HALDIMAND & NORFOLK

STATE OF THE ENVIRONMENT REPORT 2003

Prepared by

Wayne Tucker, B.A., M.Sc
Epidemiologist
Haldimand-Norfolk Health Unit
(519) 426-6170, ext 215
wayne.tucker@haldimand-norfolk.org

HALDIMAND-NORFOLK HEALTH UNIT

MESSAGE FROM THE ACTING MEDICAL OFFICER OF HEALTH

This State of the Environment Report is the first of its kind in Haldimand and Norfolk counties. It provides important and valuable information regarding outdoor air quality in Haldimand and Norfolk counties. This represents Part 1 of a comprehensive environmental assessment. Part 2 will focus on water quality and Part 3 on land.

Over the past three decades Ontario has seen a dramatic improvement in air quality. This does not mean that we should be complacent and accept this improvement as the 'best that we can do'. Rather, we should recognize the positive steps made in the past and continue to strive to improve our air quality. This will reduce its negative impact on the health of the residents of Ontario, and the residents of Haldimand and Norfolk.

There are a number of public health risks related to air pollution and poor air quality. These air quality parameters are monitored by air quality monitoring stations and those are monitored by the provincial government's regular monitoring network.

Traditionally, the Long Point monitoring station has recorded levels of ozone higher than the other provincial monitoring stations. This is clearly a health issue for the residents of Haldimand and Norfolk, which is influenced by pollutants coming from the Ohio Valley and other areas in the United States.

Levels of other pollutants in Haldimand and Norfolk have either been stable over the past number of years or have been reducing. This can be seen as a positive step towards the overall improvement of the air quality for residents of Haldimand and Norfolk counties. These positive trends need to continue and all efforts at a local and provincial level to improve air quality should be encouraged and wholeheartedly supported.

I wish to recognize the work of the Haldimand-Norfolk Health Unit and in particular the work of Mr. Wayne Tucker that went into the preparation of this report.

Jeff Tschirhart, MD, CCFP
Acting Medical Officer of Health
Haldimand-Norfolk Health Unit

MESSAGE FROM THE PROGRAM COORDINATOR – HEALTHY ENVIRONMENT

Air quality is a society-wide problem, and all levels of government have important roles to play in protecting the public by curbing smog-causing emissions. The Haldimand-Norfolk State of the Environment Report (SOER) 2002 - Air Quality is a technical document with a lot of data and graphs of the contaminants that are monitored in Haldimand and Norfolk Counties.

The report identifies outdoor air pollutants and indicates if they cause a health effect, such as respiration problems, asthma, cardiovascular disease or if it is a carcinogen etc. Some pollutants cause aesthetic problems i.e. odour. This report does not attempt to determine the source (local or remote) of the contaminants, or to address the health risk associated with each contaminant at the concentration that it is found.

Most smog-producing air pollutants in Ontario are released as unburned by-products of the gasoline, coal and natural gas we use in vehicles, homes and businesses, industrial boilers and power plants. Smog "precursors" are also released by industrial processes, in the evaporation of liquid fuels, and in the use of solvents and other volatile products, such as oil-based paints.

Smog originates both locally and outside Ontario. On hot summer days, for example, more than 50 percent of the smog-causing ozone that affects Ontario is carried here on the wind from the United States. Still, almost half of the problem originates right here in Ontario.

It's our domestic contribution to the air quality problem that we need to start addressing more effectively. The perception is that industry with its big chimneys is THE source of air pollution, no doubt they are a major contributor, but the private sector contributes its share. For example, in 2000 the transportation sector was responsible for approximately 63% of the Nitrogen Oxides (NOx) emissions in Ontario. In contrast, industry was responsible for 70% of the Sulphur Dioxide (SO2) emissions in Ontario in 1999. The adage that if you aren't part of the solution, you are part of the problem is very applicable to air quality.

Municipalities can help by introducing by-laws, for example the burning by-law recently passed by Norfolk County will help reduce contaminants from domestic open fires that contribute a great deal to the local air pollution. Individuals can do a lot to reduce emissions at a local level.. Some measures are as simple as turning down the thermostat in the house at night, tune the car or truck, limit the time a vehicle idles, increase the insulation in the house, don't burn refuse, limit the use of two stroke engines, don't use gas powered equipment on a smog day, keep volatile compounds (varsol, gasoline, diesel fuel, turpentine, oil based paint, etc.) covered to prevent evaporation. Most things we put into the air stay there for a long time, some settle out and others combine to produce more complex contaminants.

Hopefully this report will give some insight into the air pollutants that are actually present in Haldimand and Norfolk Counties and encourage everyone to do their part to improve the local air quality.

Glen Steen, BSc, CPHI(C)
Program Coordinator
Healthy Environment Team
Haldimand-Norfolk Health Unit
(519) 426-6170, ext 204
glen.steen@haldimand-norfolk.org

Acknowledgements

The Haldimand-Norfolk Health Unit would like to thank the following people for their contribution in editing/reviewing the Haldimand and Norfolk State of the Environment Report (SOER) 2003 – Air Quality.

Karen Boughner	Manager Haldimand-Norfolk Health Unit
Dr. Jeff Tschirhart	Acting Medical Officer of Health Haldimand-Norfolk Health Unit
Patti Moore	General Manager Health & Social Services Department
Glen Steen	Program Coordinator Haldimand-Norfolk Health Unit
Adam Stevens	Epidemiologist Brant County Health Unit
Frank Dobroff	Air Quality Analyst Ministry of the Environment

TABLE OF CONTENTS

Message from the Acting Medical Officer of Health……. 1
Message from the Program Coordinator – Healthy Environment..…… 2
List of Acknowledgements……. 3
Table of Contents…… 4
List of Figures……. 5
List of Tables……..……..…… 6
Highlights…… 7
Introduction…… 9
Air Quality in Ontario……. 9
Ontario's Air Quality Index Monitoring Network……. 10
Health Effects Related to Smog/Air Pollution – General…….. 10
Health Effects Related to Smog - Haldimand and Norfolk……. 11
US Sources of SMOG……..…….……..…… 14
Air Quality Monitoring Stations Located in Haldimand and Norfolk Counties……. 14
Air Quality Index (AQI)……. 19
How to interpret the AQI?…….. 19
How does the Ministry of Environment (MOE) calculate the AQI?…….. 19
Air Quality Forecast…… 20
Ground Level Ozone (O_3)…… 24
Volatile Organic Compounds (VOC)……. 30
Volatile Organic Compounds (VOC) – Benzene…… 30
Volatile Organic Compounds (VOC) – Toluene……. 31
Ortho-xylene (Benzene,Toluene & Xylene or BTX)…….. 32
Polycyclic Aromatic Hydrocarbons (PAH)……..……... 33
Polycyclic Aromatic Hydrocarbons (PAH) – Benzo(a)pyrene…… 34
Nitrogen Oxides (NO_x) ……..….. 35
Sulphur Dioxide(SO_2) …….. 38
Total Reduced Sulphur (TRS)……. 39
Inhalable Particulate (PM_{10})……..…….. 40
Respirable Particulate ($PM_{2.5}$)……. 41
Total Suspended Particulate (TSP)……. 43
Coefficient of Haze (Soiling Index)…… 46
Dustfall…… 47
Fluoridation…….. 49
Conclusion…… 51
References……..…….. 54

LIST OF FIGURES

Figure 1.1 Health Effects of Pollution
Figure 1.2 Asthma rates for Ontario's 37 Public Health Units
Figure 1.3 Smog Advisories (1993-2001)
Figure 1.4 Annual Ozone levels (1992-2001)
Figure 1.5 Monthly Ozone levels (2001)
Figure 1.6 Number of Ozone Exceedance Days (1991-2000)
Figure 1.7 Number of Ozone Exceedance Days at Sites Across Ontario (2000)
Figure 1.8 Number of Ozone Exceedance Days at Sites Across Ontario (1995)
Figure 1.9 Number of Ozone Exceedance Days at Sites Across Ontario (1991)
Figure 1.10 Benzene levels (1994-2001)
Figure 1.11 Tolune levels (1992-2001)
Figure 1.12 Ortho-xylene (1992-2001)
Figure 1.13 Polycyclic Aromatic Hydrocarbons (PAH) Total levels (1994-2001)
Figure 1.14 Benzo(a)pyrene levels (1994-2001)
Figure 1.15 Nitrogen Oxides (NOx) levels – Annual (1992-2001)
Figure 1.16 Nitrogen Oxides (NOx) levels – Monthly (2000)
Figure 1.17 Total Reduced Sulphur (TRS) – Annual (1992-2001)
Figure 1.18 Inhalable Particulate (PM_{10}) – Annual (1992-2001)
Figure 1.19 Respirable Particulate ($PM_{2.5}$) – Annual (1998-2001)
Figure 1.20 Respirable Particulate ($PM_{2.5}$) – Monthly (2001)
Figure 1.21 Total Suspended Particulates (TSP) – Annual (1992-2001)
Figure 1.22 Total Suspended Particulates (TSP) – Monthly (2001)
Figure 1.23 Coefficient of Haze (Soiling Index) – Annual (1992-2001)
Figure 1.24 Coefficient of Haze (Soiling Index) – Monthly (2001)
Figure 1.25 Dustfall – Annual (1992-2001)
Figure 1.26 Dustfall – Monthly (2001)
Figure 1.27 Fluoride – Annual (1992-2001)

LIST OF TABLES

Table 1.1 Ontario's Air Quality Index Monitoring Network
Table 1.2 Nanticoke Air Quality Monitoring Stations
Table 1.3 Air Quality Index (AQI) Pollutants and Their Impact
Table 1.4 Overview of Air Pollutants and General Health Effects
Table 1.5 Ranking of Ozone Exceedance Days
Table 1.6 Ontario Nitrogen Oxides (NOx) Emissions by Sector 1999
Table 1.7 Ontario Nitrogen Oxides (NOx) Emissions by Sector 2000
Table 1.8 Ontario Sulphur Dioxide (SO_2) Emissions by Sector 1999
Table 1.9 Ontario Sulphur Dioxide (SO_2) Emissions by Sector 2000
Table 1.10 Sulphur Dioxide (SO_2) – Annual (1992-2001)
Table 1.11 Sulphur Dioxide (SO_2) – Monthly (2001)
Table 1.12 Total Suspended Particulates (TSP) – Seasonal Patterns (2001)

Highlights

The Haldimand-Norfolk Health Unit is pleased to present to the residents of Haldimand and Norfolk counties the first official State of the Environment Report (SOER). The SOER will be released in 3 parts in 2003. The current report is Part A and focuses on Air Quality (outdoor). The goal of this report is to describe the level of major pollutants over the last ten years and identify times when these pollutants exceed the provincial standards. A second goal of this report is to help residents of Haldimand and Norfolk counties understand the health impact of these pollutants. Despite the fact that pollutants are for the most part within the provincial standards, there are health risks associated with these pollutants. It is not possible to be specific about the health impacts of pollutants because there are a variety of reasons for poor health. For example, although we know that air pollution can trigger asthma, there are other triggers of asthma in a population (pollen, exercise, etc). At times of poor air quality the young, the elderly and those with existing medical conditions are those who are mostly affected by air pollution. The following highlights are some of the key findings of the Air Quality report. Please see the full report for additional details on these points and for a description of these pollutants. The full report can be downloaded from the **Haldimand-Norfolk Health Unit** website (www.haldimand-norfolk.org).

- The level of ozone at the Long Point station has consistently recorded the highest number of ozone exceedance days (1hr above Ontario standard of >80 ppb) in Ontario over the last ten years. In 2000, Long Point had 20 ozone exceedance days compared to 5 in London, 4 in Toronto (downtown) and 4 in Hamilton (downtown). The main health impact of high ozone levels is respiratory related illnesses.

- Based on the Air Quality Index (AQI), the air quality at the Simcoe station was reported to be "good" or "very good" 90% of the time in 2000, compared to 88% at the Long Point station.

- Volatile Organic Compounds (VOC) contributes to ground level ozone via a chemical reaction with the Nitrogen Oxides and the sun. The main health impact of VOCs (such as Benzene) is cancer. Currently there are no Ontario standards for VOCs like Benzene making it difficult to assess its health impact. Of the 3 stations measuring Benzene in Halidmand and Norfolk, the Nanticoke Village station, had the highest Benzene level over the last 8 years (1994-2001).

- Polycyclic Aromatic Hydrocarbons (PAH) are classified as "probably carcinogenic to humans." The most toxic of the PAHs is Benzo(a)pyrene. The Benzo(a)pyrene level at the Nanticoke Village station exceeded the Ontario 24 hr objective 9 times in 2001. The Ontario annual objective has been repeatedly exceeded at the Nanticoke Village station for the last nine years (1994-2001). In 2001, the Nanticoke Village station exceeded the Ontario objective 5 times.

- Nitrogen Oxides (NOx) stations within Haldimand and Norfolk counties did not exceed the Ontario 24 hr standard in 2001. NOx levels did show a seasonal variation in 2001. NOx levels were the lowest in the summer months of June, July, and August. The main health impact of NOx is increased respiratory related problems.

- Over the last 10 years (1992-2001) none of the Sulphur Dioxide (SO_2) stations in Haldimand and Norfolk counties exceeded the annual Ontario objective of 20 ppb. The main health impacts of SO_2 are on the respiratory and cardiovascular systems.

- Total Suspended Particulates (TSP) is measured at 4 stations within Haldimand and Norfolk. None of these stations exceeded the annual Ontario objective of 60 ug/m^3over the last 10 years (1992-2001). TSP levels in 2001 did show a seasonal variation with May-Aug having the highest TSP levels.

- PM_{10} (Particulate Matter – less than 10 microns) is measured at the Walpole South in Haldimand-Norfolk. The Ontario 24 hr objective was exceeded 2 times in 2001. The main health impact of PM_{10} is increased respiratory related problems.

- $PM_{2.5}$ (Particulate Matter – less than 2.5 microns) is measured at the Simcoe station. The Ontario 24 hr objective was exceeded 10 times in 2001. The main health impact of $PM_{2.5}$ is increased respiratory related problems.

- Soiling index is a measure of the amount of dust in the air (less than 10 microns). The annual Ontario objective was not exceeded by the Nanticoke Village station over the last 10 years (1992-2001). The main health impact of the soiling index is increased respiratory related problems.

- Dustfall is a measure of the amount of particles that settles on the ground due to gravity. Dustfall is not considered a health issue. None of the stations with Haldimand and Norfolk exceeded the annual Ontario objective over the last 10 years (1992-2001).

- Total Reduced Sulphur (TRS) is a group of odourous pollutants that smells like "rotten eggs". TRS is not normally considered a health issue. The Ontario 1 hr objective was not exceeded at the Walpole station in 2001, but was exceeded once at the Nanticoke Village.

Introduction

The Haldimand and Norfolk State of the Environment Report (HN-SOER) 2003 – Air Quality (outdoors) is the first official report of this type. The Haldimand-Norfolk Health Status Data Report 1993 did contain a small section on the environment. The goal of this report is to focus on the air quality environmental issues that are important to residents of the Haldimand and Norfolk counties. The HN-SOER 2003 – Air Quality will supplement the Haldimand and Norfolk Community Health Status Report 2002. Together, these two documents provide residents of Haldimand and Norfolk with a very comprehensive look at the health issues. The HN-SOER 2003 Air Quality focuses on how air quality impacts on one's health, whereas the Haldimand and Norfolk Community Health Status Report 2002 is a very detailed look at the health status of residents. The HN-SOER 2003 Air Quality is Part 1 of a comprehensive State of the Environment Report for Haldimand and Norfolk counties. Parts 2 and 3 will follow the release of Part 1 and will focus on water and land, respectively.

There are a number of different units of measure that are used throughout this report. For example, ppm (parts per million), ppb (parts per billion), ug/m^3 (micrograms per cubic metre), and ng/m^3 (nanograms per cubic metre). It is important to understand the unit of measure when interpreting tables or figures, or when comparing data from this Air Quality report with other sources of air quality for Haldimand and Norfolk counties. It is equally important to understand how to convert data reported in ppm to ppb (or vise versa). For example, .10 ppm is equal to 100 ppb and 200ppb is equal to .20 ppm. One can convert ng/m^3 to ug/m^3(or vise versa), for example, .0003 ug/m^3 is equal to .3 ng/m^3.

AIR QUALITY

Air Quality in Ontario

According to the Ministry of Environment (MOE) the "air quality in Ontario improved significantly during the past 30 years … ." (MOE Air Quality Report, 2000). For example, over the last 30 years sulphur dioxide was reduced by 83% and carbon monoxide by 81%. The major pollutants nitrogen oxides and nitrogen dioxide were reduced by 49% and 23%, respectfully over the last 26 years (MOE Air Quality report 2000). Clearly, there is evidence that air quality in Ontario has improved over the last 30 years despite increases in population, number of vehicles on the road, etc. Irrespective of this positive trend in reducing pollutants in the air there is still a lot of work to be done to improve the air quality in Ontario. It is important to understand that not all of the poor air quality in Ontario is being produced in Ontario. "A major portion of Ontario's smog is a direct result of emissions from the US." (MOE Air Quality report 2000). One example, of a program initiated by the Ontario government to improve air quality in Ontario is the Drive Clean program. According to a press release from the MOE, Ontario's Drive Clean program has resulted in a 15.2% reduction in smog causing emissions from vehicles in the Greater Toronto Area and Hamilton (MOE August 7, 2000 press release). This 15.2% reduction amounts to 14,800 less tonnes of pollutants in the environment. This reduction was reported for a 3 year period (1999, 2000, & 2001). For more information on the Drive Clean program see - http://www.driveclean.com/.

Ontario's Air Quality Index Monitoring Network

There are **36** air quality monitoring stations in Ontario that are part of Ontario's air quality index monitoring network (Table 1.1). Please note that the majority of the air quality stations in Haldimand-Norfolk are not listed here. These stations are part of the provincial government's regular monitoring network.

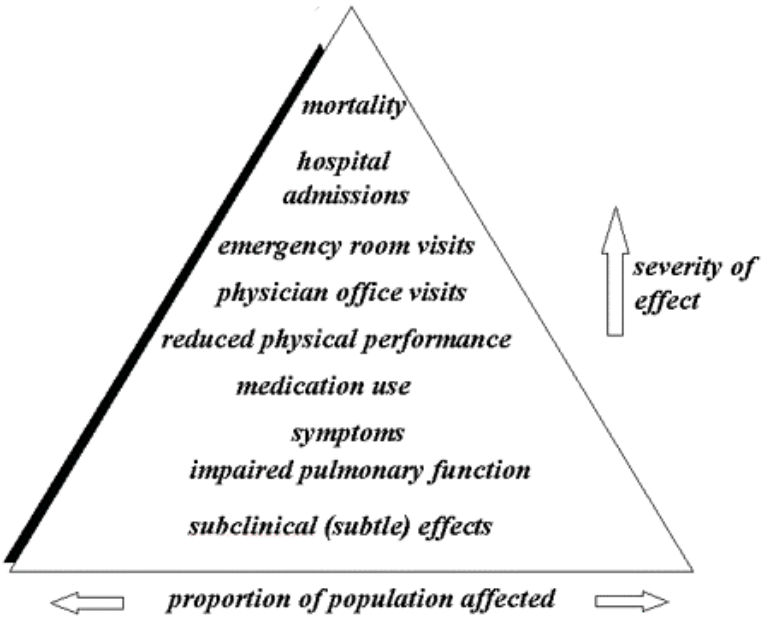
Table 1.1 Ontario's Air Quality Index Monitoring Network

Windsor Downtown	**Hamilton Downtown**	**Barrie**
Windsor West	**Hamilton Mountain**	**York Region**
Merlin	**Hamilton West**	**Parry Sound**
Sarnia	**Toronto Downtown**	**Dorset**
Grand Bend	**Toronto East**	**Ottawa**
London	**Toronto North**	**Kingston**
Tiverton	**Toronto West**	**Cornwall**
Simcoe	**Burlington**	**Peterborough**
Kitchener	**Oakville**	**Thunder Bay**
Niagara Region	**Oshawa**	**Sault Ste. Marie**
Guelph	**Brampton**	**North Bay**
Port Stanley	**Mississauga**	**Sudbury**

Health Effects Related to Smog/Air Pollution - General

There are a number of health effects related to smog. Smog is composed of a number of pollutants that will be discussed in more detail later in this chapter. According to Health Canada, how smog affects an individual's health depends on a number of factors such as - where you live, length of exposure, weather, age, current state of health and the level and type of pollutants in the air (Health Canada - http://www.hc-sc.gc.ca/english/iyh/environment/smog.htm, August15, 2002). People with existing health conditions such as heart and lung problems are at a higher risk since smog can worsen these types of conditions. Seniors are at a higher risk since they are more likely to have heart and lung problems. Children are also at a higher risk due to the fact that their respiratory systems are still developing and to increased exposure via a more active lifestyle (Health Canada - http://www.hc-sc.gc.ca/english/iyh/environment/smog.htm, August15, 2002).

Figure 1.1 Health Effects of Pollution



Source: Health Canada (http://www.hc-sc.gc.ca/hecs-sesc/air_quality/definitions.htm)

According to Health Canada air pollution is known to affect both the respiratory and cardiac systems. Figure 1.1 highlights how the health effects of pollution can be seen as a pyramid. At the bottom of the pyramid are those health effects that affect a higher proportion of the population when the severity of effect is lower. At the top of the pyramid are those health effects that affect a much smaller proportion of the population, example mortality (Health Canada - http://www.hc-sc.gc.ca/hecs-sesc/air_quality/definitions.htm, Oct 3, 2002). Acute respiratory symptoms such as chest discomfort, coughing, and wheezing are common when air pollution levels are low. Increasing cases of cardiovascular and respiratory hospitalizations, as well as mortality (non-accidental) are seen at higher air pollution levels (Health Canada - http://www.hc-sc.gc.ca/hecs-sesc/air_quality/definitions.htm, Oct 3, 2002). "The young, elderly and sensitive populations with existing conditions of either cardiovascular disease or respiratory disorders such as asthma, emphysema, chronic bronchitis or allergy problems, are the most widely affected by poor air quality" (Health Canada - http://www.hc-sc.gc.ca/hecs-sesc/air_quality/faq.htm, Oct 3, 2002).

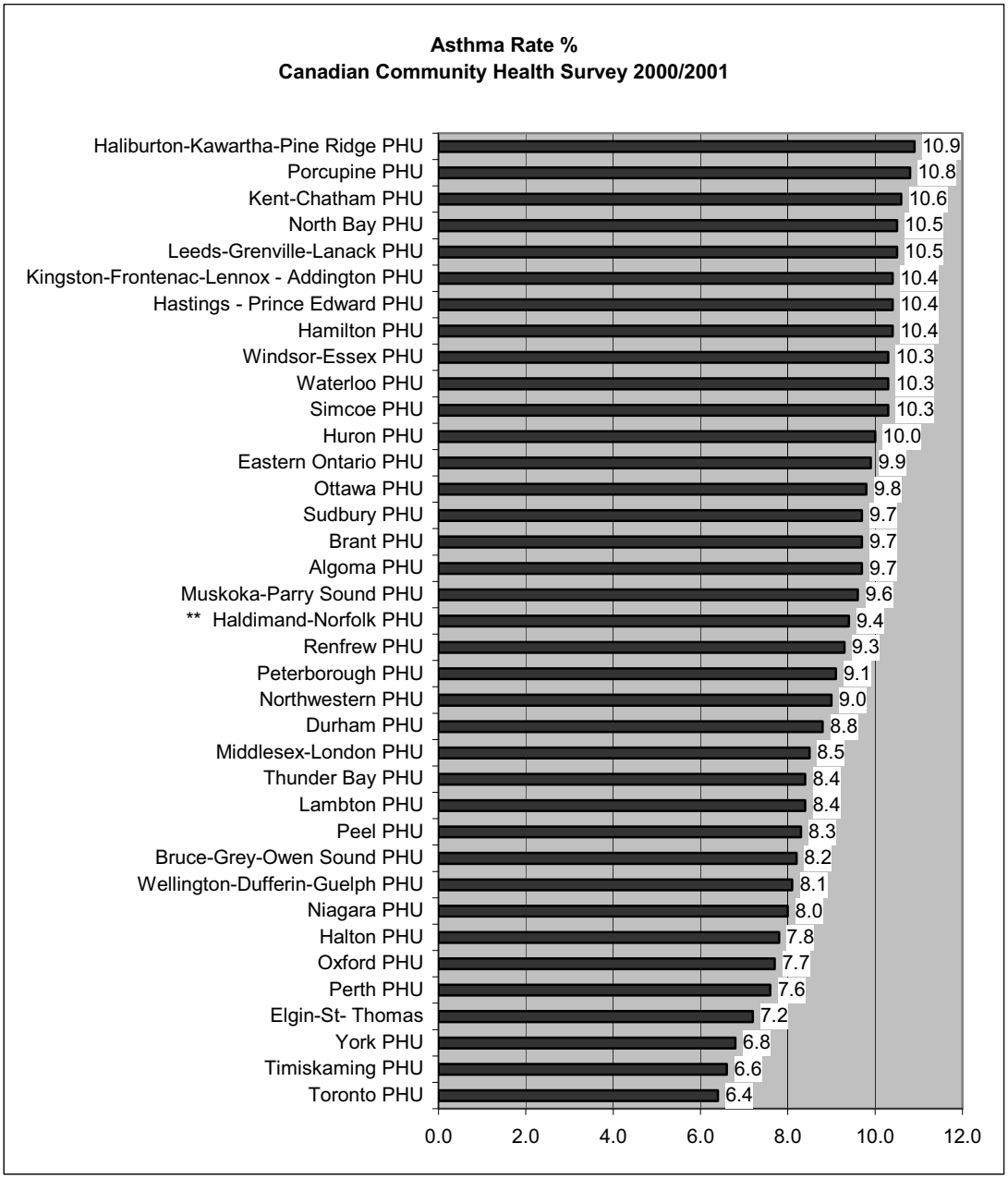
Health Effects Related to Smog - Haldimand and Norfolk

It is not possible to isolate exactly how much of an impact poor air quality has on the health of residents of Haldimand and Norfolk, but it is important to highlight those health conditions that are affected by air pollution. Lifestyle choices like smoking have a negative impact on health. It is therefore not possible to determine the extent to which respiratory hospitalizations discussed below are related to the higher rate of smoking by Haldimand and Norfolk residents or poor air quality. Results from the Canadian Community Health Survey (2000/2001) reported that 24.6% of Haldimand and Norfolk residents were daily smokers, compared to 20.1% in Ontario and 21.5% in Canada. The Haldimand and Norfolk Community Health Status Report 2002 did find some interesting results for those conditions that are influenced by air pollution. This report

found that the standardized hospitalization rate for Diseases of the Respiratory System (ICD-9 Chapter) 1999/2000 was significantly higher in Haldimand and Norfolk compared to Ontario. Seventy-percent of the hospitalizations related to Diseases of the Respiratory System in 1999/2000 was the result of chronic obstructive pulmonary disease (30%), pneumonia (26.1%), acute respiratory infections (12.7%) and asthma (10.4%). The 1999/2000 age-standardized hospitalization rate for chronic obstructive pulmonary disease was significantly higher (73% higher) in Haldimand and Norfolk compared to Ontario. Also, the 1999/2000 age-standardized hospitalization rates for acute respiratory infections were significantly higher (16% higher) in Haldimand and Norfolk compared to Ontario.

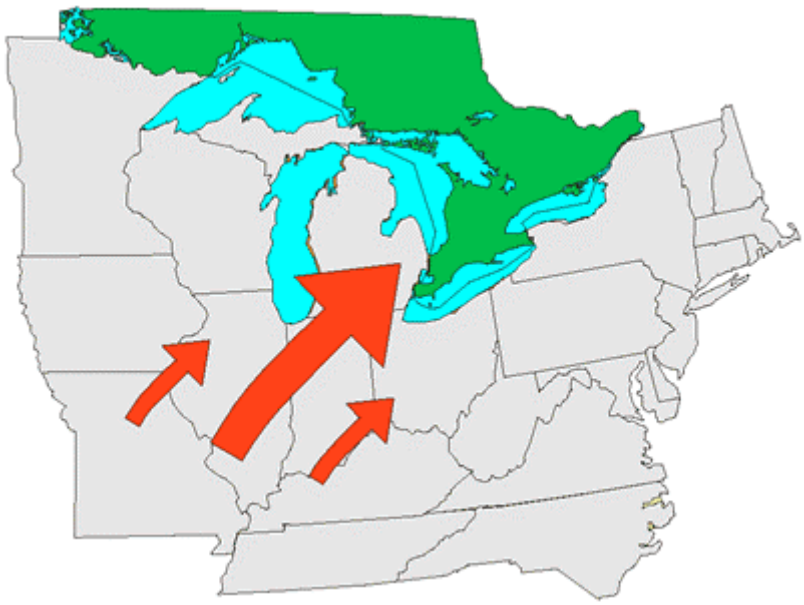
Results from the recently released Canadian Community Health Survey (CCHS) 2000/2001 indicated that 9.4% of those aged 12 and older indicated they had asthma that had been diagnosed by a health care professional. The 95% confidence interval for this estimate is 6.8% (low) to 11.9% (high). The CCHS results are based on a sample of the residents of Haldimand and Norfolk. This proportion was slightly higher than the provincial rate of 8.5% and the national rate of 8.4%. Looking at the asthma rates within Ontario, 18 Health Units had a higher asthma rate than Haldimand and Norfolk and 18 Health Units had a lower asthma rate than Haldimand and Norfolk. See Figure 1.2 for a comparison of the asthma rates for the 37 Health Units in Ontario. It is important to note that these proportions are based on self-reported data and there is no way to confirm these asthma rates. It is interesting that residents of Toronto had the lowest asthma rates compared to the other 36 Health Units in Ontario. The confidence interval for this estimate was 5.4% (low) to 7.4% (high).

Figure 1.2 Asthma rates for Ontario's 37 Public Health Units



US Sources of SMOG

Not all of the pollutants that are measured in Haldimand and Norfolk counties are produced in Haldimand and Norfolk. According to the Ministry of Environment, "more than 50% of Ontario's ground-level ozone and fine particulate matter comes from the U.S." (http://www.airqualityontario.com/science/transboundary.cfm). The image below illustrates the prevailing wind pattern from the US that results in elevated smog for Ontario. Unfortunately, residents of Haldimand and Norfolk are exposed to a lot of pollution that does not originate from within Haldimand and Norfolk counties.



Source: http://www.airqualityontario.com/science/transboundary.cfm

Nanticoke Air Monitoring Network
[Air Quality Monitoring Stations Located in Haldimand and Norfolk Counties]

The focus of the air quality report is on outdoor air quality indicators. Haldimand and Norfolk is unique to the rest of Ontario such that there are 12 air quality monitoring stations that were put into place during the development of the Nanticoke industrial park (see Table 1.2). The 12 stations measure a number of pollutants. Not all stations measure the same pollutants. For example, the Stelco North station only measures TSP, whereas the Long Point station measures Sulphur Dioxide (SO^2), Ozone, Nitrogen Oxides (NOx), Wind and Temp. Currently, Long Point and Nanticoke Village are the only two stations that monitor Wind and Temp (not included in Table 1). Jarvis used to measure Wind but was terminated in 2002. The Long Point station will be terminated at the end of 2002 and replaced with the Port Stanley station. The Port Stanley station is not located within the Haldimand and Norfolk counties. It was the position of the Environment Monitoring & Reporting Branch of the MOE to close the Long Point station because newly added $PM_{2.5}$ measurement to the Air Quality Index would be effected by sand on the beach on windy days. The closing of the Long Point station will be a loss of information on sulphur dioxide, ozone, and nitrogen oxides for the south western border of Haldimand & Norfolk which are important indicators of quality of the air coming from the United States.

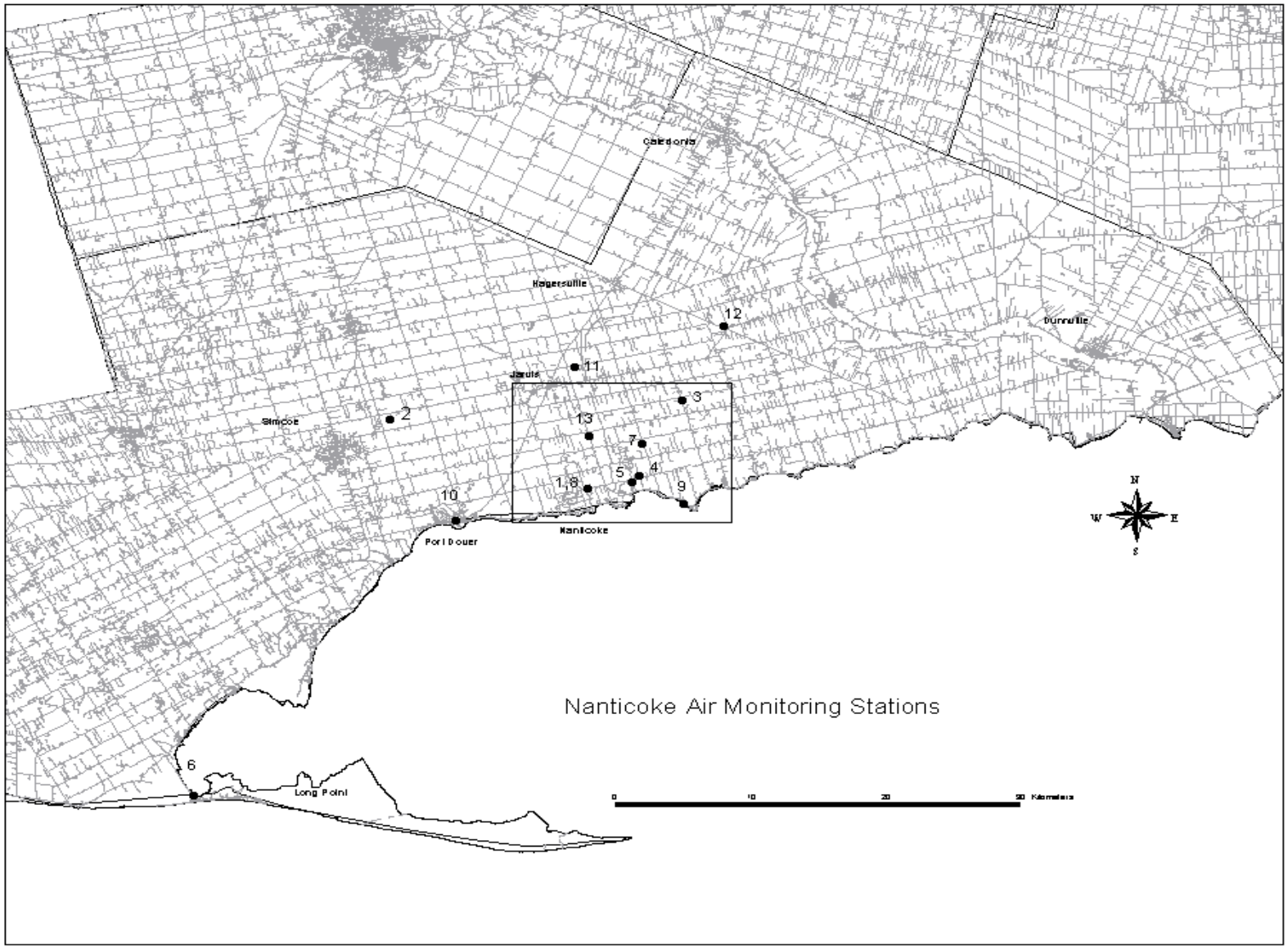
Table 1.2 – Nanticoke Air Quality Monitoring Stations

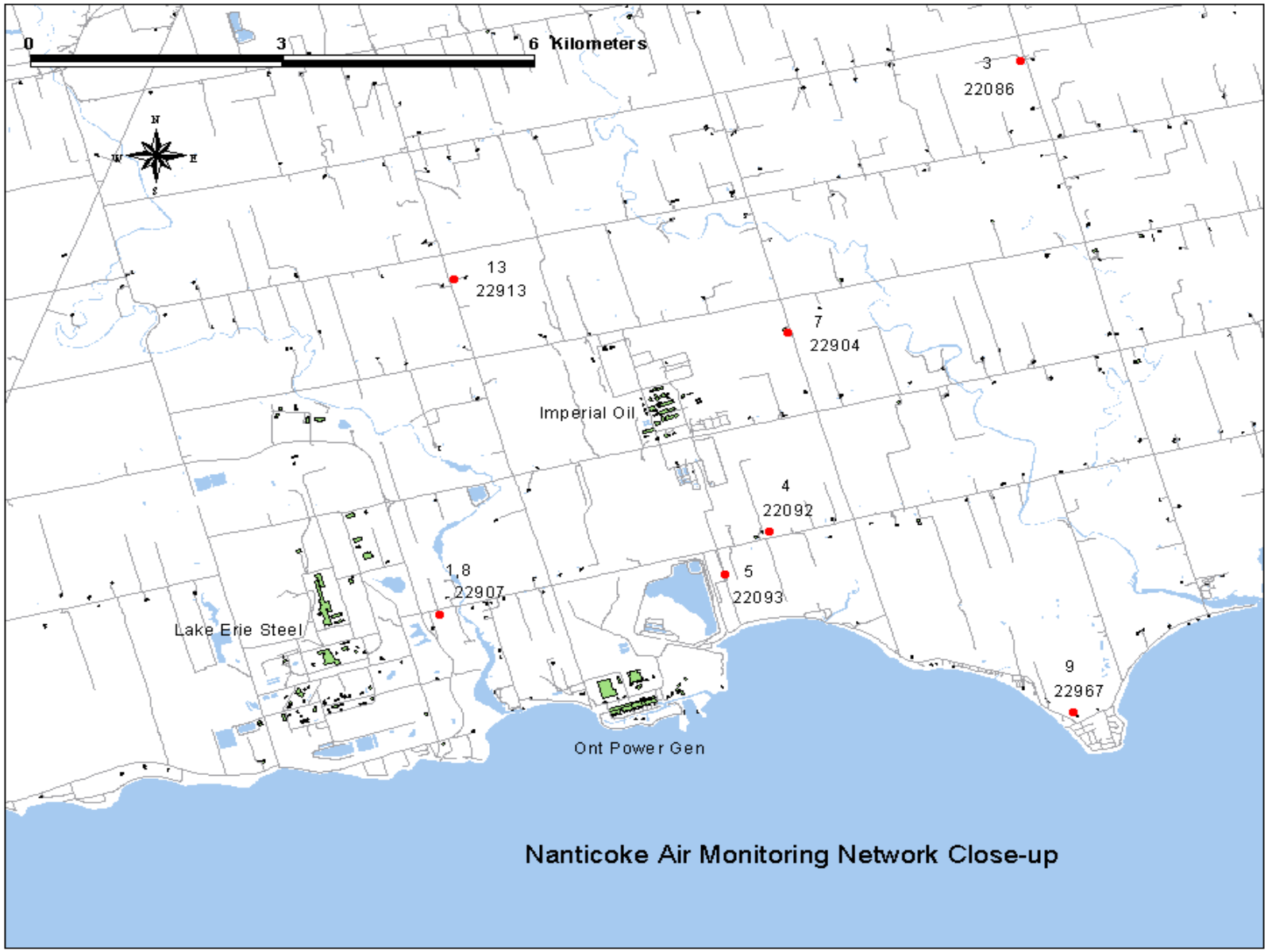
Map #	Location	$S0_2$	TSP	PM_{10}	COH	TRS	O_3	NOx	$PM_{2.5}$	DF	F	VOC	PAH
1	Nanticoke Village									X	X		
2	Simcoe	X					X	X	X			X	X
3	Cheapside	X						X					
4	Rainham/Sandusk		X							X			
5	NGS Flyash Area									X			
6	Long Point	X					X	X					
7	Walpole South	X	X	X		X						X	
8	Nanticoke Village	X	X		X	X						X	X
9	Stelco North		X										
10	Jarvis												
11	Balmoral	X											
12	Nanticoke Road	X											

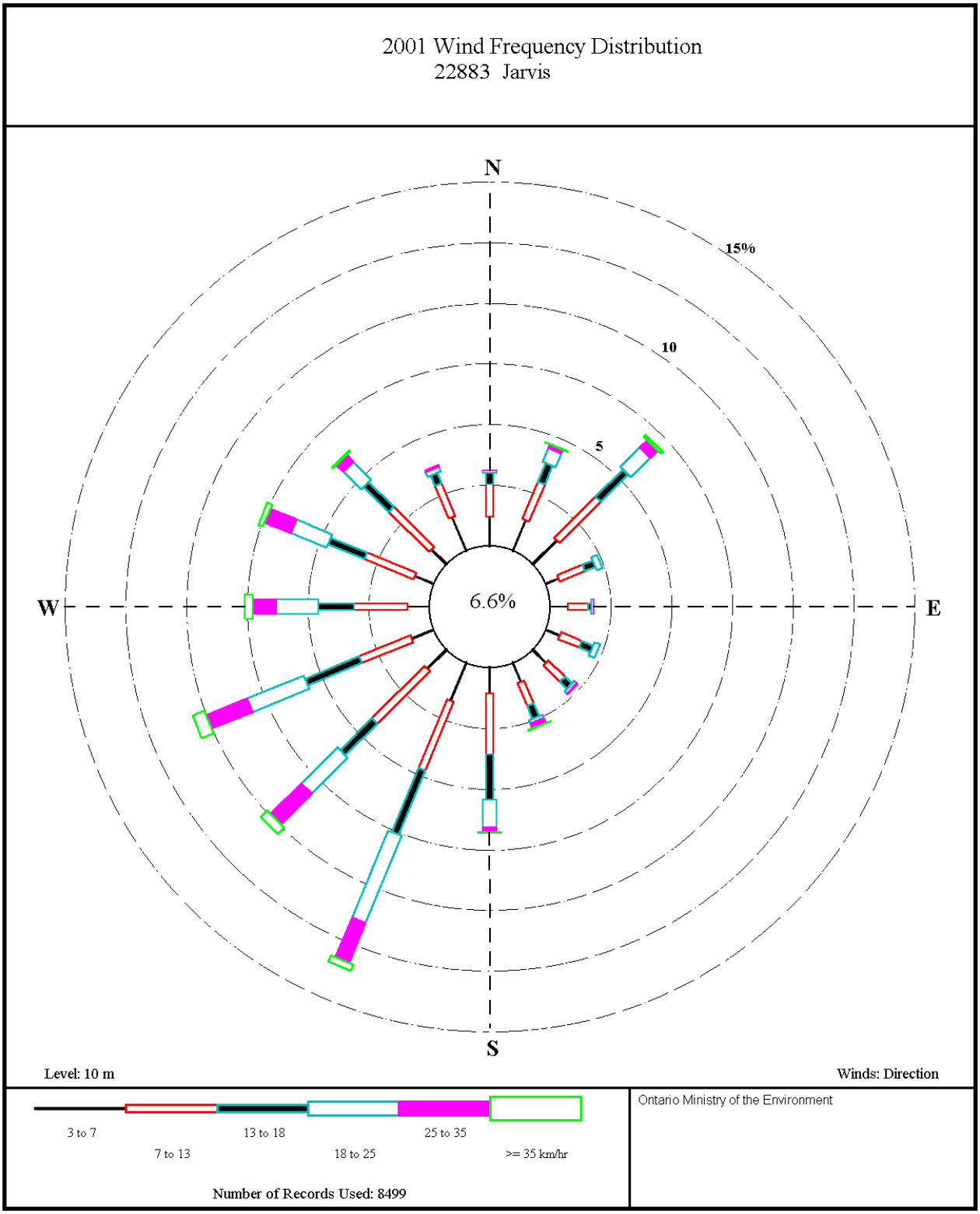
Legend	Pollutant
SO_2	Sulphur Dioxide
TSP	Total Suspended Particulate
PM_{10}	Inhalable Particulate
COH	Soiling Index
TRS	Total Reduced Sulphur
0_3	Ozone
NOx	Nitrogen Oxides
$PM_{2.5}$	Respirable Particulate
DF	Dustfall
F	Fluoride
VOC	Volatile Organic Compounds
PAH	Polycyclic Aromatic Hydrocarbons

Source: Ministry of the Environment

The following two maps identify the 12 air quality monitoring stations outlined in Table 1.2. To locate these air quality monitoring stations on the maps use the Map # in Table 1.2. The second map provides a close-up of the Nanticoke Air Monitoring Network and identifies the location of the Nanticoke industries. The prevailing wind pattern (50% of the time) is a sector, which ranges from south-southwest to northwest. These wind results were based on the Jarvis station.


Caledonia
Hagersville
Jarvis
Simcoe
Dunnville
Port Dover
Nanticoke
Long Point
1,8
2
3
4
5
6
7
9
10
11
12
13
N
W
E
S
Nanticoke Air Monitoring Stations
0
10
20
30 Kilometers


0
3
6 Kilometers
N
W
E
S
3
22086
13
22913
7
22904
Imperial Oil
4
22092
1,8
22907
5
22093
Lake Erie Steel
9
22967
Ont Power Gen
Nanticoke Air Monitoring Network Close-up


2001 Wind Frequency Distribution
22883 Jarvis
N
15%
10
5
W
E
6.6%
S
Level: 10 m
Winds: Direction
3 to 7
7 to 13
13 to 18
18 to 25
25 to 35
>= 35 km/hr
Number of Records Used: 8499
Ontario Ministry of the Environment

There are a number of different indicators that can be used to measure air quality, some of these measures are summary measures such as the Air Quality Index (AQI) which measures 6 key indicators, whereas other indicators are much more specific and measure only one pollutant such as Sulphur Dioxide. It is important to have a clear understanding of all the indicators that will be part of this air quality chapter.

Air Quality Index (AQI)

The AQI is a summary measure of the air quality in Ontario. The lower the AQI the better the air quality. The AQI measures a number of pollutants such as Sulphur Dioxide, Nitrogen Dioxide, Ozone, Carbon Monoxide, Suspended Particles, and Total Reduced Sulphur). A more detailed description of each of these pollutants will be provided in this section.

How to interpret the AQI?

Most people are aware of the Ministry of Environment (MOE) air quality advisories during smog events. An AQI rating of 0 – 15 indicates "very good" air quality with no known health effects for the majority of the population. Likewise a rating of 16 – 31 indicates "good" air quality. An AQI rating of 32 – 49 indicates "moderate" air quality with some adverse health effects for sensitive people. An AQI of 50 - 99 or greater indicates that air quality is "Poor " and AQI of 100 or greater indicates "very poor" air quality. Health effects become increased to an increased number of people at higher pollutant levels. See Table 1.3 for a description of the Air Quality Index pollutants and their impact on one's health.

There are currently 36 air quality monitoring stations that are part of Ontario's Air Quality Index (AQI) network. There is some overlap between Ontario's Air Quality Index (AQI) network and the Nanticoke monitoring network. Air monitoring stations in Simcoe (22071) and Long Point (22901) are part of both air quality monitoring networks. According to the MOE, "The advisories and watches are based on forecasts by meteorological models 24-72 hours in advance. The station data is used to track the accuracy of the forecast by indicating the levels of pollutants reached, and when to call off advisory." (Frank Dobroff – Air Quality Analyst – Ministry of Environment). Simcoe and Long Point air quality stations were added to the AQI network in 2000. The other 10 stations within Haldimand and Norfolk are not part of the AQI network.

How does the Ministry of Environment (MOE) calculate the AQI?

"At the end of every hour, the concentration of each pollutant that the stations monitor is converted into a number ranging from zero upward, using a common scale, or index. The pollutant with the highest number at a given hour becomes the AQI reading." (MOE - http://www.airqualityontario.com/science/aqi_description.cfm, August16/02).

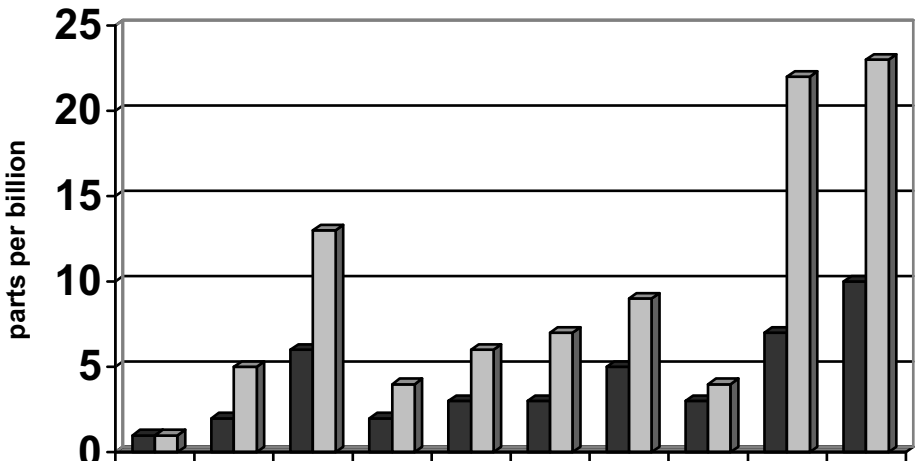
Using the Air Quality Index (AQI) as a summary measure of air quality. The air quality in Simcoe was reported to be "good" or "very good" 90% of the time in 2000. There were 14 days in 2000 when the AQI was greater than 49 indicating that air quality; during those days were poor. Moderate air quality (AQI 32-49) in Simcoe was reported on 111 days (MOE Air Quality report 2000). The air quality monitoring station in Long Point reported "good" to "very good" air quality 88% of the time in 2000. Still there were 20 days in Long Point in 2000 when the AQI was greater than 49 indicating that air quality was poor or very poor. Moderate air quality (AQI 32-49) in Long Point was reported on 122 days (MOE Air Quality Report 2000). It is important to

put all of this in perspective. Of all the monitoring stations listed in the MOE Air Quality Report for 2000, Long Point had the highest number of poor air quality days in Ontario. Simcoe had the third highest number of poor air quality days in Ontario. In 2000 at both the Simcoe and Long Point stations ozone levels accounted for 100% of the hours that a pollutant was responsible for an AQI greater than 31 (i.e., moderate or poor air quality). Ozone levels across Ontario are typically the main pollutant responsible for the poor air quality in Ontario. A definition of ground-level ozone will be discussed later in this report. A new Pollutant ($PM_{2.5}$) was added to the AQI in 2002. The likely impact of adding $PM_{2.5}$ to the AQI is that fewer of the 'poor' air quality days will be due to ozone levels and more will be due to fine particle measurement ($PM_{2.5}$). Up until adding $PM_{2.5}$ to the AQI, ozone was predominately the determining factor for a "smog day." It is expected that $PM_{2.5}$ will become a major contributor to the AQI and a determining factor for future "smog days" within Haldimand and Norfolk counties. Simcoe is currently the only station measuring $PM_{2.5}$ within Haldimand and Norfolk counties.

Air Quality Forecast

The Ministry of the Environment (MOE) now provides the public with an early warning that poor air quality is expected in a particular area. The likelihood of a smog day is related to weather forecasts. The MOE will issue two kinds of smog alerts. A **"smog watch"** is issued when there is a 50% chance that a smog day will occur within the next three days. A **"smog advisory"** is issued by the MOE when a smog day is expected within the next 24 hours. This two-level smog alert was initiated by the Ministry of the Environment on May 1, 2000. Photochemical "SMOG" is a mixture of ground-level ozone, toxic gases, and airborne particles that can have a negative impact on human health. Residents of Haldimand and Norfolk can be notified of a possible SMOG day by a number of ways: radio, MOE website, television, direct email smog alerts from the Ministry, Haldimand-Norfolk Health Unit (www.haldimand-norfolk.org) and telephone. The goal of the **"smog watch"** and **"smog advisory"** is to provide residents of Haldimand and Norfolk with an early alert system so that they can take appropriate precautions to protect themselves.

Figure 1.3 **Smog Advisories -1993-2001**



	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
# Smog Advisories	1	2	6	2	3	3	5	3	7	10
# Smog Days	1	5	13	4	6	7	9	4	22	23

Figure 1.3 reports the number of smog advisories that were issued for Haldimand and Norfolk counties for the period 1993 to 2002. Also, reported in the figure is the number of smog days that was reported. For example, in 2002 there was 10 smog advisories and these advisories were comprised of 23 smog days in Haldimand and Norfolk counties. There was a much higher number of smog days in Haldimand and Norfolk counties for the years 2001 and 2002.

The air quality report is focused strictly on reporting air quality data obtained from the 12 monitoring stations located within the Haldimand and Norfolk counties. Prior to reporting air quality data from these air quality monitoring stations it is important for the reader not only to have an understanding of the health effects of various pollutants (see Table 1.3) but also to have an overview of these pollutants (see Table 1.4). Table 1.4 is a useful guide to describing these pollutants, outlining the major sources, as well as health and ecological effects related to these pollutants.

Pollutants

There are many different pollutants that affect the air quality within Haldimand and Norfolk counties. The goal of this chapter is to concentrate on the major pollutants including Sulphur Dioxide, Total Suspended Particulate, Inhalable Particulate, Soiling Index, Total Reduced Sulphur, Ozone and Nitrogen Oxides. In addition to reporting on these specific pollutants summary measures like the Air Quality Index (AQI) will also be discussed. See Table 1.4 for an overview of these critical pollutants and the associated health effects of these pollutants.

Table 1.3 Air Quality Index Pollutants and Their Impact

Index	Category	Carbon Monoxide] (CO)	Nitrogen Dioxide (NO_2)	Ozone (O_3)	Sulphur Dioxide (SO_2)	Suspended Particles (SP)	SO_2 + SP	Total Reduced Sulphur (TRS)
0-15	Very Good	No known harmful effects	No known harmful effects	No known harmful effects	No known harmful effects	No known harmful effects	No known harmful effects	No known harmful effects
16-31	Good	No known harmful effects	Slight odour	No known harmful effects	Damages some vegetation in combination with ozone	No known harmful effects	No known harmful effects	Slight odour
32-49	Moderate	Blood chemistry changes, but no noticeable impairment	Odour	Respiratory irritation in sensitive people during vigorous exercise; people with heart/lung disorders at some risk	Damages some vegetation	Some decrease in visibility	Damages vegetation	Odour
50-99	Poor	Increased symptoms in smokers with heart disease	Air smells & looks brown. Some increase in bronchial activity in people with asthma	Sensitive people may experience irriation when breathing and possible lung damage when physically active; people with heart/lung disorders at greater risk; damages some plants	Odourous; increasing vegetation damage	Decreased visibility; soiling evident	Increased symptoms for people with chronic lung disease	Strong Odour
100 over	Very Poor	Increasing symptoms in non-smokers with heart disease; blurred vision: some clumsiness	Increasing sensitivity for people with asthma and bronchitis	Serious respiratory effects, even during light physical activity; people with heart/lung disorders at high risk; more vegetation damage	Increasing sensitivity for people with asthma and bronchitis	Increasing sensitivity for people with asthma and bronchitis	Significant effects for people with asthma & bronchitis	Severe odour; some people experience nausea and headaches

Source: Ministry of the Environment – Air Quality Report 2000

Table 1.4 - Overview of Air Pollutants and General Health Effects.

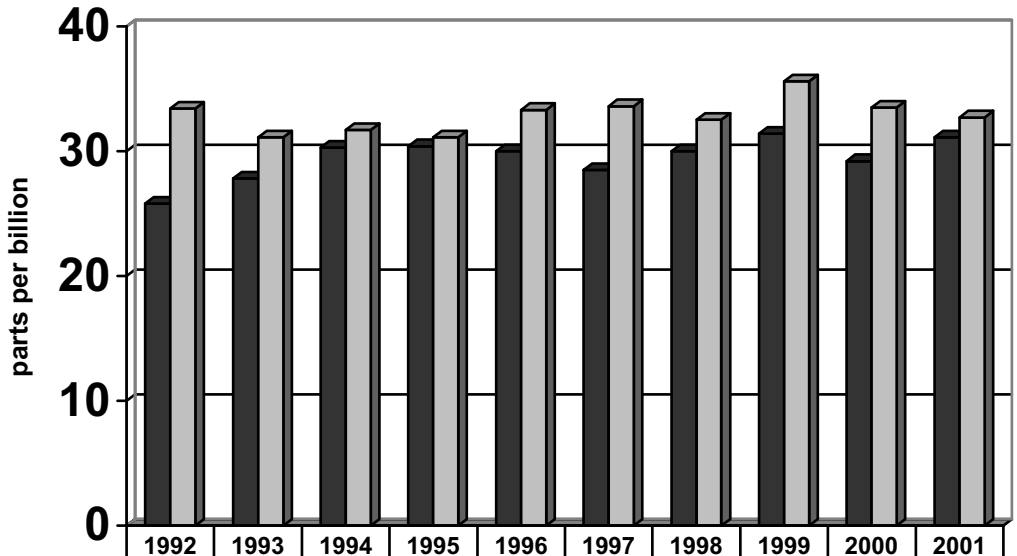
Pollutant	Characteristics	Sources	Ontario Criteria	General Health Effects	General Ecological Effects
Ozone	A colourless gas. Major component of summer smog.	Ozone is not emitted directly into the atmosphere. It is produced by photochemical reaction of nitrogen oxides and volatile organic compounds.	1h average 80 ppb	Irritation of the lungs and difficulty in breathing. Exposure to high concentrations can result in chest tightness, coughing, and wheezing. Increased hospital admissions and premature death.	Damage to agricultural crops, ornamentals, forests and natural vegetation.
Inhalable Particles (PM_{10})	Particles of solid or liquid matter that stay suspended in the air in the form of dust, mist, aerosols, smoke, fume, soot, etc. Size range less than 10 microns.	Industrial processes including combustion, incineration, construction, metal smelting, etc. Also motor vehicle exhaust and road dust. Natural sources such as forest fires, ocean spray and volcanic activity.	24 h average 50 ug/m^3	Primarily associated with the aggravation of respiratory conditions such as asthma.	Damage to vegetation, deterioration in visibility and contamination of soil.
Respirable Particles ($PM_{2.5}$)	Same as PM10 except size range of particles is less than 2.5 microns.	Same as PM10. However, also formed in the atmosphere by the transformation of gaseous precursor emissions such as SO2 and NOx.	24h average 30g/m3	Decreased lung function, increased hospital admissions, increased respiratory symptoms and disease and premature death.	Same as PM_{10}
Total Reduced Sulphur	Offensive odours similar to rotten eggs or cabbage.	Industrial sources include steel industry, pulp and paper mills and refineries. Natural sources include swamps and marshes.	1h average 27 ppb	Not normally considered a health hazard. They are the primary cause of odours.	
Sulphur Dioxide (SO2)	Colourless gas with a strong adour similar to burnt matches	Electric utilities and non-ferrous smelters. Also primary metal processing, iron ore smelters, pulp and paper, petroleum refineries, etc. Any fuel burning containing sulphur.	1 h average 250 ppb 24 h average 100 ppb 1 y average 20 ppb	Breathing discomfort, respiratory illness, aggravation of existing respiratory and cardiovascular disease. People with asthma, chronic lung or heart disease are most sensitive to SO2.	Leads to acid deposition, which causes lake acidification, corrosion and haze. Damage to tree leaves and crops.
Nitrogen Dioxide (NO2)	Gas with a pungent and irritating odour.	Automobiles, thermal power plants, incineration, etc. Natural sources include lightning and soil bacteria.	1 h average 200 ppb 24 h average 100 ppb	Increasing sensitivity for people with asthma and bronchitis.	Leads to acid deposition: adverse effect on vegetation.
Carbon Monoxide (CO)	Colourless, odourless, tasteless and poisonous gas.	Major source is transportation sector; i.e., road vehicles, aircraft and railways.	1 h average 30 ppm 8 h average 13 ppm	Impairment of visual perception, work capacity, learning ability and performance of complex tasks.	

Ground Level Ozone (O_3)

Ground level ozone is but one of several air pollutants that contribute to the level of smog in Haldimand and Norfolk counties. "Ground-level ozone is a gas formed when nitrogen oxides and volatile organic compounds react in the presence of sunlight." (MOE Air Quality Report, 2000, p.10). The other contributors to smog are: sulphur dioxide, carbon monoxide, nitrogen oxides, volatile organic compounds, toxics, and particles (MOE Air Quality Report 2000). Of the 12 air quality monitoring stations located within Haldimand and Norfolk, only the Simcoe (22071) and the Long Point stations (22901) measure ground level ozone levels.

Figure 1.4 reports the annual average ozone levels for Simcoe and Long Point over the last ten years. Ozone levels have consistently been higher in Long Point than Simcoe. Although there has been some fluctuations between 1992-2001, there is no declining pattern over the last ten years. The average ozone level at the Simcoe air quality monitoring station for the years 1992 to 2001 was 29.5 ppb, compared to 32.9 ppb at the Long Point station. The general health effects associated with ozone levels are irritation of the lungs and breathing problems. High ozone levels can result in chest tightness, coughing, and wheezing. These health effects tend to result in increased hospitalizations and premature death due to respiratory conditions.

Figure 1.4 **OZONE (1992-2001)**
(annual average ozone levels)

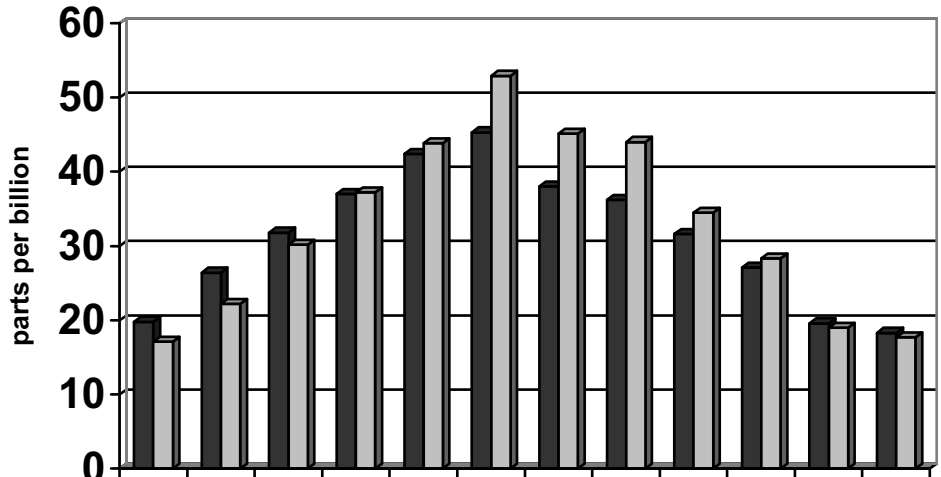


	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Simcoe	25.8	27.8	30.3	30.4	30	28.5	30	31.4	29.2	31.1
Long Point	33.4	31.1	31.7	31.1	33.3	33.6	32.5	35.6	33.5	32.7

Figure 1.5 reports the monthly mean ozone levels for Simcoe and Long Point for 2001. It is clear from Figure 1.5 that ozone levels are the highest in the Summer months and lowest in the Winter months for both Simcoe and Long Point.

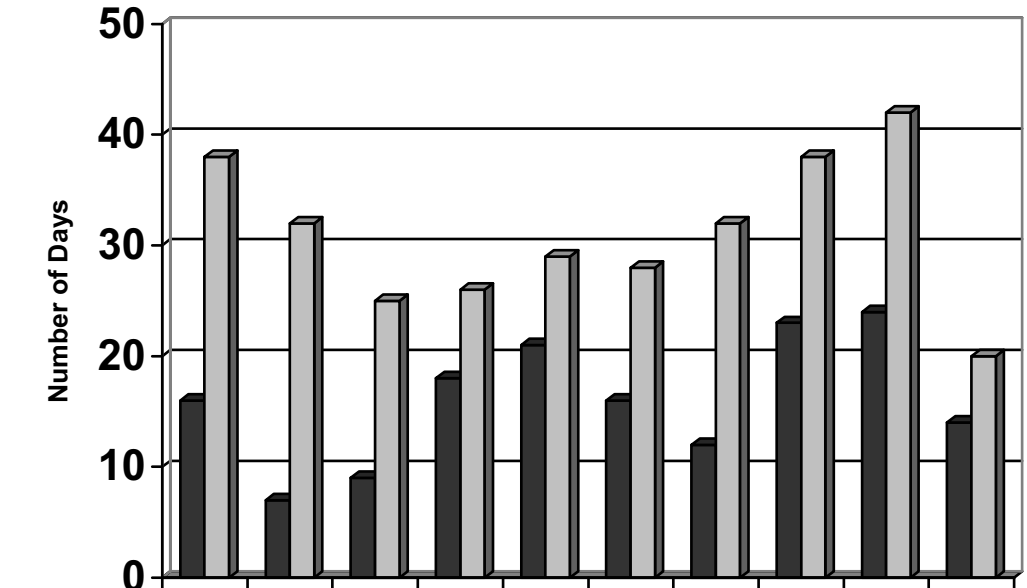
Figure 1.5 **OZONE - 2001**

Monthly OZONE Means



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Simcoe	19.8	26.4	31.8	37	42.4	45.3	38	36.2	31.6	27.1	19.6	18.3
Long Point	17.1	22.2	30.2	37.2	43.8	52.9	45.1	44	34.5	28.3	19	17.7

Figure 1.6 **OZONE Exceedance Days (at least 1 hour >80ppb)**



	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Simcoe	16	7	9	18	21	16	12	23	24	14
Long Point	38	32	25	26	29	28	32	38	42	20

An ozone exceedance day is defined as any day when the ozone level for at least one hour exceeds the Ontario objective of > 80 ppb. Looking at a 10 year trend (1991-2000), the number of ozone exceedance days has not shown either a consistent increasing or decreasing trend (Figure 1.6). The number of ozone exceedance days for Long Point in 2000 was the lowest it has been in the last ten years. There is a big difference in the number of ozone exceedance days between Simcoe and Long Point air quality monitoring stations. Long Point consistently has had a larger number of ozone days compared to Simcoe.

Table 1.5 compares the number of Ozone exceedance days at both the Simcoe and Long Point stations by ranking these stations with the other 34 stations in Ontario. Over the ten year period 1991 to 2000 Long Point had the highest ranking each year. In other words, Long Point had consistently the highest number of ozone exceedance days for the years 1991-2000. The ranking for Simcoe was better than Long Point, although between 1993 and 2000 Simcoe was ranked in the top 10 when compared with the other air quality stations in Ontario.

Table 1.5 Ranking of Ozone Exceedance Days

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Simcoe	18	12	8	3	4	7	7	8	8	3
Long Point	1	1	1	1	1	1	1	1	1	1

Figures 1.7, 1.8, & 1.9 illustrate that the number of ozone exceedance days at Long Point have consistently been the highest compared to the other air quality stations in Ontario for the years 2000, 1995 and 1991. It is interesting to note that the number of ozone exceedance days appears not to be influenced by the rural location of some of the air quality monitoring stations. For example, downtown Toronto had 4 ozone exceedance days in 2000 compared to 20 days in Long Point. The much higher number of ozone exceedance days in Long Point is clearly influenced by the pollutants that come from the United States.

Figure 1.7 Number of Ozone Exceedance Days at Sites Across Ontario - 2000

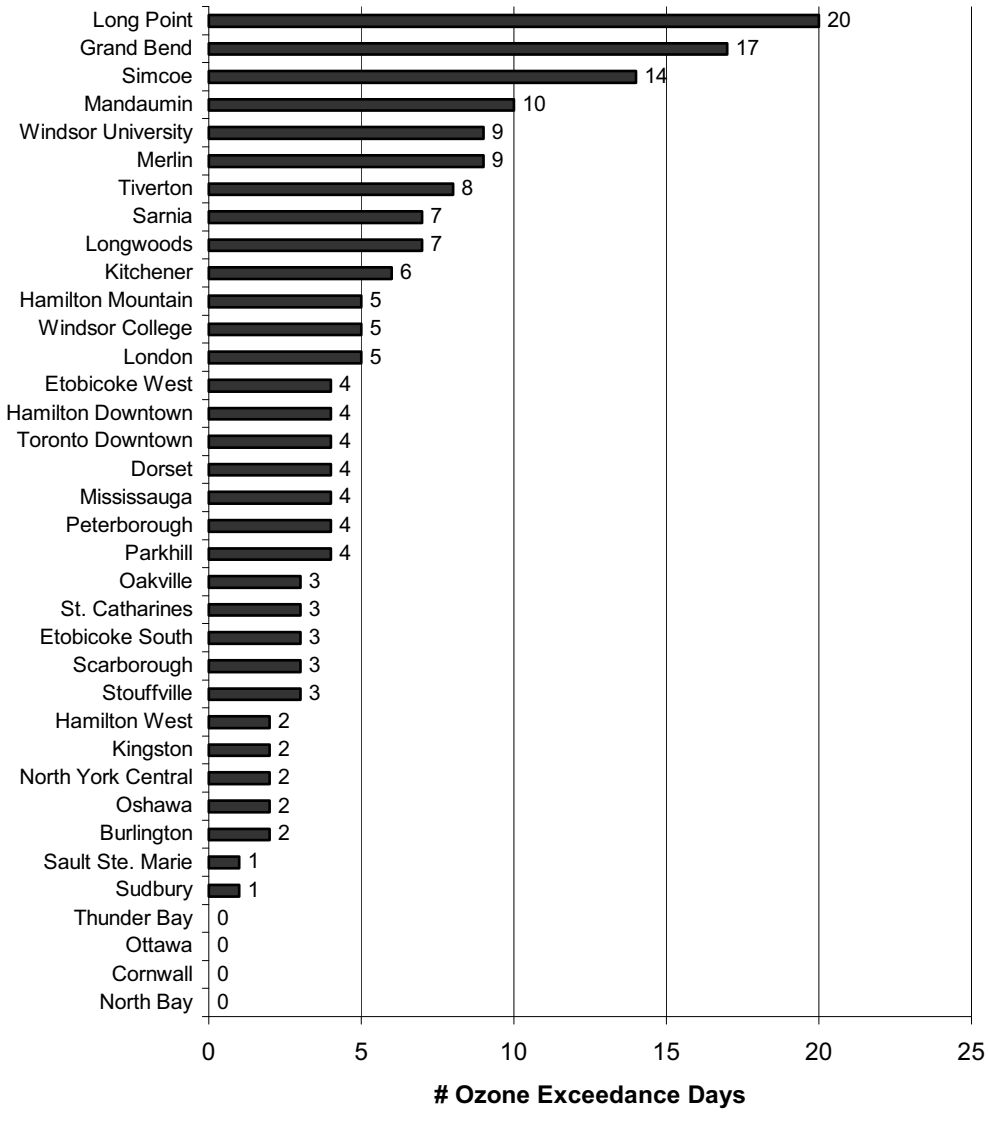


Figure 1.8 Number of Ozone Exceedance Days at Sites Across Ontario - 1995

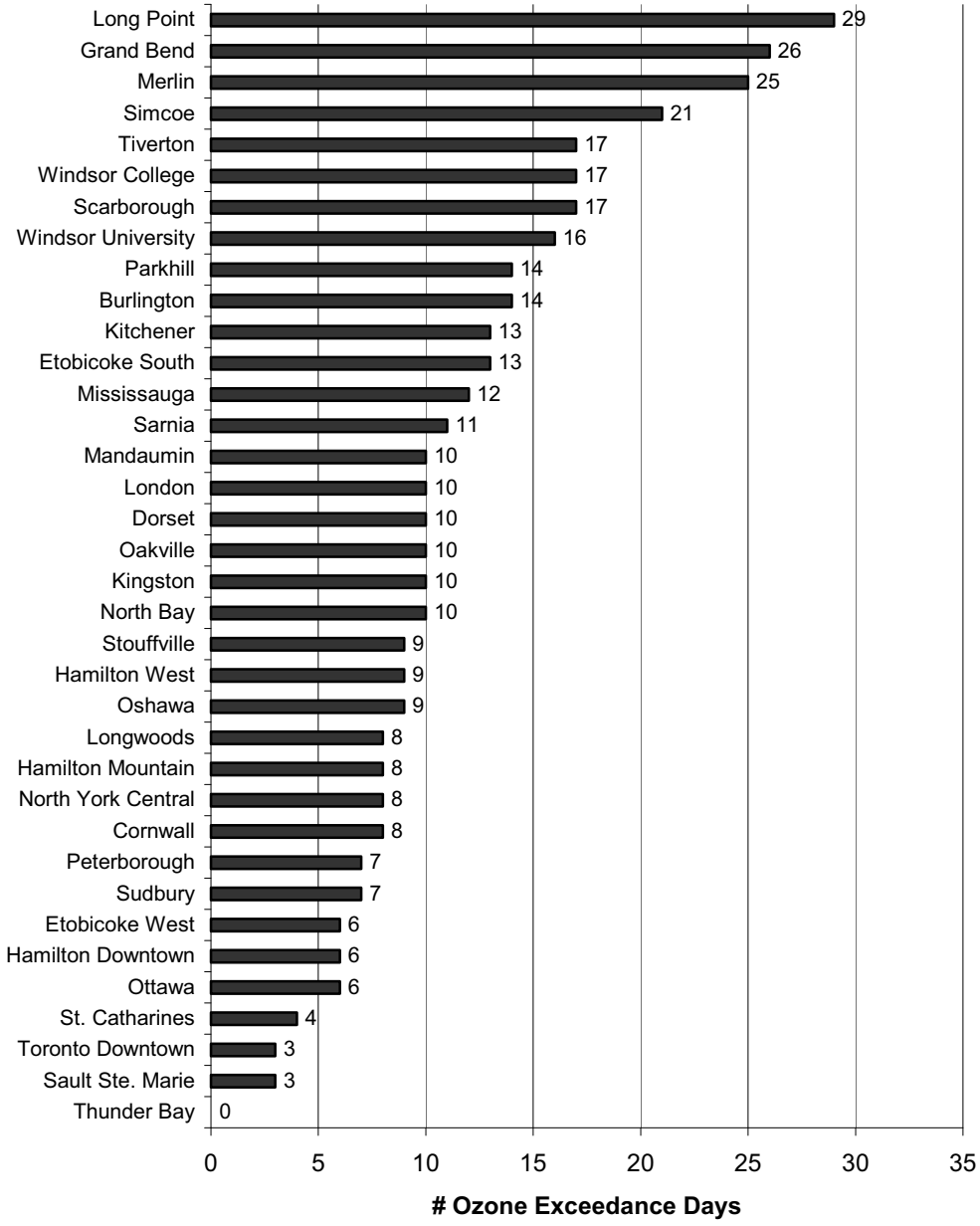
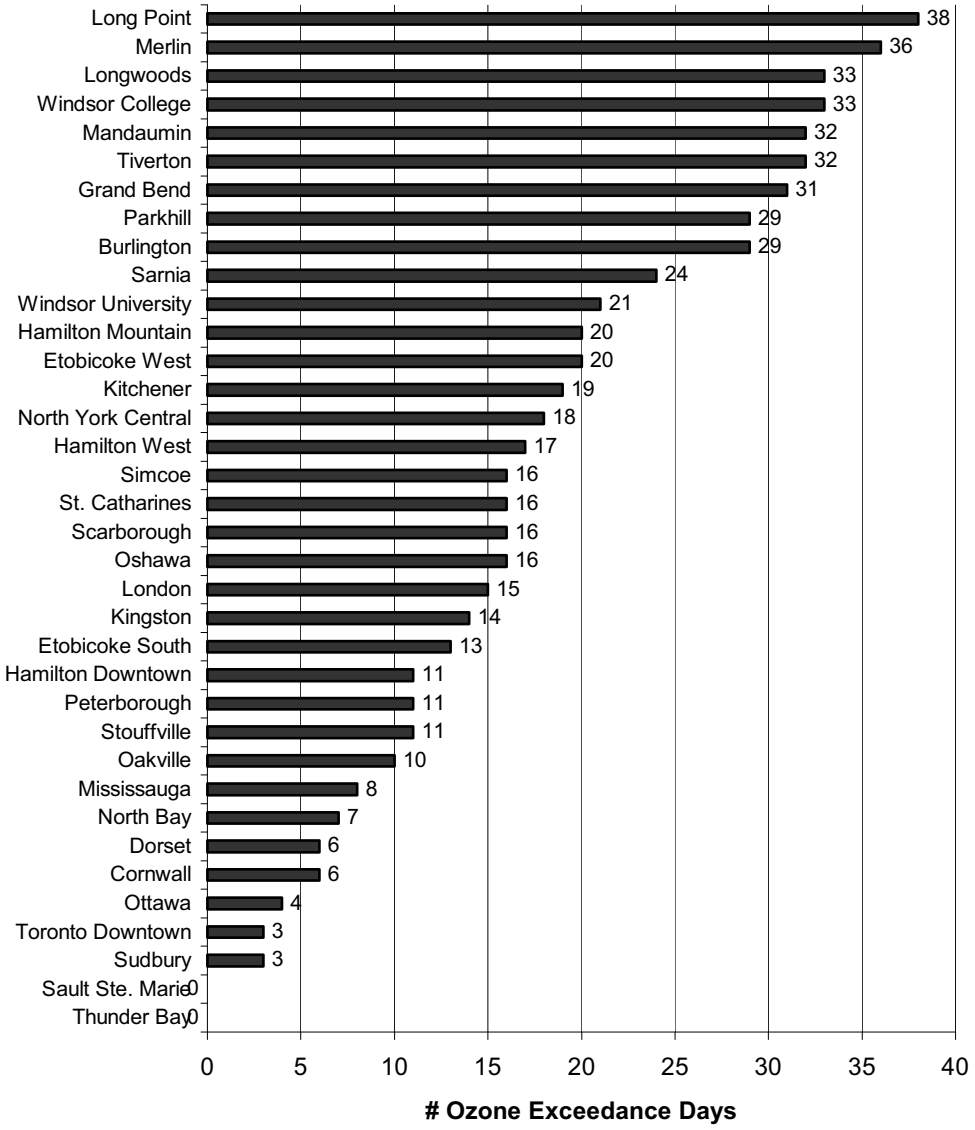


Figure 1.9 Number of Ozone Exceedance Days at Sites Across Ontario - 1991



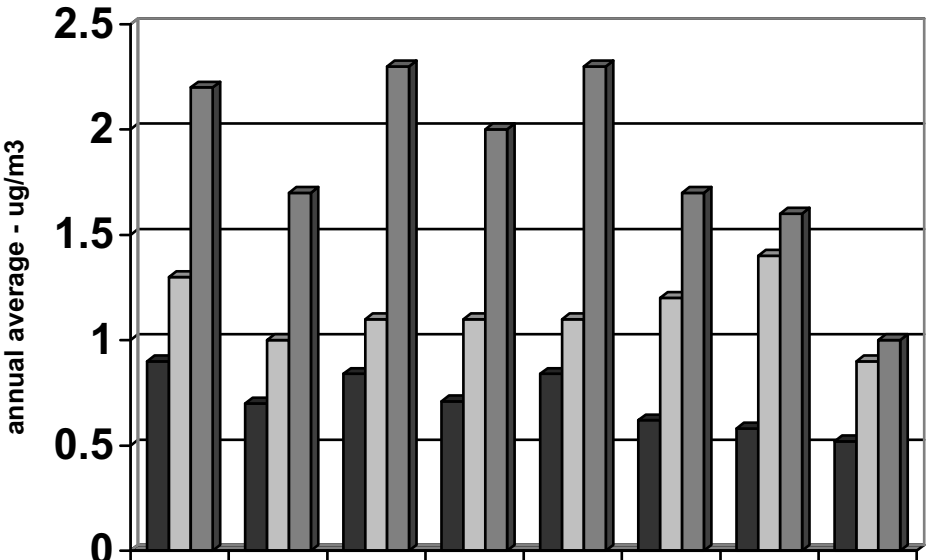
Volatile Organic Compounds (VOC)

Volatile Organic Compounds (VOC) is one of the pollutants that contribute to ground level ozone via a chemical reaction with nitrogen oxides and the sun. "VOCs are emitted into the atmosphere from a variety of sources, including vehicles, fossil fuel combustion, steel-making, petroleum refining, fuel-refilling, industrial and residential solvent use, paint application, manufacturing of synthetic materials (e.g. plastics, carpets), food processing, agricultural activities and wood processing and burning" (MOE – Air Quality Report 2000, p. 32). There are three sites within Haldimand and Norfolk that measure levels of VOCs in the air – Simcoe (22071), Walpole South (22904) and Nanticoke Village (22907). This section will focus on those VOCs that are known to have an effect on one's health. The main health effects associated with VOCs are cancer and effects on the central nervous system.

Benzene

Benzene is a volatile aromatic hydrocarbon and is typically used in the making of plastics and other chemical products (MOE – Air Quality Report 2000). Benzene is a common component of gasoline and therefore vehicle exhaust is the main source of benzene in the environment (Basrur, 2002). "Benzene may cause various types of leukemia, lymphoma and blood diseases, and is classified as a human carcinogen." (MOE – Air Quality Report 2000, p. 32). Other health effects associated with long-term exposure to low levels of benzene include reproductive effects and depression of the immune system (Basrur, 2002). Nanticoke Village, Walpole South and Simcoe all measure Benzene levels. Nanticoke Village had higher levels of Benzene compared to Walpole South and Simcoe (Figure 1.10). No consistent increasing or decreasing trend was found for benzene levels over the last ten years. There currently are no Ontario standards or guidelines for benzene (Standards Development Branch, Ministry of Environment, 1999).

Figure 1.10 **BENZENE (1994-2001)**

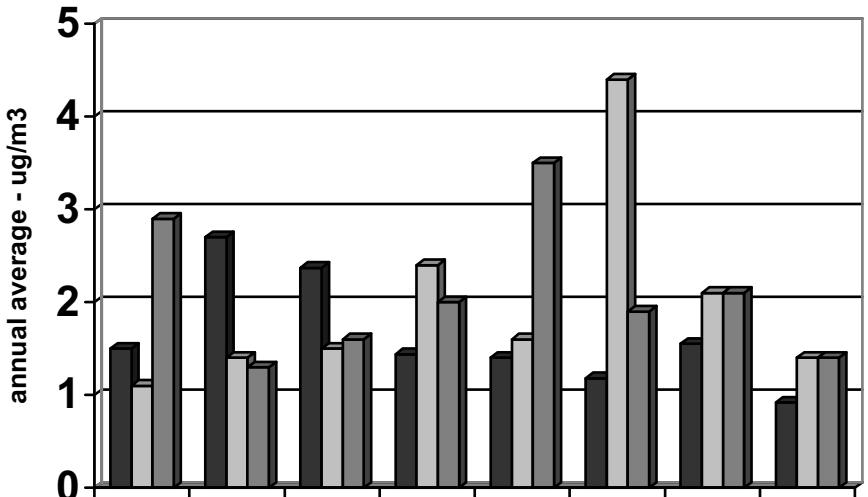


	1994	1995	1996	1997	1998	1999	2000	2001
Simcoe	0.9	0.7	0.84	0.71	0.84	0.62	0.58	0.52
Walpole South	1.3	1	1.1	1.1	1.1	1.2	1.4	0.9
Nanticoke Village	2.2	1.7	2.3	2	2.3	1.7	1.6	1

Toluene

"Toluene is an aromatic hydrocarbon that is used to make chemicals, explosives, dyes and many other compounds. It is used as a solvent for inks, paints, lacquers, resins, cleaners, glues, and adhesives." (MOE Air Quality Report – 2000, p. 32). Toluene is not considered a carcinogen but is known to affect the central nervous system of humans and animals (MOE Air Quality Report – 2000). See Figure 1.11 for annual Toluene levels for Simcoe, Walpole South and Nanticoke Village stations. There are no annual standards for toluene, but the 24 hr standard is 2000 ug/m^3 (Standards Development Branch, MOE, 1999). There were zero times in 2001 when the 24 hr standard was exceeded for Simcoe, Walpole South and Nanticoke Village stations. During the period 1994-2001, there was no consistent pattern for annual Toluene levels at these stations. Also, no station consistently had the highest or lowest annual Toluene levels for the years 1994 to 2001.

Figure 1.11 **TOLUENE (1994-2001)**

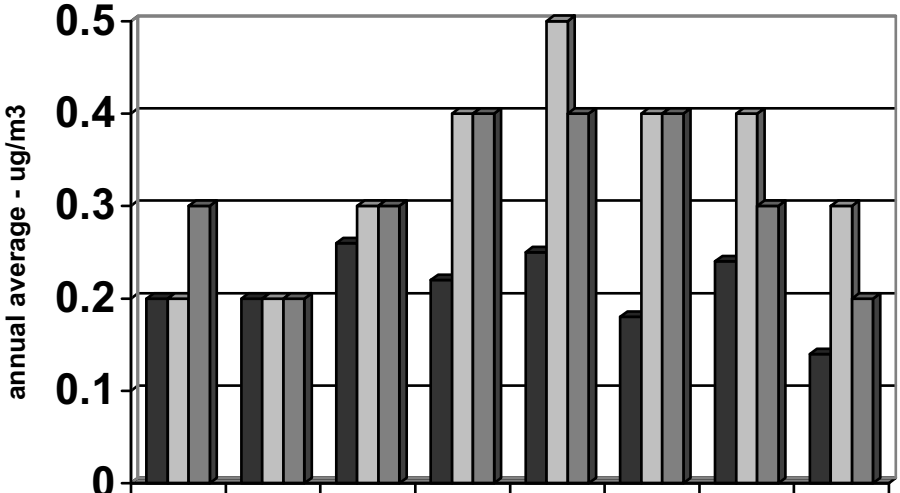


	1994	1995	1996	1997	1998	1999	2000	2001
Simcoe	1.5	2.7	2.37	1.44	1.4	1.18	1.55	0.92
Walpole South	1.1	1.4	1.5	2.4	1.6	4.4	2.1	1.4
Nanticoke Village	2.9	1.3	1.6	2	3.5	1.9	2.1	1.4

Ortho-xylene (Benzene,Toluene & Xylene or BTX)

Ortho-xylene (BTX) is an aromatic hydrocarbon that is known to affect the central nervous system as a depressant but is currently not considered a carcinogen due to a lack of evidence (MOE Air Quality Report, 2000). "Sources of ortho-xylene as a result of human activity include oil refining, motor vehicles, wood-burning stoves and fireplaces whereas natural sources include coal tar, oil, forest fires and plant volatiles." (MOE Air Quality Report, 2000, p 33). There currently are no Ontario standards for BTX but there are Ontario standards for Toluene and Xylene. See Figure 1.12 for the annual BTX levels for the years 1994 to 2001. There does not appear to be any consistent increasing or decreasing trend for the years 1994-2001.

Figure 1.12 **ORTHO-XYLENE (1994-2001)**

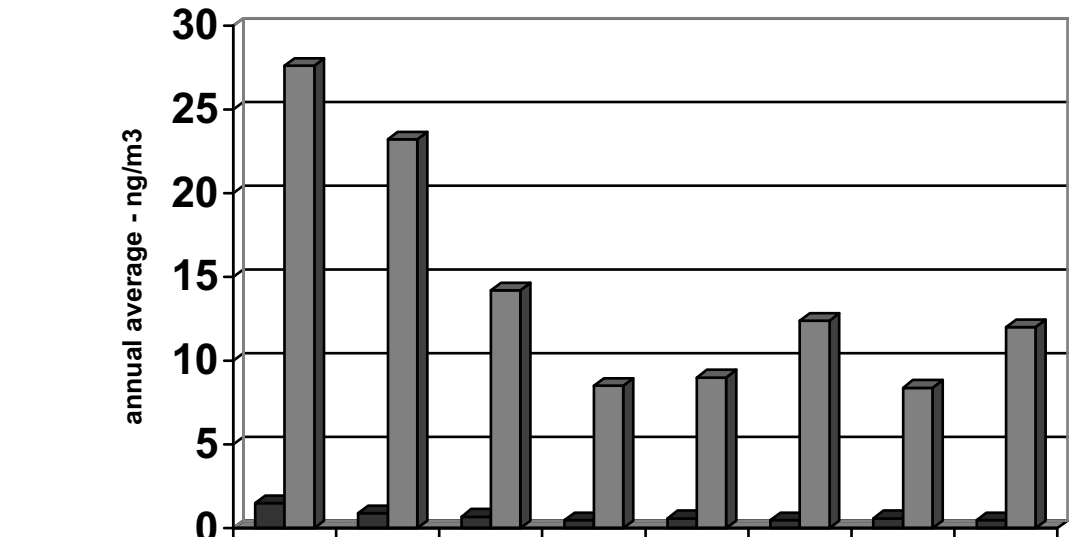


	1994	1995	1996	1997	1998	1999	2000	2001
Simcoe	0.2	0.2	0.26	0.22	0.25	0.18	0.24	0.14
Walpole South	0.2	0.2	0.3	0.4	0.5	0.4	0.4	0.3
Nanticoke Village	0.3	0.2	0.3	0.4	0.4	0.4	0.3	0.2

Polycyclic Aromatic Hydrocarbons (PAH)

There are a variety of sources of PAHs in the environment; natural, industrial, and combustion. The main natural source is forest fires. There are a number of industrial sources, for example, aluminum plants, petroleum refineries, coke production, etc. Finally, there are several ways that combustion sources contribute to PAHs levels in the environment – residential heating, open air fires/agricultural burning, incineration, transportation, thermal power plants, industrial combustion, etc (Health Canada, 1994). PAHs have been classified as "probably carcinogenic to humans". This means that PAHs are believed to have some chance of having an adverse effect at any level of exposure (Health Canada, 1994). Figure 1.13 reports the PAH totals for Simcoe and Nanticoke Village, for the last eight years (1994-2001). Clearly, the PAH totals at Nanticoke Village have consistently been much higher than the levels at Simcoe. In contrast to the Simcoe station that has seen little change in PAH totals during the period 1995 to 2001, Nanticoke Village has seen a considerable reduction in PAH totals between the same period. Although there are a number of PAHs, the focus of this section is on Benzo(a)pyrene (Figure 1.13). There currently are no Ontario standards for PAH total levels.

Figure 1.13 **PAH-Total (1994-2001)**

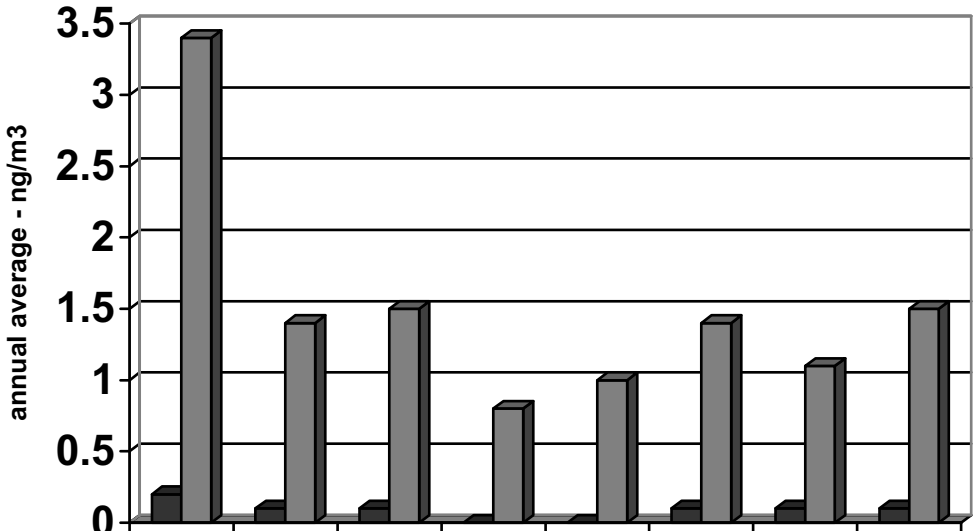


	1994	1995	1996	1997	1998	1999	2000	2001
Simcoe	1.5	0.9	0.7	0.5	0.6	0.5	0.6	0.5
Nanticoke Village	27.6	23.2	14.2	8.5	9	12.4	8.4	12

Benzo(a)pyrene

Benzo(a)pyrene is considered to be a probable human carcinogen and linked to stomach tumors (ingestion), lung tumors (inhalation) and skin tumors (skin absorption) (Ten Key Carcinogens in Toronto Workplaces and Environment, 2002). Benzo(a)pyrene is considered to be the most toxic of the PAHs. Figure 1.14 reports the Benzo(a)pyrene levels for the period 1994 to 2001 for the Simcoe and Nanticoke Village stations. Nanticoke Village clearly had much higher levels of Benzo(a)pyrene compared to Simcoe. According to the Standards Development Branch – MOE (1999) the annual Ontario standard is .0003 ug/m^3 or .3 ng/m^3 and the 24 hr average is 1.1 ng/m3 or .0011 ug/m^3. The 24 hour average benzo(a)pyrene level at Nanticoke Village (22907) was exceeded 9 times in 2001. The Simcoe station did not exceed the 24 Ontario benzo(a)pyrene standard in 2001. For the period 1994 to 2001, the Simcoe station was below the annual Ontario objective. In contrast, the Nanticoke station exceeded the annual Ontario standard for all the years between 1994 and 2001. For example, in 2001 the benzo(a)pyrene level at Nanticoke Village was 5 times above the Ontario standard and in 1994 the level was 11 times above the annual Ontario standard of .3 ng/m^3.

Figure 1.14 **BENZO(a)PYRENE (1994-2001)**

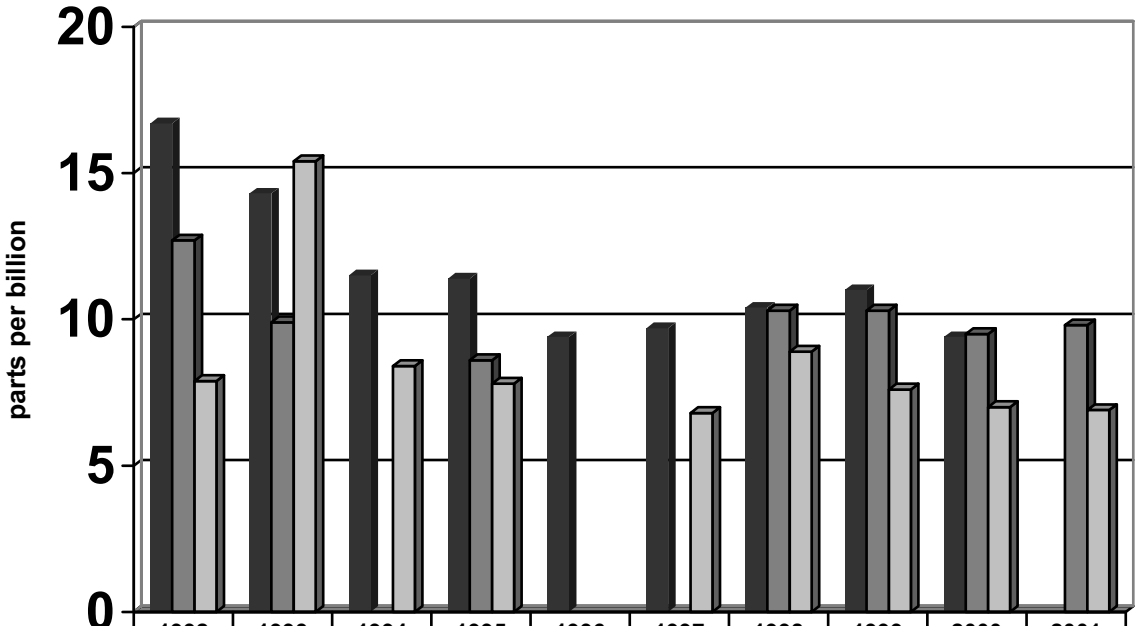


	1994	1995	1996	1997	1998	1999	2000	2001
Simcoe	0.2	0.1	0.1	0	0	0.1	0.1	0.1
Nanticoke Village	3.4	1.4	1.5	0.8	1	1.4	1.1	1.5

Nitrogen Oxides (NO_x)/ Nitrogen Dioxide (NO_2)

"Nitrogen Dioxides (NO_2) is a reddish-brown gas with a pungent and irritating odour" (MOE Air Quality Report 2000, p.20). NO_2 is one of the key contributors to ground level ozone levels. It is estimated that 63% of the Nitrogen Oxides (NOx) in Ontario is the result of the transportation sector. NO_2 is a major contributor to NOx. The remaining NOx is primarily the result of industry. The main health impact of $N0_2$ is on the respiratory system, i.e., increased sensitivity for people with asthma and bronchitis. There are three sites within the Haldimand and Norfolk counties that measures levels of NOx – Simcoe (22071), Cheapside (22086) and Long Point (22901). The Ontario guideline for NO_x is .2 ppm/hour or .10 ppm/24 hrs or 200 ppb for a 1 hr average and 100 ppb for a 24 hour average (Standards Development Branch – MOE, 1999). There are no annual Ontario standards for NOx . The Ontario 24hr standard for NOx was not exceeded by either of the NOx stations within Haldimand and Norfolk counties in 2001.

Figure 1.15 **Nitrogen Oxides (1992 - 2001)**
Annual average NOx levels

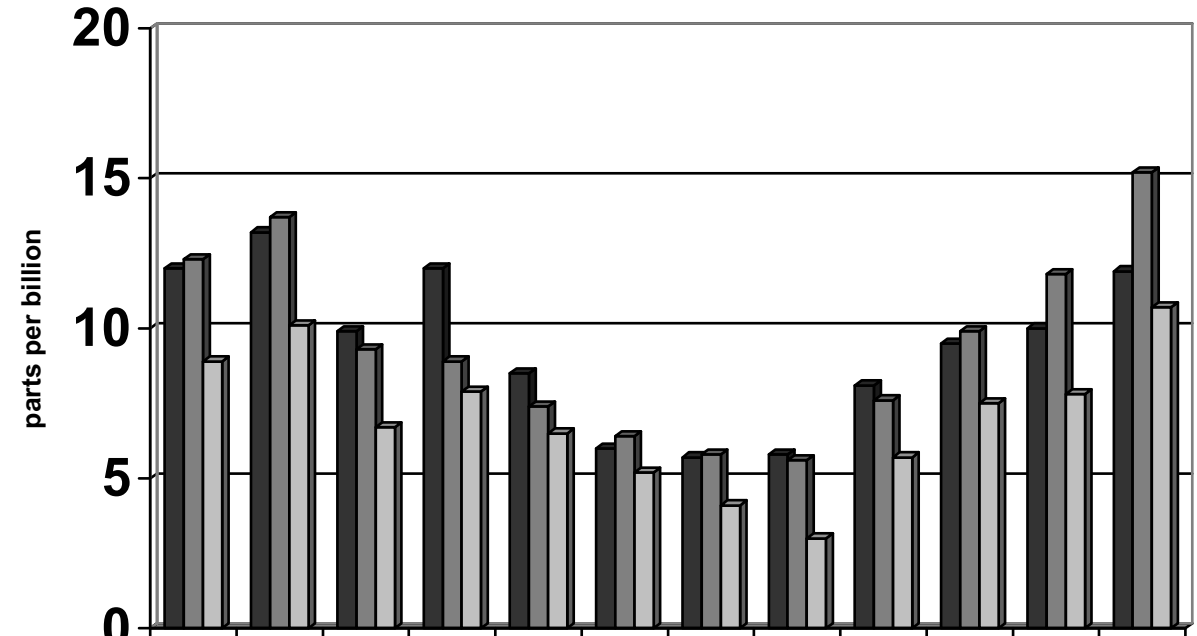


	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Cheapside	16.7	14.3	11.5	11.4	9.4	9.7	10.4	11	9.4	
Simcoe	12.7	9.9		8.6			10.3	10.3	9.5	9.8
Long Point	7.9	15.4	8.4	7.8		6.8	8.9	7.6	7	6.9

Figure 1.15 reports the annual average NOx levels for the years 1992 to 2001. There is no clear pattern over the last ten years, i.e., there is no consistent increasing or decreasing trend. The average NOx level between 1992 - 2001 was 12 ppb for Cheapside, 10.2 ppb for Simcoe and 8.5 ppb for Long Point. Cheapside tended to have the highest NOx levels compared to the other NOx stations within Haldimand and Norfolk. Tables 1.6 and 1.7 reports that the transportation sector is the largest contributor of NOx (63.5%), followed by industry (17.2%) and electricity (14.7%).

Figure 1.16 reports the monthly NOx levels for 2000. The figure does illustrate that there is a seasonal variation in the NOx levels. The NOx levels in 2000 were the lowest in the summer months (May-June) for all 3 NOx stations within Haldimand and Norfork counties. For example, at the Cheapside station in 2000 the average NOx levels for May-June was 6.5 ppb compared to 11.8 (Jan-Apr) and 9.9 (Sept-Aug). The same pattern was true for the Simcoe and Long Point stations.

Figure 1.16 **Nitrogen Oxides (NOx) - 2000**
Monthly average NOx levels



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cheapside	12	13.2	9.9	12	8.5	6	5.7	5.8	8.1	9.5	10	11.9
Simcoe	12.3	13.7	9.3	8.9	7.4	6.4	5.8	5.6	7.6	9.9	11.8	15.2
Long Point	8.9	10.1	6.7	7.9	6.5	5.2	4.1	3	5.7	7.5	7.8	10.7

Table 1.6 Ontario Nitrogen Oxides (NOx) Emissions by Sector 1999

Sector	Contribution
Transportation	63.5%
Industry	17.2%
Electricity	14.7%
Residential & Commercial	4.6%

Source: MOE Fact Sheet - http://www.ene.gov.on.ca/envision/news/102401fs.htm , August 16, 2002.

Table 1.7 Ontario Nitrogen Oxides (NOx) Emissions by Sector 2000

Sector	Contribution
Road Vehicles	35%
Other transportation	28%
Utilities	15%
Other processes	12%
Misc. Area Sources	8%
Primary Metals	2%

Source: MOE Air Quality Report 2000.

Sulphur Dioxide(SO_2)

SO_2 is a colourless gas which is often described as smelling like burnt matches. According to the MOE Air Quality Report 2000 about 69% of the SO_2 emitted in Ontario in 2000 came from smelters and utilities. Other industrial contributors to SO_2 include steel mills, pulp and paper mills, refineries, iron mills. There are a number of health effects associated with exposure to high levels of SO_2 such as "… breathing problems, respiratory illness, changes in the lung's defences, and worsening respiratory and cardiovascular disease." (MOE Air Quality Report 2000, p. 19). High risk individuals include those who have a lung condition, heart condition or have asthma. Out of 23 SO_2 monitoring sites in Ontario in 2000, Simcoe was ranked 11th and Long Point was ranked 15th (MOE Air Quality Report 2000). There are seven SO_2 monitoring sites within the Haldimand and Norfolk counties – Simcoe (22071), Cheapside (22086), Long Point (22901), Walpole South (22904), Nanticoke Village (22907), Balmoral (22911) and Nanticoke Rd (22913). The Ontario guidelines for SO_2 are .25 ppm (1hr) or 250 ppb (1 hr), .10 ppm or 100 ppb (24 hour) and .02 ppm or 20 ppb (annual). Using these quidelines no site in Ontario in 2000 exceeded the .02 ppm guideline. The highest SO_2 was observed in Sarnia (.010 ppm) and Windsor (Windsor West - .008 ppm & Windsor Downtown - .0062 ppm). According to the MOE, industry accounted for 70% of the Sulphur Dioxide (SO_2) emissions in 1999 (see Tables 1.8 and 1.9).

Table 1.8 Ontario Sulphur Dioxide (SO_2) Emissions by Sector 1999

Sector	Contribution
Industry	69.9%
Electricity	23.7%
Transportation	5.6%
Residential & Commercial	1.1%

Source: MOE Fact Sheet - http://www.ene.gov.on.ca/envision/news/102401fs.htm , August 16, 2002.

Table 1.9 Ontario Sulphur Dioxide (SO_2) Emissions by Sector 2000

Sector	Contribution
Smelters	42%
Utilities	27%
Refineries	10%
Area Sources	10%
Other Processes	7%
Primary Metals	4%

Source: MOE Air Quality Report 2000.

Table 1.10 Sulphur Dioxide (SO2) – 1992 – 2001 – Average annual SO2 levels (ppb).

	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Simcoe	3.3	3	2.4	1.6	2.7	3.1	3.8	3.7	4.3	5
Long Point	4.5	2.5	3	1.8	3	2.7	3	3.7	3.7	4.5
Cheapside	4.7	4.2	5.2	2.7	3.7	4.4	5	4.6	5	5.2
Walpole South						6.6	4.9	5.3	4.8	5.2
Balmoral	3.0	3.0	3.0	2.0	3.0	1.0	1.0	2.0	2.0	2.0
Nanticoke Rd.	2.0	3.0	3.0	2.0	2.0	2.0	2.0	2.0	2.0	4.0
Nanticoke Village	4.4	4.6	5.9	3.8	5	5.1	5.4	7.3	7	5.6

The Ontario guidelines for $S0_2$ are 250 ppb for a 1 hr average, 100 ppb for a 24 hour average and 20 ppb for an annual average. Over the last ten years (1992-2001) none of the $S0_2$ stations in Haldimand and Norfolk have exceeded the annual Ontario objective of 20ppb (see Table 1.10). Table 1.11 reports the monthly SO_2 levels for 2001. There is no consistent seasonal variation in the monthly SO2 data for 2001.

Table 1.11 Monthly S02 levels (ppb) for the 7 stations within Haldimand and Norfolk counties for the year 2001.

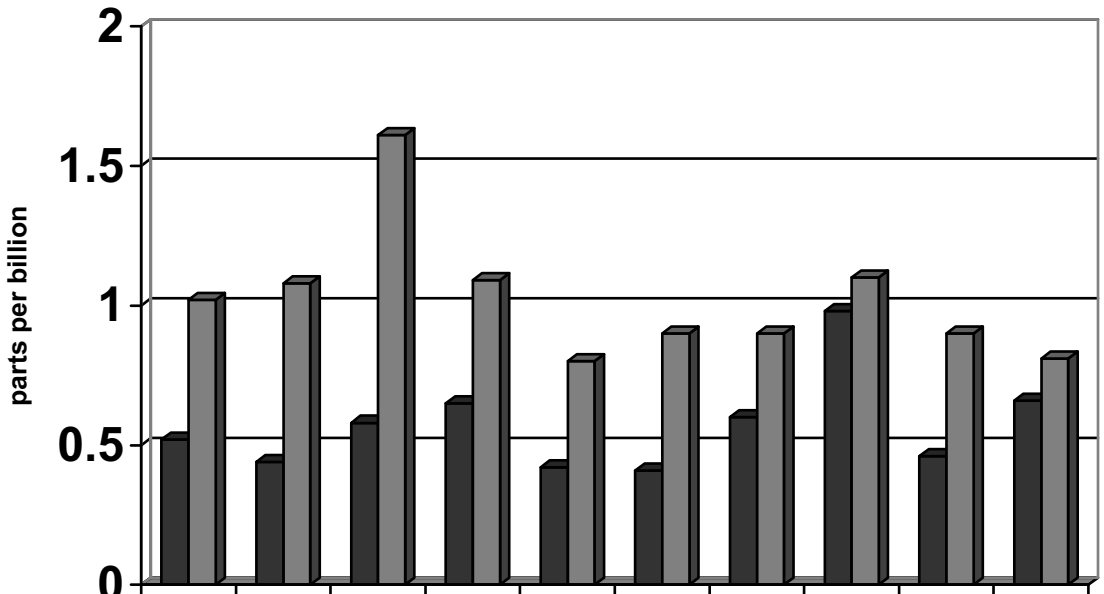
	Simcoe	Cheapside	Long Point	Walpole South	Nanticoke Village	Balmoral	Nanticoke Rd.
Jan	7.0	8.3	6.6	9.2	7.0	1.9	4.1
Feb	5.6	5.8	4.5	7.2	3.8	1.0	3.4
Mar	3.3	4.2	5.1	4.9	3.4	1.5	3.9
Apr	5.6	5.3	3.2	4.9	6.2	2.0	5.0
May	8.1	4.4	4.7	5.2	7.1	5.0	3.9
Jun	5.4	4.5	5.3	3.5	5.4	2.0	3.6
Jul	4.2	3.4	2.7	4.3	3.3	1.0	3.2
Aug	3.7	4.1	4.0	3.4	3.6	1.7	4.9
Sep	3.5	5.7	3.6	4.3	4.8	2.3	3.5
Oct	3.7	6.1	4.1	4.9	8.0	1.4	2.8
Nov	5.6	5.0	5.9	INS	9.5	.8	3.5
Dec	3.8	5.2	4.7	5.8	5.6	.7	4.6
Average	5.0	5.2	4.5	5.2	5.6	1.8	3.9

Total Reduced Sulphur (TRS)

TRS is a group of odourous pollutants that includes hydrogen sulphide which smells like rotten eggs. The main industrial sources of TRS are pulp and paper mills, refineries, and the steel industry. "TRS compounds are not normally considered a health hazard except at very high concentrations" (MOE Air Quality Report 2000, p. 22). There are two monitoring sites within Haldimand and Norfolk that measures TRS – Walpole South (22904) and Nanticoke Village (22907). The Ontario criteria for TRS is 27 ppb (1 h average). Although TRS is not considered a health hazard, TRS does have a strong odour. See Figure 1.17 for TRS levels for the last ten years. There currently are no annual standards for TRS. The Ontario 1 hr objective of 27 ppb was

not exceeded at the Walpole South station in 2001, but was exceeded once by the Nanticoke Village station in 2001. The 20 ppb H2S standard was exceeded 4 times at Nanticoke Village station in 2001.

Figure 1.17 **Total Reduced Sulphur (1992-2001)**

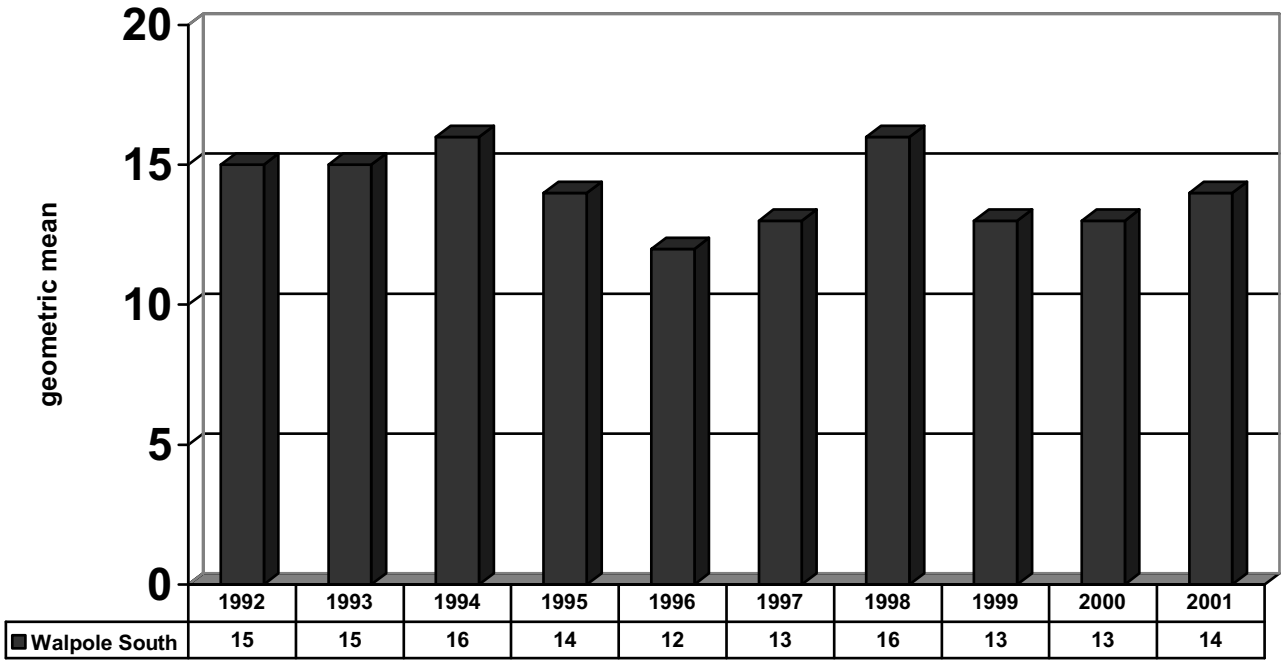


	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Walpole South	0.52	0.44	0.58	0.65	0.42	0.41	0.6	0.98	0.46	0.66
Nanticoke Village	1.02	1.08	1.61	1.09	0.8	0.9	0.9	1.1	0.9	0.81

Inhalable Particulate (PM_{10})

"PM_{10} are particles of solid or liquid matter that stay suspended in air in the form of dust, mist, aerosols, smoke, fume, soot, etc. Size range less than 10 microns". (MOE Air Quality Report 1999). The main health hazard is for those with respiratory related conditions like asthma. There was only one PM_{10} monitoring station in Haldimand and Norfolk located at Walpole South (22304) prior to 2002 – a non-continuous type sampler. In 2002, a continuous monitor was established at Nanticoke Village. The Ontario objective is 50 $\mu g/m^3$ for a 24 hr average. The 24 standard was exceeded 2 times in 2001 at the Walpole South station. There currently are no annual Ontario standards for PM_{10}. PM_{10} are particles that can enter the respiratory system and have an impact on one's health. "There is now compelling evidence that people with asthma, respiratory and cardiac disease are more sensitive to inhalable and respirable particulates." (Ontario's Smog Plan 1998, p.5). PM_{10} is an inhalable particulate in the environment. According to Ontario's Smog Plan 1998, "…it is estimated that current levels of inhalable particulates are associated with 1,800 premature deaths and 1,400 cardiac and respiratory hospital admissions in Ontario every year." According to Figure 1.18 the annual geometric mean for PM_{10} at Walpole South has remained relatively stable over the last 10 years.

Figure 1.18 **Inhalable Particulate (PM10) - (1992 - 2001)**
Annual Geometric Mean



Respirable Particulate ($PM_{2.5}$)

$PM_{2.5}$ is the same type of pollutant as PM_{10} except the size of the particle is smaller – 2.5 microns instead of 10 microns. There are also a number of health risks associated with this type of pollutant. "Decreased lung function, increased hospital admissions, increased respiratory symptoms and disease and premature death" (MOE Air Quality Report 1999). "There is now compelling evidence that people with asthma, respiratory and cardiac disease are more sensitive to inhalable and respirable particulates." (Ontario's Smog Plan 1998, p.5). $PM_{2.5}$ is an inhalable particulate in the environment. The Ontario objectives for this pollutant are 24 h average 30ug/m3. Simcoe (22071) is the only air quality monitoring station within Haldimand and Norfolk that measures $PM_{2.5}$. Although $PM_{2.5}$ is monitored it is currently not part of the Air Quality Index (AQI). Ontario added $PM_{2.5}$ to the AQI in August 2002. "Adding $PM_{2.5}$ into Ontario's AQI would likely lead to an increase in the number of times Ontario's air quality hits the "poor" category" (MOE Press Release, June 2002). See Figure 1.19 for $PM_{2.5}$ levels for the years 1998 to 2001. There was a decline in $PM_{2.5}$ over the last few years. Figure 1.20 reports the monthly $PM_{2.5}$ levels for the Simcoe station. In 2001 the summer months of June, July and Aug had the highest levels of $PM_{2.5}$ in the air. The Ontario standard of 30ug/m3 was exceeded 10 times in 2001 at the Simcoe station.

Figure 1.19 PM 2.5 - Respirable Particulate (1998-2001)

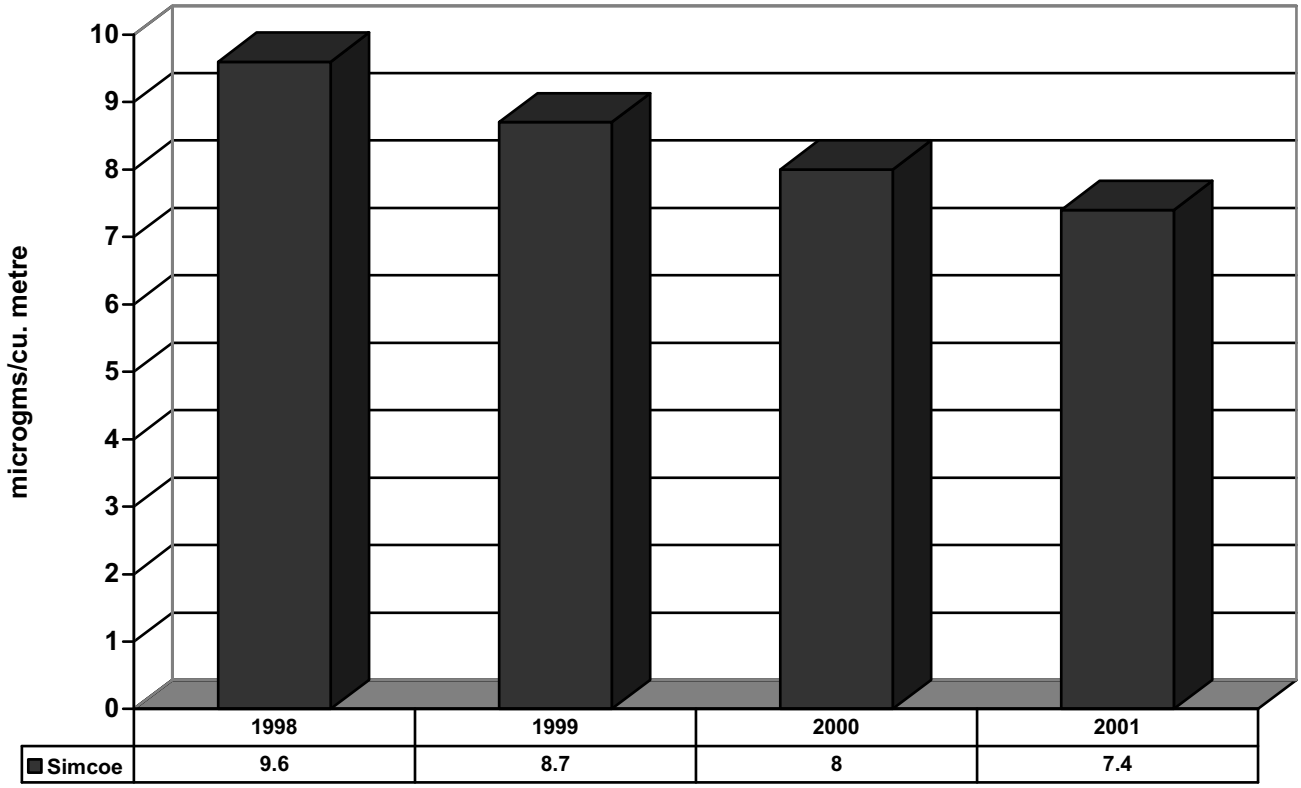
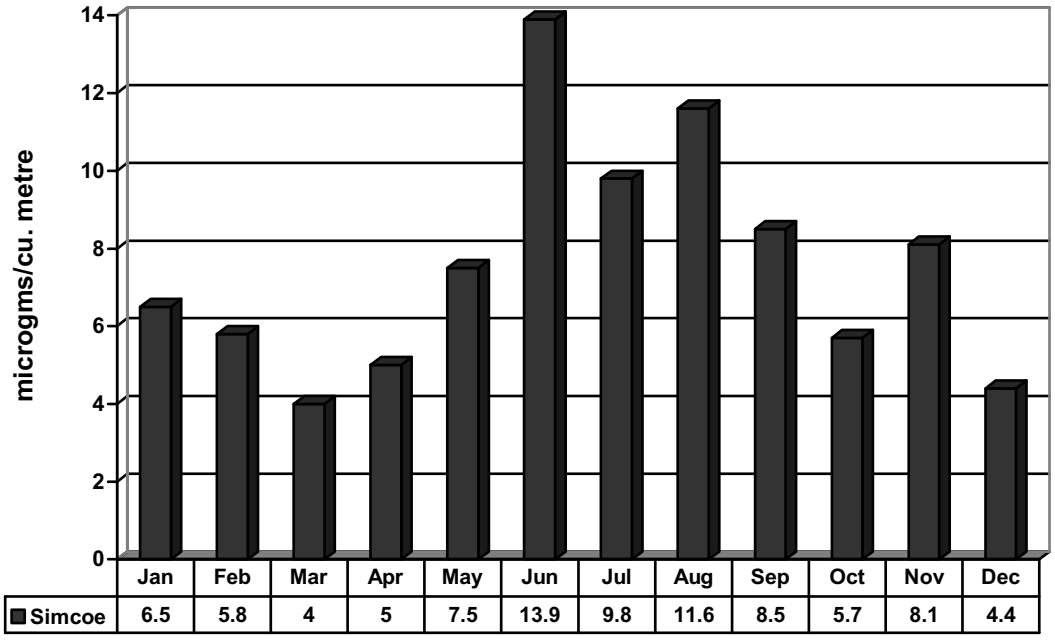


Figure 1.20 **PM2.5 - Respirable Particulate - 2001**



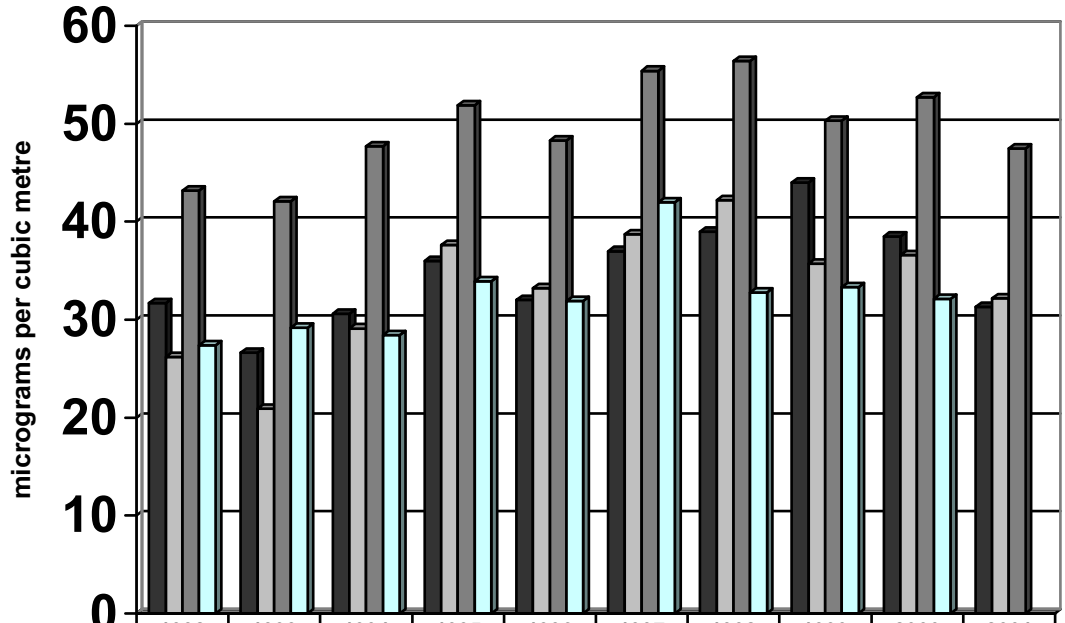
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Simcoe	6.5	5.8	4	5	7.5	13.9	9.8	11.6	8.5	5.7	8.1	4.4

Total Suspended Particulate (TSP)

Total Suspended Particulate (TSP) refers to all of the liquid and solid airborne particles found in the atmosphere. TSP is monitored at 4 air quality stations within Haldimand and Norfolk - Rainham/Sandusk (22092), Walpole South (22904), Nanticoke Village (22907) and Stelco North (22964). The Stelco North sampler was relocated to Peacock Point station (22969) in 2001. The Ontario objectives for TSP are 120 micrograms per cubic metre($\mu g/m^3$) for 24 hours and 60 $\mu g/m^3$ for a yearly geometric mean. None of the stations measuring TSP have exceeded the annual Ontario objectives of 60 $\mu g/m^3$. Some of the samples have exceeded the 24 hr objective of 120 $\mu g/m^3$. For example, in 2001 there was 1 sample at Rainham/Sandusk that exceeded the Ontario 24 hr objective. The other two stations Walpole South and Nanticoke Village had no 24 hr samples that exceeded the Ontario objective in 2001. Of the 4 TSP stations within Haldimand and Norfolk, Nanticoke Village consistently had the highest annual TSP levels over the last ten years (1992-2001).

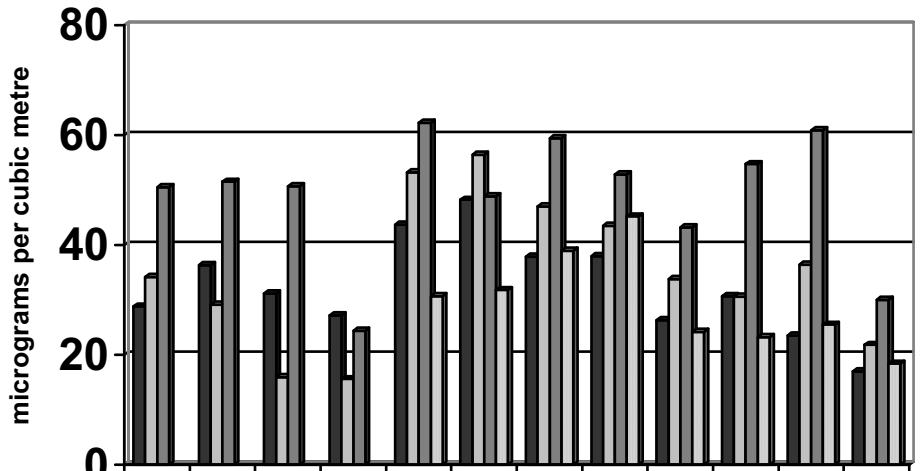
Figure 1.21

Total Suspended Particulates (1992 - 2001)
Annual Geometric Mean



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Rainham/Sandusk	31.7	26.6	30.6	36	32	37	39	44	38.5	31.3
Walpole South	26.2	20.9	29.1	37.6	33.2	38.7	42.2	35.7	36.6	32.2
Nanticoke Village	43.2	42.1	47.7	51.9	48.3	55.4	56.4	50.3	52.7	47.5
Stelco North	27.4	29.2	28.4	33.9	31.9	42	32.8	33.3	32.1	

Figure 1.22 **Total Suspended Particulates - 2001**
Monthly Geometric Means



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainham/Sandusk	28.8	36.3	31.2	27.2	43.7	48.2	37.9	38	26.3	30.7	23.5	17
Walpole South	34.2	29.1	15.9	15.6	53.2	56.4	47	43.5	33.8	30.6	36.4	21.8
Nanticoke Village	50.5	51.5	50.7	24.4	62.2	48.8	59.4	52.8	43.2	54.7	60.9	30
Peacock Point					30.7	31.8	38.9	45.2	24.2	23.2	25.5	18.4

Although Figure 1.22 reports the monthly TSP levels for 2001 it is difficult to see the seasonal pattern. Table 1.12 illustrates more clearly the seasonal pattern for TSP. The period of May – June in 2001 had the highest TSP levels for all 4 of the air quality monitoring stations within Haldimand and Norfolk.

Table 1.12 Seasonal patterns of Total Suspended Particulates (TSP) for 2001 (Geometric Means)

	Jan - Apr	May - Aug	Sept - Dec
Rainham/Sandusk	30.9	41.9	24.4
Walpole South	23.7	50.0	30.6
Nanticoke Village	44.3	55.8	47.2
Peacock Point		36.6	22.8

Coefficient of Haze (Soiling Index)

The soiling index is a measure of dust in the air. It measures those particles that are less than 10 microns in diameter (inhalable range). Nanticoke Village (22907) is the only air monitoring station within Haldimand and Norfolk that measures the soiling index. The data in Figure 1.23 represents the annual average soiling index (per 1000 ft) for the last ten years. The average (annual) soiling index over the last 5 years (1997-2001) has for the most part been lower than the previous 5 year period (1992-1996). The Ontario objective for the soiling index is 1.0/1000 ft (hour) and 0.5/1000 ft (annual average). According to Figure 1.23 the annual soiling index for Nanticoke Village was below the Ontario objective over the last ten years.

Figure 1.23 **Soiling Index (1992-2001)**

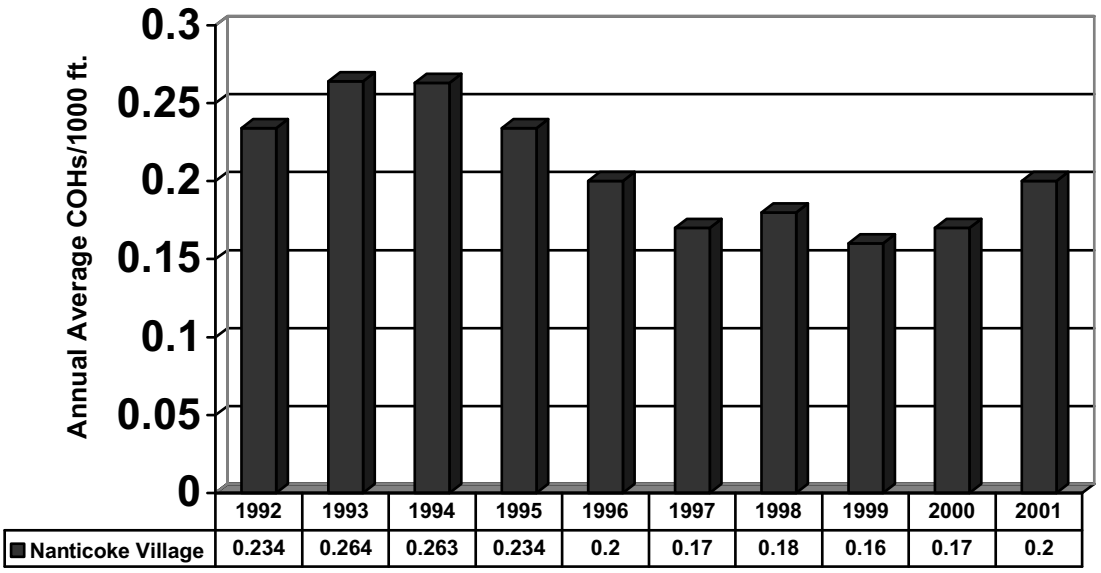
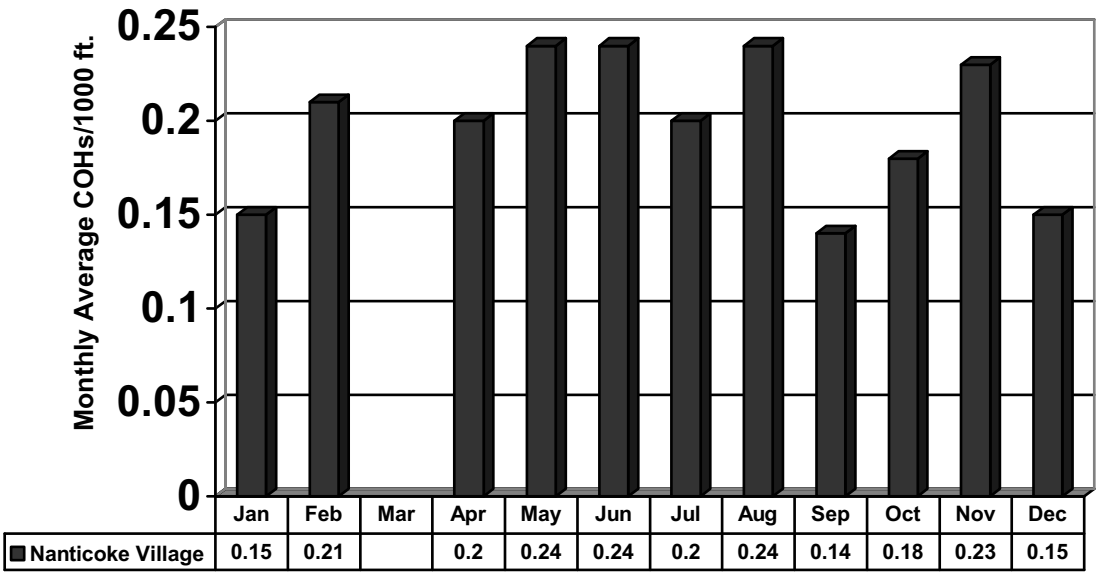


Figure 1.24 reports the monthly Soiling Index for Nanticoke Village for 2001. There does appear to be a seasonal pattern for soiling index levels. The period of May-Aug had a higher average soiling index level (0.23) compared to Jan-Apr (0.19) and Sept-Dec (0.17) for the year 2001.

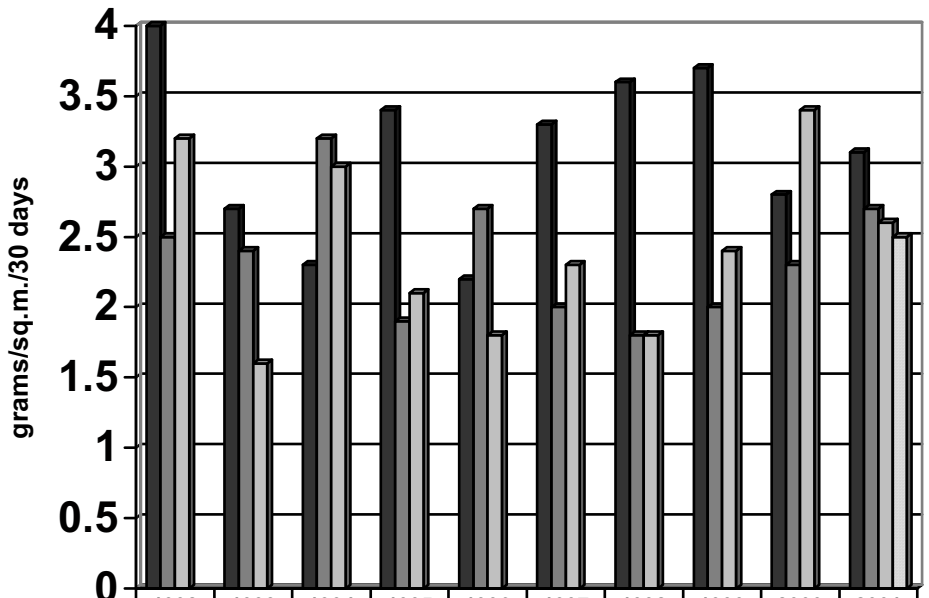
Figure 1.24 **Soiling Index (2001)**



Dustfall

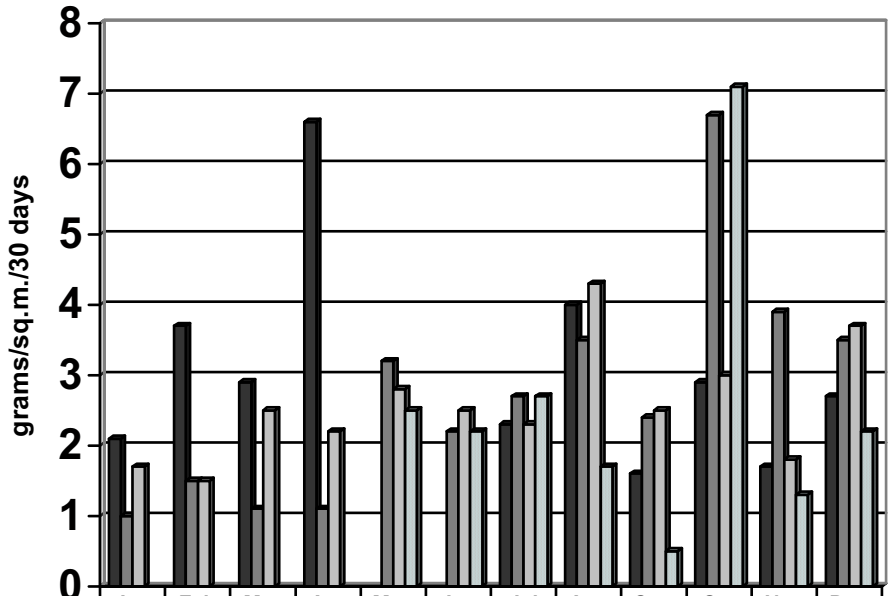
Dustfall is the amount of particles that settles on the ground due to gravity. Dustfall is considered a heavy material and, for the most part, non-inhalable due to the size of the particles. Dustfall is therefore not considered a health issue, although it can generate a lot of attention due to the fact that people see 'dustfall' as a nuisance. Accumulation of dustfall is often seen in the morning on vehicles. Nanticoke Village (22070), Rainham/Sandusk (22092), NGS Flyash Area (22093) and Port Dover (22969) are the 4 air quality monitoring stations within the Nanticoke Monitoring Network that measures levels of dustfall. The measuring of dustfall at Port Dover is new – started May, 2001. The provincial objectives for dustfall are 7.0 grams per square metre per 30 days, with an annual mean of 4.5. Dustfall is measured in terms of its nuisance level, not in terms of its health impact. Dustfall is not part of the Air Quality Index. See Figures 1.25 for the dustfall levels for the last ten years (1992-2001). There is no consistent increasing or decreasing trend to the dustfall data during this period. See Figure 1.26 for the monthly dustfall levels for 2001. There does not appear to be any seasonal variation in the dustfall levels. None of the air quality stations measuring dustfall in Haldimand and Norfolk exceeded the Ontario objective of 4.5 grams/sq.m/30 days annual over the last 10 years.

Figure 1.25 **Dustfall (1992-2001)**



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Nanticoke Village	4	2.7	2.3	3.4	2.2	3.3	3.6	3.7	2.8	3.1
Rainham/Sandusk	2.5	2.4	3.2	1.9	2.7	2	1.8	2	2.3	2.7
NGS Flyash Area	3.2	1.6	3	2.1	1.8	2.3	1.8	2.4	3.4	2.6
Port Dover										2.5

Figure 1.26 **Dustfall - 2001**

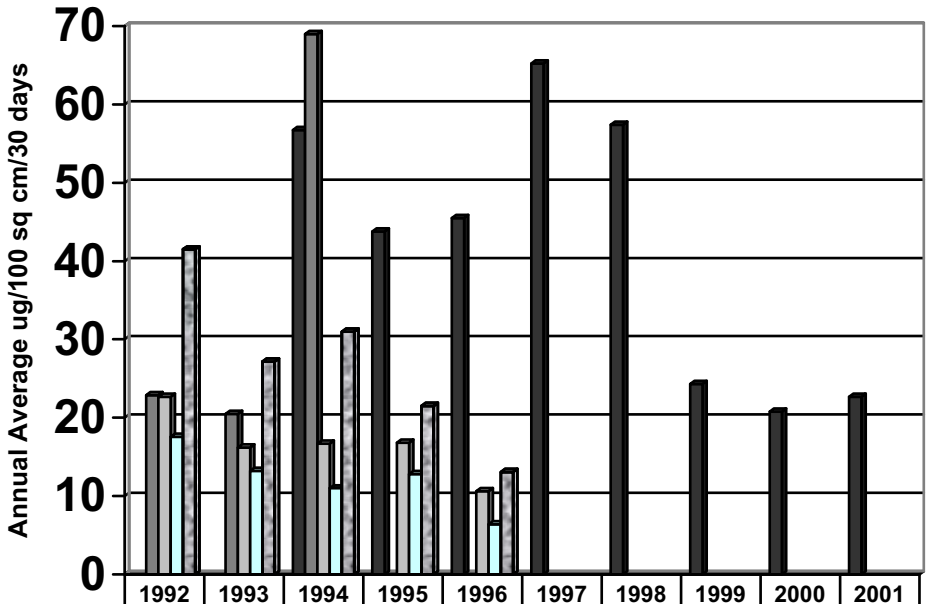


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Nanticoke Village	2.1	3.7	2.9	6.6			2.3	4	1.6	2.9	1.7	2.7
Rainham/Sandusk	1	1.5	1.1	1.1	3.2	2.2	2.7	3.5	2.4	6.7	3.9	3.5
NGS Flyash Area	1.7	1.5	2.5	2.2	2.8	2.5	2.3	4.3	2.5	3	1.8	3.7
Port Dover					2.5	2.2	2.7	1.7	0.5	7.1	1.3	2.2

Fluoridation

Used to measure the amount of fluoride compounds in the ambient air. The measurement of fluoride is currently taken at Nanticoke Village. There has been some change over the years in terms of which stations measured fluoride. Figure 1.27 reports the annual average for the last ten years. Station 22057 is south of Nanticoke Village on Nanticoke Creek, station 22074 is next to Imperial Oil office, station 22083 is near Dogs Nest and station 22961 is called Nanticoke North (west of Nanticoke Rd.). Stations 22074, 22083 and 22961 were discontinued in 1997, whereas station 22057 was discontinued in 1995. Station 22070 (Nanticoke Village) started in 1994 and is currently the only station that measures fluoride compounds in the air. Focusing on the Nanticoke station there was a considerable reduction in levels of fluoride starting in 1999.

Figure 1.27 **Fluoride (1992 - 2001)**



	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Nanticoke Village			56.7	43.8	45.5	65.2	57.4	24.3	20.8	22.7
22057	22.9	20.5	69							
22074	22.7	16.2	16.7	16.8	10.6					
22083	17.6	13.2	11	12.8	6.4					
22961	41.5	27.2	31	21.5	13.1					

Conclusion

The Haldimand and Norfolk State of the Environment Report (SOER) – Air Quality is intended to offer residents of Haldimand and Norfolk counties with a detailed look at the air quality issues. For the most part, the period 1992 to 2001 was selected as the reporting period to enable one to see a trend over time. Also, the monthly reporting of these same pollutants was reported for a particular year to determine whether seasonal patterns existed. To help put the data into perspective the Ontario standards for the various pollutants are discussed. The Air Quality report is Part 1 of the State of the Environment Report, Parts 2 and 3 will focus on Land and Water.

Clearly, there are a number of health issues that are influenced by the levels of the various air pollutants with Haldimand and Norfolk. The main health impact of pollution is on the prevalence of respiratory diseases, such as asthma. It is not possible to determine exactly what proportion of the respiratory diseases within Haldimand and Norfolk is due to pollution. It is important to point out that according to the Haldimand and Norfolk Community Health Status Report 2002, the standardization hospitalization rate for Diseases of the Respiratory System (1999/2000) was significantly higher in Haldimand and Norfolk compared to Ontario. Based on results from the Canadian Community Health Survey 2000/2001, the self-reported asthma rate in Haldimand and Norfolk is 9.4% (aged 12 and older), compared to the provincial rate of 8.5% and the national rate of 8.4%.

Ground level ozone is clearly an air pollutant that is a problem for residents of Haldimand and Norfolk residents. Of all the 36 air quality stations in Ontario, Long Point has consistently had the highest number of ozone exceedance days (at least 1 hr above Ontario standard of >80ppb) for the last ten years (1991 – 2000). In 2000, Long Point had 20 ozone exceedance days compared to 5 in London, 4 in Toronto (downtown) and 4 in Hamilton (downtown).

Volatile Organic Compounds (VOCs) is one of the pollutants that contribute to ground level ozone via a chemical reaction with nitrogen oxides and the sun. The main health effects associated with VOCs are cancer and effects on the central nervous system. Benzene is a VOC with vehicle exhaust being the main source for this pollutant. Benzene is classified as a human carcinogen. There currently are no Ontario standards for this carcinogen making it impossible to interpret the benzene levels within Haldimand and Norfolk counties. Other VOCs like Tolune and Ortho-xylene (BTX) are not considered carcinogenic but are known to affect the central nervous system. There currently are no Ontario standards for BTX.

Polycyclic Aromatic Hydrocarbons (PAH) are produced in the environment via natural, industrial and combustion. PAHs have been classified as “probably carcinogenic to humans.” There currently are no Ontario standards for PAH total levels. The PAH totals at Nanticoke Village have consistently been much higher than levels at Simcoe. The most toxic of the PAHs is Benzo(a)pyrene. The benzo(a)pyrene level in Nanticoke Village exceeded the Ontario 24 hr objective 9 times in 2001. Also, the Ontario annual objective has been repeatedly exceeded at Nanticoke Village for the last nine years (1994-2001). In 2001, the Nanticoke Village station exceeded the annual Ontario objective by 5 times.

Nitrogen Oxides is an air pollutant in Ontario with the transportation sector being the major contributor. There are no annual Ontario NOx standards, but there are 1 hr and 24 hr standards. The Ontario 24hr standard for NOx was not exceeded by either of the NOx stations within Haldimand and Norfolk counties in 2001. The NOx annual levels at the 3 stations within Haldimand and Norfolk counties have not shown either an increasing or decreasing trend over the last ten years (1992-2001). In 2000 the monthly NOx levels did show some seasonal variation.

For the 3 NOx stations within Haldimand and Norfolk counties the NOx levels were the lowest in the summer months of June, July and August.

Sulphur Dioxide (SO_2) is an air pollutant in Ontario with the industry sector being the major contributor. Over the last ten years (1992-2001) none of the SO2 stations in Haldimand and Norfolk counties have exceeded the annual Ontario objective of 20 ppb. There does not appear to be any seasonal variation in the SO2 levels at the stations with Haldimand and Norfolk counties.

There are three different measures of the amount of liquid and solid airborne particles found in the air. Total Suspended Particulate (TSP) measures all of the liquid and solid airborne particles, whereas PM_{10} measures particles of solid and liquid which are less than 10 microns in size. $PM_{2.5}$ is the same as PM_{10} but measures particles (solid & liquid) that are less than 2.5 microns in size. Of the 4 stations within Haldimand and Norfolk that measures TSP, Nanticoke Village station consistently had the highest TSP annual levels (1992-2001). It is important to understand that none of these stations exceeded the annual Ontario objective of 60 ug/m^3 over the last ten years (1992-2001). TSP levels for 2001 do show a seasonal variation pattern for the stations within Haldimand and Norfolk counties. The period of May – Aug had the highest TSP levels. Walpole South is the only station in Haldimand and Norfolk that measures PM_{10}. Over the last ten years (1992-2001), the annual PM_{10} average remained relatively stable with no consistent pattern (increase or decrease). There currently are no annual Ontario objectives for PM_{10}. There is a 24 hr Ontario objective of 50 ug/m^3. This Ontario objective was exceeded 2 times in 2001. The Simcoe station is the only air quality station within Haldimand and Norfolk that measures $PM_{2.5}$. There is no annual Ontario objective for $PM_{2.5}$ but there is a 24 hr objective of 30 g/m^3. There were 10 times in 2001 when the 24 hour objective was exceeded at the Simcoe station (all during summer smog incidents).

The soiling index (Coefficient of Haze) is a measure of the amount of dust in the air. It measures particles that are less than 10 microns in diameter (inhalable range). Nanticoke Village is the only station within Haldimand and Norfolk that measures the soiling index. The annual Ontario objective (0.5/1000 ft), was not exceeded by the Nanticoke Village station over the last ten years (1992-2001). There does appear to be a seasonal variation in the 2001 soiling index data.

Another measure of particles is Dustfall, which measures the amount of particles that settles on the ground due to gravity. Dustfall, for the most part, is non-inhalable and therefore is not considered a health issue. None of the air quality stations within Haldimand and Norfolk that measures dustfall, exceeded the annual Ontario objective of 4.5 g/m^3/30 days over the last ten years (1992-2001).

Total Reduced Sulphur (TRS) is a group of odourous pollutants that smells like 'rotten eggs'. TRS is not normally considered a health issue except at very high concentrations. There currently are no annual Ontario standards for TRS. Walpole South and Nanticoke Village are the two stations within Haldimand and Norfolk that measures TRS. Over the last ten years, TRS has been higher at the Nanticoke station compared to the Walpole Station. There has not been a consistent increasing or decreasing pattern at either station over the last ten years (1992-2001). The Ontario objective of 27 ppb – 1 hr average was not exceeded at the Walpole South station in 2001, but was exceeded once at the Nanticoke Village station in 2001.

The Haldimand and Norfolk State of the Environment Report (2003) – Air Quality provides an opportunity to review the air quality of Haldimand and Norfolk over the last ten years. Pollutants such as Ozone, NOx, SO_2, TRS, PAH [Benzo(a)pyrene], PM_{10}, VOCs, TSP, and Dustfall have not shown a consistent decreasing trend over the last ten years. Some of these pollutants have

shown more variability over the last ten years compared to other pollutants. The only pollutant to show a slight declining trend over the last 4 years was $PM_{2.5}$ at the Simcoe station.

REFERENCES

Basrur, S.V. Ten Key Carcinogens in Toronto Workplaces and Environment: Assessing the Potential for Exposure, Toronto Public Health, 2002.

Haldimand-Norfolk Health Unit/Grand River District Health Council, Haldimand and Norfolk Community Health Status Report, 2002

Health Canada, http://www.hc-sc.gc.ca/english/iyh/environment/smog.htm, August15, 2002

Health Canada, http://www.hc-sc.gc.ca/hecs-sesc/air_quality/definitions.htm, Oct 3, 2002

Health Canada, http://www.hc-sc.gc.ca/hecs-sesc/air_quality/faq.htm, Oct 3, 2002

Health Canada, 1994 (**get the FULL reference**)

Ministry of the Environment (MOE), Air Quality Report 2000

Ministry of the Environment (MOE), Air Quality Report 1999

Ministry of the Environment (MOE), http://www.ene.gov.on.ca/envision/news/2002/080701.htm August 7, 2000

Ministry of the Environment (MOE), June, 2000 press release

Ministry of the Environment (MOE), http://www.airqualityontario.com/science/aqi_description.cfm, August16/02

Ministry of the Environment (MOE), http://www.airqualityontario.com/science/transboundary.cfm

Ministry of the Environment (MOE), Fact Sheet, http://www.ene.gov.on.ca/envision/news/102401fs.htm , August 16, 2002

Ministry of the Environment (MOE) - Standards Development Branch, Point of Impingement Standards, Point of Impingement Guidelines, and Ambient Air Quality Criteria (AAQCs), 1999

Ontario's Smog Plan, 1998

Statistics Canada, Canadian Community Health Survey, 2000/01