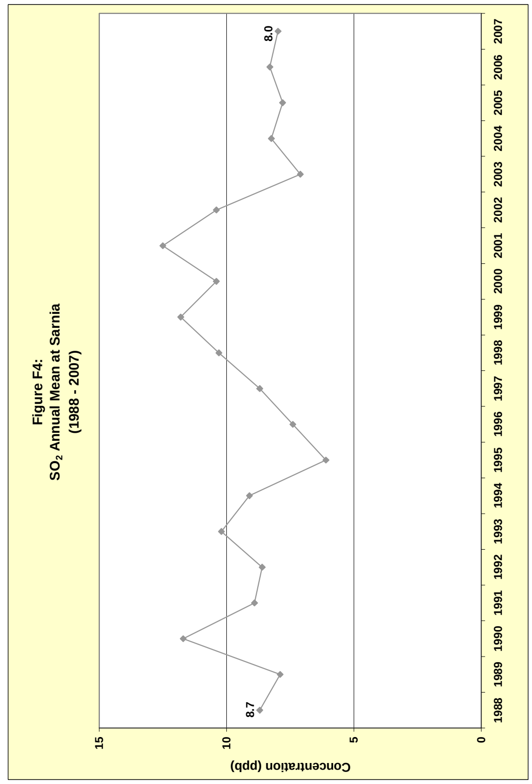

Figure F4:
SO_2 Annual Mean at Sarnia
(1988 - 2007)

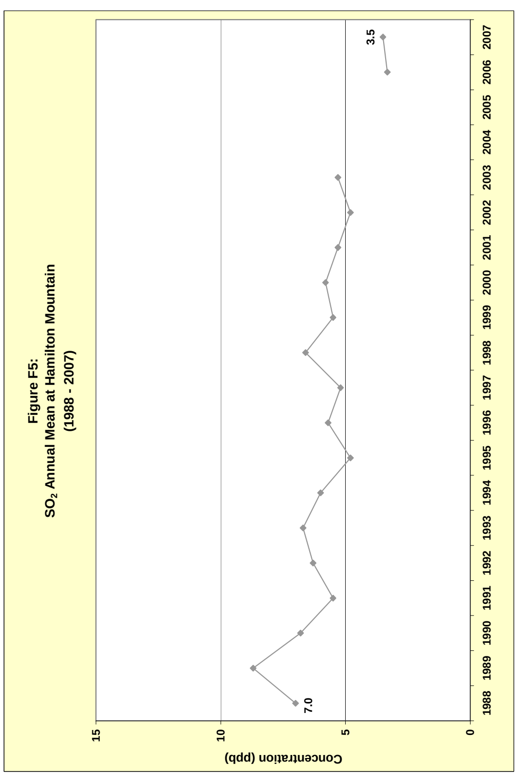

Figure F5:
SO_2 Annual Mean at Hamilton Mountain
(1988 - 2007)

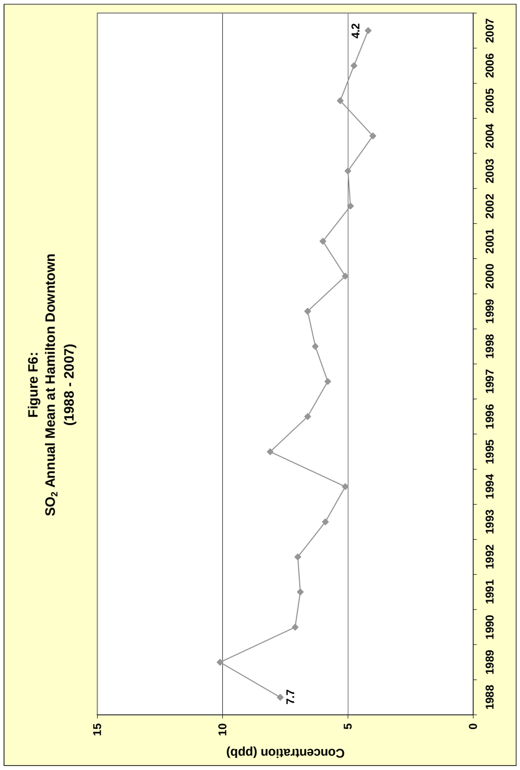

Figure F6:
SO_2 Annual Mean at Hamilton Downtown
(1988 - 2007)

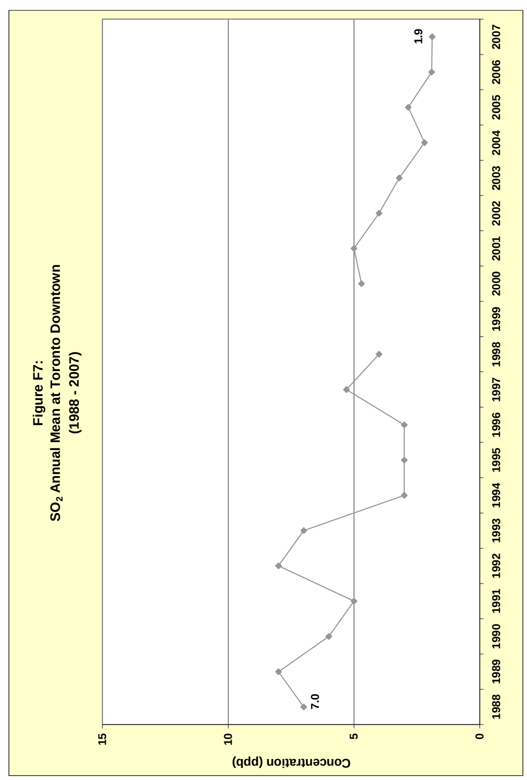

Figure F7:
SO_2 Annual Mean at Toronto Downtown
(1988 - 2007)

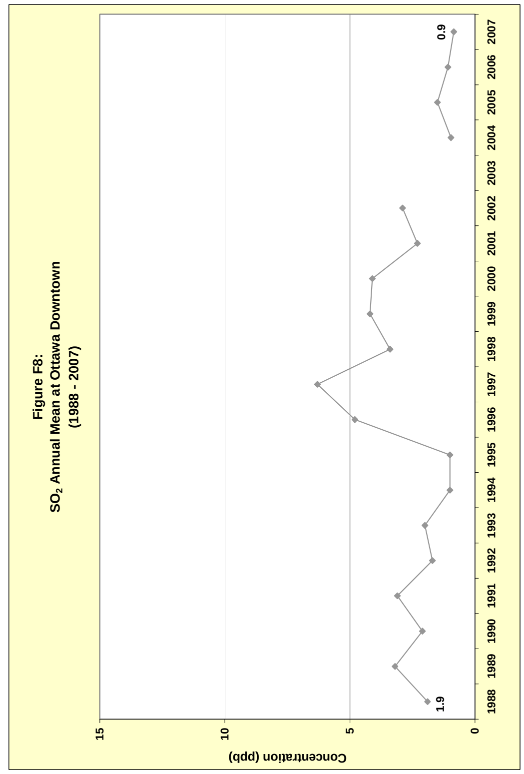

Figure F8:
SO_2 Annual Mean at Ottawa Downtown
(1988 - 2007)

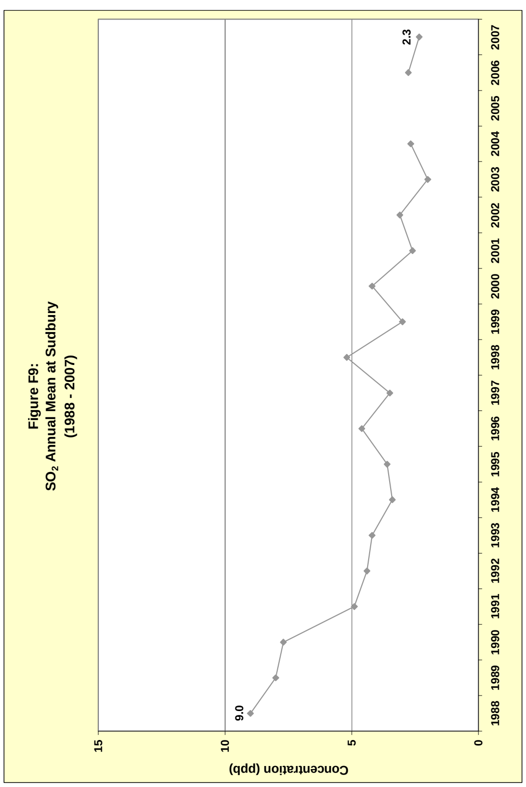

Figure F9:
SO_2 Annual Mean at Sudbury
(1988 - 2007)

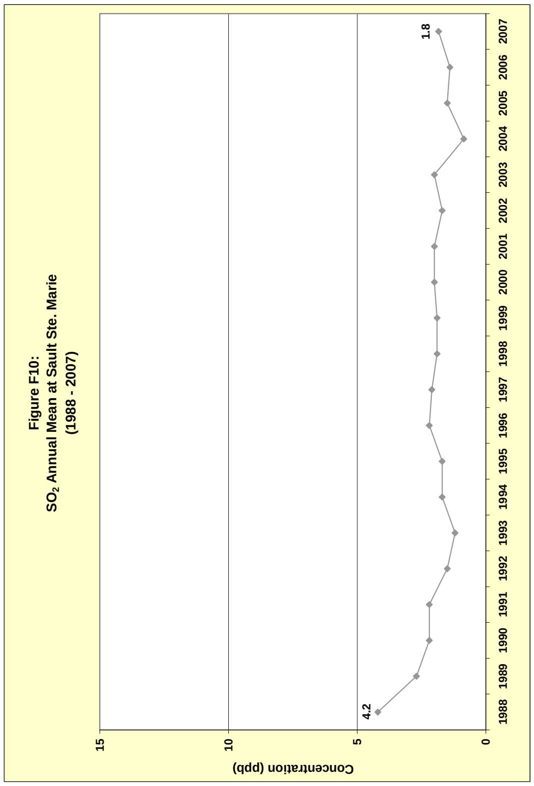

Figure F10:
SO_2 Annual Mean at Sault Ste. Marie
(1988 - 2007)