Clean Air

HAMILTON

2008 Progress Report

June 2009

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Executive Summary

- *Clean Air Hamilton* is a community initiative to improve air quality in the City of Hamilton. It has a diverse membership with representation from environmental organizations, industry, businesses, academic institutions, and different levels of government. Initiated in 1998, *Clean Air Hamilton* works to improve air quality in Hamilton by:
    - Initiating research on air quality;
    - Providing policy advice to all levels of government;
    - Encouraging emission reductions among individuals and companies operating in Hamilton; and
    - Promoting behavioural changes in companies, government, institutions and individuals in Hamilton that will reduce energy consumption and improve air quality.
- It is perceived by many in Hamilton that the City's industrial sector is the major contributor to poor air quality, and that reductions in industrial emissions should be a primary focus of air quality improvements. While significant reductions in industrial emissions have been realized in recent years, efforts need to continue to make even more improvements; however, emissions from mobile sources (personal and commercial vehicles), energy and fugitive dusts must be reduced significantly if we are to make meaningful improvements to local air quality.
- Air monitoring in Hamilton is done through two fixed networks - the Hamilton Air Monitoring Network (HAMN) and Air Quality Index (AQI) monitors run by the Ontario Ministry of the Environment. HAMN is an extensive network of fixed air monitors focussed on monitoring air quality in the east end industrial core.
- Mobile monitoring can assess air quality in areas with specific air quality issues, roam city-wide or determine local air quality conditions right down to the street level.
- Mobile monitoring can identify local air emissions sources that are not in the traditional east end industrial core.
- Mobile monitoring studies conducted in Hamilton showed that high pollutant exposures occur near arterial roads and highways due to emissions from mobile (i.e., transportation) sources.
- There is a need to consider the health impacts of transportation-related pollutants in transportation planning and urban design.
- Hamiltonians need support and encouragement to reduce their transportation-related emissions by switching to sustainable transportation including public transit, bicycles, walking, hybrid and electric vehicles, etc. Cycling/walking routes throughout Hamilton that are removed from heavy traffic corridors would facilitate healthy, active transportation.
- Climate Change is an area of environmental concern. The linkages between measures to reduce greenhouse gas emissions, improve local air quality, and reduce energy consumption need to be communicated and addressed through action.
- The City needs to maintain support for actions that will improve local air quality, reduce greenhouse gas emissions, and increase energy conservation while increasing the level of dialogue within community groups on the health impacts of poor air quality and the best actions and lifestyle changes that will lead to air quality improvements for all citizens.

Clean Air Hamilton **continues to encourage activities undertaken by the City, industries and citizens to reduce air pollutants and improve local air quality in their operations and transportation choices.** ***Clean Air Hamilton*** **actively cultivates partnerships with organizations that have air quality improvement goals that are aligned with those of** ***Clean Air Hamilton*** **and the City of Hamilton.**

1.0 Introduction

Clean Air Hamilton is pleased to present the 2008 Progress Report on Air Quality to Hamilton City Council. This report presents local air quality trends and the activities undertaken by *Clean Air Hamilton* in 2008 to help improve air quality in the City of Hamilton. This report gives an update on new initiatives and on activities that have continued from previous years.

1.1 Background

The former Hamilton-Wentworth Regional Council endorsed the establishment of *Clean Air Hamilton* (then called the Hamilton-Wentworth Air Quality Improvement Committee or HAQIC) in 1998 following the publication of a series of reports by the Hamilton Air Quality Initiative (HAQI) in October 1997.

In 1997, the Hamilton Air Quality Initiative made 25 recommendations to improve air quality in Hamilton. Over the past 11 years, *Clean Air Hamilton* and partners have made significant progress in addressing and responding to these recommendations (see **Appendix A**).

Background air quality reports prepared by the Hamilton Air Quality Initiative and published in 1997 to 1998 and the 2000 to 2007 *Clean Air Hamilton* Annual reports are available online at: http://www.cleanair.hamilton.ca/

1.2 Impact

Clean Air Hamilton continues to receive regional, national and international attention for its outstanding leadership and commitment to improving local air quality. The *Clean Air Hamilton* website receives over 1,500 hits a week and inquiries about *Clean Air Hamilton's* activities are received regularly from organizations and individuals in Canada, the U.S. and from around the world. Many innovative projects have emerged, directly and indirectly, from *Clean Air Hamilton*.

Members of *Clean Air Hamilton* have engaged City Council and the community in decision-making and issues related to air quality, including transportation (e.g., mobile monitoring studies, anti-idling strategies, Hamilton Transportation Master Plan, Hamilton Truck Route study, Rapid Transit), planning (e.g., mobile monitoring, Liveable Cities, Urban Official Plan), air monitoring (e.g., mobile monitoring, Hamilton Air Monitoring Network), education initiatives and community air quality awareness (e.g., Upwind/Downwind Conference, Living for the Environment Conference, Earth Day Hamilton, and *Clean Air Hamilton* website).

2.0 Clean Air Hamilton

2.1 Vision Statement

"*Clean Air Hamilton* is an innovative, multi-stakeholder agent of change dedicated to improving air quality in our community. We are committed to improving the health and quality of life of citizens through communication and promoting realistic, science-based decision-making and sustainable practices."

2.2 Goals

Clean Air Hamilton has identified the following goals as a guide for future actions:

- To improve air quality throughout the City and to meet all ambient air quality criteria ;
- To raise *Clean Air Hamilton*'s visibility in the community and to be recognized as the authoritative voice on local air quality issues;
- To galvanize broad-based support for a process and an action plan to improve air quality;
- To provide information and advice that decision-makers value;
- To influence decision-makers to choose sustainable practices and alternatives; and
- To affect behavioural changes to improve air quality.

2.3 *Clean Air Hamilton* Membership in 2008

Dr. Brian McCarry (Chair)	McMaster University
Paul Barrett	Green Venture
Alex Basiji	Health Canada
Stephen Brotherston	Citizen
Michael Brown	ArcelorMittal Dofasco
Dr. Denis Corr	McMaster University/Rotek Environmental
Heather Donison	Planning & Economic Development, City of Hamilton
Mark Dunn	Ontario Ministry of the Environment
Barry Duffey	Ontario Ministry of the Environment
Robert Hall	Public Health Services, City of Hamilton
Chris Hill	Public Works, City of Hamilton
Bill Janssen	Planning & Economic Development, City of Hamilton
James Kaspersetz	Citizen
Ross Kent	Citizen
Alan Kirkpatrick	Public Works, City of Hamilton
Karen Logan	Hamilton Industrial Environmental Association
Stuart Lord	Horizon Utilities
Lynda Lukasik	Environment Hamilton
Geoff Lupton	Public Works, City of Hamilton
Paul Massuto	Citizen
Dr. Ted Mitchell	Citizen
Brian Montgomery	Planning & Economic Development, City of Hamilton
Hossein Naghdianei	Environment Canada
Carl Slater	Ontario Ministry of the Environment
Steve Walsh	Public Health Services, City of Hamilton
Pete Wobschall	Green Venture

Clean Air Hamilton is dependent upon the voluntary contributions of its members. In order to continue to make air quality improvements in Hamilton, *Clean Air Hamilton* continues to supplement the voluntary contributions of members with renewed and ongoing commitments of funding from key stakeholders, including various levels of government, the City of Hamilton, local industries and academic institutions, as well as recruiting new members into the organization.

Clean Air Hamilton is committed to recruiting new members who have the time, expertise and interest in air quality issues to work in a committee-based format to find ways to improve air quality in the City. *Clean Air Hamilton* is particularly interested in engaging with committed individuals who want to work and undertake research to improve air quality in Hamilton. *Clean Air Hamilton* is interested in working with individuals and with representatives from industries, schools and school boards, community groups and others who partner on one or more actions identified by *Clean Air Hamilton*. Interested individuals should contact the City of Hamilton's Air Quality Coordinator by telephone at (905) 546-2424 ext. 1275 or by e-mail at cleanair@hamilton.ca

2.4 Strategic Activities in 2008 and Beyond

Clean Air Hamilton has identified nine strategic issues related to air quality improvements and climate change that the committee wishes to focus on over the next 2-3 years. These issues have been identified for research, communication and program activities by *Clean Air Hamilton* in collaboration with our partners:

- **Public Health Protection:** Bring an Air Quality Health Index to Hamilton; produce communications to citizens about the health effects of poor air quality, particularly on smog days and inversion days.
- **Active & Sustainable Transportation:** Encourage the use of active and sustainable means of energy-efficient transportation and encourage emissions reductions by moving away from single occupancy personal transportation.
- **Smart Drivers:** Reduce unnecessary idling of vehicles, reduce impacts of vehicle emissions, and reduce emissions from driving.
- **Air Quality Communication:** Continue to communicate on the impacts and sources of poor air quality, encourage behavioural changes, and increase support for *Clean Air Hamilton*.
- **Climate Change:** Provide a forum to discuss the linkages between climate change and air quality and encourage action to reduce climate change impacts in Hamilton.
- **Emission Reductions Strategies:** Develop a plan to reduce emissions from small, medium and large scale sources on "bad air" days, e.g., smog days.
- **Energy Conservation:** Encourage energy conservation by promoting best practices and by encouraging reducing wasteful uses of electricity. This promotion will make the connection between climate change and poor air quality.
- **Land Use Planning:** Encourage actions by the City through land use policies to promote reductions of emissions and improvements in air quality through better planning tools.
- **Tree Programs:** Develop a tree networking and tree inventory organization for all the tree planting activities across the City.

Details of these activities can be found in **Appendix B**. The 2008 *Clean Air Hamilton* Report presents the actions undertaken in 2008 by members of *Clean Air Hamilton* and our partners to address these strategic issues.

2.5 Financial and In-Kind Contributions

The City of Hamilton currently provides an annual contribution of $80,000/year in support of *Clean Air Hamilton* and its activities. This money is leveraged by funding provided by partner institutions and by the in-kind support of community volunteers who donate their time and expertise. In 2008 *Clean Air Hamilton*'s partners and volunteers provided $200,000 in in-kind and financial support. *Clean Air Hamilton*'s 2008 financial report is available in **Appendix C**.

3.0 Air Quality in Hamilton

3.1 Air Pollution Health Impacts – Hamilton and Ontario

Poor air quality is associated with a range of health impacts, including eye, nose and throat irritation, breathing difficulties, coughing, wheezing, and the aggravation of existing conditions like asthma. There is no evidence that air pollution causes asthma directly; however, there is ample evidence that poor air quality exacerbates a pre-existing asthma condition. Also, some segments of the population, particularly young children and the elderly, are much more susceptible to the adverse health effects of poor air quality.

Less appreciated is the fact that the *respiratory* illnesses many people associate with poor air quality account for less that 20 percent of the adverse health effects; cardiovascular impacts are far more prevalent. *Clean Air Hamilton*'s 2003 air pollution health assessment report projected that over 66 percent of the health outcomes arising from air pollution in Hamilton would be manifest as *cardiovascular* illnesses. The report estimated that five key air pollutants – nitrogen dioxide, ground level ozone, fine particulate matter, sulphur dioxide and carbon monoxide -- contribute to approximately 100 premature deaths and 620 hospital admissions in Hamilton each year (**see Figure 1 & 2 below**).

Figure 1: Air Pollution Health Impacts – Respiratory Admission, Mortality, and Cardiovascular Hospital Admissions due to Poor Air Quality in Hamilton (2003)

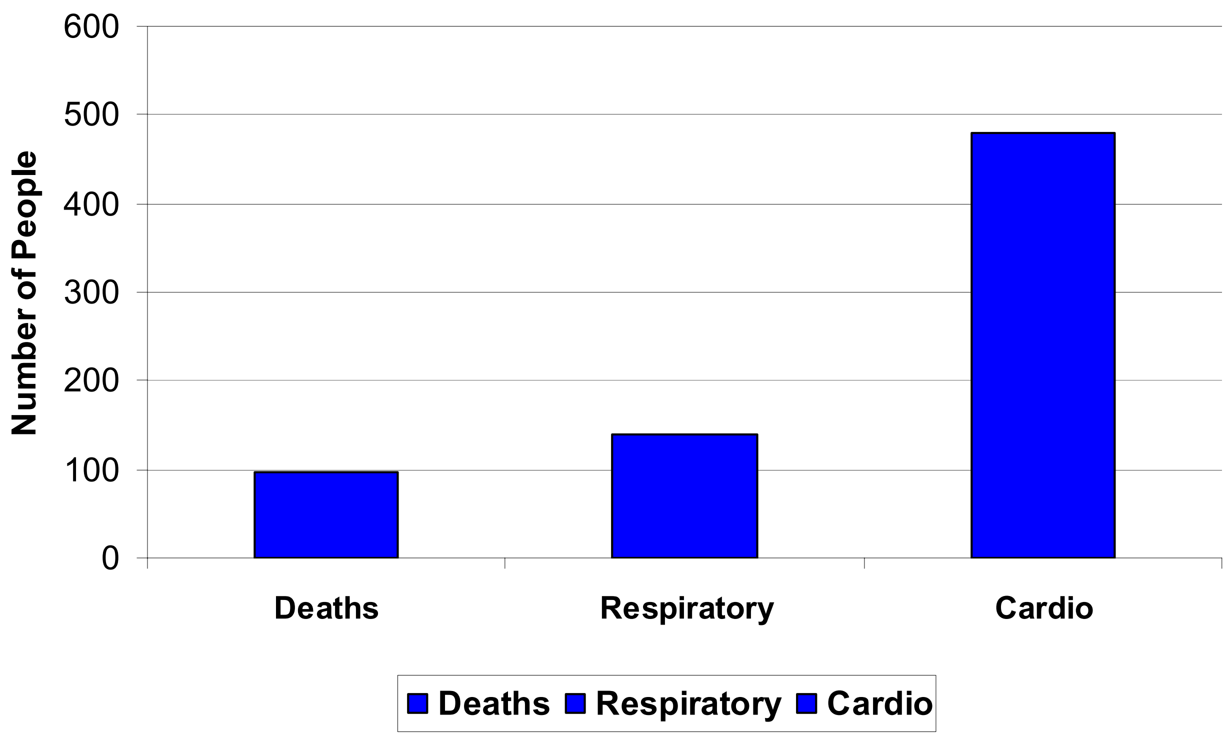
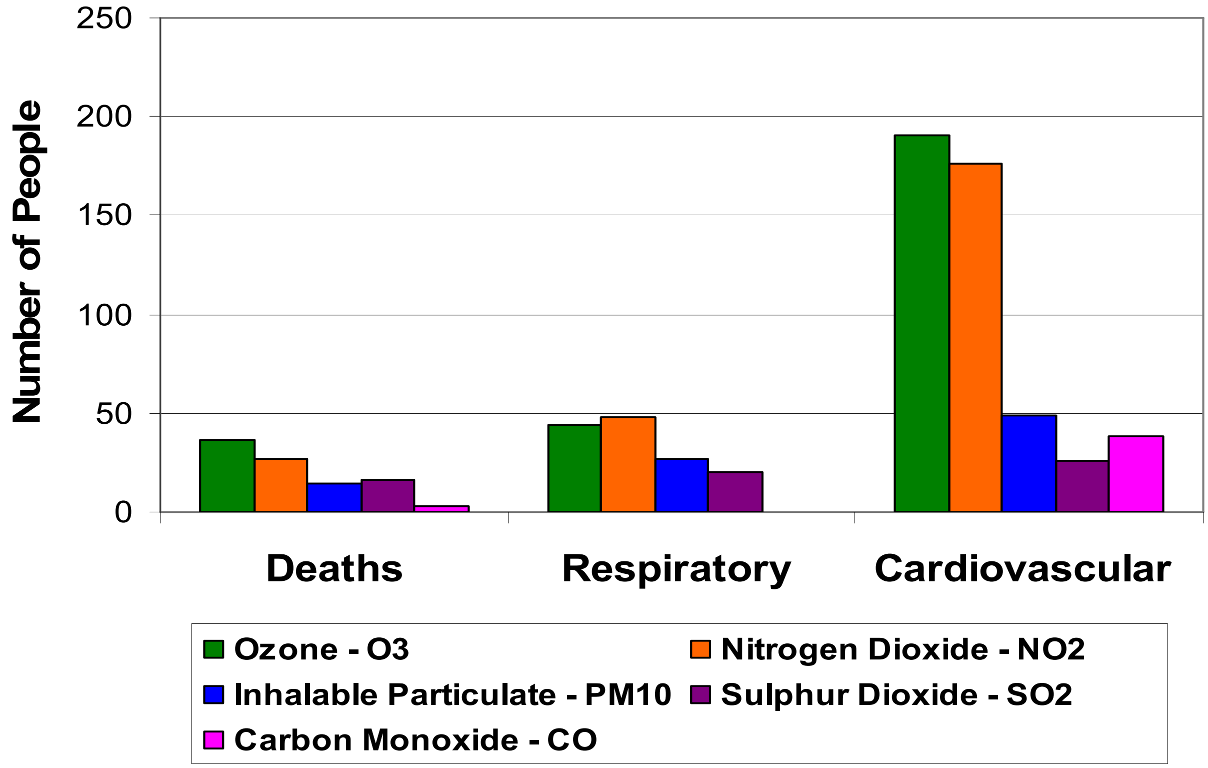


Figure 2: Air Pollution Health Impacts – Health Impacts by Pollutant in Hamilton



Backgrounder on Cardiovascular Disease:

The term "cardiovascular" refers to the heart and associated blood vessels. While any disease which affects the heart or blood vessels is termed cardiovascular (e.g., stroke) cardiovascular disease is commonly used to refer to blockages of arteries (due to build-up of *plaques*) and hardening of the arteries (called *arteriosclerosis*). When the blood vessels supplying blood to the heart are constricted or have hardened, the medical condition is called *coronary artery disease*. If blood flow is stopped for some reason, a heart attack (or *myocardial infarction*) will likely occur.

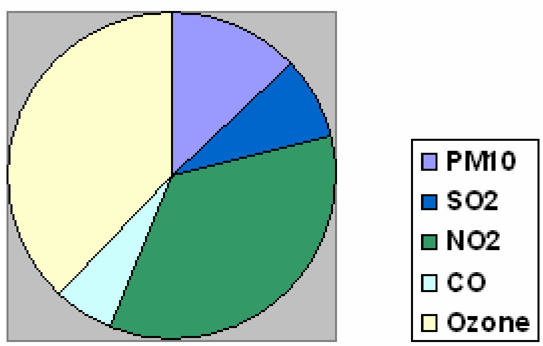
The accumulation of plaque and the hardening of arteries is chronic, and typically progresses for years or even decades without any apparent symptoms. In about 50% of cases, the first symptom of heart disease is a sudden heart attack.

While the risks of cardiovascular disease due to poor diet, lack of exercise and smoking are well established, recent research has focused on the contribution that air pollution can have on the incidence of cardiovascular disease and the triggering of heart attacks.

Recent investigations[1] examining the chronic health effects of exposure to air pollutants have demonstrated that there is an increased risk related to human health as the air quality gets poorer. Noteworthy, particulate matter less than 2.5 microns in diameter (called $PM_{2.5}$) has been shown to have a direct impact on the development of cardiovascular disease in humans. After controlling for the traditional risk factors (i.e., smoking, age, diabetes, diet/cholesterol, exercise/body mass index, etc.), it was determined that for each 10 $\mu g/m^3$ (micrograms per cubic meter) increase in $PM_{2.5}$, the risk of a cardiovascular disease increased by 24%. The risk of death from a cardiovascular event (e.g., heart attack, stroke) increased by 76%.

Other recent reports[2] have focussed on the health effects of "ultra-fine" particles in the air. These particles are extremely small (typically between 0.02 and 0.1 micron) and constitute a portion of the particulate fraction called $PM_{2.5}$ discussed above. Amazingly, these ultra-fine particles can be taken up directly by many cell types, including lung cells. While the mechanisms of the health impacts that result from the uptake of these ultra-fine particles remain unknown, there is no dispute that exposure to ultra-fine particles leads to altered cell function in a number of key areas of cellular activity.

Figure 3: Contribution of Air Pollutants to Air- Derived Health Impacts in Hamilton (%



[1] Sources:
Annette Peters, Ph.D. et al., Exposures to Traffic and the Onset of Myocardial Infraction, New England Journal of Medicine, 2004
Kristen A. Miller, M.S. et al., Long-Term Exposure to Air Pollution and Incidence of Cardiovascular Events in Women, New England Journal of Medicine, 2007
Ontario Medical Association, The Illness Costs of Air Pollution, 2005
Murray Finkelstein, et al., Traffic Air Pollution and Mortality Rate Advancement Periods, American Journal of Epidemiology, 2004

[2] Sources:
Lawrence D. Frank, et al., Many Pathways from Land Use to Health, Journal of the American Planning Association, 2006
Alan Abelsohn, et al., Identifying and managing adverse environmental health effects: 2. Outdoor air pollution, Canadian Medical Association Journal, 2002
Public Health Agency of Canada, http://www.phac-aspc.gc.ca/ccdpc-cpcmc/cvd-mcv/index_e.html

Another finding that has come from the large-scale epidemiology studies of air quality in large urban areas is that differences in morbidity and mortality due to pollution effects were observed within the same city, and not just between different cities. The significance of this finding is that differences cannot be dismissed as an indication of different levels of industrial activity between cities; the urban design and the transportation-based emissions within cities that arise from transportation sources play a significant role in the levels of pollutants to which we are exposed. Specifically, both greater street connectivity and the increased ‘walkability’ of neighbourhoods decrease driving, thereby decreasing the amount of air pollution associated with automobile emissions.

The increased risk of cardiovascular disease due to air pollution may seem insignificant when compared to the established cardiovascular risk factors (e.g., diet, lack of exercise and smoking). However, because everyone is affected to some degree by poor air quality, even conservative risk estimates translate into substantial increases in total mortality risk of disease within the population. In 2005 the Ontario Medical Association (OMA) issued an update to its 2000 report on the health impacts of poor air quality in Ontario. The 2005 OMA report estimated the Illness Cost of Air Pollution (ICAP) for Ontario in 2005 to be $16 B (or about $1250 per year for every person in Ontario).This estimate had been increased substantially from the OMA’s 2000 report, based on new evidence of the chronic effects of exposures to air pollution . This estimate includes not only the costs of hospital admissions and death but also the estimated costs of visits to doctors, lost work days, lost productivity, lack of wellness, etc.

Since the 2003 *Clean Air Hamilton* air pollution and health assessment report, several other air pollutant and health impact reports have been released. The *Clean Air Hamilton* 2003 assessment should be considered to be on the lower range of mortality estimates while the OMA’s report estimates are on the higher end of the range; both are comparable overall.

While the OMA did not provide a breakdown of the illness cost for the Hamilton region, the local figure for the cost of air pollution impacts would be around $750 M, based on the proportion of the local population (~600,000) compared to the total population of the Province of Ontario (~12,500,000). The estimated health impacts on the health of Hamiltonians as a result of smog can be found in **Table 1**. These estimates are in line with the predictions made in the 2003 Air Quality Health Effects Report conducted for *Clean Air Hamilton*.

Table 1: 2005 Illness Cost of Air Pollution –

Regional Data for Hamilton-Wentworth Regional Municipality

(Source: Ontario Medical Association, 2005)

	Number of Individuals in 2005	Number of Individuals in 2026 (Projected)
Premature Deaths	290	500
Hospital Admissions	810	1,200
Emergency Visits	2,840	4,250

The 2005 OMA report predicted 5,800 premature deaths in Ontario each year due to poor air quality. The data in **Table 1** are derived from these estimates. Three years later in May 2008, the OMA revised its 2005 estimates from 5,800 to 9,600 premature deaths per year. This 66% increase in the health impacts reflects the latest risk estimates that were published after the release of the 2005 OMA report. In the past when premature death estimates were increased, all other health indicatiors increased by a similar percentage. It is a reasonable assumption to conclude that all health impacts of poor air quality also increased by about 66%.

Clean Air Hamilton has long advocated for the development of a health-based Air Quality Index; a well-conceived health index would provide the public with useful information about current air quality conditions and provide the public with strategies they can use to reduce their exposures.

The Government of Canada has developed an Air Quality Health Index (AQHI) and is in the process of piloting the use of this index in selected cities across Canada prior to a nation-wide adoption of the AQHI in a few years. The Government of Canada's new AQHI is calculated in a different manner compared to the current Air Quality Index (AQI) that is reported by the Ontario Ministry of the Environment. The four key air pollution contributors to health effects impacts are nitrogen oxides (NO_X), ozone (O_3), respirable particulate material ($PM_{2.5}$), and sulphur dioxide (SO_2). In the case of the MOE's AQI, only the highest three readings of these four contributors are used to calculate the AQI. It has been recognized for several years that the impacts of air pollutants are additive; thus, it makes sense to use all four of the major contributors in determining health effects impacts. This latter approach was used in *Clean Air Hamilton*'s health studies. This approach is also embodied into the Government of Canada's new AQHI.

The AQHI has been introduced in the City of Toronto and the Halton, Peel, York and Durham Regions. *Clean Air Hamilton* is keen to bring the AQHI reporting system to Hamilton and is working with the Government of Canada to investigate whether Hamilton can become a test city for this new air quality health index.

For more information on The Government of Canada's AQHI visit www.airhealth.ca

3.2 Air Monitoring - Hamilton

Air monitors collect outdoor air quality data and these data are compared to levels of air pollutants that constitute to provincial and federal air standards. Another use of this data is to identify sources of air pollutants, and evaluate the potential impacts of air emissions on human health.

Traditional air monitors are fixed monitoring units that can monitor air quality at fixed locations in certain geographical areas of a city. In Hamilton, two local fixed air monitoring networks exist the provincial Air Quality Index (AQI) monitors (West Hamilton, Mountain and Downtown) operated and maintained by the Ontario Ministry of the Environment (MOE) and the Hamilton Air Monitoring Network an industry-funded network with monitors in the industrial core of Hamilton. The AQI network also includes equipment from Environment Canada as part of its National Air Pollution Surveillance Station (NAPS) network at two of the AQI stations.

Mobile monitoring has also been undertaken in Hamilton since 2004 as a pilot project for the City and *Clean Air Hamilton*. The mobile monitoring van can roam city-wide to determine local air quality conditions.

Additional air monitoring is conducted by the local Ministry of Environment office and includes routine particulate monitoring and short term survey work. In 2008, special surveys were conducted near specific industries on the south Mountain, Flamborough and west Hamilton. A special survey which included intensified particulate monitoring was also conducted, aimed at identifying black fallout sources in the north end using microscopy methods developed by the Ontario Ministry of the Environment. Background sampling was also conducted in advance of the Randle Reef remediation project slated to start in 2010. The MOE TAGA (Trace mobile Atmospheric Gas Analyzer) van also conducted short surveys in the Hamilton industrial zone in 2006 and 2008 and near the Glanbrook landfill in 2008.

Hamilton Air Monitoring Network

The Hamilton Air Monitoring Network (HAMN) is an industry funded, local air monitoring network comprising 22 local companies who have committed to assessing air quality in Hamilton on a regular basis and tracking changes in air quality. On-going operating costs and expenses related to the upgrading of air monitoring equipment and instruments are borne by industries within the network. The network provides air quality reports to the MOE on a regular basis and all reports are audited by the MOE to ensure a consistent and high quality level of data. The Ministry also conduct regular audits of the equipment at the HAMN sampling sites.

Clean Air Hamilton, HAMN, the City and the Ontario Ministry of the Environment are working together to develop a real-time air monitoring website that will allow the public to view the air quality data as it is collected by the monitors in both HAMN network. The website is predicted to be operational by June 2009. The air quality data from the Ontario Ministry of the Environment's three Air Quality Index (AQI) stations will also be made available on-line.

Mobile Monitoring

Between late 2004 and 2008, mobile monitoring surveys were undertaken for *Clean Air Hamilton* to obtain a comprehensive picture of the air quality across the City of Hamilton, in particular air and health impacts due to traffic emissions and atmospheric inversions conditions. (**see Section 5.1**) Recent mobile monitoring studies from around the world have shown that the short-term, peak exposures that are experienced near air emission sources can have serious detrimental health impacts in some individuals.

Mobile monitoring differs from fixed air monitoring stations, in that mobile monitoring can be used to focus on locations with specific air quality issues, roam city-wide or determine local air quality conditions such as near traffic intersections. Mobile monitoring samples at "street level" which reflects exposures of individuals to air pollutants at ground level. The mobile sampling can be used to focus on locations with specific issues or to determine representative local air quality conditions (e.g., at traffic intersections) which are common issues in numerous areas across this and other cities.

The mobile monitoring vehicle is outfitted with a Global Positioning Satellite (GPS) detector and modified to support a data acquisition system and a data storage system. Data can be collected using various real-time monitors on board the vehicle to measure NOx (nitrogen oxides), SO2 (sulphur dioxide), PM (airborne particulate matter) and CO (carbon monoxide) simultaneously. **Figure 4** shows the mobile unit that was outfitted with the real-time air monitors and a meteorological station. In Phase 2 of the study, some of the monitoring systems were upgraded and outfitted with a better data collection system that is capable of simultaneously storing air pollutant data and global positioning satellite (GPS) data; the GPS data is used in collaboration with an enhanced geographic information system (GIS) program to allow for the mapping of air pollutant data locations.

Figure 4: Mobile Air Monitoring Unit and the Real-time Display on a Laptop Computer

The first of a series of peer-reviewed papers in the scientific literature reporting on the mobile monitoring data was published in March 2009.

3.3 Hamilton Air Quality – Trends and Comparisons over Past Ten Years

Examination of the trends in ambient air quality in Hamilton over the last decade (see **Appendix D**) shows that there have been reductions in the air levels of some pollutants such as benzene, total reduced sulphur and benzo[a]pyrene. The ambient levels of other pollutants, such as particulate material (PM_{10} and $PM_{2.5}$), nitrogen oxides (NO_x) and sulphur dioxide (SO_2) have decreased slowly over this period. These reductions have resulted from actions taken to reduce emissions by the industrial sector in Hamilton. On the other hand, those pollutants whose levels have reduced only modestly over the last decade are due primarily to transportation sources (i.e., cars and trucks), the roadway system due to road dust resuspension and various other sources of fugitive dusts. Finally the levels of ground level ozone (O_3) have been steadily increasing over the past decade, primarily due to long-range transport of pollutants into southern Ontario

When we compare recent levels of air pollutants in Hamilton to levels of the same pollutants in other southern Ontario communities over the past 16 to 18 years (see **Appendix D**), the trends show that:

- The levels of nitrogen oxides (NO_x) in Hamilton have decreased in recent years and are now similar to or slightly higher than other cities in southern Ontario;
- The levels of ground-level ozone (O_3) in southern Ontario during the summer months have increased over the past decade; ozone levels in Hamilton are usually equal to or lower than levels in other Southern Ontario cities. Rural areas of Ontario near large lakes often experience the highest levels of ground-level ozone during smog events, particularly areas like Turkey Point, Simcoe and the Bay of Quinte;
- The levels of sulphur dioxide (SO_2) in Hamilton tend to be higher than in other southern Ontario communities due to local industrial activities; however, as noted above, SO_2 levels in Hamilton have continued to decrease in recent years.

The air quality in Hamilton is impacted by a combination of factors that do not co-occur in other communities in southern Ontario:

- The roads in and around Hamilton are heavily used by local citizens, commuters passing through Hamilton and long-distance traffic. As a consequence, the air quality is adversely impacted by the mobile emissions generated by gasoline-powered vehicles and transport trucks (diesel-powered vehicles);
- Hamilton is home to a large number of small, medium and large industries;
- Hamilton's location at the west end of Lake Ontario, the local topography (i.e., the escarpment) and prevailing weather conditions contribute to situations wherein air pollutants levels below the escarpment are often higher than levels above the escarpment. These conditions arise during inversion events which may last from 2 to 12 hours and are most common in the spring and fall.
- Hamilton is also affected by trans-boundary air pollution (primarily ground-level ozone and air particulates from sources in the mid-western United States) in a manner similar to the pollution experienced in many other communities in south-western Ontario; and
- On those rare occasions when winds come from the south, Hamilton may be impacted by emissions from the Nanticoke coal-fired generating station.

3.4 Smog Advisories and Smog Advisory Days

What is a Smog Advisory?

The Ontario Ministry of Environment (MOE) monitors the air quality in Ontario and provides a rating of the air quality called the Air Quality Index (AQI). A smog advisory is issued by the MOE when the Air Quality Index reaches or exceeds a value of 50; a smog advisory day is declared when it is predicted that it is likely that the AQI may reach or exceed 50 on an upcoming day or the AQI has already reached a value over 50 and is expected to remain above 50 for the advisory period. There are three AQI stations in Hamilton which provide the air quality index data used to calculate the AQI.

Smog advisories are issued to alert the public when widespread elevated levels of air pollution exist (i.e., when AQI values exceed a value of 50). Such conditions exist during persistent smog episodes and are commonly characterized by high levels of ozone and/or particulate matter in a regional context. Local advisories may be issued for just Hamilton, if local emissions are expected to cause AQI values of 50 or higher usually due to particulate matter.

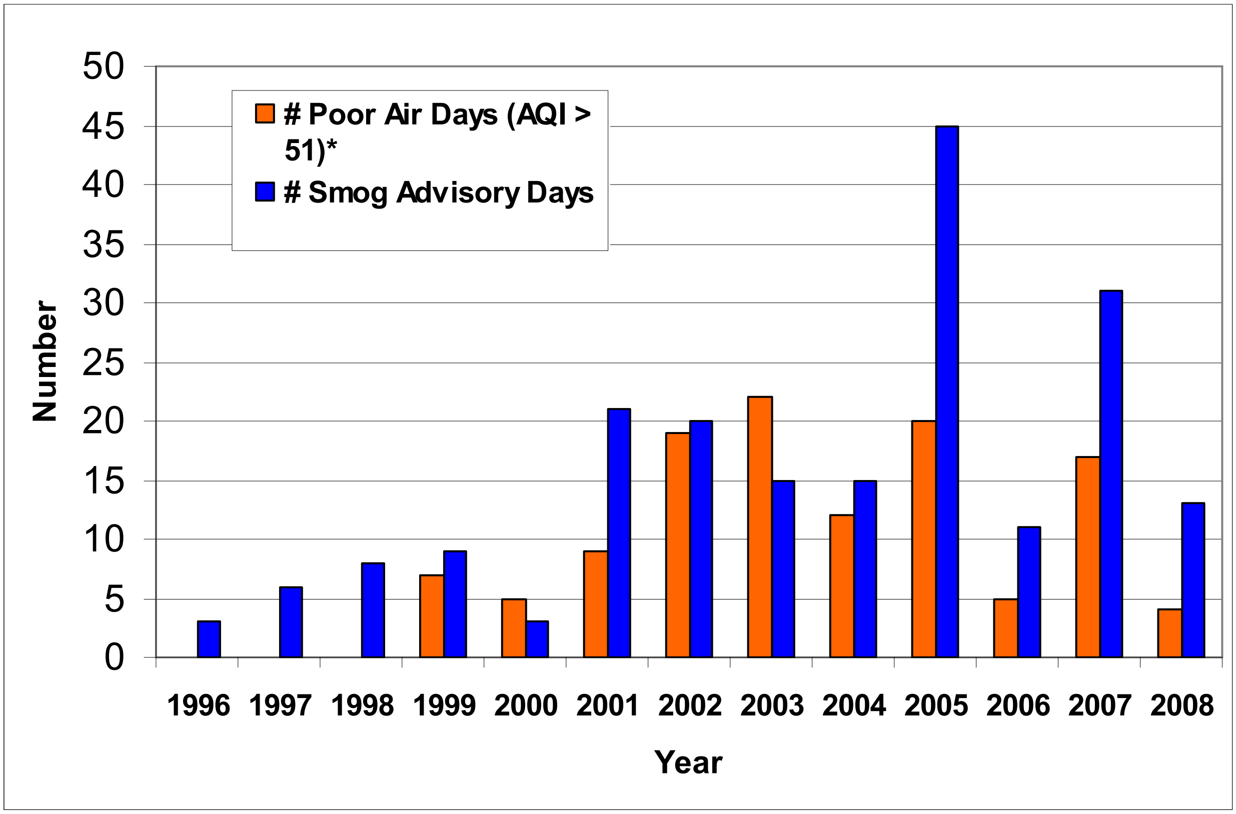
The AQI is determined based on the highest value of any one of four key air health-related contaminants – Particulate matter ($PM_{2.5}$,) nitrogen oxides (NO_x), sulphur dioxide (SO_2) or ground-level ozone (O_3). In the summer months smog days and air quality advisories are usually issued based on high ozone levels due to regional pollution whereas in the spring and fall the smog alerts are issued primarily due to high levels of particulate matter due to local pollution. An additional AQI subindex exists for total reduced sulphur (TRS) to measure sulphur odours.

Gaseous air pollutants such as nitrogen oxides and volatile organic compounds (NO_X, VOCs) can react under the influence of sunlight to afford a complex mixture of chemical products, including ground-level ozone. This mixture of pollutants is commonly called smog. The ozone that forms one of the constituents of smog is called ground-level ozone to distinguish it from the ozone in the stratosphere (i.e., the ozone which is found ~20-40 km above the earth's surface); stratospheric ozone is important in absorbing harmful ultraviolet radiation from the sun and thus reducing the levels of ultraviolet light that reach the earth's surface. Ozone is a severe lung irritant and when inhaled along with respirable particulate matter and other pollutants such as nitrogen oxides, the impacts on the lungs of susceptible individuals, such as the elderly and the young, can be dramatic.

In 2008, 13 smog advisory days were declared by the Ontario Ministry of Environment for the City of Hamilton **(see Figure 5)**. In September 2008, Hamilton had a significant poor air quality day when the AQI reached a value of 85 for one hour. This air quality event was the result of a temperature inversion which trapped the air in the lower City areas and did not allow pollutants to disperse. The result was that levels of particulate matter increased rapidly. Fortunately the inversion event only laster about 2-3 hours. The other 3 poor air quality days occurred in April and November 2008. Ozone did not reach the Poor range of the AQ index (50-100) at the downtown station but did so at the Mountain station on three of the aforementioned dates.

Figure 5 below shows the numbers of smog advisory days and poor air quality days over the past nine years. Poor air quality days are defined as days where the AQI was greater than 49 for at least 1 hour during the day.

Figure 5: Number of Poor Air Quality Days and Smog Advisory Days in Hamilton between 1999 and 2008



* Data from Downtown Hamilton Air Monitoring Station

Ontario's Smog Alert Program was enhanced on August 23, 2002 when $PM_{2.5}$ was incorporated into the provincial Air Quality Index. Prior to this date smog advisories were issued only for exceedances in ground-level ozone levels.

Figure 6: AQI Ranges (Ministry of the Environment)

Air Quality Index (AQI) Categories	
AQI Ranges and Categories	**Colour**
0-15 Very Good	Blue
16-31 Good	Green
32-49 Moderate	Yellow
50-99 Poor	Orange
100+ Very Poor	Red

What do the MOE's Air Quality Index readings mean in terms of health impacts?

- If the air quality value is below 16, the air quality is considered very good.
- If the air quality value is below 32, the air quality is considered good.
- If the AQI value is in the range of 32 to 49 (moderate category), there may be some adverse effects in sensitive individuals.
- An index value in the 50 to 99 range (poor category) may result in some short-term adverse effects on humans, particularly sensitive individuals, and on animals; these conditions may also cause some damage to vegetation and property.
- An AQI value of 100 or more (very poor category) may cause adverse effects on a large fraction of the exposed human and animal populations. There will also be increased damage to plants, crops and property.

For further information, consult the Ontario Ministry of Environment's Air Quality site at: www.airqualityontario.com.

Smog Advisories

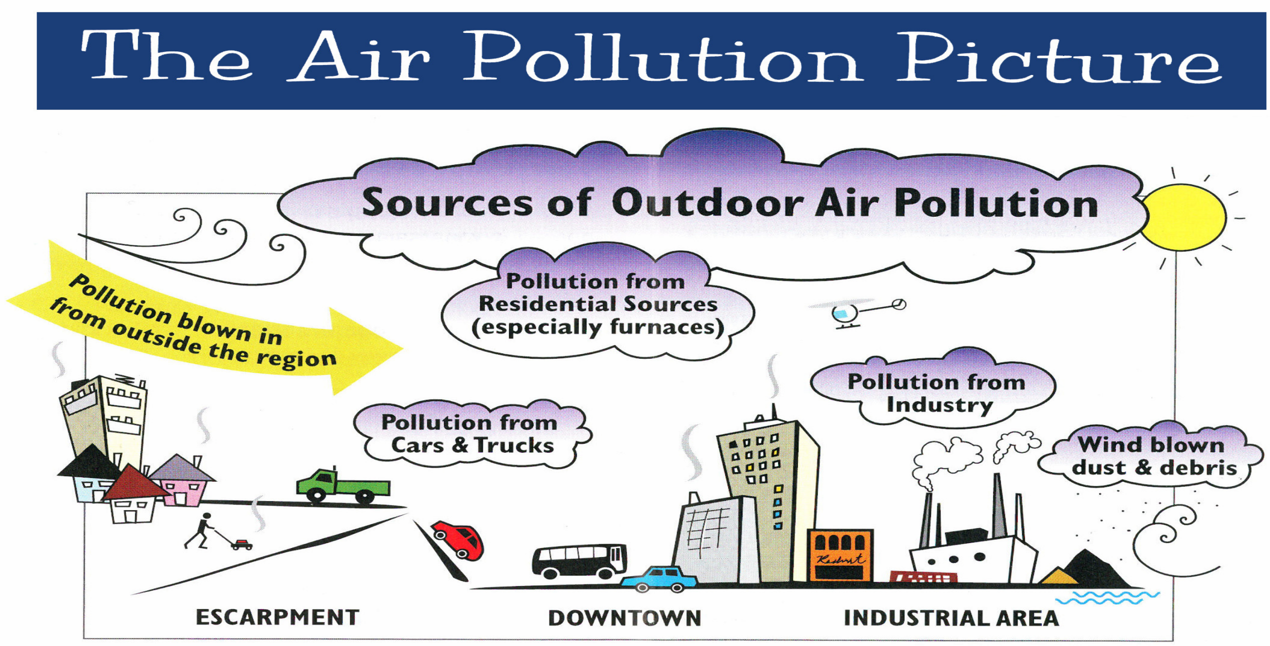
When a smog advisory is declared, the Ministry of the Environment notifies the City and the City reduces its corporate emissions according to the Corporate Smog Response Plan. Actions undertaken by the City include encouraging staff to take transit, to car pool, and to walk or cycle to work. The City also notifies all contractors of the smog advisory and encourages them to adjust their work schedules accordingly, to reduce the use of cleaners, solvents and oil based paints, to reduce the use of gas-powered equipment and vehicles, and employees may work from home where permitted.

There are also examples of local industries taking action to reduce their emissions on smog days and throughout the year as members of the Hamilton Industry Environmental Association (HEIA). Many industries have smog action plans that notify their employees when a smog advisory has been called and to cut back production where required. In addition, some industries promote anti-idling of fleet and employee vehicles, encourage employees to bike or take transit to work where possible, reduce air-borne dust through increased sweeping and washing on site, and have energy conservation plans in place to improve air quality.

Appendix E outlines some of the actions that individuals and employers can undertake to reduce emissions year round, particularly during smog advisories, to improve local air quality in Hamilton.

3.5 Emission Sources within Hamilton

The task of compiling an accurate and up-to-date inventory of emission sources within an urban area is a significant challenge for a number of reasons. First, not all sources are required to report their emissions and are thus unaccounted for in the National Pollutant release Inventory (NPRI). Second, not all sources of emissions are reported accurately, often because those who report the data do not have the information needed or the skill set to complete an accurate report.

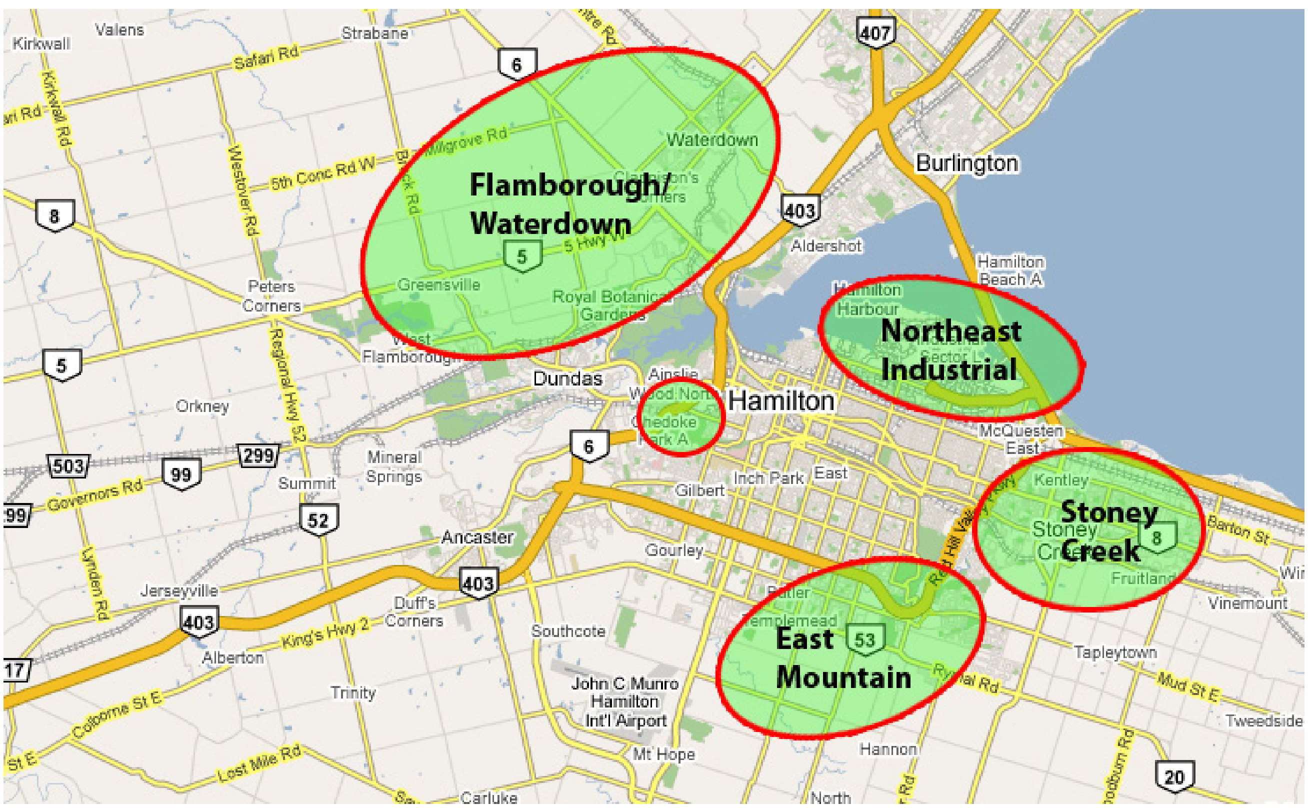


Based on available emissions inventory data from the Ontario Ministry of the Environment and Environment Canada it is possible to conclude that:

- The transportation sector (i.e., mobile sources such as cars and trucks) is the leading source of NO_x emissions within the City of Hamilton, followed closely by the industrial sector;
- The industrial sector is the source of over one-half of the directly-emitted $PM_{2.5}$;
- Road dust, construction activities and area sources such as fireplaces and home heating are a source of $PM_{2.5}$; as noted above industry sources account for the other half;
- The industrial sector is the leading source of SO_2 in Hamilton(~90%); and
- The industrial sector is the leading source (~60%) of volatile organic compounds (VOCs); the remaining VOCs are releases due to general solvent use by companies and individuals, followed by engine emissions from the transportation sector.

In 2005, a mobile monitoring study (**see Section 5.1**) conducted for *Clean Air Hamilton* and the City identified and ranked sources of air pollutants in Hamilton. Historical fixed-site air monitoring data and NPRI data for Hamilton (2004) were used to develop a target list of sources of health-impacting air pollutants and locations for the mobile study. Five separate industrial areas were identified in the city (**Figure 7**) - Flamborough/Waterdown (aggregates), East Mountain (aggregates), West Hamilton/Frid (mixed industrial and university), Northeast Industrial Area (heavy and mixed industrial) and Stoney Creek (mixed industrial and aggregates).

Figure 7: Emission Sources by Region in the Hamilton Area

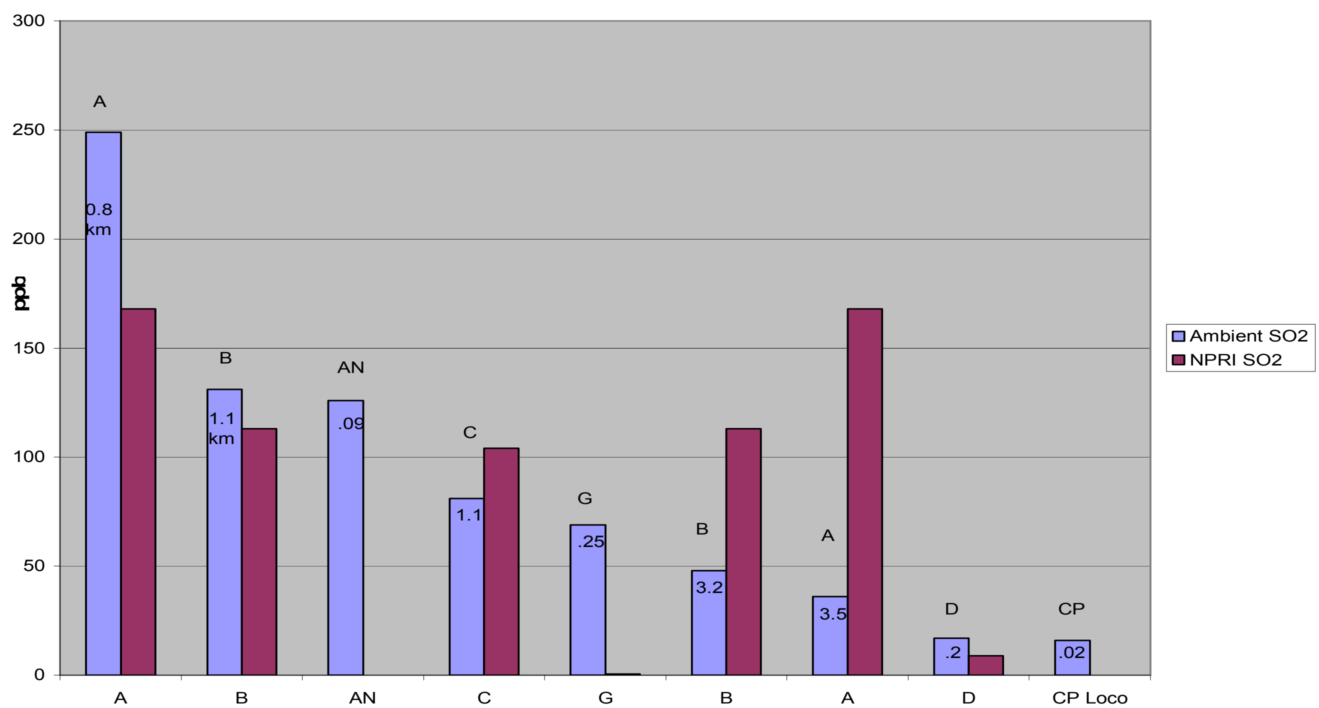


Mobile scans for the pollutants were performed in traverses across the city, at selected industrial areas, and at traffic intersections. Industrial point sources monitored included large integrated steel industries, steel by-products processors, recycling/scrap operations, foundries, chemical plants, storage piles, agricultural materials processing, brick manufacturing, university operations, vegetable oil processing, carbon black manufacturing, rail shunting/truck transfer and a cogeneration natural gas plant.

Although it might be expected that industrial sources would be responsible for the highest concentrations of pollutants, the 2005 mobile study found that overall, the highest concentrations were observed near major road intersections and along heavily used roads affected by dirt track-out in the industrial sectors of the city. These high levels are attributed to the impacts of city traffic emissions and the industrial transportation sector, respectively. Industrial point sources still made significant contributions, particularly for SO_2.

Figure 8 shows a comparison of the ambient SO_2 levels (blue bars) measured using the mobile monitoring vehicle when the vehicle is situated downwind of a number of companies in Hamilton. The maroon bars indicate the relative releases of SO_2 as reported by these companies to the National Pollution Release Inventory (NPRI). Since measurements were made at locations at varying distances from the sources, these distances (in kms) are also included on **Figure 8**.

Figure 8: Comparison of Ambient SO2 Levels Measured near some Industries with Reported NPRI Data for SO2 Releases.



A-Integrated Steel, B-Integrated Steel, AN-Steel Byproducts, C-Carbon Black, G-Steel, D-Lime and CP-Rail Yard

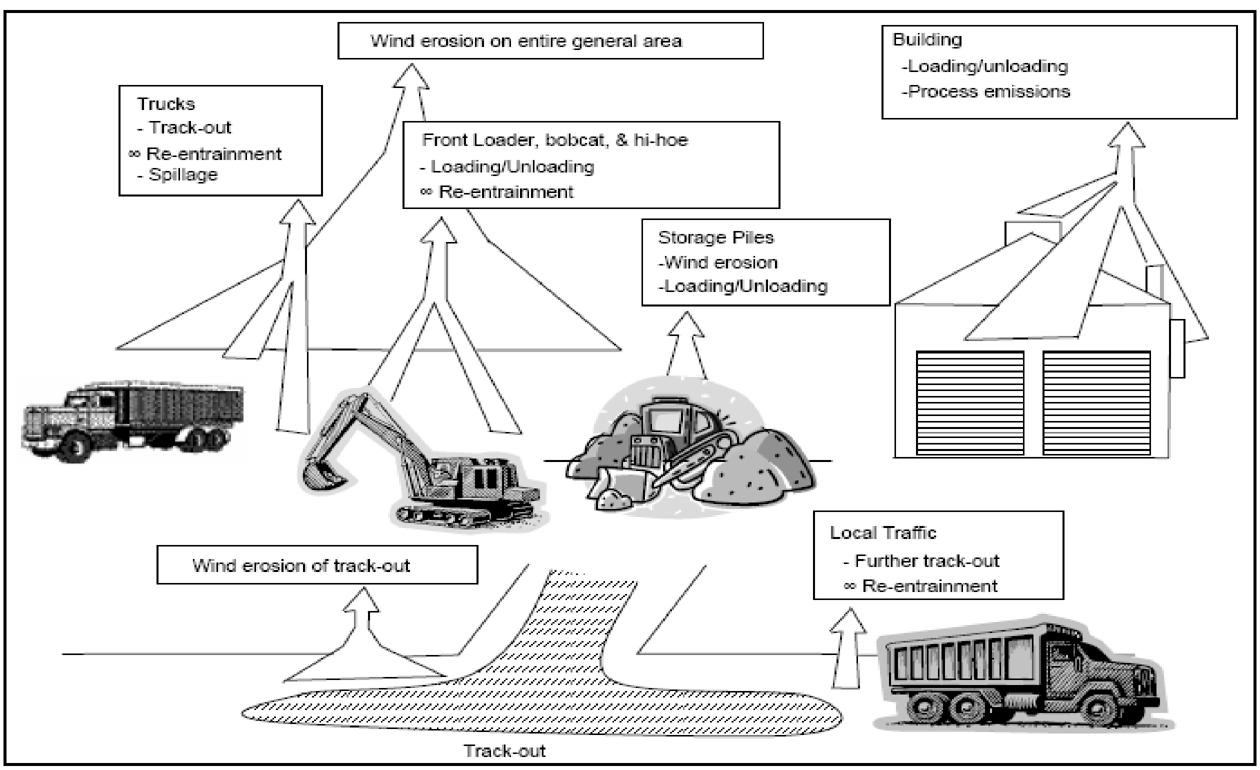
The NPRI emissions from integrated steel companies and a carbon black manufacturer are, in some cases, orders of magnitude higher than smaller companies. However, these companies have long distances to points of impact and sufficient dilution occurs so that monitored ambient levels are comparable to and often lower than those downwind of companies with smaller reported NPRI emissions. Of course during pollutant accumulation conditions such as atmospheric inversions, it will be total emissions that most influence ambient levels.

3.6 Fugitive Dusts

Clean Air Hamilton has identified fugitive dusts as a significant source of airborne particulate matter in Hamilton. Fugitive dusts are dusts that arise from non-point sources and include road dusts, agricultural dusts, and dusts that arise from materials handling, construction operations, handling of outdoor storage piles, etc. (see **Figure 9**). The compositions of fugitive dusts and road dusts vary depending upon the materials used or stored, adjacent land uses, local emission sources and traffic loads.

Only recently has it been realized that re-suspended road dusts are a very significant source of inhalable particulate (PM_{10}) and respirable particulate ($PM_{2.5}$) that can impact human health. Historically, road dusts and fugitive dusts from industrial operations have been regarded simply as "nuisance" dusts and have been considered mainly as an aesthetic problem rather than an "air contaminant," "emission" or a concern for human health.

Figure 9: Common Sources of Fugitive Dusts



Courtesy of the Ministry of the Environment, 2006

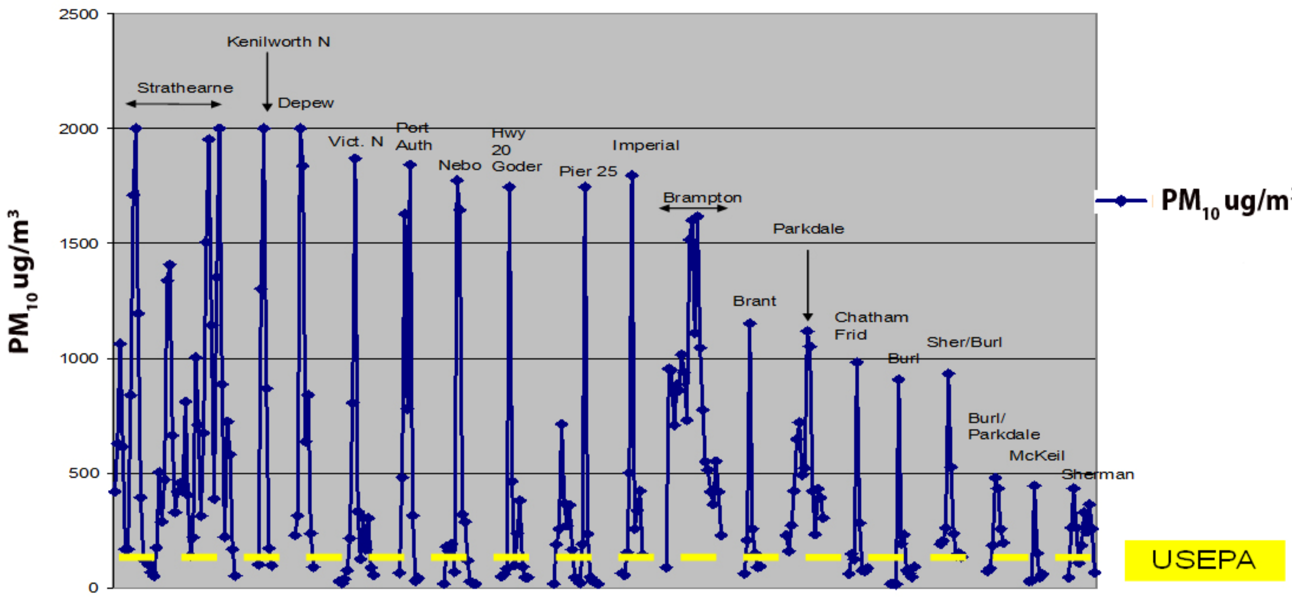
Mobile monitoring studies conducted for *Clean Air Hamilton* and the City have shown that the worst dust clouds on industrial roads coincided directly with extraordinarily high levels of particulate material on the roads. Along some roads in the industrial area of Hamilton re-suspended road dust resulted in very high concentrations of inhalable particulate material (PM_{10}, up to 2000 µg/m^3), respirable particulate ($PM_{2.5}$, up to 300 µg/m^3) and very small particles (PM_1, up to 125 µg/m^3).

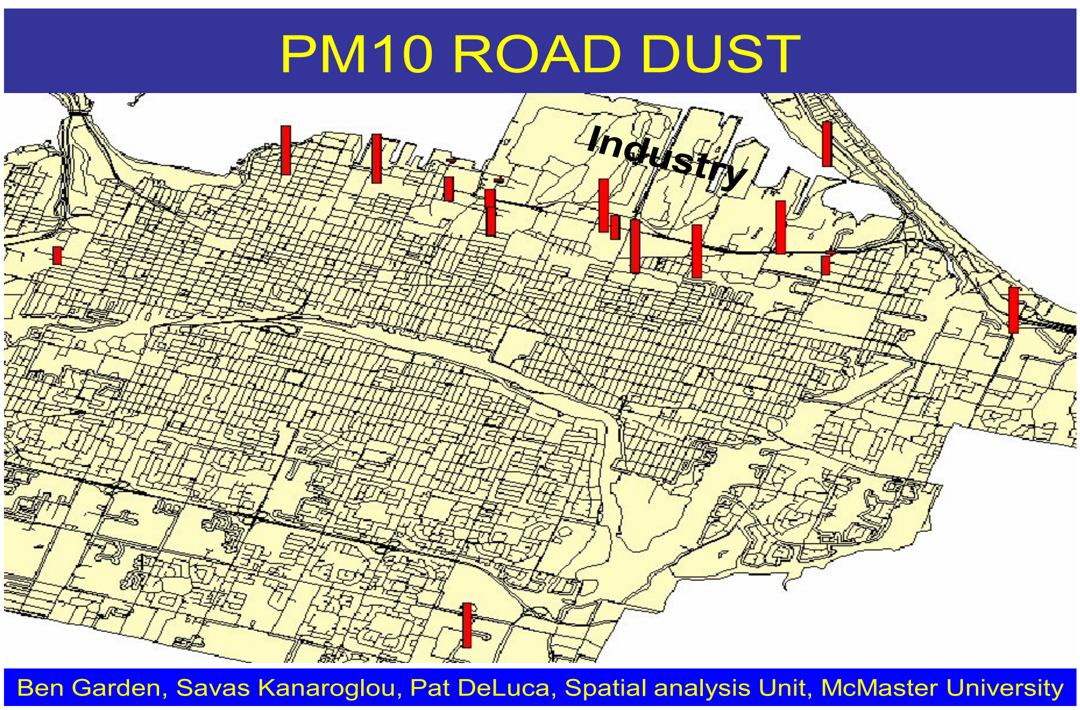
Road dusts have traditionally been regarded simply as nuisances and of little impact except for the need to wash vehicles regularly to keep them clean. Data from the mobile monitoring survey clearly show that road dusts have the potential for serious health effects impacts at the levels measured in Hamilton's industrial areas. Roads function as "line sources" of particulate materials; the greatest impacts of these dusts are on people working on the properties proximate to these roads or on local residents who may be impacted by these dusts.

Fugitive dust control is an important responsibility at all industrial sites, particularly industries that handle or store large amounts of particulate-containing or particulate-generating materials, such as bulk storage facilities and the aggregate handling facilities. On-site management of soils and dusts has a direct influence on the amount of dusts generated and dispersed into the air due to normal plant operations; unpaved roads and unpaved areas on-site can result in the tracking of significant amounts of dirt and industrial materials off-site and onto City roadways.
Industries need to implement dust control best practices on their sites to prevent dusts and soils from becoming airborne and to implement best practices to prevent or reduce the amounts of materials being tracked-out from their site. These practices include paving roads on-site, particularly the stretch of road that leads directly off-site, routine maintenance of on-site roads using street sweepers, installation of wheel wash stations at the exit to the property to remove dirt before trucks drive on City roads, etc.

Figure 10 shows a composite of real-time PM_{10} data obtained in 2005 and 2006 near 18 different locations in the City where visible clouds of road dust were observed during the mobile monitoring study. The peak concentration data from these 18 different locations across the City were combined into a single graph for comparison purposes. Fourteen of these eighteen locations were associated with track-out of dirt from specific industrial facilities. These track-out locations were identified as being in need of clean-up and additional street sweeping to reduce airborne particulate loadings due to road dust re-suspension.

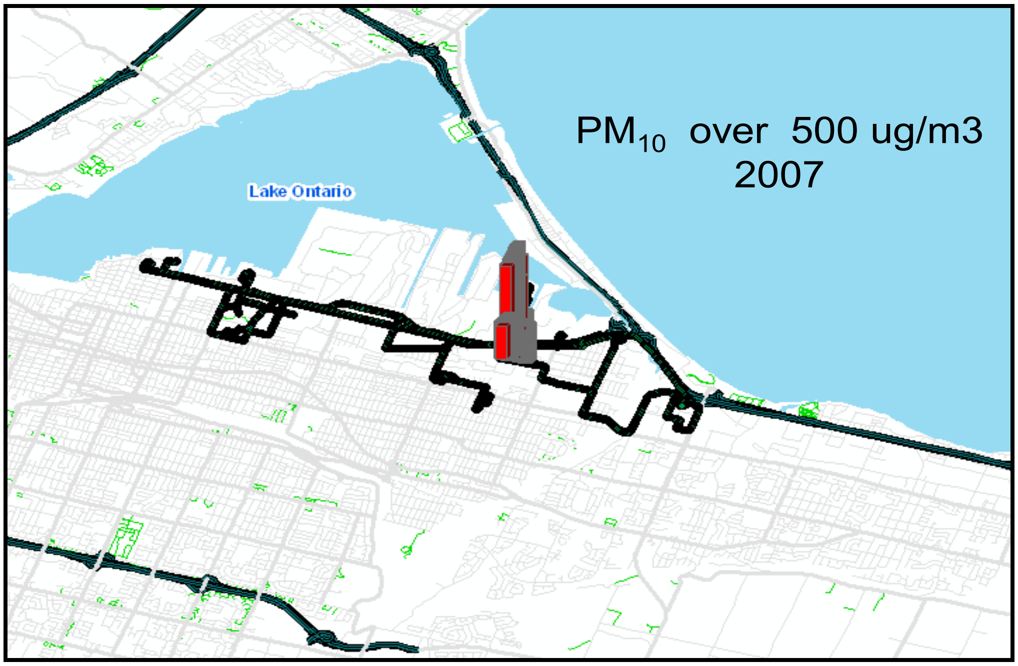
Figure 10: PM10 Road Dust Track-out: 18 Locations, 14 Sources Monitored in 2005/2006





Based on data collected in 2005 when we found 14 locations had PM_{10} values above 500 $\mu g/m^3$ (**Figure 11**), we expected the 2007 data to show a similar number of locations with PM_{10} levels greater than 500 $ug/m.^3$. To our surprise there were only 2 locations with levels above 500 $ug/m.^3$ These sampling data indicate that significant improvements in local air quality conditions have resulted from education and compliance initiatives.

Figure 11: Two Locations Where PM10 Values Exceeded 500 ug/m3 in 2007 Survey

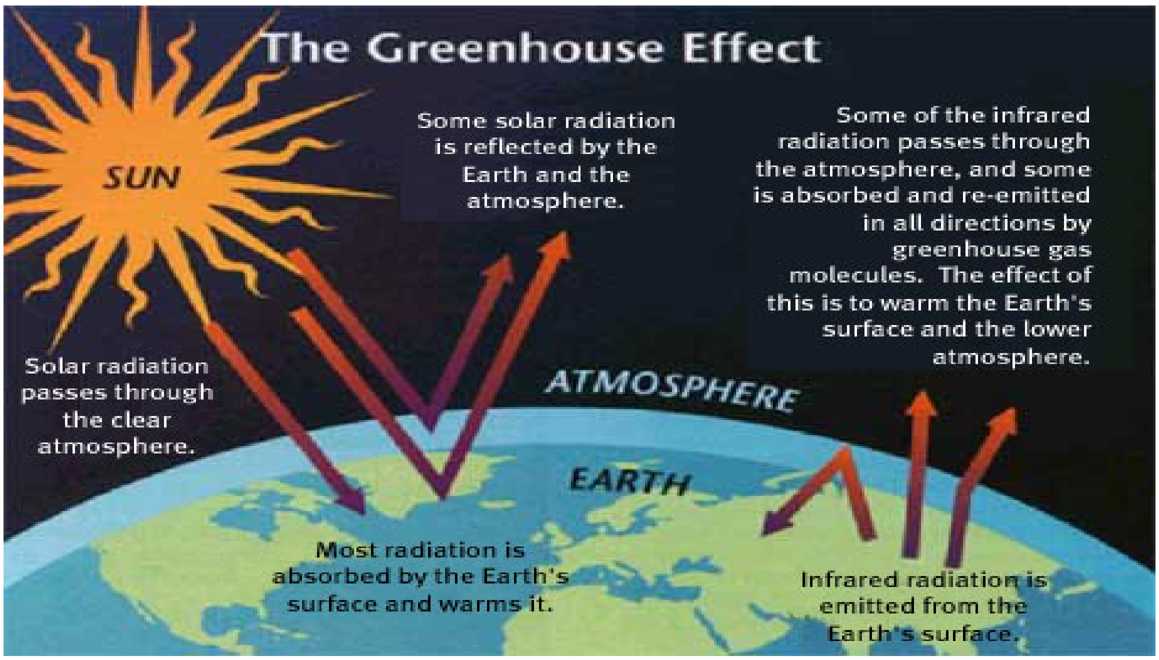


The reduction of fugitive dust since 2005 is mostly likely the result of increased awareness of the problem due to a Fugitive Dust workshop held in conjunction with the City of Hamilton, the Ministry of the Environment and the Hamilton Port Authority. Following the workshop, the Ministry sent information requests to a number of companies in Hamilton asking about dust mitigation practices employed at their facilities and the local office of the Ministry generated a priority inspection list to follow up with workshop attendees or other significant fugitive dust sources. The City has increased street sweeping service in the Strathearne Avenue area and in the Burlington Street Industrial Area, provided more effective street sweeping using new regenerative-air street sweepers and increased frequency of boulevard, median and street flushing. The industrial community along Strathearne Avenue have formed the Strathearne Dust Commitee to look at best industrial practices to address fugitive dust from local operations. The Hamilton Port Authority is a member of the Strathearne Dust Committee. The Hamilton Port Authority ensures that street sweeping takes place twice per month, weather permitting, on Hamilton Port Authority owned roads including the northern section of Strathearne Avenue North and Pier 24 Gateway.

Clean Air Hamilton continues to work with various stakeholders to reduce road dusts and road dusts impacts on the community. Education activities, monitoring programs and partnerships with various agencies and industries to reduce road dusts at source are the approaches *Clean Air Hamilton* has used to reduce the burden of road dust impacts on the citizens of Hamilton.

4.0 Linkages between Climate Change and Air Quality

Climate Change refers to the long-term change in average weather patterns resulting from the release of substantial amounts of greenhouse gases (GHGs), such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) into the atmosphere; these levels are over and above the natural levels of these substances. The increased levels of these infrared-absorbing substances results in an intensification of the earth's natural greenhouse effect. These chemicals absorb heat energy very efficiently and transfer this heat energy to the atmosphere, resulting in an increased warming of the atmosphere.



Climate change can be caused by natural processes, such as a change in the sun's strength, and by human activities. Dramatic changes in climate and weather patterns over the past 25 years are a direct result of human activities and the release of carbon dioxide due to the combustion of fossil fuels for transportation, manufacturing, heating, cooling and generation of electricity. This use alone is responsible for 70 – 90% of greenhouse gasses, with the rest coming from land uses such as agriculture and forestry.

In 2007 the International Panel on Climate Change (IPCC) issued a series of reports which outlined the unanimous consensus of nearly 1000 scientists from around the world. This consensus was reached after thorough evaluation of all available evidence on climate change. The IPCC has declared that there is a very high probability that increases in the emissions of GHGs due to fossil fuel combustion, large-scale deforestation via the burning of forests and the intensification of agriculture have resulted in and will continue to cause a net increase in global mean temperatures with concomitant changes to climates around the world. Changes will be most profound in the extremes of the northern and southern hemispheres.

Table 2: Greenhouse Gases, their Atmospheric Lifetimes and Global Warming Potentials.

Greenhouse Gas	Lifetime in the atmosphere	Global Warming Potential (20 years)*
Carbon Dioxide (CO_2)	5 to 200 years	1
Methane (CH_4)	12 years	62
Nitrous Oxide (N_2O)	114 years	275
Sulphur Hexafluoride (SF_6)	3,200 years	15100
Carbon Tetrafluoride (CF_4)	50,000 years	3900

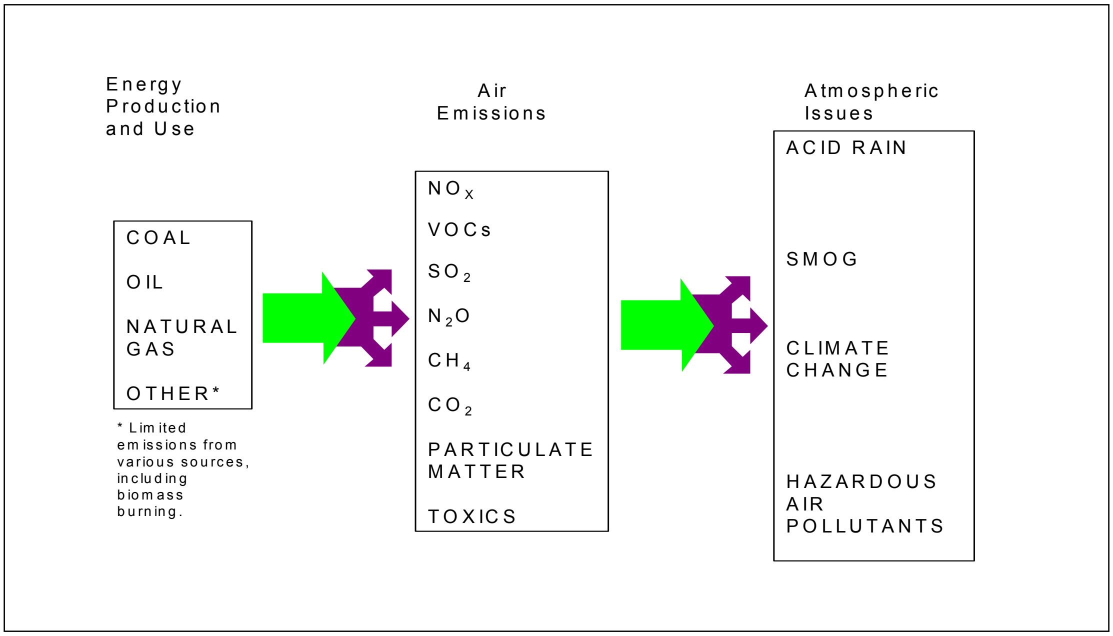
Source: Centre for Science in the Earth System and ICLEI. Preparing for Climate Change: A Guidebook for Local, Regional, and State Governments. 2007.
* Direct Global Warming Potentials (GWPs) relative to carbon dioxide (for gases for which the lifetimes have been adequately characterized). GWPs are an index for estimating relative global warming contribution due to atmospheric emission of a kg of a particular greenhouse gas compared to emission of a kg of carbon dioxide. GWPs calculated for different time horizons show the effects of atmospheric lifetimes of the different gases.

Increased awareness of climate change and its associated impacts such as extreme weather patterns are now widespread among the general public. The popular press gives little or no credence any longer to claims made by "climate change nay-sayers." Until very recently, few governments or government agencies in Canada and elsewhere recognized that there was a direct connection between the chemical substances released by combustion processes, climate change, air quality issues, and public health.

The **2008 Upwind/Downwind Air Quality Conference: Climate Change & Healthy Cities** (hosted by *Clean Air Hamilton* and the City on February 25^{th} and 26^{th}, 2008) focussed on the linkages between climate change and air quality. Climate change and poor air quality are inextricably linked because both are driven to a large part by combustion emissions of carbonaceous fuels. The focus for climate change is on carbon dioxide, the principal greenhouse gas which is formed when carbonaceous fuels are burned as sources of energy and heat.

The focus for air quality is on particulate matter, nitrogen oxides, oxides of sulphur and carbon monoxide as direct emissions from combustion processes. Ozone, also an important air quality parameter, is not released to the atmosphere directly; rather ozone is produced when the above components interact under the influence of sunlight. All of these emissions are linked to health impacts and climate change because all are combustion by-products or the results from a combustion by-product.

Figure 12: Combustion of Fossil Fuels for Electricity, Home Energy, Transportation, Industry, and Municipalities results in Air Emissions and Atmospheric Issues



Source: 2003. Chiotti. Pollution Probe

The focus for air quality is on the minor by-products of combustion, nitric oxide, sulphur dioxide, fine particulate matter, etc. which cause deleterious health effects in people. Higher temperatures due to climate change result in increasing demands for electricity (often coal-combustion generated electricity) for air conditioning; thus, on hot days the levels of air pollutants are sometimes driven higher by energy demands. If Canada could meet its Kyoto targets, fossil fuel consumption would be almost 25% lower than it is today; the average air quality would improve by about 25% due to reductions in the combustion by-products which result from our need for energy.

Table 3: Health Canada's Impacts from Climate Change and Variability (2008)

Health Issues	Examples of Health Vulnerabilities
Temperature-related morbidity and mortality	Cold and heat related illnesses, mental health, respiratory and cardiovascular stress, occupational health stress.
Health effects of extreme weather events	Social and mental health stress due to disasters, injuries, preparedness and population displacements, damaged public health infrastructure, occupational health hazards.
Air pollution related health effects	Respiratory diseases, cardiovascular diseases, cancer, allergens and asthma, changed exposure to outdoor and indoor air pollutants and allergens.
Water and food borne contamination	Enteric diseases.
Vector-borne infections and diseases	Changed patterns of diseases caused by bacteria, viruses and other pathogens carried by mosquitoes, ticks and other vectors.
Health effects of stratospheric ozone depletion	Cancer, cataracts, immune suppression.
Population vulnerabilities in cities and communities	Rural and Urban health, seniors, children, homeless and low income, traditional cultures, disabled, immigrant populations.
Health and socio-economic impacts	Loss of income and productivity, Social disruption, Diminished quality of life, Increased costs to health care.

Adapted from http://www.hc-sc.gc.ca

Poor air quality, combined with heat stress from hotter weather, poses serious health challenges to the most vulnerable in society, the very young and the elderly. Climate Change will have significant impacts on human health. Health Canada (2008) has identified eight significant health concerns related to Climate Change (**Table 3**) . They include health effects from increased smog episodes, illnesses and deaths caused by heat and cold waves, water- and food-borne contamination, diseases transmitted by insects, health effects of stratospheric ozone depletion, and extreme weather events. Planning decisions at the local level with regards to transportation and land use patterns, energy usage and conservation, and health will have dramatic, beneficial long-term impacts on local air quality.

5.0 Transportation Emissions - Linkages to Air Quality and Health

5.1. Mobile Monitoring Research

Mobile monitoring surveys were undertaken for *Clean Air Hamilton* between 2004 and 2008 to obtain a comprehensive picture of the air quality across the City of Hamilton, in particular air and health impacts due to traffic emissions and atmospheric inversions conditions. Preliminary data from these surveys were presented in previous *Clean Air Hamilton* reports and some of the findings are presented here. A more detailed account of recent research can be found in **Appendix E**.

To support on-going air quality improvement actions, mobile monitoring for NO_x (nitrogen oxides), SO_2 (sulphur dioxide), PM (airborne particulate matter) and CO (carbon monoxide) were performed in traverses across the city, near selected industrial areas, near traffic intersections, at schools during student pickup and drop-off times, near restaurant drive thrus, and along highways.

Figure 13: Mobile Sampling Areas (2007)

Main Road Sampling Track

Residential vs. Traffic-Related Emissions

Measurements made in the Mobile Monitoring Study demonstrated that the citizens of Hamilton are exposed to very high levels of pollutants due to traffic-related emissions. Pollutant concentrations were found to be very high on and close to roadways but these levels decrease very quickly with increasing distance from roadways. Levels of 300 µg/m^3 of PM_{10} and 150 ppb (parts per billion) of nitric oxide (NO) were measured routinely, while ambient levels in residential areas were found to be between 20-40 µg/m^3 of PM_{10} and 4-20 ppb of NO. Thus, peak roadway concentrations of these pollutants exceed levels observed in residential areas by 20 to 50 times.

Figure 14 shows the levels of four important air contaminants (sulphur dioxide SO_2, carbon monoxide CO; nitric oxide NO and inhalable particulate material PM_{10}) at seven road locations in Hamilton. The first five (on the left in the figure) are values obtained along major roads or at major intersections; the remaining data are the average for all roads in Hamilton (called “Road avge.”) and a typical example of data from a street in a residential area of Hamilton; residential areas are at a distance from major roads but are usually within 200-500 m of such roads.

Figure 14: Mobile Monitoring Study - Levels of Four Air Contaminants

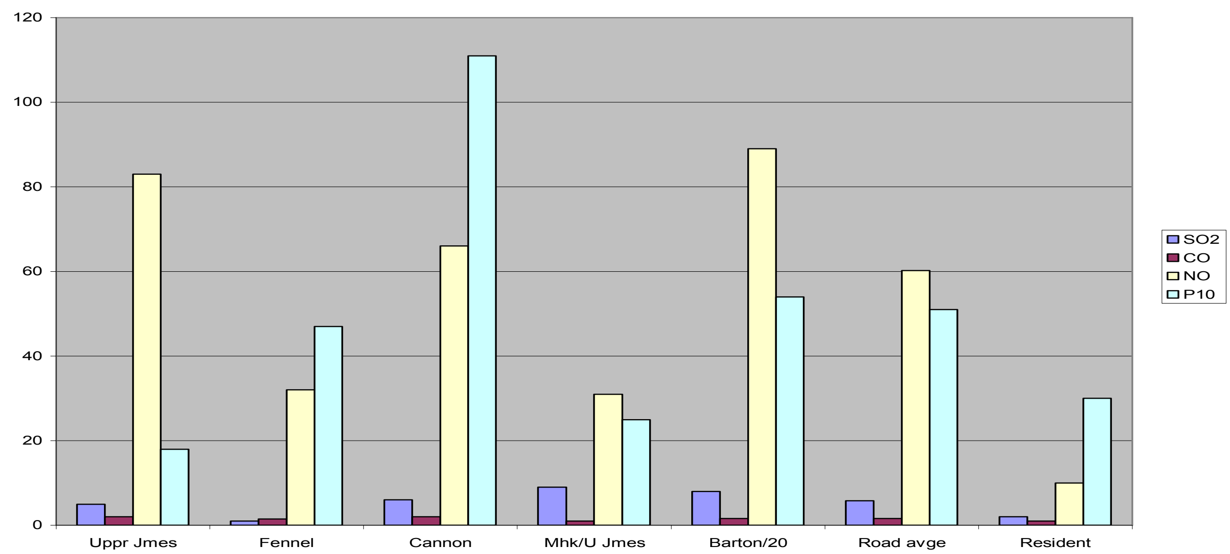
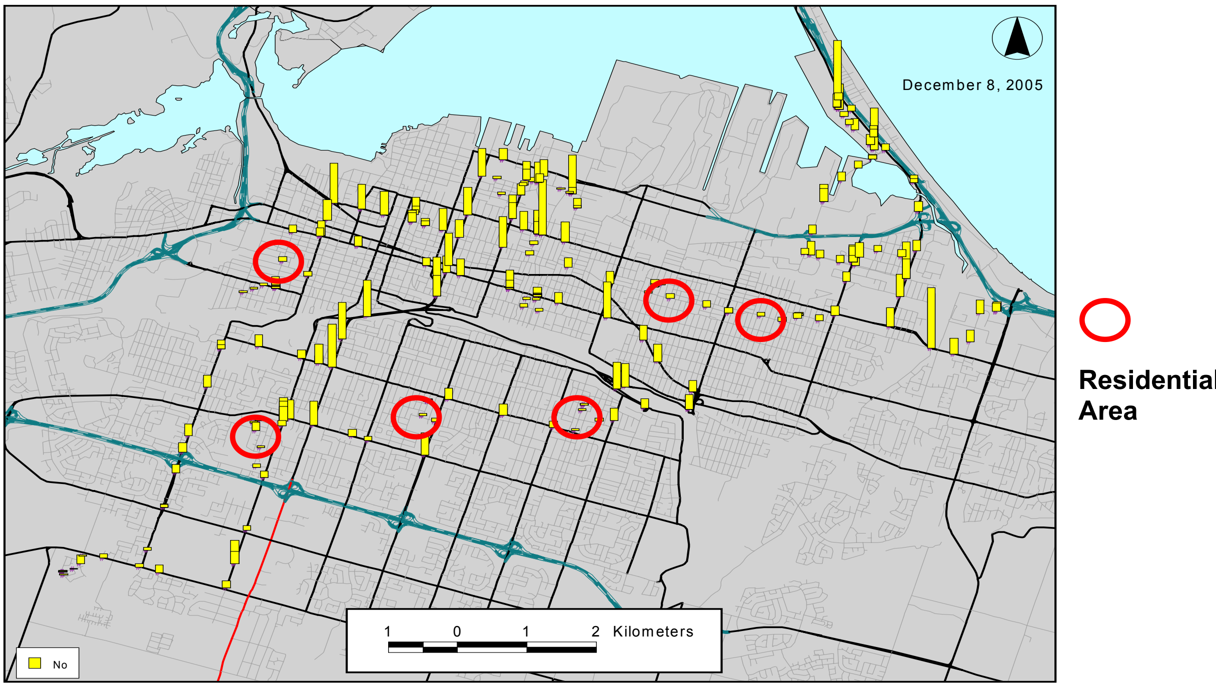


Figure 15 shows a map of Hamilton onto which has been superimposed the levels of nitric oxide (NO) in the air as measured by the air monitoring van at numerous locations in Hamilton. Nitric oxide is a combustion pollutant and is emitted directly by cars and trucks; as such, NO is an excellent measure of the impacts of vehicular pollution. The greater the height of a yellow bar in **Figure 15**, the higher the level of NO measured. Readings taken along 4-lane roads and at major intersections, together with a number of readings made in residential areas of the city are shown in **Figure 16**.

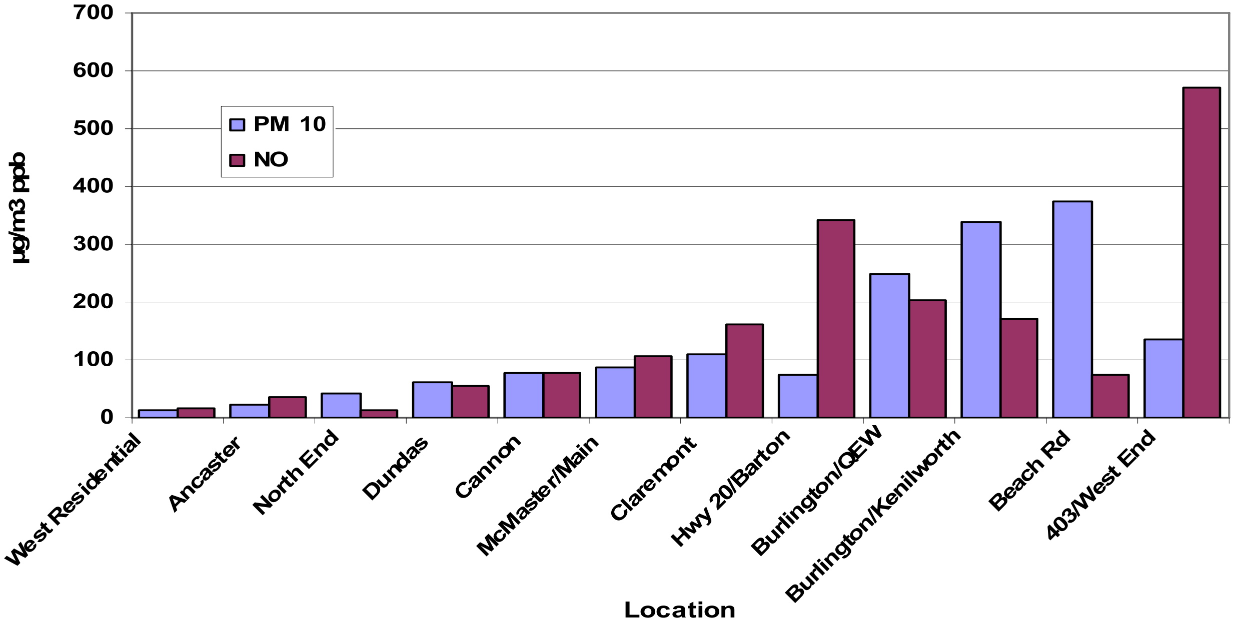
Figure 15: Residential vs. Traffic-related Levels of Nitric Oxide (NO)



The areas circled in red in **Figure 15** are residential areas within the city; within these red circles the levels of NO are very low compared to the heights of some of the yellow bars associated with locations along major roads in the city. Clearly, residential areas experienced relatively low levels of traffic-related pollutants compared to levels measured along many major roads and major intersections within Hamilton.

Additional mobile monitoring work in 2007 showed extremely high levels of NO (nitric oxide) were observed along the Highway 403 corridor from the junction at Main St. West and the 403 to the junction with the Lincoln Alexander Parkway. A peak NO value of 586 ppb was measured along Highway 403. This NO level is the highest ever measured in Hamilton and is much higher than NO levels observed directly downwind of large industrial sources.

Figure 16: Levels of PM10 and NO Along Roads in Hamilton

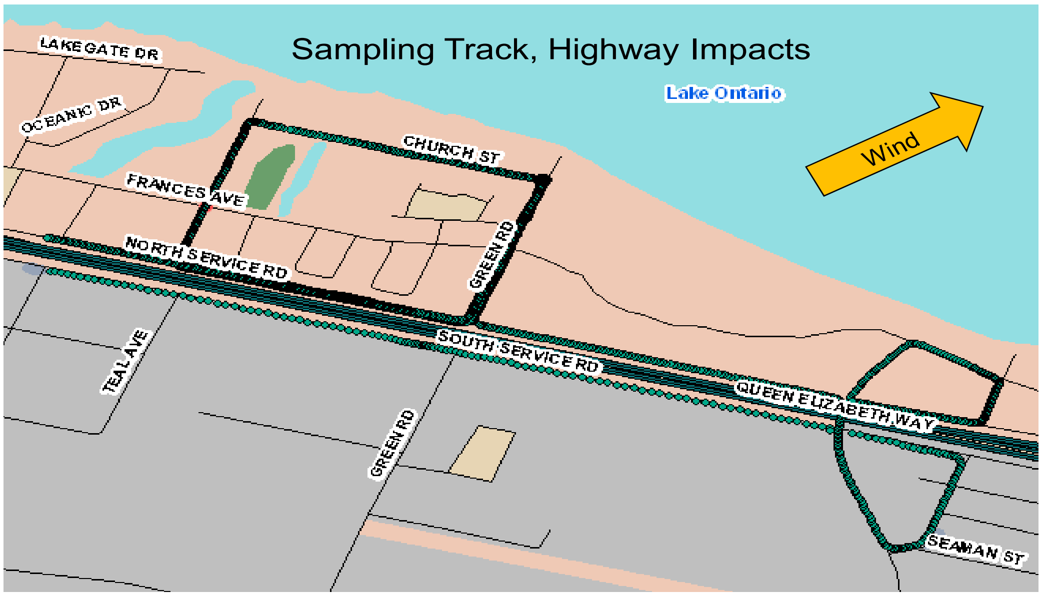


The data in **Figure 16** are organized in order of increasing levels of either PM_{10} or NO. The levels were lowest in residential areas (i.e., areas with low vehicular impacts) and highest in areas with the highest vehicular traffic, i.e., along major roads and highways. These levels are typical levels of exposures for humans working or driving in these areas. For clarity, this figure does not include any locations with high fugitive dust contributions. The primary sources of PM_{10} in these samples are combustion sources, particularly vehicles.

Some of the highest levels of air pollutants in the Hamilton area are measured along local highways, the QEW and Highway 403.

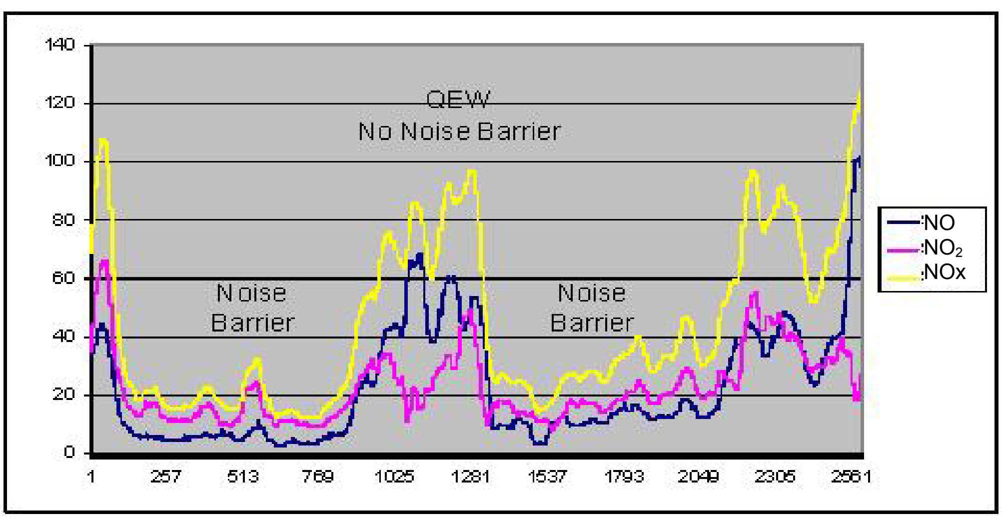
Pollutant levels were measured under steady wind conditions both upwind and downwind of the Queen Elizabeth Way highway (**Figure 17**). Levels were also measured at different distances downwind from the highway to assess downwind impacts.

Figure 17: QEW Highway, Land Use Patterns (Residential Pink), Sampling Locations (Green/BlackLine)



While gathering data parallel to highway on the downwind side, at one point there was a sudden drop in measured values of vehicle related air pollutants. It was realized that the reason was the sheltering effect of a high noise barrier on the residential side of the QEW. See **Figure 18**. These mobile monitoring data suggests that noise barriers along highways not only reduce noise levels but also result in substantial reductions in exposures to combustion-derived air pollutants.

Figure 18: Noise Barrier Effect, NO, NO2 and NOx with and without Noise Barrier.



Traffic Emissions & Health Impacts

In the mobile monitoring studies, the impacts of individual pollutants were examined, using different compounds as tracers for different sources, e.g., SO_2 for industry sources and NO for traffic sources. Since the relative health impacts of each pollutant tracer are known, we can calculate predicted total health effects for these pollutants. The pollutant effect metrics used were those reported by Jerrett and Sahsuvaroglu in their May 2003 report to *Clean Air Hamilton* "A Public Health Assessment of Mortality and Hospital Admissions Attributable to Air Pollution in Hamilton" (School of Geography and Geology and McMaster Institute of Environment and Health). The latter health impacts were determined based on an assessment of the data in over 250 scientific publications linking air quality to public health outcomes.

Figure 19 shows the land use patterns, including residential use, around a major intersection in East Hamilton and the sampling track used to obtain upwind and downwind measurements as well as the concentrations in the residential area.

Figure 19: Queenston Road and Centennial Parkway Intersection, Land Use Patterns and Mobile Monitoring Sampling Route (Red Line)

Figure 20: Health Impacts Predictions Near the Intersection of Queenston Road and Centennial Parkway in Hamilton

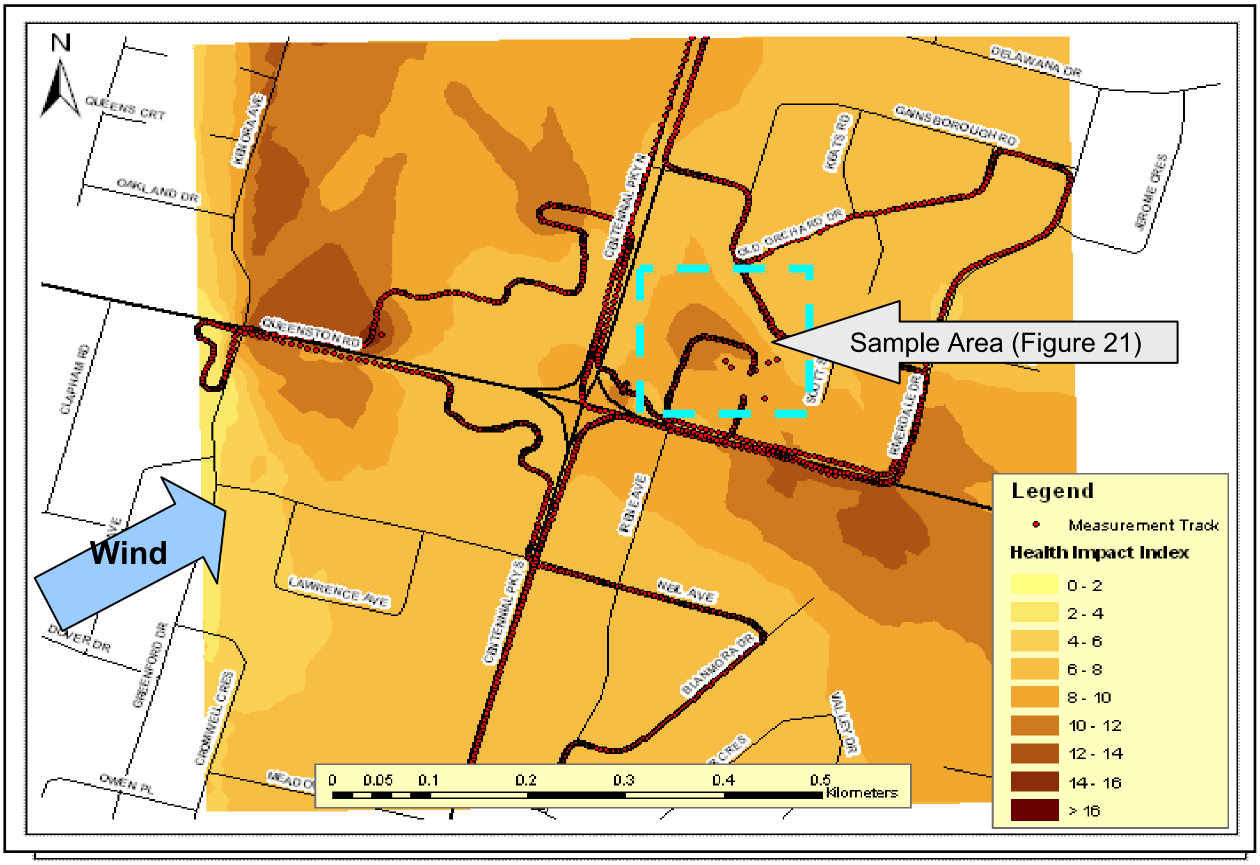


Figure 21: Health Impacts, by Percentage, Downwind from Intersection.

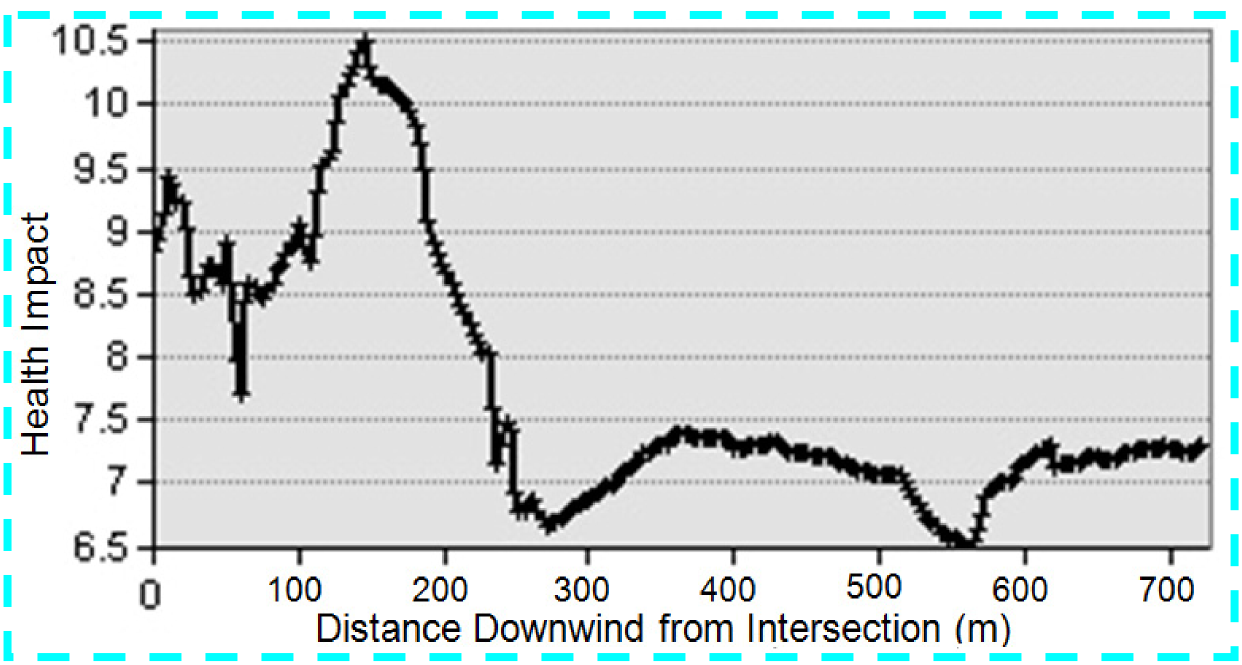


Figure 20 shows the intersection of Queenston Road and Centennial Parkway in the east end of Hamilton. The brown dots show the locations where air pollutant data were collected along the path of the mobile monitoring vehicle as it was driven along roads in the area. The wind direction during this sampling period is shown as a pale blue arrow. The air pollutant data obtained from the brown dot locations were used to calculate the pollutant levels over the entire area. Then the resulting air quality “map” was used to calculate the health effects map shown as **Figure 20**: the darker the colour on the map, the greater the health effects impact.

Figure 21 shows the calculated health impact as a function of downwind distance from the intersection along the monitoring route. It is clear from **Figure 21** that there are elevated health impacts due to the combination of air pollutants when you are located downwind of a busy intersection. From this figure, the most significant increase in health impacts occur between 100m to 200m downwind from the intersection of Queenston Road and Centennial Parkway. Health effects impacts are expressed as annual mortality percentage increases as if there had been constant exposures at these levels throughout a year; while this is clearly not the case, these values are still very useful as comparisons but should not be used as absolute values. In other words, these “images” are snapshots which represent short-term exposures.

Inversion Days, Traffic Emissions & Health

One phenomenon that can result in dramatically increased levels of air pollution is a meteorological event called a temperature inversion. During a temperature inversion air pollutants become “trapped” under an invisible blanket of warmer air which prevents the normal dispersion of air pollutants. An inversion event is a unstable metrological situation and can last for a few hours to a couple of days. During these events, pollution levels and human health impacts can reach high levels. Inversion events typically happen 4 to 6 times a year during the spring and fall.

Figure 22 and **23** on the following page show the relationships between industrial emissions, traffic emissions and the resultant health impacts on an inversion day. In addition to the impacts of industrial emissions on both the lower and the upper city, the emissions of contaminants from mobile sources (particularly from vehicles on major roads and highways) are also very significant.

Figure 22: Prevailing Winds (from Southwest) Normal Day: Average Health Impacts*

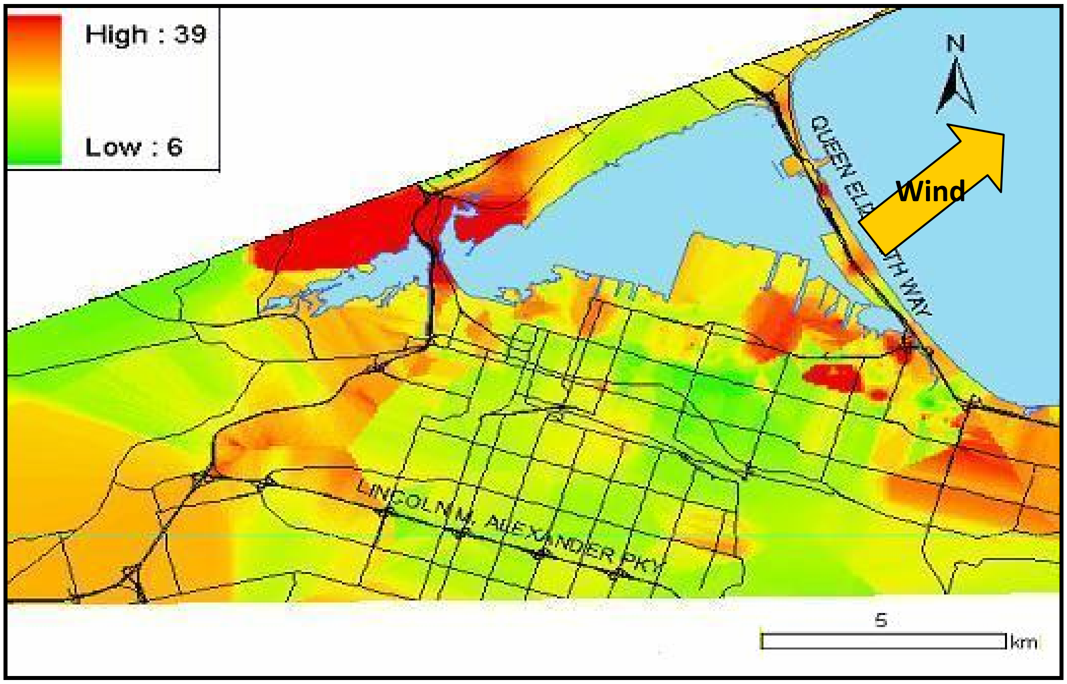
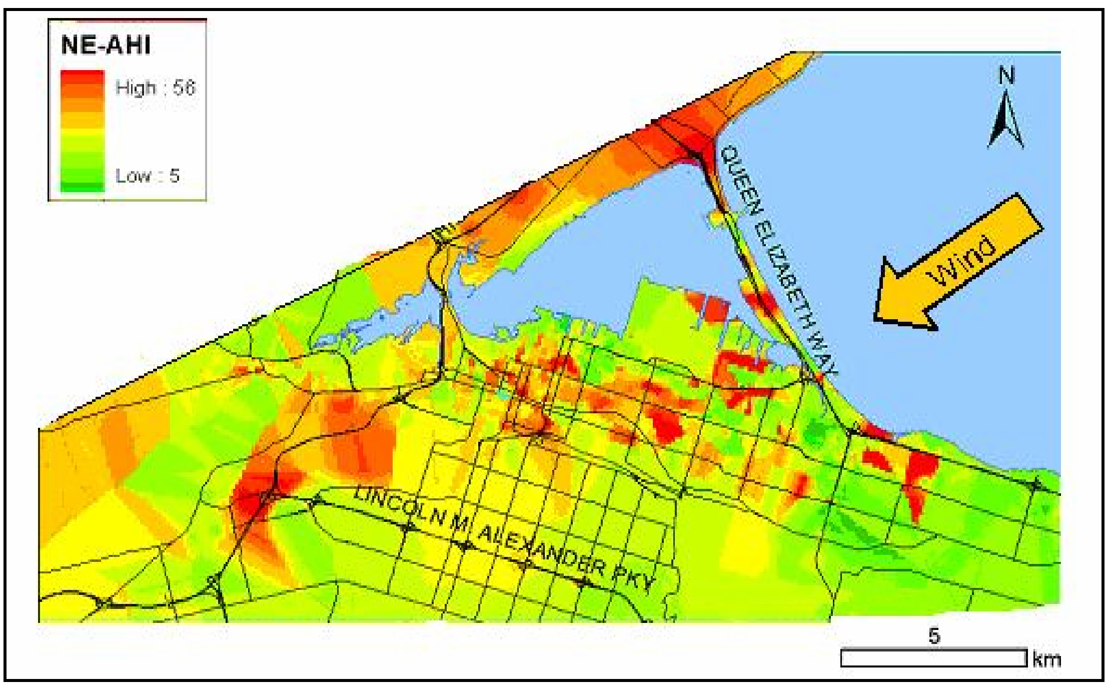


Figure 23: Inversion Day with Northeast Winds: Average Health Impacts



* Please note that these pictures are interpolation surfaces and not the result of detailed models. As a result, they need to be interpreted with caution, particularly at the edges where no sampling data are currently available, e.g. Burlington. In these cases the program may extrapolate to higher pollutant levels than actually exist and additional measurements would need to be made.

Figures 22 and 23 show the predicted health impacts across the City of Hamilton on two different types of wind days. **Figure 22** shows a composite of 15 sampling days under “normal” conditions, i.e. prevailing winds from the south west. **Figure 23** is a composite picture from 8 north east wind/inversion days with winds from the NE industrial area blowing back across the city. These maps are based on mobile monitoring data collected between 2005 and 2007. Clearly, during north east wind/inversion conditions there are significant impacts on much greater numbers of citizens and at higher health impact levels over wider areas. This also shows that both traffic and industry effects are significant under these atmospheric conditions and all available means should be taken to reduce these effects.

Please note that these pictures are interpolation surfaces and not the result of detailed models. As a result, they need to be interpreted with caution, particularly at the edges where no sampling data are currently available, e.g. in Burlington. In these cases the program may extrapolate to higher pollutant levels than actually should be predicted; additional measurements need to be made in these areas.

An important part of the mobile monitoring study is to share these findings with the public and decision makers; our goal is to make the air pollutant data available to researchers and professionals involved in city-scale air quality modeling. It is important that decision makers realize that every planning decision that is made has an air quality impact associated with it. Thus, planning decisions need to take air quality issues into account in order for the air quality in Hamilton to improve in the future.

6.0 Urban Planning – Linkages to Air Quality, Climate Change & Public Health

In Hamilton, there is increasing awareness and understanding about the contributions that urban design and transportation emissions make to air pollution and climate change. It is evident that the levels of transportation-based emissions are directly related to urban planning decisions, access to public transit, access to other means of active transportation, and proximity to mobile transportation corridors.

Increasingly, world-wide research in city design, urban planning, transportation planning and public health is revealing relationships between urban design, poor air quality and climate change, energy usage, and public health.

Buildings and their construction account for 25% of Canada's overall greenhouse gas (GHG) emissions through new construction, combustion of fossil fuels to meet building utility requirements and electrical consumption in lighting and air conditioning. Most emissions come from the combustion of fossil fuels to provide heating, cooling, and lighting and to run electrical equipment and appliances after the building is constructed. The manufacture of building materials and products, and emissions from transportation sources generated by urban sprawl, also contribute significant greenhouse gas emissions every year.

Single-use, dispersed neighbourhoods, located far from downtowns, produce nearly 3 times more annual emissions per household than mixed-use, compact neighbourhoods near the downtown.

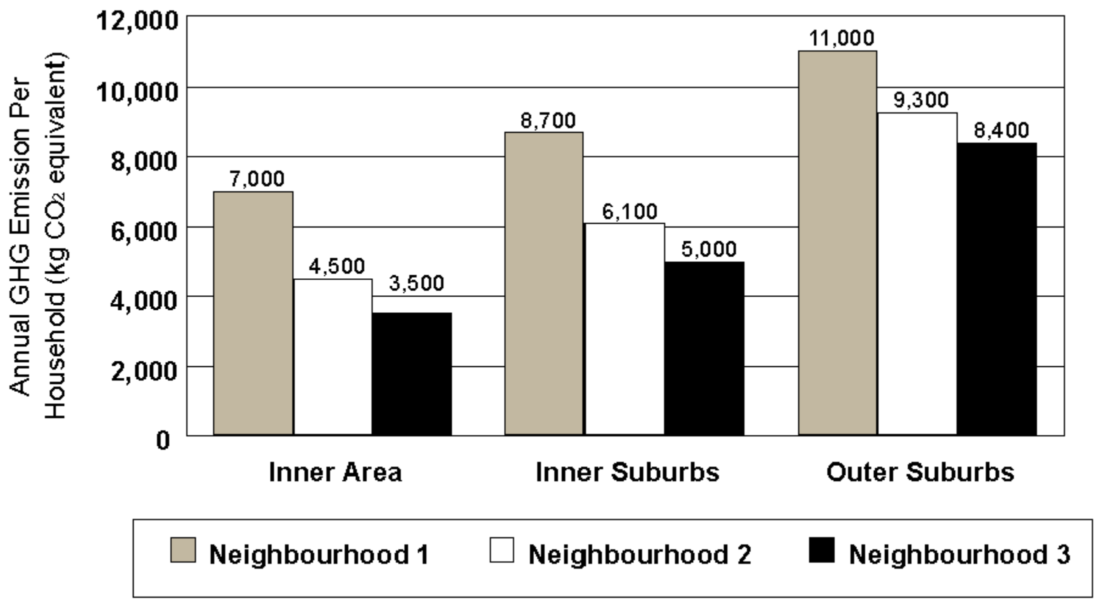
Within the same location, developing more compact neighborhoods with mixed-use and pedestrian oriented designs decreases greenhouse gas emissions by 25-50%.

Canadian Mortgage and Housing Corporation (2000)

The Canadian Mortgage and Housing Corporation undertook a study to develop a model of GHG emissions from personal urban transportation given variations in neighbourhood characteristics, including community and housing design, socio-economic factors, and location. The 2000 study looked at 3 types of Neighbourhoods – 1) Conventional Suburban Development, 2) Medium-density neighbourhoods and 3) Neo-traditional neighbourhoods (neighbourhoods that are more "friendly" to pedestrians, bicyclists, and transit users).

Figure 24 reveals the results of this study and shows that households in the inner areas of a City (i.e., downtowns and core areas) have lower annual GHGs emissions than their suburban counterpart areas based on personal transportation.

Figure 24: Neighbourhood Locations and GHG Emissions from Personal Transportation



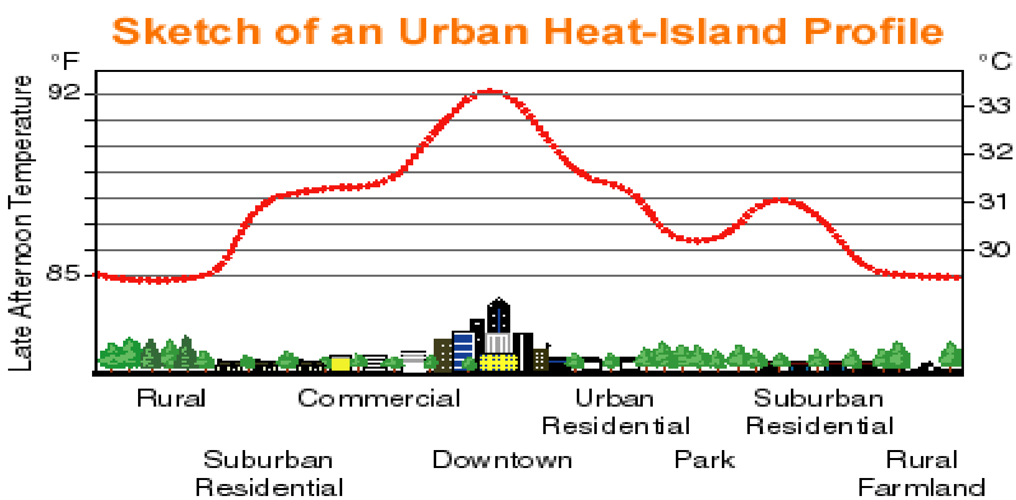
These results provided valuable insight into how communities can be designed and planned to reduce GHG emissions from passenger travel in urban areas. Infill development to increase resident population in inner areas and inner suburbs is more effective than greenfield development in moderating the growth of GHG emissions, even if the new greenfield neighbourhood is neo-traditional rather than typical auto-dependent/suburban in design. However, neighbourhood design is also a significant determinant of GHG emissions and can go a long way in improving the sustainability of neighbourhoods in the outer regions of urban areas.

Mapping projects by the Centre for Neighbourhood Technology (2003) (http://www.travelmatters.org/maps/regional) on the carbon dioxide emissions from vehicle travel for metropolitan regions of Chicago, Los Angeles and San Francisco indicate how city centers have higher emissions than the surrounding rural areas. This is not surprising as city centers have much higher populations than rural areas. When the overall emissions data is divided by the number of households in any given area, emissions in the city centers are lower per household than the surrounding areas. Households in these city centers have easier access to public transportation systems, drive less often or shorter distances, and walk or bike to their destinations.

According to the *Ontario College of Family Physicians* (2005), people who live in low-density, car-dependent neighborhoods are likely to walk less, to weigh more, and to suffer from obesity, high blood pressure, diabetes, cardiovascular and other diseases, compared to people who live in higher density, multi-use communities. Dr. Lawrence Frank[3], a speaker at the 2006 Upwind Downwind Conference, found in his research linking urban design patterns and obesity that every additional 30 minutes spent driving per day translates into a 3 percent increase in the likelihood of obesity and that every additional kilometer (0.6 miles) walked translates into 4.8 percent reduction in the likelihood of being obese.

According to the Ontario Professional Planning Institute (2007) another health problem related to urban form are Urban Heat Islands, which are created when green spaces are replaced with asphalt and buildings. Cities can be up to 4 to 7 degrees Celsius hotter than their suburban or rural surroundings on hot summer days. This is referred to as "the heat island effect" and occurs because urban development replaces trees and natural surfaces with large amounts of paved and dark asphalt, coloured surfaces like roofs, walls, roads, and parking lots that absorb, rather than reflect, the sun's heat.

Figure 25: The Urban Heat Island



Not only does an urban heat island intensify the effects of extreme heat on certain days in the summer, putting people at risk of heat-related health problems (low-income elderly persons living in non-air-conditioned units are particularly vulnerable), but the higher atmospheric temperatures leads to the formation of smog particulates, ground-level ozone which exacerbates breathing problems for many people (ICLEI, 2005) . As the city temperatures rise, people use more energy for air-conditioning in buildings and cars, leading to increased carbon dioxide emissions.

The Ontario Provincial Policy Statement (2005) states that 'land use patterns within settlement areas shall be based on densities and a mix of land uses which minimize negative impacts to air quality and climate change, and promote energy efficiency".

[3] Frank, L., Andresen, M., and Schmid, T., Obesity Relationships With Community Design, Physical Activity, and Time Spent in Cars. American Journal of Preventive Medicine. June 2004.

The planning and implementation of transportation systems and land use patterns have direct results currently and in the future on local air quality, climate change, energy usage and the attendant impacts on human health.

In 2007, the Ontario Professional Planning Institute released a position paper - *Healthy Communities, Sustainable Communities* - focusing on healthy and sustainable communities that emphasizes the importance of urban design, active transportation, and green infrastructure. The Canadian Institute of Planners has also recognized the need for Planners to address climate change and is developing a policy paper for its members.

Urban and transportation design in Hamilton can provide solutions and choices through the use of new technologies such as green buildings using standards developed through Leadership in Energy and Environmental Design (LEED) and vegetated rooftops; transit and active transportation-orientated community designs can provide a variety of transportation choices to reduce the need for travel and fossil fuel emissions; strengthening development towards existing communities, creating walkable neighbourhoods through mixed land-uses; and preserving open spaces encourages smart city growth and discourages urban sprawl; and, limiting development in hazard prone areas and limit the loss of greenfields and biodiversity that can soften the impacts of unpredictable climate patterns.

7.0 *Clean Air Hamilton* Programs and Strategic Activities

7.1 Active & Sustainable Transportation

7.1.1 Transportation Demand Management

Transportation Demand Management (TDM) aims to change the travel behaviour of citizens and to encourage the use of more sustainable transportation alternatives.

Transportation Demand Management is aimed at:

- Changing people's mode of travel by switching from Single Occupany Vehicles (SOV) to more efficient modes of transport;
- Changing people's time of travel to better utilize existing transportation infrastructure
- Changing travel behaviour and making better use of the existing infrastructure through management techniques including:
    - Increasing car occupancy,
    - Increasing transit and transit usage,
    - Increasing cycling & walking to work,
    - Decreasing the number of trips and trip length,
    - Spreading out of peak periods and reducing the need (and expenditure) for new vehicle infrastructure.

The City of Hamilton's Public Works Department took over the responsibility for TDM in Hamilton and seeks to provide stability and co-ordinate plans for sustained growth in TDM-related programs and initiatives.

The City of Hamilton has been undertaking TDM-related programs for some time, including the provision of discounted employee transit passes. Currently, 170 employees utilize the payroll deduction program to obtain their transit pass. City Council is requesting that the program be promoted across the City to encourage employers to subsidize their employees transit passes.

The City of Hamilton is increasing the use of transit, through additional funds provided by the provincial government and Metrolinx. New articulated buses are being purchased to enhance the B-Line and create Bus Rapid Transit (BRT) on the James/Upper James service, referred to as the A-Line. In addition, all transit vehicles include bike racks to encourage cycling and transit connections. These are all positive steps to provide more frequent, reliable transit service to encourage more residents to use public transit instead of a car.

The City utilized funds available from Metrolinx to open Hamilton's first Secure Bike Parking Facility in the downtown area. The facility supports 43 bicycles in the York Street Parkade and had an occupancy rate of almost 50% during the peak cycling season. Plans are underway to design an install a second facility in the Convention Centre Parking Garage in 2009.

The City is continually adding bike lanes and facilities throughout the City towards a fully connected cycling network. In 2008, the City added 22 km of new bike lanes and 2 km of paved shoulders on a rural road to improve the safety for cyclists. The City's Cycling Master Plan is also under review and available for public consultation with a new plan is to be considered by City Council in 2009.

7.1.2 Smart Commute

Smart Commute is a partnership between Metrolinx and the cities and regions of the Greater Toronto Area and Hamilton to reduce traffic congestion and to take action on climate change through improved transportation efficiencies.

Smart Commute helps local employers and commuters to explore different commuter choices like carpooling, teleworking, transit, cycling, walking and flexible work hours. Smart Commute's goal is to help make commuting easier, healthier and more enjoyable.

With growth and development in the City of Hamilton, alternative modes of travel must be made available to reduce single occupant vehicle (SOV) trips. The Smart Commute Initiative provides an opportunity to increase travel mode choices while potentially leading to:

- Reductions in Single Occupancy Vehicle (SOV) trips by up to 15% when fully implemented
- Reductions in greenhouse gas emissions estimated at 20,000 tonnes annually.
- Reduced congestion and delays for people and goods movement
- Improved public safety
- Enhanced accessibility and mobility options
- Resource conservation and support for efficient land use through reduced infrastructure costs and space requirements, and
- Reduced parking facility costs for participating business, and improved employee recruitment, retention and productivity.

Members of the public can also access services like the Carpool Zone at www.carpoolzone.ca as well as through the Metrolinx web portal at www.metrolinx.com.

For information on Smart Commute, visit: www.smartcommute.ca/hamilton/

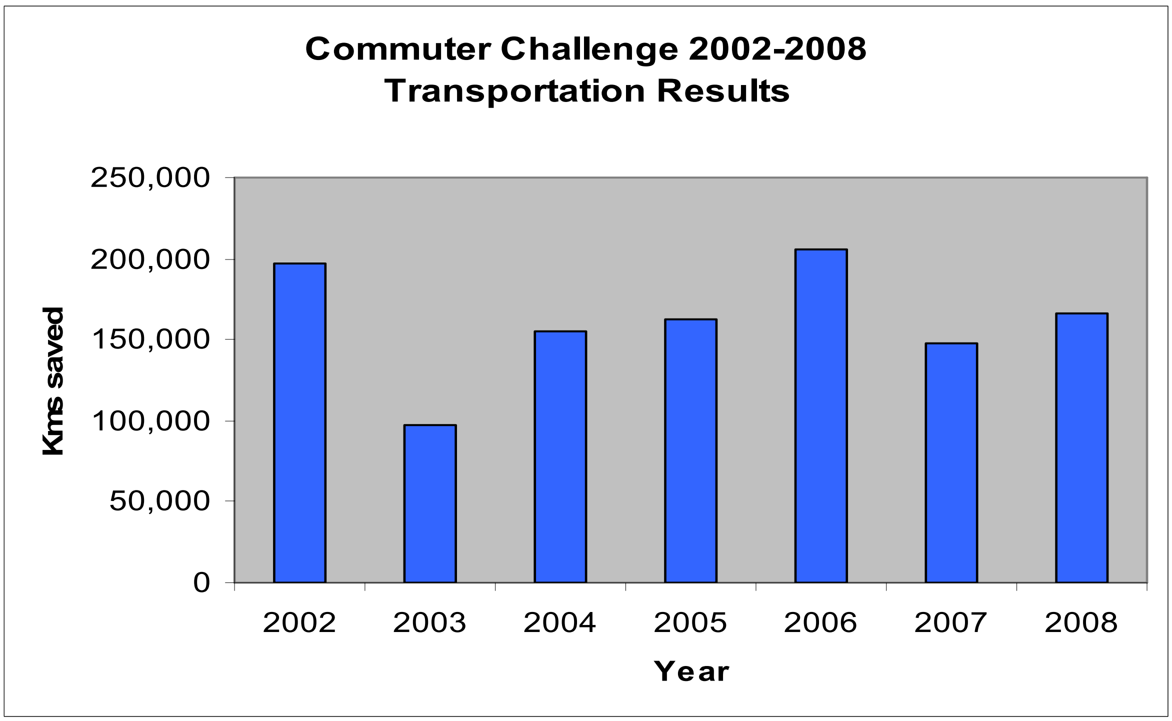
7.1.3 Commuter Challenge

The Commuter Challenge is a week-long, friendly competition between Canadian cities to see which city can reduce carbon dioxide emissions the most. Cities reduce their emissions by encouraging citizens to use active and sustainable modes of transportation. Participants make a commitment to walk, jog, cycle, rollerblade, take public transit, carpool or telecommute to work or school during Environment Week in June.

The Commuter Challenge promotes active and sustainable commuting and the personal, social and environmental cost/benefits of alternatives to the single occupant vehicle (SOV). The goal is to reduce the number of SOVs traveling on our roads thereby reducing the levels of emissions, improving air quality and slowing climate change. The Commuter Challenge raises awareness of alternative transportation choices and demonstrates how using these alternatives can result in improved air quality and reduced greenhouse gas emissions.

In 2007, The City of Hamilton's Public Works Department assumed responsibility and funding of this annual event. This was a logical fit as the City of Hamilton through Public Works was developing a plan to pursue transportation demand management (TDM) in partnership with the Smart Commute Association.

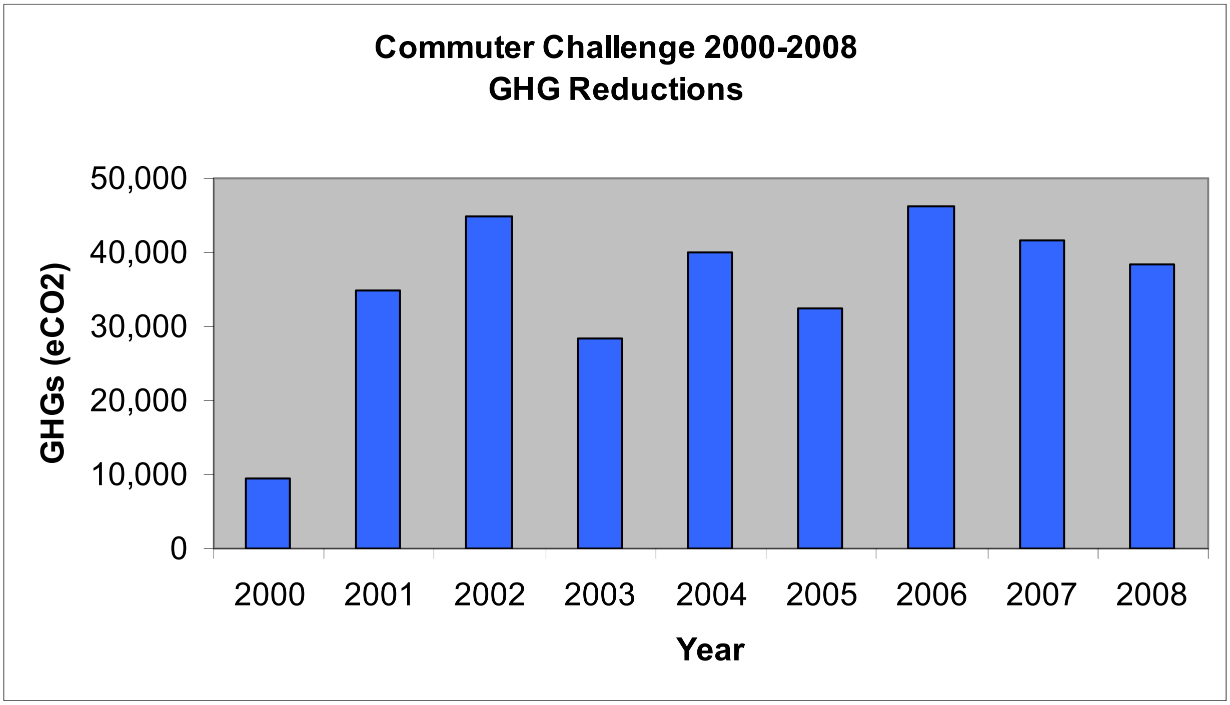
Figure 26: Reduction in Travel Distance by Single Occupancy Vehicles



In 2008 1,433 individuals in the Hamilton area participated in the 2008 Commuter Challenge and saved 166,171 km of single occupancy vehicle travel.

In terms of pollution and emissions reductions, the actions of participants in the 2008 Commuter Challenge saved 2.65 kilograms of fine particulate matter ($PM_{2.5}$) and 242.61 kilograms of nitrogen oxides. Participants also saved 38,432 kilograms of carbon dioxide equivalent (eCO_2); eCO_2 is a generalized measurement of the global warming impact of emissions based on the most common greenhouse gas, CO_2. Over the past 8 years, the Commuter Challenge in Hamilton has reduced greenhouse gas emissions by 316,075 kilograms of eCO_2.

Figure 27: Reductions in Greenhouse Gas Releases Due to the Commuter Challenge



7.1.4 Totally Transit

The Bus Education pilot program "Totally Transit" is an initiative of Green Venture and Hamilton Street Railway (HSR). The purpose of the Totally Transit program introduces Grade 5 students to the ins and outs of the HSR and encourages students to feel confident about taking the bus as a means of transportation and educating them on air quality and climate change improvements related to transportation use.

From January to December 2008, Green Venture delivered the Totally Transit presentations to 358 students at ten elementary schools and presented six twenty-minute Totally Transit sessions to an additional 100 students at the St Helen School's Eco Fair and 95 residents at the Keith Neighbourhood Bus Introduction EcoFair. As part of the program, surveys to determine post program behavioural changes and attitudes towards transit use were developed. To date, data from 136 first surveys has been collected.

Totally Transit has received very positive reviews from participant teachers and students alike. Teachers are supportive of linking the application of life skills to the environment.

Updated Science and Technology curriculum expectations have been identified for grades 2,3,4,5 & 7 and will serve as the basis for the development of additional program activities and to further enhancements to the program. Furthermore, Grade 5 has solid potential in mathematics and the application of living skills to physical activities as does Grade 7 in the geography curriculum.

7.2 Smart Driver

7.2.1 EcoDriver

In 2008, Green Venture began a new program focused on drivers of light duty vehicles. The EcoDriver program is provincially funded by Ministry of the Environment through Green Communities Canada. Driving produces tailpipe emissions that reduce air quality and contribute to climate change. Since driving is an often inescapable part of the everyday lives of a majority of Canadians it is important that drivers learn how they can reduce the emissions from their vehicles. Reducing the amount of fossil fuels burned directly reduces the amount of climate changing greenhouse gases emitted.

Green Venture continues to deliver this series of presentations, public outreach, workshops and materials that provide tips and seek commitments to help the public drive more fuel efficiently, thereby reducing harmful tailpipe emissions. The program has a strong anti-idling component which is consistent with Hamilton's message that idling for more than 10 seconds requires more fuel than turning off and restarting the engine and incorporates other simple maintenance and driving techniques.

EcoDriver tips:

- Go Idle Free - turn the key off when waiting or stopped for more than 10 seconds.
- Warm Up on the Go - drive gently for the first few minutes to warm up the vehicle.
- Tire Pressure - check tires and inflate to correct tire pressure once per month.
- Easy on the Pedal - eliminate jackrabbit starts and hard braking.
- Combine Trips - eliminate highly polluting short trips.
- Slow Down - highway driving at 120 km/hr uses 20% more fuel than 100 km/hr.

7.2.2 The Idling Stinks Campaign

On June 2008, the City of Hamilton's Anti–Idling Control By-law (By-Law 07-160) came into effect. The idling by-law applies to government fleets, and all personal and private commercial vehicles operating in and through the City of Hamilton. Since June 2008, the City has received 25 enquires or complaints about idling vehicles.

In 2008, *Clean Air Hamilton*, Green Venture and city staff continued the idling awareness campaign, initiated in 2006, directed at the broader Hamilton community. The campaign encourages behavioural change among those who live and work in Hamilton, through education, awareness and commitment-seeking.

The primary goal of the *Idling Stinks* Campaign is to raise awareness in the Hamilton community about the negative impacts of emissions from idling vehicles; these impacts include increased local air pollution, higher greenhouse gas production, wasted money and fuel and the health effects impacts of the resulting air pollution. In 2008, Green Venture implemented several methods of communicating the anti-idling message in their successful community awareness campaign, which included:

- Distribution of approximately 193 anti-idling awareness signs to schools, recreational facilities, libraries, and businesses. These signs were in addition to the 204 signs previously distributed in 2007 and 2006 to schools, businesses, retirement and nursing homes, driving schools and City Hall.

- Engagement of approximately 236 drivers at schools and summer camp locations with 182 pledging to turn off their engine and not idle.

- The Green Venture idling website received numerous hits and interested residents accessed anti-idling materials for their own use and distribution. In 2008 in excess of 1,400 visitors accessed the online air quality pages for over 1,600 visits.

- A "BIA Idle Free Zone Tool Kit" was presented at meetings of four of Hamilton's twelve BIAs. Ottawa Street, Stoney Creek and Westdale BIAs agreed to partner with Green Venture to implement the tool kit and the Downtown BIA is supportive of the idea.

- The Air Quality portion of the Green Venture website was updated with winter anti-idling tips and FAQs about By-law 07-160 in January 2009.

For information on the campaign, visit Green Venture's Idling Stinks website: www.greenventure.ca/cc.asp?ID=161

7.2.3 Car Share

Car share arrangements are popular in many Canadian cities. By sharing a vehicle, participants reduce unnecessary car trips and use other modes of travel thereby reducing their personal emissions. Car shares are also quite affordable for members and can lead to fewer vehicles on city streets.

In March 2009, Green Venture in partnership with the First Unitarian church hosted an evening presentation and hosting development workshops in Hamilton facilitated by an external car share expert to consolidate interest and produce a working framework for the continued efforts for car sharing in Hamilton. The presentation informed participants on car share models and their benefits, provided a forum for discussion, and mobilized those interested in further pursuing the establishment of a local car share program.

7.2.4 Private Fleets – Fuel Management Workshop

Apart from individual vehicle owners, many businesses both small and large operate their own vehicle fleets. According to the Repair Our Air Fleet Challenge, fleet vehicles idle between 20-60% of their operating time. It is estimated that the average long-haul truck idles away $1,800 worth of fuel every year. A number of the large long-haul trucking firms are now encouraging their drivers to shut their engines off whenever feasible.

In Hamilton, apart from the Idling Stinks campaign, there are no anti-idling programs available to assist businesses, particularly small and medium-sized businesses. Some organizations have developed their own anti-idling policies while others are currently developing policies.

To engage private fleets in Hamilton, Green Venture and the City teamed up with Natural Resources Canada to deliver two Fleet Management 101 Workshops. Fleet Management 101 focuses on the basics of developing a fuel management plan including greenhouse gas reductions, and selling the plan to fleet managers. The workshop focuses on mixed fleets with a range of vehicles including light duty, heavy duty and equipment. These vehicles are more likely to be spotted idling on city streets and therefore be subject to an anti-idling by-law. A Highway Trucking Fleet workshop was added to target Hamilton based long haul trucking operators and others whose fleets do business in Hamilton.

Considerable efforts were made to promote and invite industry representatives to the workshops. Promotions included: a news release, purchased advertising space in the Business Link Hamilton–Halton October 2008 issue, a posting in the Hamilton Chamber of Commerce's weekly e-newsletter to members, invitation through Public Works to City contractors, and cold calls.

Despite these efforts, attendance at the first workshop had eleven participants representing eight organizations (4Refuel Canada, Arcelor Mittal, Purolator, Transcare Logisitic Inc., Real Food for Real Kids, Haldimand Country, City of Owen Sound and Town of Pelham). Interest in the highway trucking workshop was low with only two participants (Markel and MacKinon Transport Inc.) attending.

7.2.5 Smog Patrol

The Ministry of the Environment's Smog Patrol conducts province-wide roadside inspections of both heavy duty and light duty vehicles (registered in Ontario or from out-of-province) to ensure compliance with Ontario's motor vehicle emission standards (Ontario Regulation 361/98).

In 2008, the Ministry of the Environment had two vehicle emission inspection blitzes in the industrial core of Hamilton to address the role heavy duty diesel trucks and other vehicles play in particulate emissions in Hamilton. Between June 23-27, 2008 and July 22 to 24, 2008, 402 vehicles were inspected by the Ministry's smog patrol. Approximately 13% (53 vehicles) failed, several were issued tickets, violation notices and orders.

7.3 Climate Change

7.3.1 Upwind Downwind 2008 Conference

Every two years *Clean Air Hamilton* hosts the Upwind/Downwind Conference, a two-day event which highlights (a) the latest in air quality research, particularly as it applies to the human health impacts of air pollution, and (b) strategies and activities to improve air quality on local, regional and national scales. The programs of these conferences have been designed to be accessible to the non-expert and are targeted to the identification of problems and the implementation of practical solutions to improve air quality and public health at the local level. Sessions in past conferences have been devoted to the health impacts of air pollution, urban planning and urban design strategies to reduce air pollution, energy efficient strategies for homes and industries and local initiatives and success stories from across North America that have led to real improvements in the quality of life of citizens.

The 2008 conference invited 19 speakers from the fields of human health, urban planning, science, architecture, engineering, public policy, and municipal government and community initiatives. The conference provided an opportunity to discuss the types of actions governments, industries and citizens will need to take in order to make significant progress to address air quality improvements and climate change impacts. The 2008 conference attracted 288 attendees including decision makers and staff at the federal, provincial and municipal levels, health practitioners, planners, academics, university, college and high school students, community groups and non-governmental agencies.

The conference also engaged local citizens through a free public lecture on the evening of the first day on making vibrant urban cities through the encouragement of walking, cycling and public spaces. For the first time a Clean Air Fair was organized for both days which featured 45 exhibitors in areas of energy (solar, wind, geothermal), car sharing, light rail transit, electric vehicles, pesticides, municipal services, public health, waste management, and green spaces.

7.3.2 Climate Change Champions

Green Venture, Environment Hamilton, and the City partnered to help individuals and business become climate change champions by committing to actions that will achieve greenhouse gas emissions reductions of 10% by 2012 and 20% by 2020.

Hamilton's Climate Change Champions are 24 local organizations from schools, businesses, community centres, faith groups, and government committed to cutting their energy use and help combat climate change at the same time. In addition, up to 500 residents are joining Team Hamilton and making their own personal pledges to reduce their greenhouse gas emissions.

To join the climate champions, visit
www.greenventure.ca/cc.asp?ID=161

7.3.3 City's Corporate Air Quality and Climate Change Plan

In 2008, the City Of Hamilton approved an Air Quality and Climate Change Strategic Plan to undertake actions to meet corporate emission targets of 10% reduction of 2005 greenhouse gases levels by 2012 followed by a 20% reduction of 2005 greenhouse gases levels by 2020.

The City is currently undertaking a City wide greenhouse gas inventory to assess the levels of GHGs and air pollutants in Hamilton, identify sources and undertake actions to improve air quality and climate change in Hamilton and to meet the intended targets of the Strategic Plan.

To read the City's Corporate Air Quality and Climate Change Plan visit:
www.myhamilton.ca/myhamilton/CityandGovernment/ProjectsInitiatives/V2020/ClimateChange/

7.4 Energy Conservation

7.4.1 Black Out Challenge

The Black Out Challenge is an annual event in response to the City of Woodstock's Voluntary Blackout Day Challenge - a friendly invitation urging Ontario municipalities to reduce consumption by four per cent on the anniversary of the 2003 blackout in Ontario.

In 2008, Hamilton participated in its second challenge and placed second out of 38 participating Ontario municipalities by successfully reducing energy consumption by 2.9 per cent and trimming peak demand by 5.2 per cent between the hours of 12:00 p.m. and 8:00 p.m on August 14, 2008. This 5.2 per cent drop in peak demand is equivalent to taking between 5,000 and 6,000 homes completely off the electricity grid.

Hamilton placed first in the 2007 challenge; however 2008's results demonstrate an improvement since then. In 2007, Hamilton reduced consumption by 1.9 per cent and peak demand by 5 per cent.

7.4.2 *peaksaver*®[4] Program

Horizon Utilities, with support from the Ontario Power Authority, make it simple for residents to conserve energy and ease the strain on the electricity system during summer peak demand times. The ***peaksaver***® program allows residential and small commercial customers of Horizon Utilities with central air conditioning to help reduce the demands on Ontario's electricity system, through the installation of a free ***peaksaver***® programmable thermostat to replace existing thermostats. During critical times of peak electricity demand (typically on hot summer days), a signal can be remotely sent by the Ontario Power Authority to cycle the central air conditioner's compressor (15 minutes on, then 15 minutes off) over a four-hour period, to reduce the amount of electricity it uses.

In 2007, 885 ***peaksaver***® programmable thermostats were installed. In 2008, 2,196 ***peaksaver***® programmable thermostats were installed. To book an appointment call peaksaver at 1-866-323-0206

For information on the *peaksaver*® Program or to sign up, visit Horizon Utilities: www.horizonutilities.com

7.4.3 *Generation Conservation*

Generation Conservation is an innovative and exciting curriculum-based energy conservation program offered by Horizon Utilities for Grade 5 students attending schools in Hamilton and St. Catharines. *Generation Conservation* lesson plans include tangible, hands-on activities such as measuring the energy expenditure of wind-up toys; comparing the amount of electricity required to light strings of old-fashioned, incandescent versus new, energy-efficient LED holiday lights; making a fan and then turning it into a wind turbine; as well as charting and graphing the energy consumption of old and new appliances.

The students undertake activities at home as well, including a home energy audit. This interaction between students and families results in families learning how simple changes in behaviour start conserving energy, saving money and improving the environment. It also provides a family forum to discuss how the adoption of conservation technologies adds to the savings.

Under *Generation Conservation*, Horizon Utilities is providing teachers' guides and workshops, student workbooks, and classroom materials to 195 schools, 400 teachers and 7,500 students and their families. The program is in partnership with the Hamilton-Wentworth Catholic District School Board, Hamilton-Wentworth District School Board, Niagara Catholic District School Board, and District School Board of Niagara, along with support of public libraries in Hamilton and St. Catharines.

[4] ® - ***peaksaver*** is a registered trademark of Toronto-Hydro Corporation. Used under license.

7.4.4 LightSaver Program

The LightSaver program is a program from the Toronto Atmospheric Fund and the Greater Toronto Area Clean Air Partnership which combines grants, financing and market research to build awareness and advance the use of LED lamps and intelligent lighting system controls across the GTA and Hamilton areas. The Lightsaver program, in partnership with municipalities, plans to undertake up to ten pilot programs to test the new low carbon lighting technologies. By using new LED and intelligent lighting system controls, energy from street, park and parking lighting can be reduced by up to 70 percent

In 2008, Hamilton was approved for three locations to pilot projects of the LightSavers program, which works to stimulate market transformation to environmentally efficient lighting technologies. The three locations for Hamilton's pilot programs are the Hamilton Amateur Athletic Association park located at 250 Charlton Avenue West, the City Housing parking lot located at 30 Congress Crescent and the Hunter Street tunnel (at James Street).

For information on the LightSaver Program, visit:
www.toronto.ca/taf/lightsavers.htm

7.4.5 Power Savings Blitz

In partnership with the Ontario Power Authority, Horizon Utilities is committed to ensuring their customers have a reliable and cost effective electricity system.

The Power Savings Blitz, a door-to-door, two-year program provides up to $1,000 worth of installed electricity-saving products (primarily lighting), offered free of charge, to small business customers categorized as non-food preparation and with loads under 50 kW. Customers are not obliged to purchase any equipment or pay any assessment fees in order to receive program-specific energy upgrades.

In the fall of 2008, Horizon Utilities became Ontario's first large utility to launch the Power Savings Blitz program. By Dec 31, 2008, a total of 504 small businesses had received retrofit upgrades for improved indoor lighting with some customers reducing lighting expenditures by up to 50 per cent.

7.4.6 Electricity Retrofit Incentive Program (ERIP)

Retrofitting an existing facility with newer equipment is a normal business practice. Technological improvements often make newer equipment more efficient and effective than old equipment.

The Electricity Retrofit Incentive Program focuses on the areas of lighting, motors, heating, ventilation and air conditioning, and overall electricity systems. These areas cover the majority of and most important electricity upgrades businesses undertake. By taking advantage of this program, businesses can contribute to a cleaner environment and benefit from incentives and lowered operating costs. In 2008, Horizon Utilities' customers contributed 1,676 kW in peak demand reduction through the ERIP program.

7.4.7 The Great Refrigerator Roundup

An older, inefficient secondary fridge, over ten years old, wastes between $120 - $150 per year in electricity costs. The Great Refrigerator Roundup ensures that materials are recycled in an environmentally responsible manner, with very little left for the landfill. Horizon Utilities' customers can book an appointment to have their appliances picked up free of charge.

In 2008, Horizon Utilities picked up over 3,800 appliances. Every 10 to 15 fridges that are recycled conserve the amount of power consumed by an average household during a year. Appointments for fridge pick up can be booked online at www.everykilowattcounts.ca or by calling 1-877-797-9473.

Appointments for fridge pick ups can be made:
www.everykilowattcounts.ca or by calling 1-877-797-9473

7.5 Land Use Planning

7.5.1 Liveable Cities

In 2009, Green Venture offered ten free presentations entitled "Liveable Cities" which discussed a new movement called Complete Streets. This movement is a response to urban sprawl, and aims to increase accessibility in areas where proper infrastructure is lacking.

Participants discovered why Complete Streets can be safer, less congested, healthier, more attractive and inclusive for all people and transportation modes.

The "Liveable Cities" presentation highlights Smart Growth and intensification to create a vibrant and liveable city and successful examples from other North American cities

The presentations provide background material and a neighbourhood audit tool to educate and engage participants to educate your group on sustainable urban planning issues in Hamilton.

7.6 Tree Programs

7.6.1 Hamilton ReLeaf Network

In April 2008, a Tree Symposium was held to connect with community and government groups involved in programs related to trees including tree planting, land use preservation and management, naturalization, heritage trees, woodlot management and education. Following the symposium, a group of volunteers from local community groups and the City met monthly to form a collaborative and communication network called the Hamilton ReLeaf Network.

The Hamilton ReLeaf Network aims to facilitate the maintenance, restoration and enhancement of a healthy and sustainable forest canopy using good forestry practises in the Hamilton area by:

- Encouraging partnerships
- Education and Outreach
- Conservation Planning from a Landscape Level

Community groups involved with programs relating to trees should contact the Hamilton-Wentworth Stewardship Council 519-826-3569 for more information on the Hamilton ReLeaf Network.

8.0 Conclusions and Recommendations

Air quality in Hamilton continues to be impacted by a number of factors that include:

- **Trans-boundary Air Pollution.** This pollution originates from sources in the mid-western United States. About 50% of all pollutants in Hamilton arrive by the prevailing winds from the southwest; in this respect, Hamilton is impacted in a manner similar to many other communities in south-western Ontario.
- **Transportation Sources.** The roads in and around Hamilton continue to be heavily used by automobiles and diesel trucks. The improved efficiencies of vehicles should result in significant reductions in tailpipe emissions; unfortunately, these improvements in fleet performance are offset by the increased numbers of vehicles, increased congestion and the increased numbers of miles driven by commuters. The continuing trend to "just-in-time" delivery has resulted in increased truck traffic throughout the region. The mobile monitoring studies have clearly demonstrated that emissions from transportation sources result in very high local levels of pollutants near major roads and highways, particularly areas downwind of major intersections.
- **Industrial Sources.** Hamilton is home to a large number of industries ranging from the large, integrated steel mills to medium-size and small industries. Emissions from stacks feature prominently in the public's view of major pollution contributors from industries; while this perception is largely correct for chemical contaminants, it is not correct for industrial particulate sources. Fugitive dusts from materials handling and storage piles, together with road dusts and track-out from industrial sites are the sources of over 80% of all air particulate produced by the industrial sector. Strategies to reduce contributions from these fugitive sources will have dramatic positive impacts on the air quality in the industrial area of the City.
- **Hamilton's Location and Topography.** The escarpment and the city's location at the western end of Lake Ontario, together with local weather conditions (e.g., thermal inversions) can result in higher levels of air pollutants in the downtown area. While there is nothing we can do to change topography and weather, we can make decisions with regard to development, transit, and other actions that will promote a sustainable economy and reduce air pollutant impacts in Hamilton.

- The majority of direct air pollution exposures of Hamilton citizens are due to vehicles, although under NE wind/inversion conditions significant industrial impacts also occur . Road intersections, highways and any accumulation of idling vehicles exacerbate these exposures.

- Air quality improvements in the City of Hamilton will be incremental and will require actions on many fronts. We recommend that the City of Hamilton:

    - Recognize the health impacts of transportation-based pollutants near major traffic corridors and take steps to implement this recognition into transportation planning and urban design.

- Since highway sound barriers can cause significant downwind reductions of air pollutants from roadways, intensive tree plantings, preferably dense evergreens, should be considered along highways and arterial roads.

- Work with local industries and the Ministry of the Environment to control both point sources and area sources of air particulate pollution, particularly road dusts, as well as reducing NO_x and SO_2 emissions.

- Undertake partnerships and enhance Air Monitoring in Hamilton to increase coverage of local sources throughout Hamilton either through fixed stations, portable monitors or increased mobile monitoring.

- Promote an active lifestyle for its citizens by developing cycling/walking routes throughout Hamilton that are separated from traffic on heavily traveled roads.

- Support and encourage Hamiltonians to reduce their transportation-based emissions through the use of transportation alternatives including public transit, bicycles, hybrid vehicles, etc. The City of Hamilton needs to continue to lead by example through transportation demand management, transportation planning and fleet upgrades.

- Undertake a community health smog plan to increase communication on smog days to vulnerable members of the community such as encourage physicians to caution patients with respiratory or cardiac difficulties to take special precautions on smog days and smog advisory days, particularly when there are low dispersion conditions, whether these events are weather-related or result by virtue of valley-type effects.

- Continue to take measures to reduce fugitive dusts in industrial sectors through education and action by encouraging local site operators to develop best practices to reduce track-out from industrial properties onto roadways.

- Continue to take measures to reduce energy consumption in City buildings and fleets. Educate and encourage the community to reduce their energy consumption at home, business and on the road.

- Continue to take a broad suite of actions to improve local air quality and combat climate change and to increase the level of dialogue with community groups on the health impacts of poor air quality and the actions and lifestyle changes that will lead to air quality improvements for all.

In 2009, *Clean Air Hamilton* will continue to address air quality issues and their relationships to public health outcomes. *Clean Air Hamilton* will continue to develop relationships with City staff to ensure that air quality goals are integrated into the decision-making processes across divisions within the City. *Clean Air Hamilton* will continue to expand its membership and to cultivate partnerships with organizations that have goals that are consistent with those of *Clean Air Hamilton* and the City.

Appendix A: 1997 Hamilton-Wentworth Air Quality Initiative (HAQI) Recommendations & 2008 Results

HAQI Recommendations	*Clean Air Hamilton* Comments & Updates
Actions to Reduce Industrial Sources	
1. Implement Code of Practice/Guidelines	The Ontario Ministry of the Environment introduced two regulations to address NOx (and SOx). One is Reg 397/01 which is the capping (and trading) for the electricity sector. The second is Reg 194/04 which is a capping and trading regulation for a number of other sectors. The steel sector endorsed Strategic Options Processes in 2000. Types of BACT and SOP introduced into the steel sector and local industries included electric arc furnaces, coal pile management practices, site wide Particulate Matter (PM) Management Plans resulting in reductions of Total Reduced Sulphur, Benzene and Particulate Matter.
2. Develop Best Available Control Technology and Practices for Major Sources	
3. Implement Strategic Options Process (SOP) Recommendations	
4. Continue Permitting Programs	The Ontario Ministry of the Environment issues certificates of approval for stationary sources of air pollutants in the province. Reg 419/05- Air Quality applies to industrial sources of pollutants and the permitting process. The Ministry should continue to develop and enforce air quality/source performance standards to protect the environment.
5. Establish Industry-Local Resident Liaison Committees	The Hamilton Industrial Environmental (HIEA) Association Community Advisory Panel was formed in 1999 to provide a venue for for community representatives and local associations to discuss environmental concerns regarding their respective communities. In addition, requirements under Reg 419/05 s.32 require meetings with the public including community and neighbourhood groups as part of the permitting process.
Reduce Emissions from Private Vehicles	
6. Reduce the number of Single-Occupancy Auto Trips: • HSR Bus Service • Urban Development • Promote Cycling • Promote Walking	Since 2000, Hamilton has undertaken the Commuter Challenge: a week-long, friendly competition between Canadian cities to reduce emissions by encouraging citizens to use active and sustainable modes of transportation.

• Discourage Parking Downtown	In 2007, the City of Hamilton produced a Transportation Master Plan that encourages increased transit ridership and promotes walking and cycling within the City. In 2009, the City will release its Offical Plan with supporting land use planning polices for increased transit, cycling and walking. In 2008, the Hamilton Street railway introduced additional bus routes to Waterdown, across the mountain on Rymal Rd, and along Wentworth Rd to Stintson Ave. In addition, all transit vehicles include bike racks to encourage cycling and transit connections. Hamilton is adding bike lanes and facilities throughout the City towards a fully connected cycling network. In 2008, 22 km new bike lanes were created. The City's Cycling Master Plan is under review and available for public consultation with a new plan is to be considered by City Council in 2009. Downtown parking can be discouraged through levers such as zoning requirements, changes in parking pricing and carpool incentives, while parking and cycling facilities development should be promoted in areas where access to public transit and/or car pooling or car sharing is provided.
7. Minimize the emissions of private vehicle use: • Promote car pooling • Encourage emissions testing • Minimize discretionary trips	Smart Commute is a partnership between Metrolinx and the cities and regions of the Greater Toronto Area and Hamilton to reduce traffic congestion and take action on climate change through transportation efficiency. Smart Commute helps local employers and commuters to explore different commuter choices like carpooling, teleworking, transit, cycling, walking or flexible work hours. The public can access services for carpolling through the Carpool Zone at www.carpoolzone.ca and Metrolinx www.metrolinx.com
8. Establish Standards for Vehicle Emissions and Implement Vehicle Emissions Testing	Since 1999, the Ontario Ministry of the Environment has operated the Drive Clean program, Ontario's mandatory vehicle emissions inspection and maintenance program that reduces vehicle emissions of smog-causing pollutants by requiring vehicles (personal and commercial) to undergo an emissions test to identify emissions

	problems and have them repaired. There are about 6.0 million vehicles in the light duty vehicle program area, many of which have been tested twice or more.
9. Anti-Idling By-laws	In 2007, the City of Hamilton enacted By-Law 06-170 that restricts the idling of vehicles in Hamilton to no more than 3 minutes. Since 2005, *Clean Air Hamilton* and the City has supported Green Venture in the delivery of an Anti-idling education campaign to the public, schools and private fleets in Hamilton.
Reduce Emissions from Commercial/Fleet Vehicles	
10. Enact Commercial Vehicle Maintenance Standards	The Ontario Ministry of the Environment Drive Clean Program includes a Heavy Duty Drive Clean program that requires large trucks and buses to pass regular emissions tests in order to have their registrations renewed. The program applies to diesel-powered vehicles registered anywhere in Ontario and to heavy-duty non-diesel vehicles in the areas of Southern Ontario where light-duty testing is required. There are about 200,000 vehicles in the heavy-duty vehicle program area.
11. Achieve More Efficient Commercial Vehicle Flow	Truck traffic should flow through the City with as little stopping, starting and idling as possible. Possible ways to achieve this include improvements to road systems, special routing of truck traffic and banning of trucks on specific routes during periods of heavy congestion. In 2008, The City of Hamilton began undertaking a comprehensive Truck Route Master Plan Study to examine the existing trucking routes, traffic patterns and truck interaction with other modes of transportation, businesses and residents of the City of Hamilton in order to determine if the truck routes need to be changed and if so, how and to where.
12. Greening of Fleets	In 1999, the former Region endorsed a hybrid vehicle partnership. The concept involved the purchase of fuel efficient, low emission hybrid electric vehicles by the Ontario Ministry of the Environment, Hamilton Hydro, and Hamilton Street Railway. In 2000, the Ontario Ministry of the Environment purchased a Honda Insight, Hamilton Hydro purchased a Toyota Prius and Hamilton Street Rail purchased two Honda Insights.

	In 2001, *Clean Air Hamilton* performed an evaluation of the hybrid Vehicle (HEV) Use. Results showed overall satisfaction with hybrid vehicle use by the City, and this initiated further development of Hamilton's hybrid fleet. In 2005, the City of Hamilton initiated the Green Fleet Implementation Plan to implement affordable and sustainable vehicle technology that demonstrates the City's leadership role toward reducing its environmental impact. Hamilton's hybrid fleet has grown to 135 vehicles and the City Transit division has also purchased 12 new diesel-electric hybrid buses. The Central Fleet has been using 5% biodiesel fuel since 2007 and estimates total GHG reduction of 546 tonnes in the period 2006-2008. Other municipalities have followed Hamilton's lead. Our partnership with many of them, in particular the City of Toronto through showcase events like the Green Fleet Expo has demonstrated our progress. The City of Hamilton is one of the leading municipalities in Ontario to transition their fleet to greener alternatives.
Other Sources	
13. Control Fugitive Dusts	Fugitive dusts are a significant source of airborne particulate matter in Hamilton. Fugitive dust control is an important responsibility of the City and at all industrial sites, particularly industries that handle or store large amounts of particulate-containing or particulate-generating materials, such as bulk storage facilities and the aggregate handling facilities. Fugitive dust control can include regular sweeping and cleaning of roads within industrial areas of Hamilton, storage pile dust control, covering open trucks, planting tree screen and vegetation, paving heavily used trucking areas, and cleaning stations to prevent dirt track out onto roads. In 2005, a Fugitive Dust workshop was held in conjunction with the City of Hamilton, the Ministry of the Environment and the Hamilton Port Authority to introduce industrial operators to fugitive dust control techniques and the health impacts of fugitive dust.

	Since 2005, The city has increased street sweeping service level in the Strathearne Avenue area and in the Burlington Street Industrial Area, provided more effective street sweeping using new regenerative-air street sweepers and increased frequency of boulevard, median and street flushing. The industrial community in Strathearne Avenue have formed the Strathearne Dust Commitee to look at best industrial practices to address fugitive dust from local operations. *Clean Air Hamilton* continues to work with various stakeholders to reduce road dusts and road dusts impacts on the community.
14. Reduce Transboundary Pollution	The biannual Upwind Downwind conference have provided a forum of education, awareness, science and policy discussions on transboundary air issues and related health impacts. In 2000, an Ozone Annex was added to the Canada and United States Air Quality Agreement. In 2008, the US EPA created tighter standards for Ozone. Unfortunately Ozone is still a transbounday pollutant that affects air quality and health in Hamilton The HAQI model won the International Dubai Award for Best Practices to Improve the Environment in 2000 and has been used as a case study nationally and internationally.
15. Develop and Implement Energy Conservation Measures: • Municipal Energy Reduction Programs • Industrial Energy Reduction Programs • Alternative Energy • Subsidies for Energy Audits • District Heating and Co-generation	In 2007, the City of Hamilton established a Corporate Energy Policy to reduce energy intensity by 3% by 2009, 7.5% by 2012 and 20% by 2020, using 2005 as the base year. The City has already begun to address the corporate fleet energy usage through Hamilton's Green Fleet Implementation Plan. In Hamilton, a number of local large industries have undertaken corporate energy reduction programs. For small and medium sized enterprises, Horizon utilities offers the Electricity Retrofit Incentive Program (ERIP) which focuses on the areas of lighting, motors, heating, ventilation and air conditioning, and overall electricity systems. Since 1999, Green Venture has undertaken energy audits for homeowners through the former Energy Star federal program and under the current ecoEnergy federal program. Both the province and federal government offer incentives for

	homeowners undertaking energy conservation retrofits. The City has begun to generate energy and reduce emissions through the use of wasted methane gas emissions. A 1.6 MW Cogeneration Facility, located at the Woodward Avenue Wastewater Treatment Plant, takes methane gas created from the wastewater treatment process to produce electricity and heat. Hamilton Community Energy (HCE) operates a district heating and co-generation facility in downtown Hamilton. The combined heat and power installation produces hot water that is distributed by underground pipeline to large buildings clustered on the west side of downtown Hamilton. Besides thermal heat, HCE's Energy Centre produces 3.5 megawatts of electricity, which is routed through the city's Electrical Distribution System.
Public Awareness	
16. Promote Public Awareness through Social Marketing	*Clean Air Hamilton* promotes behavioural changes in companies, government, institutions and individuals in Hamilton to reduce energy consumption and improve air quality. *Clean Air Hamilton* works with partners (Green Venture, Horizon Utilities, Ministry of the Environment, Environment Canada, the City) to provide programs in the community that educate and address air quality. *Clean Air Hamilton* maintains a website www.cleanair.hamilton.ca that educates and informs citizens across Canada on air quality and programs in Hamilton.
Monitoring, Research and Development	
17. Expand Capability for Inhalable/Respirable Particulate Monitoring 18. Maintain Current Monitoring System	In Hamilton, two local fixed air monitoring networks exist- the provincial Air Quality Index (AQI) monitors (West, Mountain and Downtown) and the Hamilton Air Monitoring Network which is an industry-operated network. The AQI network includes equipment from Environment Canada as part of its National Air Pollution Surveillance Station (NAPS) network at two of the AQI stations. The Hamilton Air Monitoring Network (HAMN) is an industry-operated local real time air monitoring

	network comprising 22 local companies who have committed to assessing air quality in Hamilton on a regular basis and tracking changes in air quality. HAMN was initiated in 2003 through the transfer of responsibilities for Hamilton''s air monitoring network from the Ontario Ministry of the Environment to HAMN. The network provides air quality reports to the Ministry on a regular basis and the reports are audited by the Ministry to ensure consistent and high levels of quality data. In 2008, HAMN membership increased and new air monitors are being introduced into the network in 2009
19. Expand Mobile/Portable Monitoring Capabilities	Between late 2004 and 2008, mobile monitoring surveys were undertaken for *Clean Air Hamilton* to obtain a comprehensive picture of the air quality across the City of Hamilton, in particular air and health impacts due to traffic emissions and atmospheric inversions conditions. The mobile sampling can be used to focus on locations with specific issues, to roam city-wide or to determine representative local air quality conditions (e.g., at traffic intersections) which are common issues in numerous areas across this city and in other cities.
20. Maintain Government Scientific/Laboratory Capabilities	Since 1997, government and laboratory capabilities have been maintained at the provincial and federal governmental levels.
21. Research about the Origins, Characteristics and Health Impacts of Particulates	In 2003, *Clean Air Hamilton* undertook a health assessment on air quality impacts in Hamilton, which updated the 1997 work of HAQI on air quality and health. The 2003 assessment determined 5 key pollutants result in >100 pre-mature deaths and >620 respiratory and cardiac admissions in Hamilton. In 2005 the Ontario Medical Association (OMA) issued an update to its 2000 report on the health impacts of poor air quality in Ontario. The 2005 OMA report estimated the Illness Cost of Air Pollution (ICAP) for Ontario in 2005 to be $16 B (or about $1250 per year for every person in Ontario). The mobile monitoring studies have been investigated and determining the linkages between air quality, transpiration sources and health impacts along major roadways.

22. Analyze and Model Transportation Emissions	To support on-going air quality improvement actions, mobile scans for NO_x (Nitrogen oxides), SO_2 (Sulphur Dioxide), PM (Airborne Particulate Matter) and CO (Carbon Monoxide) were performed in traverses across the city, at selected industrial areas, at traffic intersections, at schools during student pickup and drop-off times, near drive thrus, and along highways were conducted in 2005 to 2007. The mobile monitoring demonstrated that citizens of Hamilton are exposed to very high levels of pollutants due to traffic related emissions, particularily along majn transportation corridors as oppose to arterial and residential areas. The data collected by the mobile monitoring work has been shared with the province, the City, and with the McMaster Spatial Analysis Group. When transportation models undertaken by the McMaster Spatial Analysis are compared to actual emissions monitoring form the mobile study, the data are highly comparable.
23. Research on the Impact of Air Toxics on Ecosystems	The atmospheric deposition of large quantities of persistent toxics into the aquatic environment was an issue for HAQI in 10997 and remains an issue in the harbour under the Hamilton Harbour Remedial Action Plan (RAP). Movement has begun on Randle Reef with involvement and funding by all partners, federal, provincial, municipal and local communities with implementation in 2010.
24. Develop an emissions inventory and carry out atmospheric modelling	In 2008, the City Of Hamilton approved an Air Quality and Climate Change Strategic Plan to undertake actions to meet corporate emission targets of 10% reduction of 2005 greenhouse gases levels by 2012 followed by a 20% reduction of 2005 greenhouse gases levels by 2020. The City is currently undertaking a City wide air pollutant and greenhouse gas inventory to assess the levels of GHGs and air pollutants in Hamilton, identify sources and undertake actions to improve air quality and climate change in Hamilton and to meet the intended targets of the Strategic Plan.

	Clean Air Hamilton and the City have also partnered with the Clean Air Partnership to undertake studies in atmospheric modelling.
25. Review and Continued Refining of Environmental Priorities	In 1997, HAQI noted that air quality is a concern of citizens in Hamilton. This statement continues to apply today. It is still essential that air quality in Hamilton receive adequate attention and a systematic evaluation of air quality issues continues along with the establishment of priorities. *Clean Air Hamilton* through its partners continues to evaluate and recommend actions and policies to improve air quality and the health of the citizens of Hamilton.

Appendix B: 2008 *Clean Air Hamilton* Strategic Plan

Strategic Issue	Activity in the Community	Purpose, Opportunities, Pressures	Partners	Research	Communication	Actions
Public Health Protection	Heat Alert, Corporate Smog Plan	Concern for the public health in regards to AQ; expand health base for AQI	Health Canada, Public Health Communications, School boards, Parks & Recreation; Green Venture,	Air Quality Health Index (AQHI)	How individuals can avoid health problems tie health based AQI	Introduce AQHI to Hamilton
					Create a standard package for the community and corporate areas so they know what know what to do to protect health during inversion or smog days	Community Smog Plan
					Special package alerts for physicians and health care providers	
			OPHA School boards, private schools, bus operators, bus associations	Get data together comparing PM release in old school buses to new ones		Retrofitting or replace school buses, workshop
Active & Sustainable Transportation	Commuter Challenge; Smart Commute; Transportation Demand Management (City); Active & Safe Routes to Schools (Public Health); GTTA;	Encourage the use of active and alternative means of healthy transportation, reduce emissions from personal transportation	Planning, Economic Development, Public Works, Cycling Committee	Feasibility to provide corporate telework; compressed work week/months; cycling amenities; preferential carpool parking; insurance rate reductions; transit pass	Cycling workshops/events; overall promotion of alternatives; awareness of SOV negative environmental impacts	Best practices for Hamilton businesses on promoting active and sustainable transportation. Audits for businesses to gauge their level of support

		Reduced emissions from driving year round. Prioritize building on success and momentum.	Green Venture, Commuter Challenge participants, Chamber		Smart driving communication program	Promote behavioural shift;
	Totally Transit	Transit -change drivers into riders, get young people before they become drivers, make sure riders stay as riders	HSR, School boards, Green Venture, EH	What would be the economic and air quality impacts of free transit, status quo, increased fares?		School bus education program at schools; promote behavioural shift
Smart Driver	Idling Stinks campaign, NRCan Idle free program, Idle By-law	Reduce unnecessary vehicle idling in Hamilton	GV, City of Hamilton		Information on idling and by-law	Promote behavioural shift
	Drive Clean; Smog Patrol; Mobile Monitoring	Local impacts of diesel truck traffic	MOE, MTO, Public Works	Get data on diesel emissions from vehicles (mobile monitoring)	Outreach with truck industries; Smog Patrol	Remove diesel engines. Have a form of regulation that would not allow dirty diesel engines within city boundaries.
		Reduce demand for vehicle ownership and therefore unnecessary trips	Guelph Car Share Coop, People's Car, GV, EH		Engage interested Hamiltonians	Car Share Coop organizing meeting
	Fleet Smart Fuel Management 101 workshop	Reduced emissions focused on fleets	NRCan, GV			Organizing fleet workshops
Air Monitoring	HAMN required for industries to monitor airshed.	All emitting industries should participate in HAMN	HAMN, MOE		Provide HAMN data on-line	Encourage MOE to undertake monitoring requirement in C of As

		Real time monitoring available to public	HAMN, MOE		Website	HAMN data available on CAH website
		New and emerging monitoring technology, LIDAR, DIAL	MOE	Examine technology and usage	Presentations, workshops	
		Mobile Monitoring	MOE, EC, City	Inversion days, health impacts data		Continue mobile monitoring
Air Quality Communication	CAH Annual Report; CAH website; Upwind/Downwind Conference; Displays; brochures	School boards involved; potentially get a representative on CAH committee	School boards	Indicators of local action on air quality that could be reported in addition to air quality parameters		School board rep on committee
		Educate the public-what are the problems, how does it effect you, what can you do.	GV			
	CAH website	Clean air Hamilton is effective and efficient -must maintain support	City, MOE, Environment Canada, Health Canada		Update material	Look at design, content, explore new server or hosting
		Update and current, user-friendly and informative	Planning & Econ, Dev			
Climate Change	Corporate AQ&CC Plan; Climate Challenge (Environment Hamilton)	The linkages to AQ	Environment Canada, MOE, McMaster	Research linkages to AQ (CO, NOx) and actions	Outreach on AQ & CC linkages	Create a Community Climate Change action plan

		Subcommittee to look at city-wide Climate Change issues	City, McMaster, Green Venture, Environment Hamilton, Conservation Authority			
Emissions Reductions		Get on Air Pollution Index with abatement and enforcement Develop tool that can trigger immediate action by industry in poor air quality situations; Drive action when needed; Protect health	MOE, City	Research best practices	Create a standard package for the community and corporate areas so they know what to do to reduce emissions during inversion or smog days	Community Smog Plan
	Mow down pollution programs, Leaf blower education	Reduce usage of two-stroke engines, tie in with pesticide education	GV, Home Depot, Lowes, Home Hardware			Summer carbon-neutral grass cutting and lawn maintenance; Leaf blower education
Energy Conservation	Horizon Utilities programs; Energy roundtable	Promotion / energy conservation & alternatives	Public Works, NRCan, Utilities, Green Venture			Promotion / energy conservation & alternatives
	Generation Conservation curriculum-based program for Grade 5 students	Create a generation of energy conservers who understand the consequences of the wasteful use of electricity and the connection to climate change.	Hamilton-Wentworth District School Board, Hamilton-Wentworth Catholic District School Board, of Niagara, Niagara Catholic District School Board, Hamilton Libraries		Teacher workshops, teacher guides, student workbooks, classroom materials, posters, flyers	

	Light exchange/bulb	Promotion / energy conservation & alternatives	Horizon, Public Works, Green Venture, Environment Hamilton		Switch to CFL bulbs	
	Appliance exchange (a/c, fridge)		Horizon, Public Works			
	Energy Audits	Energy conservation and savings (low income neighbourhoods)	Green Venture			
Land use Planning	Official Plan review; Provincial Policy Statement;	Street design cycling lanes / parallel, pedestrian oriented streets, stop signs vs. roundabouts, driving patterns	Planning & Economic Development, Public Works, GV			Complete street audits
	Urban Heat Island (UHI)	Reduction of UHI in urban environments	Planning & Econ. Dev, Public Health, Public Works, GTA CAC, NRCan, MAH, Health Canada	Urban heat island strategies, green roofs, white roofs		
Tree Programs	Numerous tree planting programs in City (Red Hill Valley, Councillors, Street Planting, Earth Day, Ikea)	Trees improve air quality, fight climate change, lower heating and cooling costs, reduce water demand and store rainwater, increase happiness, slow traffic	GV, Conservation Authority, Public Works, Earth Day Hamilton, businesses	Develop a tree planting inventory for Hamilton; fill in gaps (i.e. low income neighbourhoods)		Develop a tree networking body--Tree Roundtable to consolidate efforts

Appendix C: 2008 *Clean Air Hamilton* Financials

In 2008, the Air Quality Budget for the City of Hamilton and *Clean Air Hamilton* was $80,000. Financial contributions for other sources was $101,700. In-kind contributions including volunteer time and advisory role of Clean Air Hamilton members on programs was $97,575.

2008 *Clean Air Hamilton* Financial Report				
Project/Program	**Clean Air Hamilton Contribution ($)**	**Other Contribution ($)**		**Total ($)**
		Financial	**In-Kind**	
Idling Awarness/Eco Driver	$15,000	$3,000 – Ministry of the Environment Go Green Fund	$800 - NRCan $600- Volunteers	$19,400
Totally Transit	$15,000		$1,200 Hamilton Street Rail	$16,200
Car Share	$5,000		$475 – First Unitarian	$5,475
Liveable Cities	$5,000		$1,500 Planning & Econ. Dev	$6,500
GHG Inventory	$40,000	$60,000 - Planning & Economic Dev.		$100,000
Mobile Monitoring		$22,000 - GeoConnections Grant $16,700- Ministry of the Environment Grant	$36,000 - Rotek Env Inc.	$74,700
Advisory			$57,000- Members	$57,000
TOTALS	**$80,000**	**$101,700**	**$97,575**	**$279,275**

Appendix D: Air Quality Indicators - Trends & Comparisons over the Past Ten Years

Air Quality Trends in Hamilton

The graphs in this Appendix illustrate trends in key air quality parameters in Hamilton over the past 10-18 years. Longer term trends from about 1970 to the mid-1990's can be found in the 1997 HAQI reports. Significant reductions were observed in all parameters between the 1970's and the mid-1990's because major industries installed pollution abatement equipment on a number of air pollution sources; see http://www.cleanair.hamilton.ca/downloads/HAQI-Environmental-Work-Group-Final-Report-Dec-97.pdf for this longer term perspective.

Since the mid-1990s, improvements have been less dramatic than had been achieved in the previous two decades. While additional improvements in industrial emissions are certainly possible, the costs of implementation of the best available technologies to achieve these goals are significantly greater than previous upgrades. Pollution abatement technologies and strategies continue to be implemented by companies within the industrial sector. During the past year there have been incidents of pollutant releases from some industrial facilities with older pollution abatement equipment. *Clean Air Hamilton* strongly recommends that all stakeholders evaluate their air pollution control equipment on a regular basis and make every effort to install the most efficient and non-polluting technologies when upgrading their pollution control equipment. Stakeholders are encouraged to identify and install the best available pollution abatement technologies when constructing new facilities or when retrofitting existing facilities.

Clean Air Hamilton recommends that all citizens critically evaluate the fuel and energy efficiencies of any energy-consuming appliances, passenger vehicles and trucks that they may be considering purchasing over the next few months. In most of the graphs below, one line represents the average ambient air levels in residential areas of the city, based on data from two or more air monitoring stations located at City Sites, while the other line represents the average ambient air levels near industrial sites, based on data from two or more air monitoring stations located near Industry Sites.

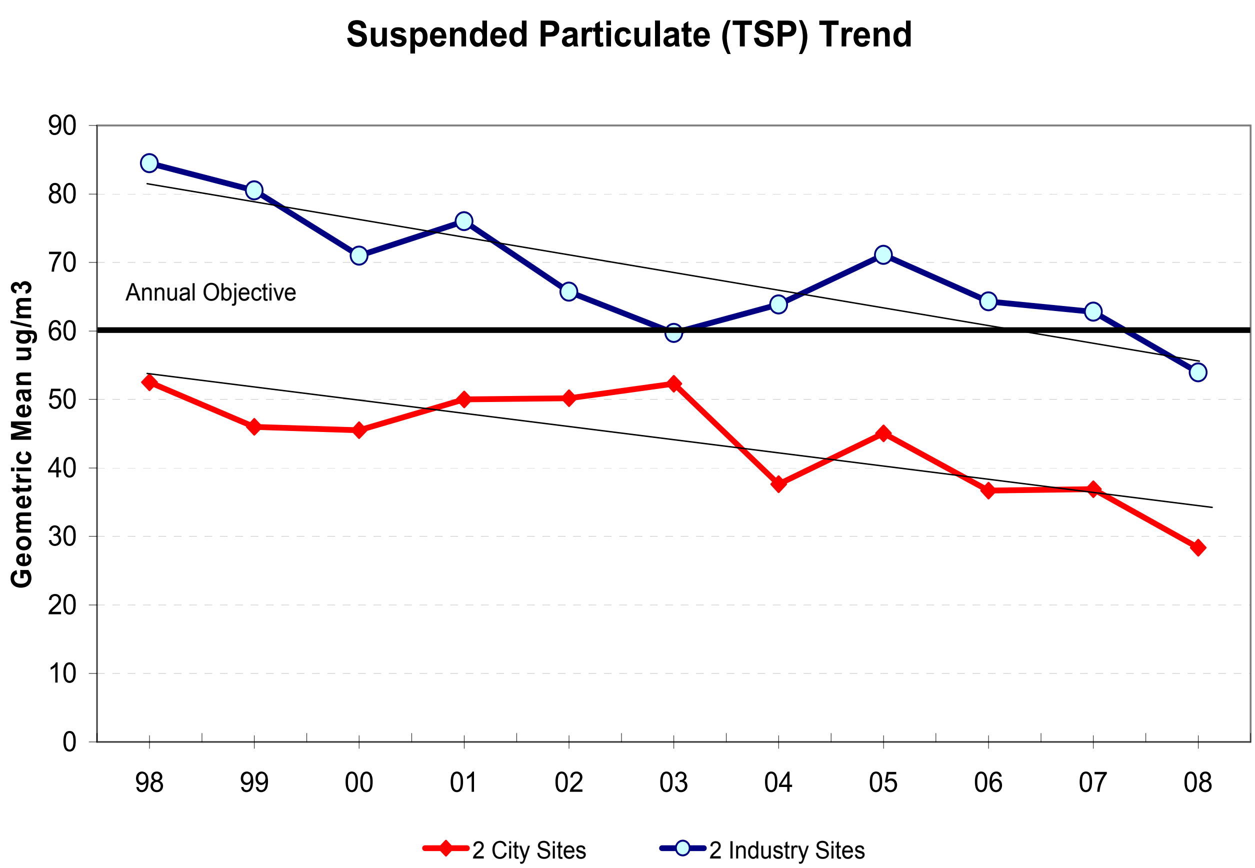
The air quality in Hamilton is affected by emissions and activities from both inside and outside our region. The 1997 Hamilton Air Quality Initiative (HAQI) reports stated that about 50% of the pollutants in Hamilton's airshed were due to sources outside the Hamilton region; indeed, the primary, non-local source was long-range, trans-boundary loadings of pollutants across south-western Ontario from sources in the mid-west region of the United States.

A 2005 report from the Ontario Ministry of the Environment showed the results of modeling estimates of the impacts of US sources on Canada. These estimates were based on the analysis of large-scale weather patterns and detailed estimates of emissions from sources in Midwestern US states. These results clearly demonstrated that about 50% of all contaminants in the air in Ontario (and in Hamilton) were the result of long-range transport from sources in the US. These sophisticated modeling studies were consistent with the estimates provided in the original HAQI Study reports.

Particulate Material: Total Suspended Particulate

Total suspended particulate (or TSP) includes all particulate material with diameters less than about 45 micrometers (µm). The largest portion of TSP with a diameter of 45 µm is similar to the diameter to a human hair and is just visible to the eye. Air levels of TSP in Hamilton have decreased about 20% since 1997. The city levels of TSP have decreased from about 50 µg/m^3 to about 40 µg/m^3 over the past decade. A substantial portion of TSP is composed of road dust, soil particles and emissions from industrial activities and transportation sources.

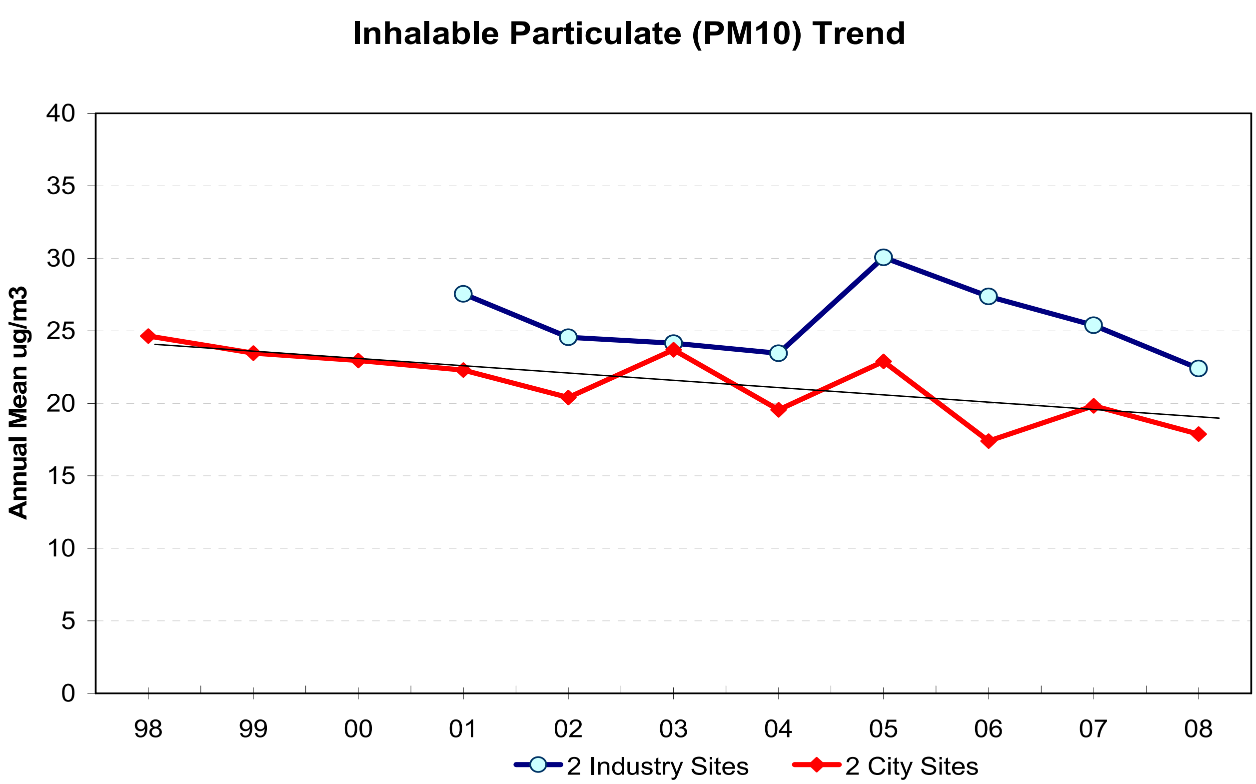
Included within the TSP category are Inhalable Particulates (PM_{10}) and Respirable Particulate ($PM_{2.5}$). By subtracting the PM_{10} or the $PM_{2.5}$ value from the TSP value it is possible to determine the net amount of particulate material in the air with sizes between about 45 µm and either 10 µm or 2.5 µm. The material in the air with diameters between 10 and 45 µm is due almost exclusively to fugitive industrial emissions and re-entrained road dust.



Particulate Material: Inhalable Particulate Matter (PM_{10})

Inhalable particulate matter (PM_{10}), the airborne particles that have diameters of 10 µm or less, is a subset of TSP. PM_{10}, which often makes up about 40% of TSP, has been clearly and consistently linked to respiratory and cardiovascular health impacts in humans. As with the TSP trend discussed above, ambient levels of PM_{10} in the city have decreased about 20% over the past decade, from about 25 µg/m^3 to about 20 µg/m^3. In areas of the city near the industrial sectors, the levels of PM_{10} are greater than city levels, reflecting the additional contributions from industry-generated PM_{10}.

PM_{10} is derived primarily from vehicle exhaust emissions, industrial fugitive dusts, and the finer fraction of road dust. Car and truck traffic counts have remained constant in Hamilton in recent years; the deceasing trend in PM_{10} over the past decade at the city both sites is likely a reflection of a combination of better performance of the vehicle fleet mix over time and better street sweeping practices in the city. The vehicle fleet performance will have improved primarily due to the lower particulate emissions from modern engines and possibly due to the removal from service of some of the worst polluting vehicles under the provincial Drive Clean program. While the impact of the Drive Clean program is difficult to assess from an emissions perspective across a city, the removal of “smokers” from the road was certainly one of the expressed goals of the program in addition to ensuring that the Ontario vehicle fleet was performing as well as could be expected.



Particulate Matter: Respirable Particulate Matter ($PM_{2.5}$)

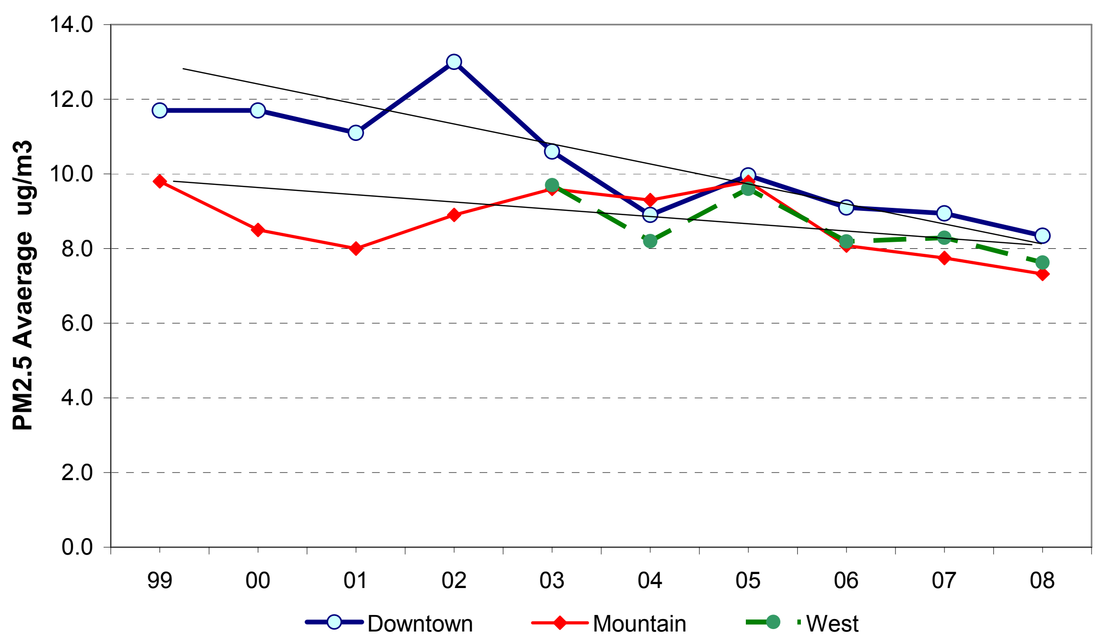
The Province of Ontario monitors respirable particulate matter ($PM_{2.5}$), airborne particles with a diameter of 2.5 µm or less. $PM_{2.5}$, which makes up about 60% of the PM_{10} in the air, has been more strongly linked to health impacts than PM_{10}. The Ontario government started measuring levels of $PM_{2.5}$ across Ontario in 1999; prior to this date there was little data on $PM_{2.5}$. In Hamilton $PM_{2.5}$ data is collected at the three AQI monitoring stations.

The trend in $PM_{2.5}$ has shown a decrease of about 20% since 1999 at the downtown site, consistent with the decreasing trends in TSP and PM_{10} in the city; the $PM_{2.5}$ levels decreased from about 12 µg/m^3 to a little below 10 µg/m^3.

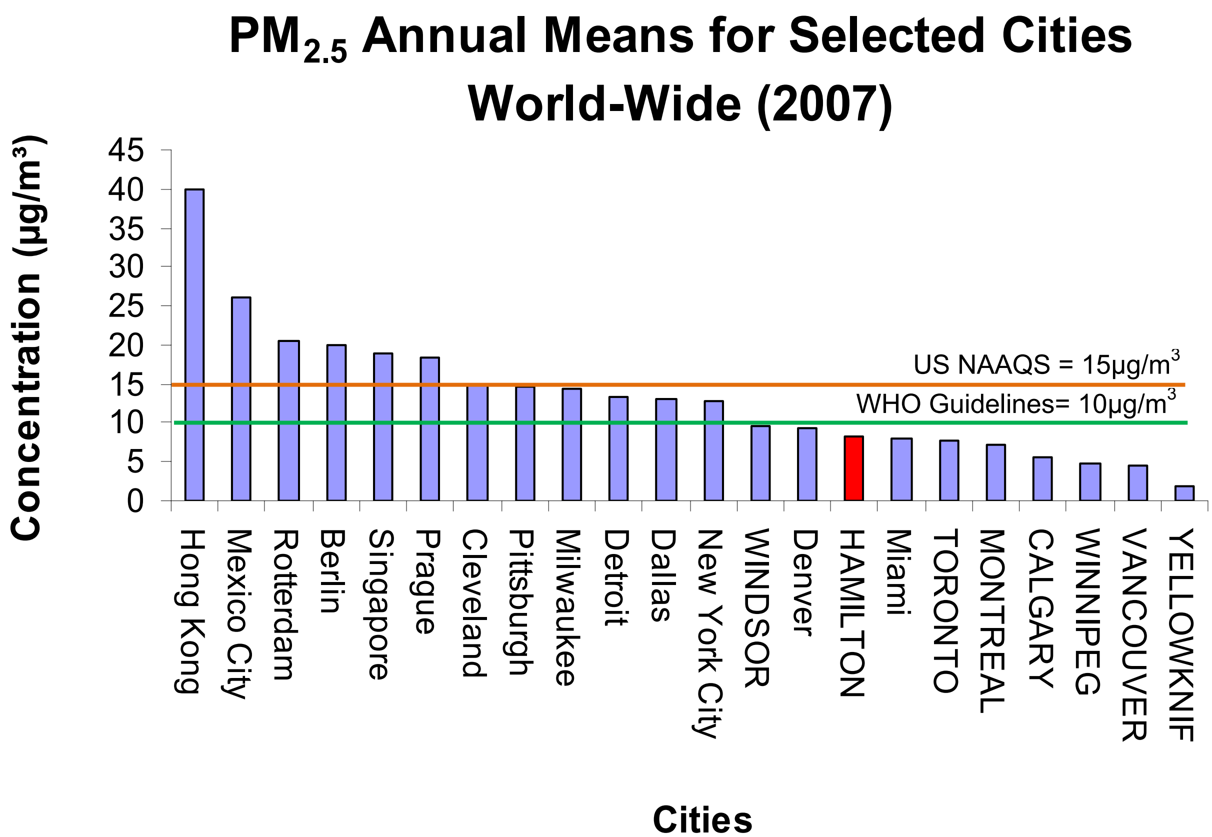
The $PM_{2.5}$ fraction of air particulate is now recognized as being responsible for essentially all of the deleterious health effects associated with air particles. Most of the particles associated with automobile exhaust, diesel exhaust and cigarette smoke have particle sizes well below 1 µm with a size range between 0.1 and 0.3 µm; vehicle combustion sources constitute about 30-50% of the mass of $PM_{2.5}$.

There has been a scientific debate over just what causes the health impacts in humans due to exposure to the $PM_{2.5}$ fraction. It is recognized that the $PM_{2.5}$ fraction contains over 95% of all particle-bound organic compounds in the air. What has not been established conclusively is whether the observed health effects are due to exposure to the $PM_{2.5}$ particles alone, to exposure to the organic compounds associated with these particles or to some combination of the particles themselves and the organic substances. Most scientists now agree that exposure to the small particles and the organic substances is the likely cause of the observed respiratory and cardiovascular health impacts attributed to particulate material exposures.

Respirable Particulate ($PM_{2.5}$) Trend



The figure below compares the annual mean levels of $PM_{2.5}$ in Hamilton with 21 other Canadian and global cities. Of the Canadian cities compared, Hamilton registered the second highest $PM_{2.5}$ annual mean reading, with only Windsor registering a higher reading. While higher than most Canadian cities, Hamilton's annual mean levels of $PM_{2.5}$ remains below the World Heath Organization (WHO) air quality guidelines and the US National Ambient Air Quality Standards (NAAQS). Out of the 22 cities compared, the five lowest annual mean levels of PM2.5 were recorded in Canadian cities. The data used for this figure was provided by Ontario Ministry of Environment.

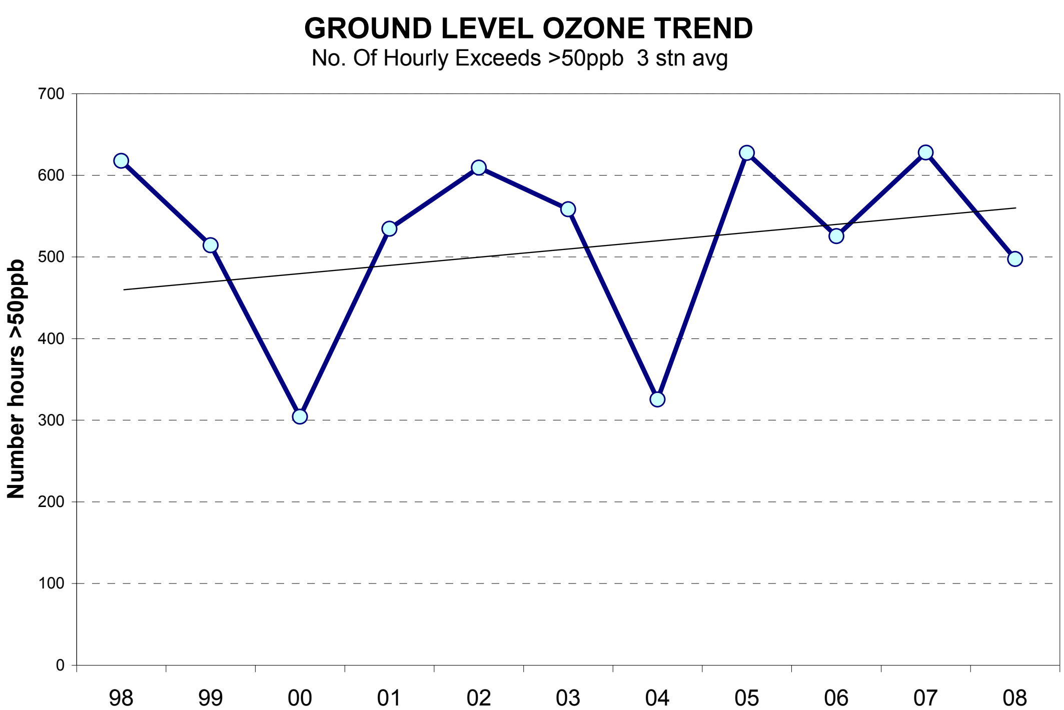


Ground Level Ozone

Ground level ozone is formed in the atmosphere when air pollutants such as nitrogen oxides (NO_X) and volatile organic compounds (VOC) react in the presence of sunlight. Air levels of ozone are higher in warmer seasons than in colder seasons because the sunlight is stronger in the summer and the temperatures are higher. The trend in ground-level ozone shows an increase of about 20% over the past decade, in contrast to the trends in many other pollutants.

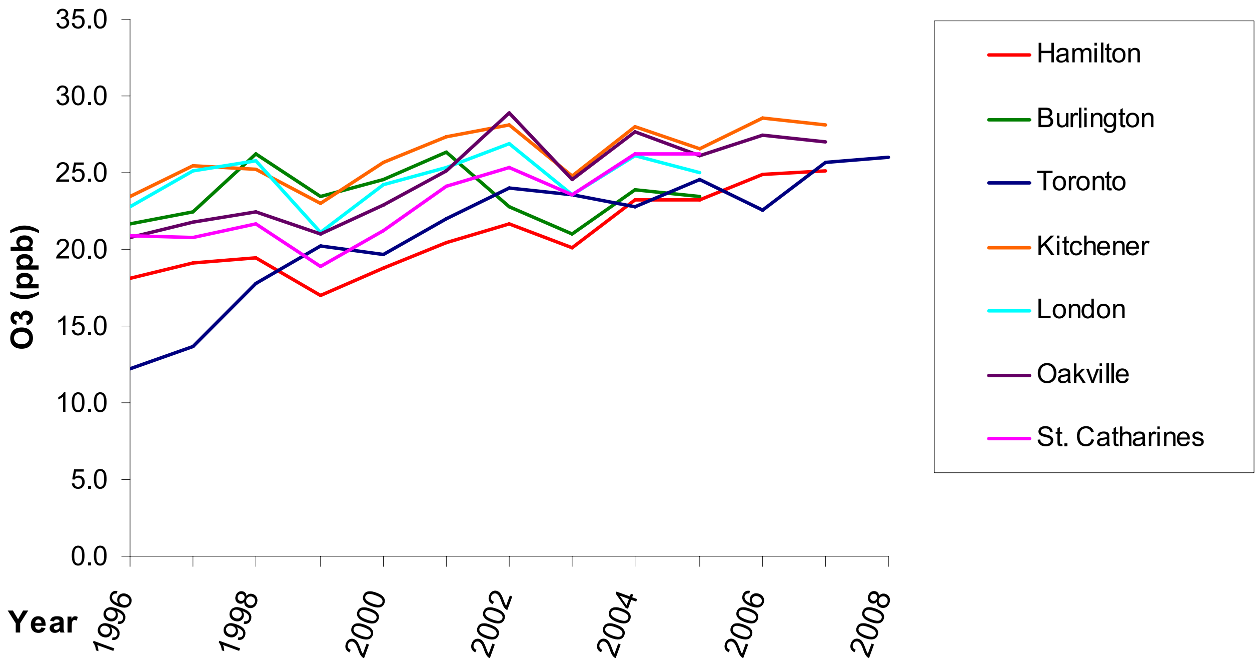
Unlike all other pollutants none of the ozone measured in Hamilton was generated from Hamilton-based sources. The formation of ground level ozone takes several hours once the pollutants have been released to the atmosphere. Thus, the ozone measured in Hamilton was produced from emissions released from sources upwind of Hamilton. Conversely, emissions from sources within Hamilton will result in the formation of ground level ozone in areas downwind of Hamilton. A substantial portion of the ozone that affects southern Ontario during smog episodes in the summer months originates from distant, upwind sources in the United States, including releases from coal-fired power plants, vehicles and urban activities in those regions.

Ground level ozone should not be confused with stratospheric ozone in the so-called "ozone layer". The ozone called "stratospheric ozone" is produced and destroyed in the stratosphere at an altitude of 30-60 km above the earth. The term "ozone depletion" refers to a decrease in the levels of stratospheric ozone due to man-made emissions, particularly halogenated refrigerants that have now been banned. Stratospheric ozone and changes in the "ozone layer" have not yet been linked to impacts of combustion emissions.

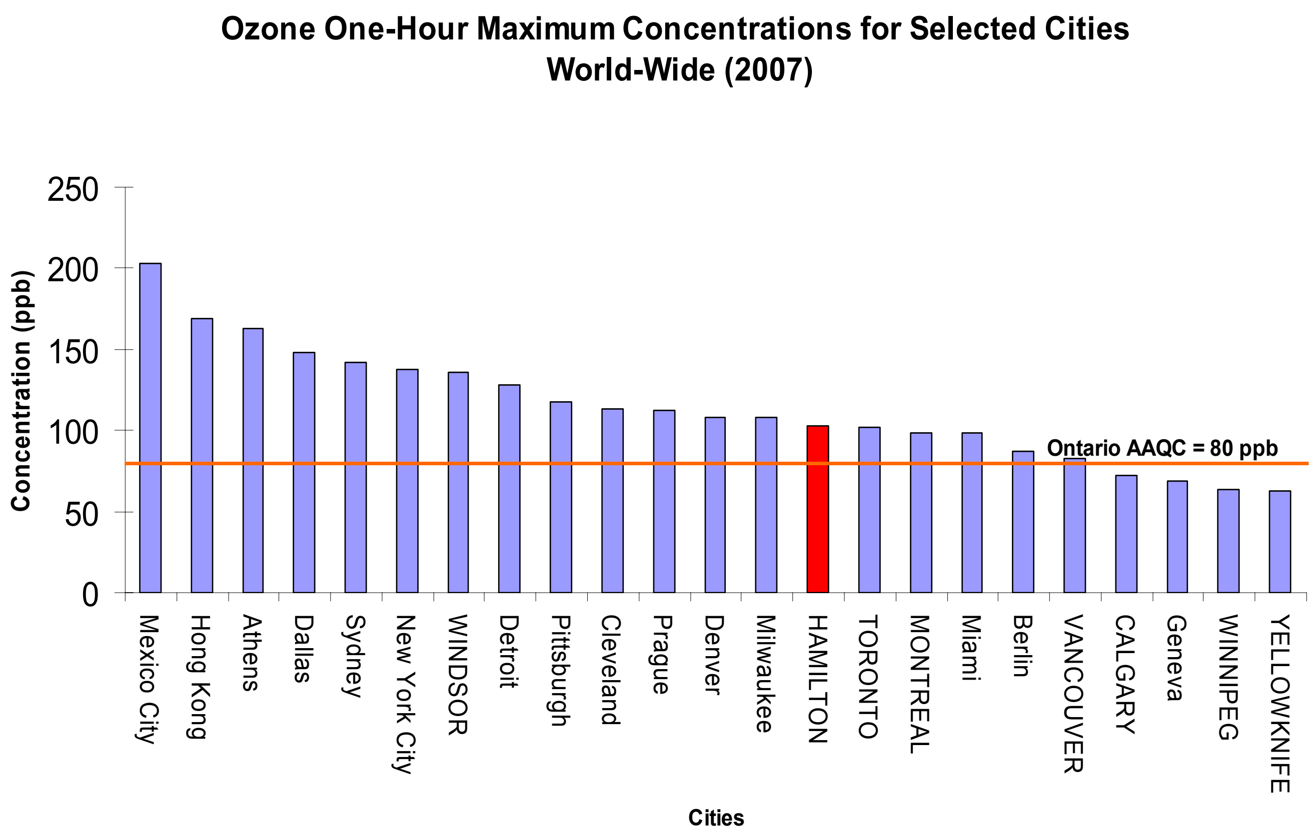


The trend in ground level ozone in Hamilton is mirrored at other locations in Ontario. Over the past 18 years the concentrations of ground level ozone across southern Ontario have increased between 10 and 30%, depending on the city. The increases seen in Hamilton during this period are similar to the trends observed in Oakville, Kitchener and Toronto.

18-Year Trends for Ozone (Seven Cities)



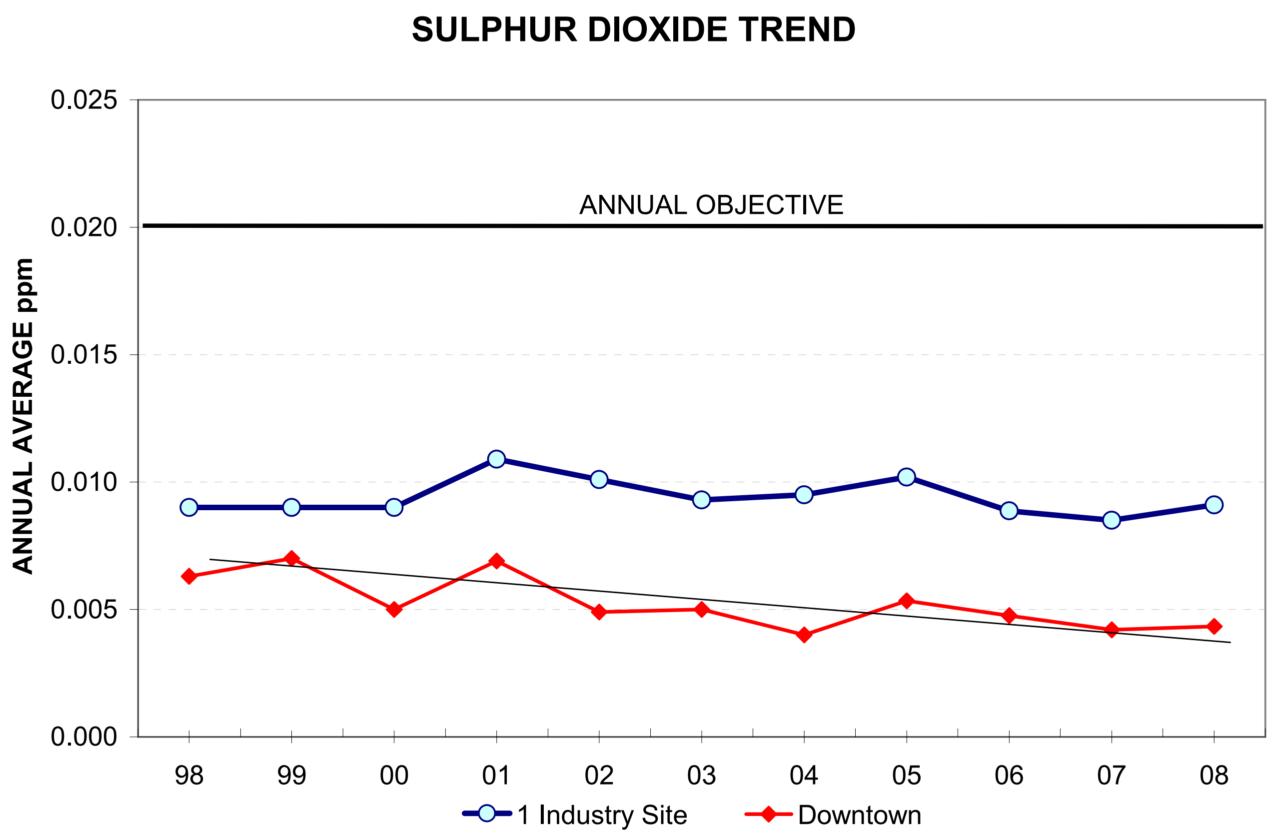
As discussed previously, the formation of ozone results from pollutants generated from outside Hamilton. Presented in the figure below, the cities with high ozone one hour maximums (ex: Windsor, Detroit, Cleveland), relative to the other cities compared, are located near the Ontario/US border. This is indicative that transboundary pollution has a significant role in ozone formation. The Ontario Ambient Air Quality Criteria (AAQC) for ozone has been unmet by the three Ontario cities compared. Only four of the 23 cities compared were able to meet these criteria. Addressing ozone pollution in cities will be a challenge and will require collaborations between countries. The data used for this figure was provided by Ontario Ministry of Environment.



Sulphur Dioxide

The principal sources of sulphur dioxide (SO_2) in Hamilton are industrial processes within the city. Significant improvements in air levels of sulphur dioxide were made in the 1970s and 1980s. Since 1995, there has been a gradual and continuous decline in air levels of SO_2. These reductions reflect actions taken to reduce SO_2 emissions from the steel industry. Combustion of fossil fuels containing sulphur is another major source of SO_2. Federal regulations to limit the sulphur content in diesel fuel to 15 parts per million by 2007 have a further impact on ambient SO_2 levels.

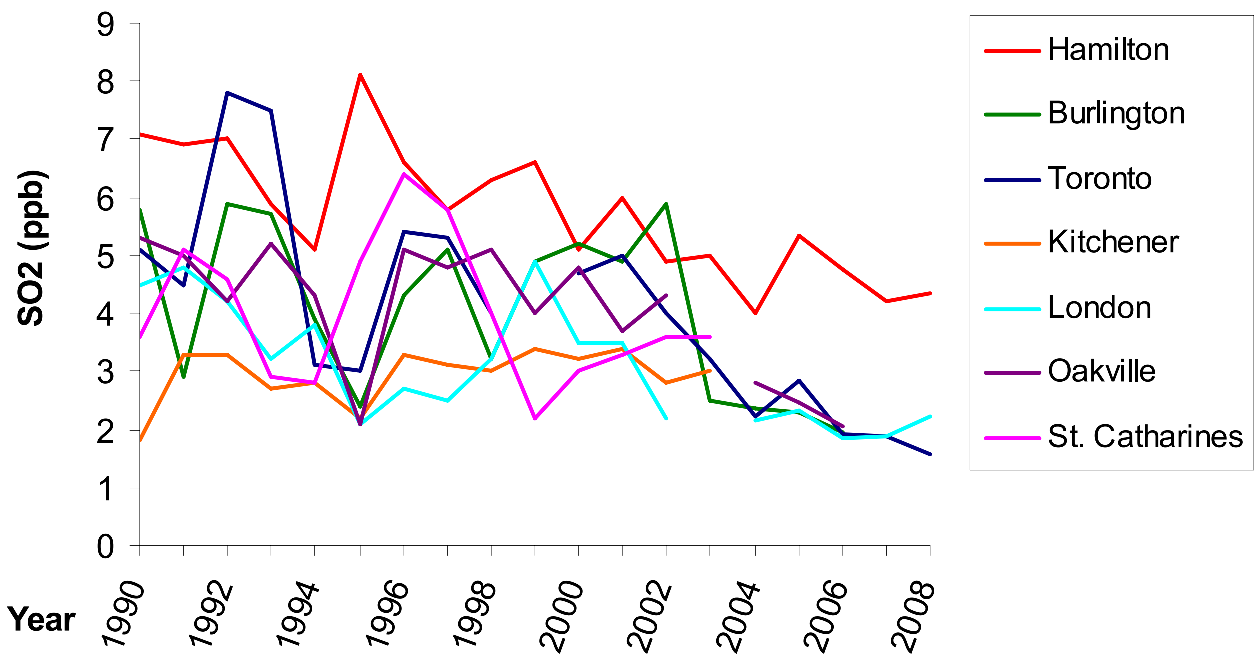
Sulphur dioxide is not only a respiratory irritant but this oxide is readily converted in the atmosphere to form sulphate particles. These particles average about 2 µm in diameter and constitute part of the respirable particulate fraction in the air. These particles tend to be acidic and also cause lung irritation when inhaled. Thus, the health concerns associated with sulphur dioxide exposures are linked to the gas itself as well as to the particulate material derived from it.



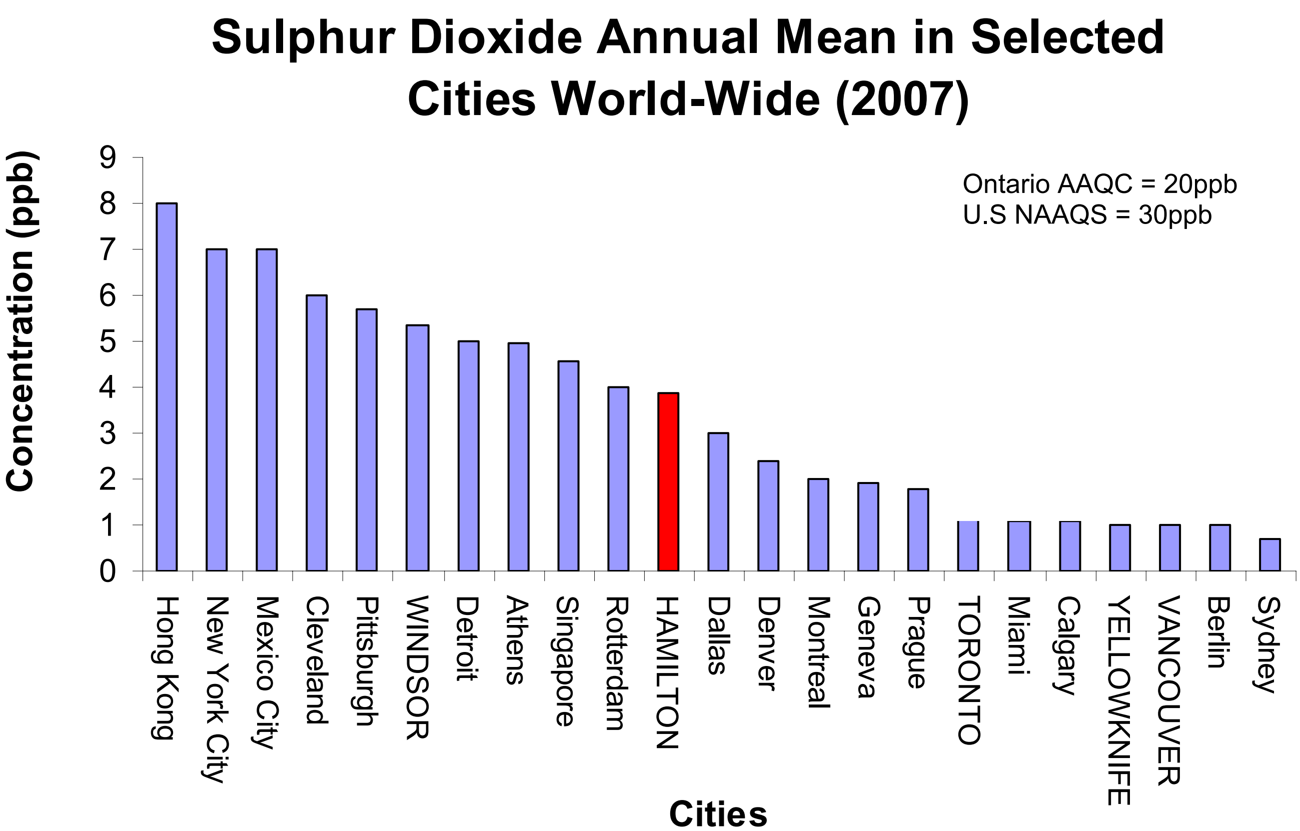
The graph below shows a comparison of the eighteen-year trends in sulphur dioxide levels in seven southern Ontario cities. The levels in Hamilton are higher than the other cities due primarily to the industrial emissions that are unique to Hamilton.

When viewing the figure below, please note that some data points contain values based on a partial year. This data may not be as representative of annual sulphur dioxide levels. Please view this figure as an approximate representation of sulphur dioxide data from these cities.

18-Year Trends for Sulphur Dioxide (Seven Cities)



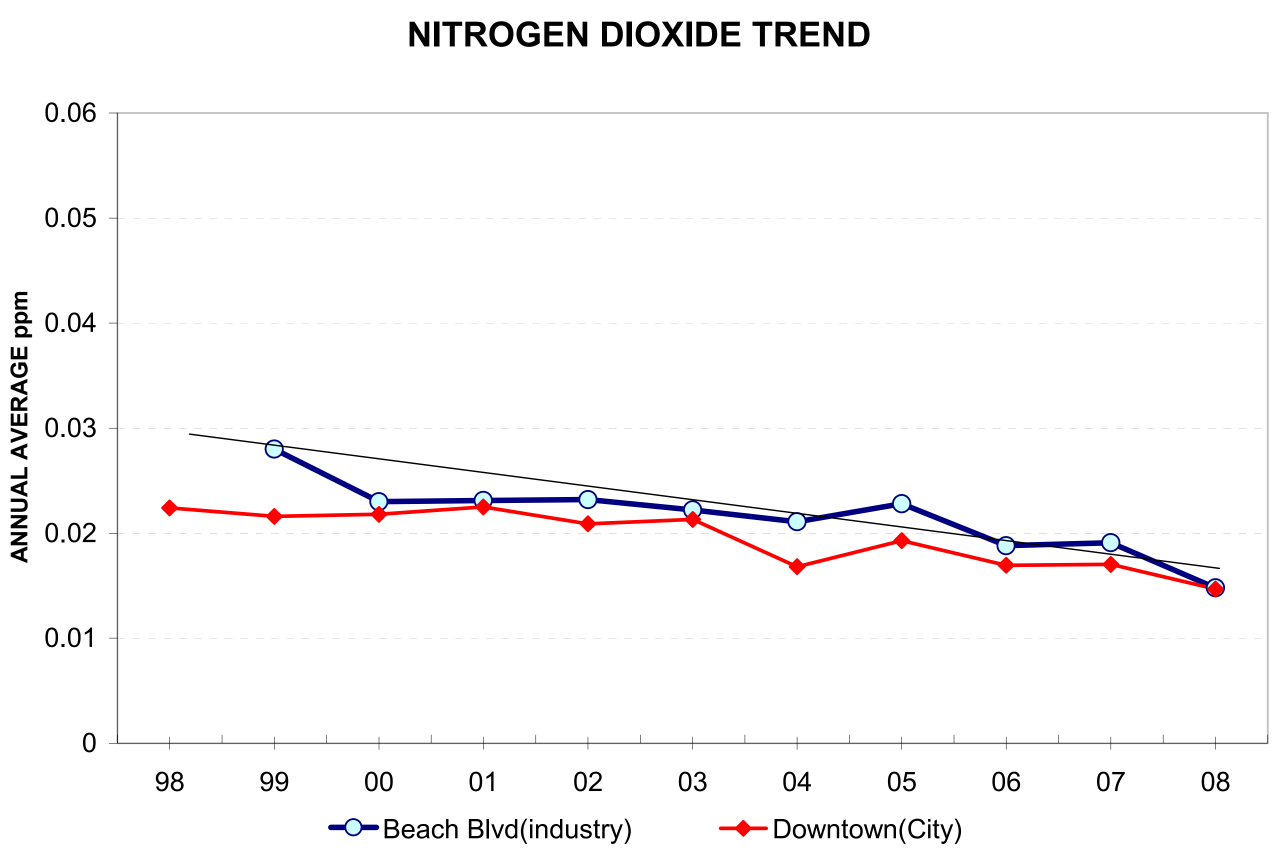
As discussed previously, Hamilton's industrial processes contributed to higher levels of SO_2. Hamilton recorded the second highest annual mean reading of SO_2 when compared to the other Canadian cities. Other cities, with a similar industrial base as Hamilton, such as Cleveland, Pittsburgh, Windsor and Detroit also recorded annual means values which were higher than most of the other cities. This demonstrates the significant effect industrial emissions have on air levels of SO_2. Despite having higher air levels of SO_2 in comparison with other cities, Hamilton's continual improvement in reducing SO_2 emissions have resulted in 2007 air levels of SO_2, which are well below Ontario Ambient Air Quality Criteria and US National Ambient Air Quality Standards. SO_2 emission reductions have had a global effect as well. All of the additional 22 cities compared recorded 2007 annual means of SO_2 that were considerably below Ontario and US SO_2 ambient air standards. The data used for this figure was provided by Ontario Ministry of Environment.



Nitrogen Dioxide

Nitrogen dioxide (NO_2) is responsible for a significant share of the air pollution-related health impacts in Hamilton. NO_2 is formed in the atmosphere from nitric oxide (NO) which is produced during the combustion of fuels such as gasoline, diesel, coal, wood, oil and natural gas. The leading sources of NO_2 in Hamilton are the transportation sector followed by the industrial sector.

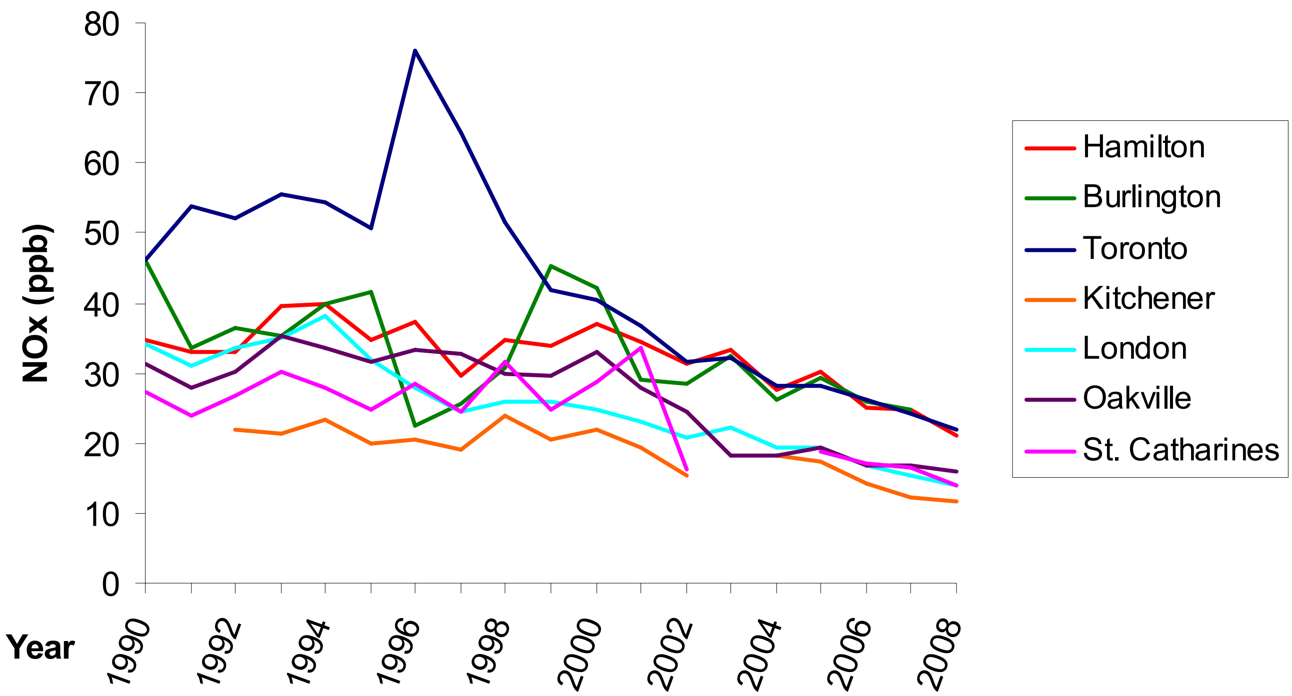
Unfortunately, there has been essentially no change in the average levels of nitrogen dioxide in Hamilton over the past decade. The level of vehicle use has increased during this time; the overall improvements in vehicle emissions performance have been offset by the increased vehicle usage in and around Hamilton.



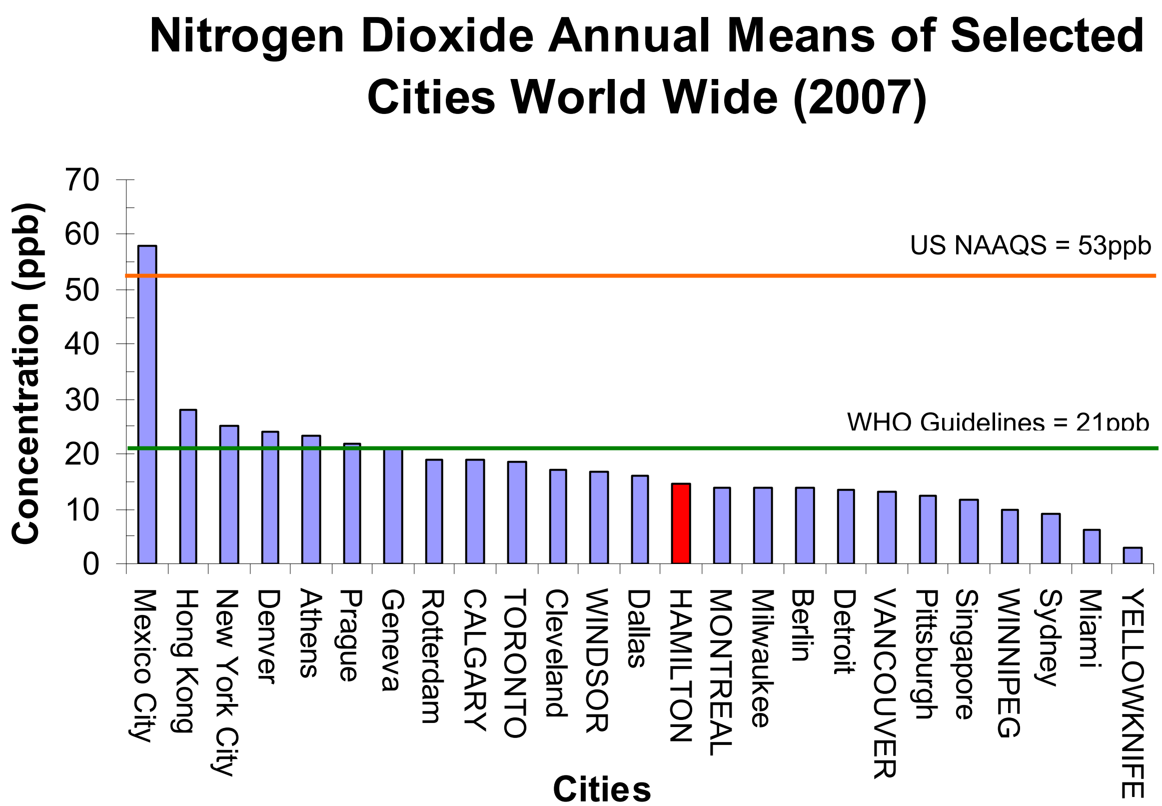
When we compare the 18-year trends in air levels of NO_x in Hamilton to NO_x levels in other Ontario cities we note that all cities have seen a decreasing trend. Toronto, which has no significant industrial NO_x contributors but significant vehicular NO_x emissions, shows the largest decrease. Since the 1990's both Toronto and London have reduced NO_x emissions by approximately 60%. Hamilton's NO_x emission have decrease by approximately 46% since 1990. The NO_x levels in Hamilton have decreased more slowly than in cities such as London and Toronto during this period due presumably to contributions from sources other than vehicles. The NO_x level is the sum of the levels of NO and NO_2. The decrease in the average NO_x levels is a reflection of improvements in emissions performance of the vehicle fleet in Ontario over the past decade.

When viewing the figure below, please note that some data points contain values based on a partial year. This data may not be as representative of annual nitrogen oxide levels. Please view this figure as an approximate representation of nitrogen oxide data from these cities.

18-Year Trends for Nitrogen Oxides (Seven Cities)



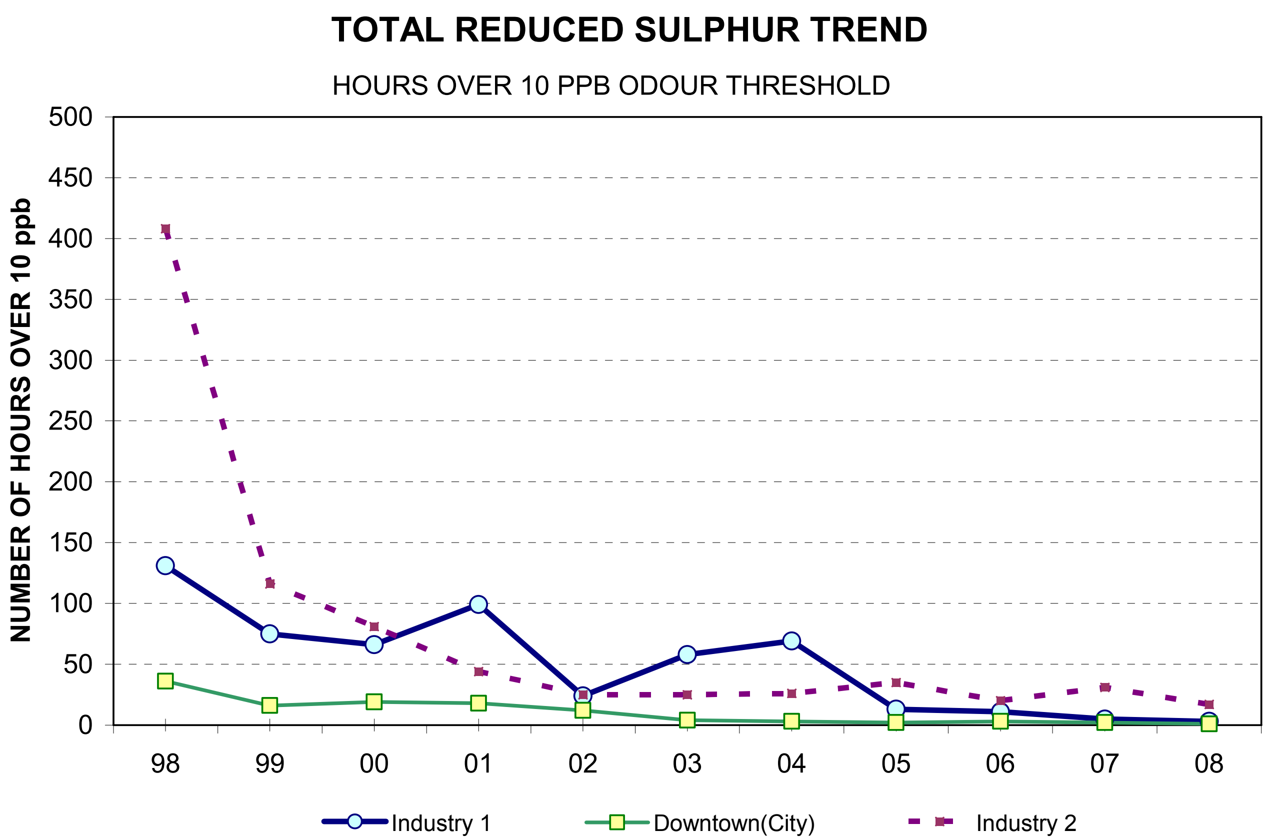
The figure below compares the annual mean levels of NO_2 levels in Hamilton with 24 other Canadian and global cities. Hamilton had the fourth highest NO_2 annual mean reading compared with other Canadian cities. Calgary, Toronto and Windsor were the three Canadian cities with higher NO_2 annual mean values. Hamilton's annual mean levels of NO_2 remain below the World Health Organization air quality guidelines and the US National Ambient Air Quality Standards. Despite being below these guidelines, Hamilton has recorded higher NO_2 annual means in comparison with cities with a similar industrial base, such as Milwaukee, Detroit and Pittsburgh. The data used for this figure was provided by Ontario Ministry of Environment.



Total Reduced Sulphur

Total Reduced Sulphur (TRS) is a measure of the sulphur-containing compounds that are the basis of many of the odour complaints related to steel mill operations, particularly coke oven emissions, blast furnace emissions and slag quenching operations. At 10 parts per billion (ppb), many people can detect TRS as an odour similar to rotten eggs.

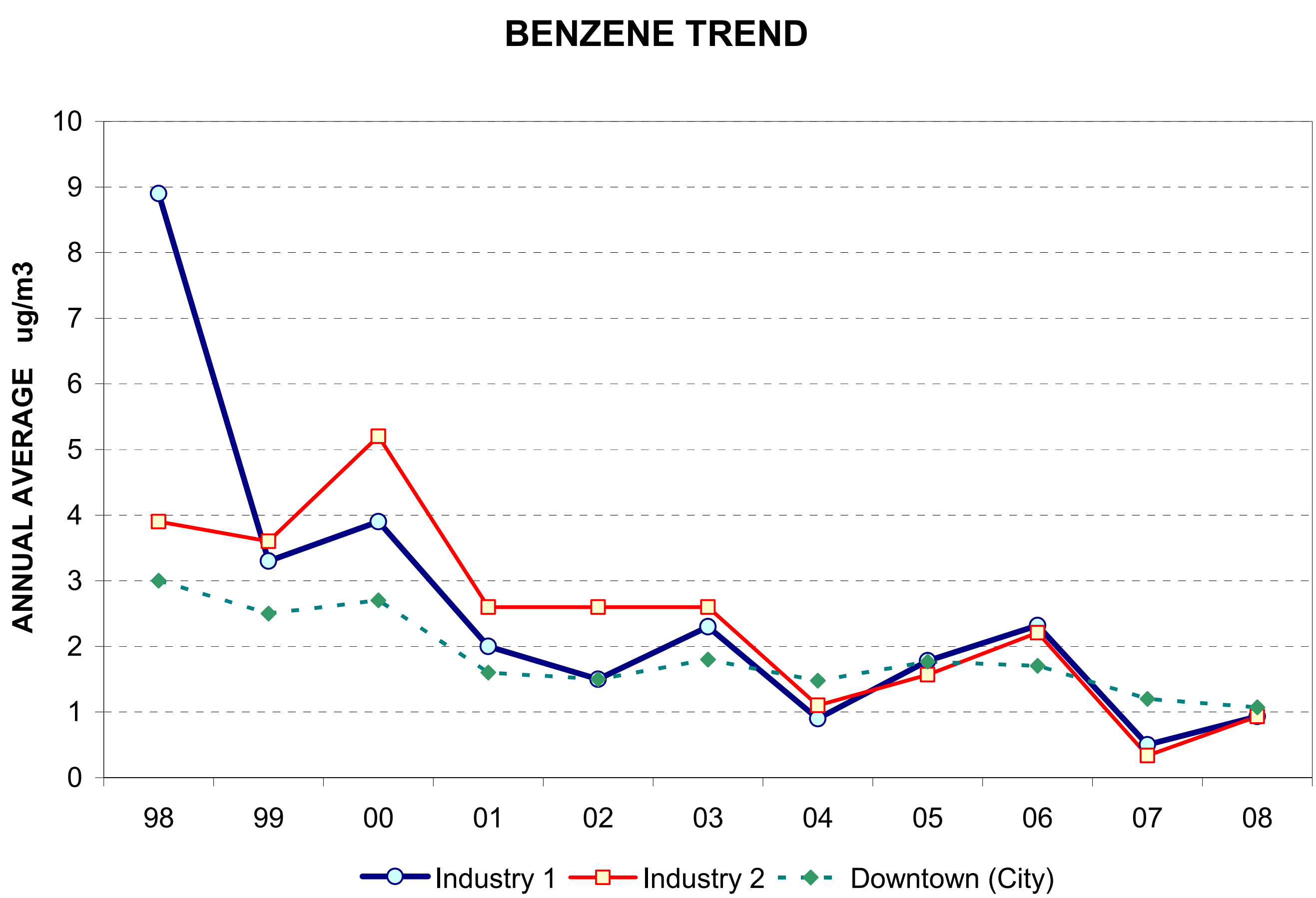
Hourly exceedances of the 10 ppb odour threshold have been reduced by between 70-90% since the mid-1990s due to significant changes in the management and operation of the coke ovens and blast furnaces. In particular, changes to slag procedures from quenching (using water) to pelletizing (using air cooling) have had the greatest effect on reducing odour-causing emissions from those operations.



Benzene

Benzene is a volatile pollutant that is capable of producing cancer in humans. Benzene is emitted from operations within the steel industry, specifically releases from the coking ovens and from coke oven by-product plant operations. Air levels of benzene have been reduced dramatically since the late 1990s due to significant upgrading of the coking plant operations, improved procedures and controls applied to the operations of the by-products plants run by both steel companies.

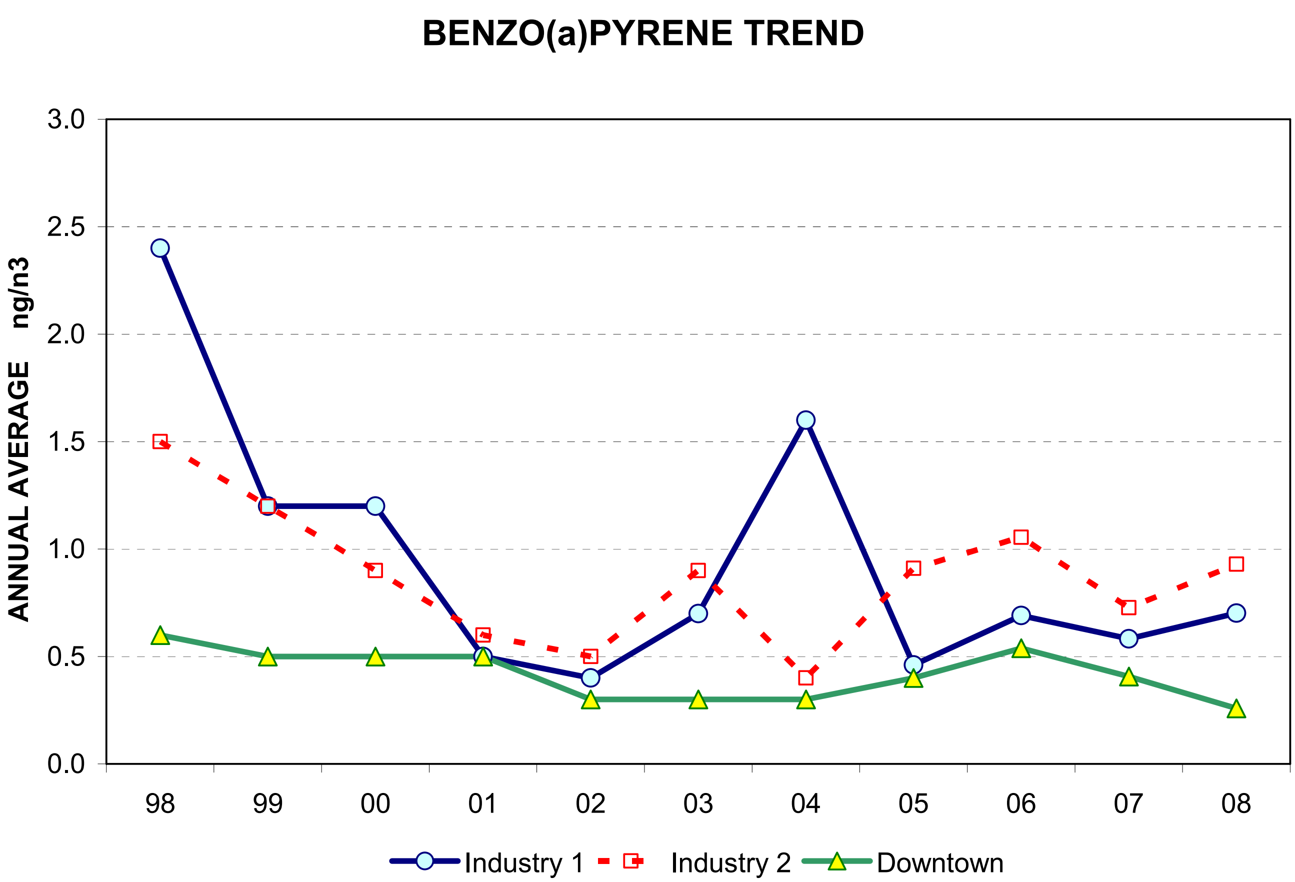
Benzene is a component of gasoline and is found wherever gasoline is used and distributed. Thus, all cities in Canada have low but measurable levels of benzene in the air. The levels of benzene in downtown Hamilton have now dropped to levels comparable to those in other Canadian and Ontario cities of comparable size.



Benzo[a]pyrene

Benzo[a]pyrene (BaP) is a pollutant capable of causing cancer in animals and humans. BaP is one member of a large class of chemical compounds called polycyclic aromatic hydrocarbons (or PAH). PAH are emitted when carbon-based fuels such as coke, oil, wood, coal and diesel fuel are burned. The principal sources of BaP in Hamilton are releases from coke oven operations within the steel industry. The significant decreases in ambient benzo[a]pyrene levels since the late 1990's are the result of improvements to the infrastructure of coke ovens themselves and increased attention to the operation and maintenance procedures for proper operation of the coke ovens.

While benzo[a]pyrene is only one of many PAH released from coking operations, BaP is undoubtedly the most potent and most studied of all PAH carcinogens (cancer-causing agents) in the scientific literature. As a result of the extensive amount of chemical and toxicological research work and occupational exposure work done with this compound, BaP has become the primary PAH carcinogen by which to compare exposures to many PAH-containing mixtures, such as vehicular emissions, coke oven emissions, barbecued foods, coal tar exposures, etc.



Projected Increase of Non-Traumatic Mortality due to Exposure to Air Pollutants

Poor air quality is associated with a range of health impacts, with increased mortality rates being one of them. The Ontario Medical Association (OMA) 2005 report on health impacts of poor air quality in Ontario estimated 290 premature deaths were associated with poor air quality. Although predicting the increase in mortality rates due to poor air quality is difficult, heath risks from air pollution are a well-accepted major public health issue.

In the *Clean Air Hamilton*'s 2003 air pollution health assessment report[5], a metric to calculate the percent increase of non-traumatic mortality associated with air pollutants was developed. This metric calculated the percent change in non-traumatic mortality per 10-unit of air pollutants and was applied to the following five air pollutants: Respirable Particulate Matter ($PM_{2.5}$), Nitrogen Dioxide (NO_2), Sulphur Dioxide (SO_2), Ozone (O_3), and Carbon Monoxide (CO). Using this metric, the figure below presents the cumulative percentage increase in non traumatic mortality resulting from air levels of $PM_{2.5}$, SO_2, and NO_2 in several cities world-wide. Please take in consideration, that these values were calculated using simple arithmetic addition and should be considered a rough indicator of the effects air pollutants have on rates of non-traumatic mortality. This figure also does not account for the health impacts resulting from synergistic effects of air pollutants (ex: SO_2 and $PM_{2.5}$).

Increase in Non Traumatic Mortality resulting from $PM_{2.5}$,SO_2, and NO_2 Pollutant Levels (2007)

5 Michael Jerrett, Talar Sahsuvaroglu. A Public Health Assessment of Mortality and Hospital Admissions Attributable to Air Pollution in Hamilton, McMaster Institute of Environment and Health, 2003, http://www.cleanair.hamilton.ca/downloads/Health-Study-(Full-Report).pdf

Appendix E: Smog Action Checklist

Personal Smog Day Actions	Will commit to	Already doing
Create your personal response plan for Smog Advisory Days and help improve air quality every day.		
Year Round Smog Reduction Actions 1. Leave your vehicle at home. Walk, cycle, carpool or take public transit (HSR , GO) whenever possible. 2. Work from home. Telecommuting is becoming popular. Ask your employer if telecommuting is an option even one or two days a week. 3. If you must use your vehicle, plan your trips to reduce distance and travel time, do all errands in one trip. 4. If you must use a vehicle, commit to be idle-free. Idling wastes fuel, impact the air and health. Hamilton has an Idling By-law. Save fuel by turning the key off if parked for 10 seconds. 5. Reduce energy consumption. Energy from fossil fuels contributes to smog. Reduce the use of non essential lighting and electrical equipment. Shut off computers and electronic equipment overnight. 6. Reduce your use of gasoline powered yard tools. 7. Tell a friend what you are doing to reduce smog.		
Summer Smog Days 1. Leave your vehicle at home. Find another way to travel around (HSR or GO transit, cycle, walk, carpool, etc.) 2. If you must use a vehicle, refuel vehicles after sundown and before sunrise if possible (before 10 am or after 6 pm) to reduce the emissions of volatile organic compounds that contribute to smog. Make sure to replace the gas cap tightly when your finished fuelling. 3. Turn the air conditioner up to 25 °C 4. Postpone or refuse to use gas and diesel power engines such as lawn mowers, chainsaws and leaf blowers. Consider using rakes or cleaner technology (electrical, four stroke engines). 5. Suspend the use of solvents, oil based paints and stains, solvent-based cleaners and other materials containing volatile organic compounds. 6. Conserve electricity – reduce the use of non-essential lighting or electrical equipment. 7. Postpone strenuous outdoor work or exercise for another day 8. Refrain from using gas or diesel powered non-essential off road vehicles (motorcycles, ATVs, marine pleasure craft).		
Winter Smog Days 1. If possible, avoid using wood as a main heating source. 2. When burning wood, use dry and seasoned wood 3. Use an engine block heater on a timer when the temperature drops below 0 °C. 4. Reduce warm up idling to 30 seconds, as long as the vehicle's windows are clear.		

Employer Smog Day Actions	Will commit to	Already doing
There are a range of strategies that can be implemented in both the private and public sector to improve air quality. Develop a Smog Plan for your organization that reduces your impacts to air quality.		
Year Round Smog Reduction Actions 1. Join the Ministry of Environment Air Quality forecast www.airqualityontario.com 2. Notify all employees and contractors when a Smog Advisory is called. Post signs, send Email notifications, etc. 3. Encourage or give incentives for employees to leave their vehicle at home. Find another way to travel around (HSR or GO transit, cycle, walk, carpool, etc.). Promote carpooling to off-site meetings, subsidize the use of public transit for employees. 4. Investigate and promote how employee telecommuting/ teleworking can work at your workplace. 5. Promote transportation challenges such as Commuter Challenge or encourage Transportation Demand Management to employees. Make it fun. 6. Commit to be idle-free. Idling wastes fuel, impacts the air and health. Hamilton has an Idling By-law. 7. Adopt or enhance a Green Fleet policy to ensure fleet vehicles and motorized equipment are at peak efficiency, use less polluting fuels (hybrids, electric, biodiesel, etc.) are replaced with fuel efficient technology or that vehicle technology is optimized. Keep your fleet properly maintained. 8. Implement an energy conservation management plan – increase the energy efficiency of office space. Reduce the use of non essential lighting and electrical equipment. Shut off computers and electronic equipment overnight.		
Summer Smog Days 1. Notify all employees and contractors when a Smog Advisory is called. Post signs, send Email notifications, etc. 2. Encourage or give incentives for employees to leave their vehicle at home. Find another way to travel around (HSR or GO transit, cycle, walk, carpool, etc.) 3. Turn the air conditioner up to 25 °C. Adopt a flexible dress code to accommodate warm workplace temperatures. 4. Encourage staff to carpool, telework or do office based work – using Email and telephone 5. Suspend non-essential motor vehicle use: a. Encourage the use of public transit, where available, or alternative transportation; delay deliveries and errands; schedule teleconferences; encourage carpooling to meetings. b. Minimize, where possible, the use of trucks and other heavy duty equipment. c. Go idle free.		

Employer Smog Day Actions	Will commit to	Already doing
Summer Smog Days (cont'd) 6. If you must use a vehicle, refuel vehicles after sundown and before sunrise (before 10 am or after 6 pm) to reduce the emissions of volatile organic compounds that contribute to smog. Make sure to replace the gas cap tightly when finished fuelling. 7. Provide alternative work options for employees working outdoors, where possible. 8. Postpone the use of gas and diesel powered engines such as lawn mowers, chainsaws and leaf blowers. Consider using rakes or cleaner technology (electrical, four stroke engines). **9.** Suspend the use of solvents, oil based paints and stains, solvent-based cleaners and other materials containing volatile organic compounds.		
Winter Smog Days 1. Notify all employees and contractors when a Smog Advisory is called. Post signs, send Email notifications, etc. 2. Reduce warm up idling to 30 seconds, as long as the vehicle's windows are clear. 3. Use a vehicle engine block heater on a timer when the temperature drops below 0 °C. 4. Suspend or reduce the use of gas and diesel powered engines, where possible.		

Appendix F: Transportation Emissions – Mobile Monitoring Research

To support on-going air quality improvement actions, mobile monitoring for NO_x (Nitrogen oxides), SO_2 (Sulphur Dioxide), PM (Airborne Particulate Matter) and CO (Carbon Monoxide) were performed in traverses across the city, near selected industrial areas, near traffic intersections, at schools during student pickup and drop-off times, near restaurant drive thrus, and along highways.

Figure 28: Mobile Sampling Areas (2007)

Main Road Sampling Track

Residential vs. Traffic-Related Emissions

Measurements made during Phase 1 of the Mobile Monitoring Study demonstrated unequivocally that the citizens of Hamilton were exposed to very high levels of pollutants due to traffic-related emissions. Pollutant concentrations were found to be very high on and close to roadways but that these levels decreased very quickly with increasing distance from roadways; concentrations of pollutants and the resulting exposures while driving can be very high indeed. The close proximity of many commuters to these direct emissions (both from diesel and gasoline vehicles) has been observed as a key factor in the increased incidence of heart attacks among commuters in Germany. Levels of 300 $\mu g/m^3$ of PM_{10} and 150 ppb (parts per billion) of nitric oxide (NO) were measured routinely, while ambient levels in residential areas were found to be between 20-40 μg/m^3 of PM_{10} and 4-20 ppb NO. Thus, peak roadway concentrations of these pollutants exceed levels observed in residential areas by 20 to 50 times.

Figure 29 shows the levels of four important air contaminants (sulphur dioxide-SO_2, carbon monoxide-CO, nitric oxide-NO and inhalable particulate material, PM_{10}) at seven road locations in Hamilton. The first five (on the left in the figure) are values obtained along major roads or intersections; the remaining data are the average for all roads in Hamilton and a typical example of data from a residential area in Hamilton; residential areas are at a distance from major roads but are usually within 200-500 m of such roads. The data collected near roads shows a range of values that span the city average near roads. The pollutant levels in the residential area were much lower than near the major roads. The levels of NO (a tracer for vehicle combustion) show the greatest differences between the roadside sites and the residential area. Clearly, residents living along major roads and those using major roads (motorists, pedestrians, cyclists, etc.) are exposed to higher levels of pollutants than individuals on side streets and in residential areas.

Figure 29: Mobile Monitoring Study - Levels of Four Air Contaminants Near Major Roads and on Residential Streets in Hamilton

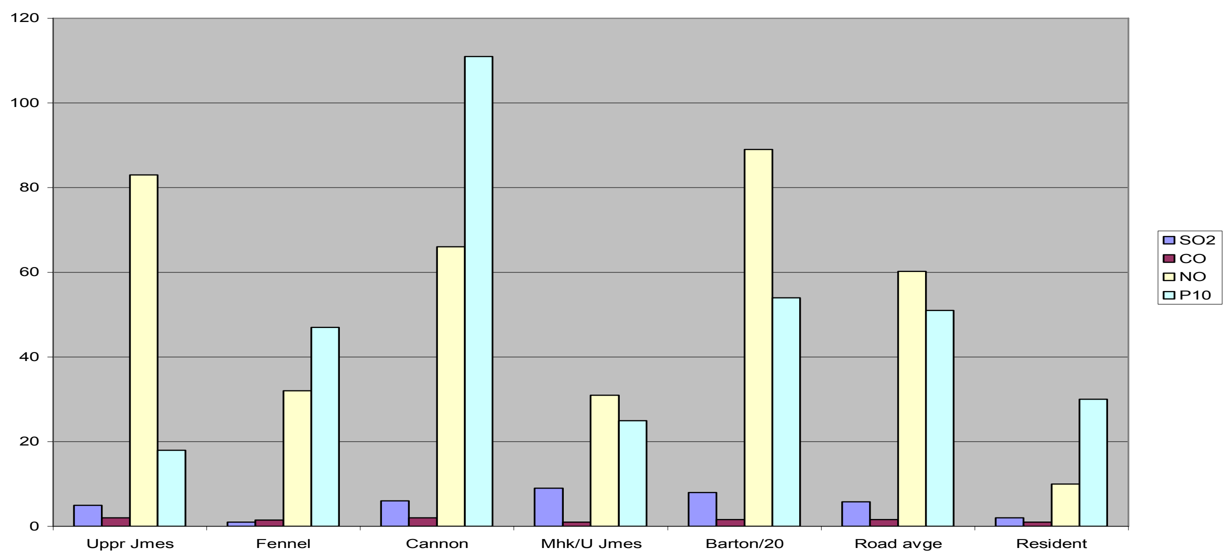
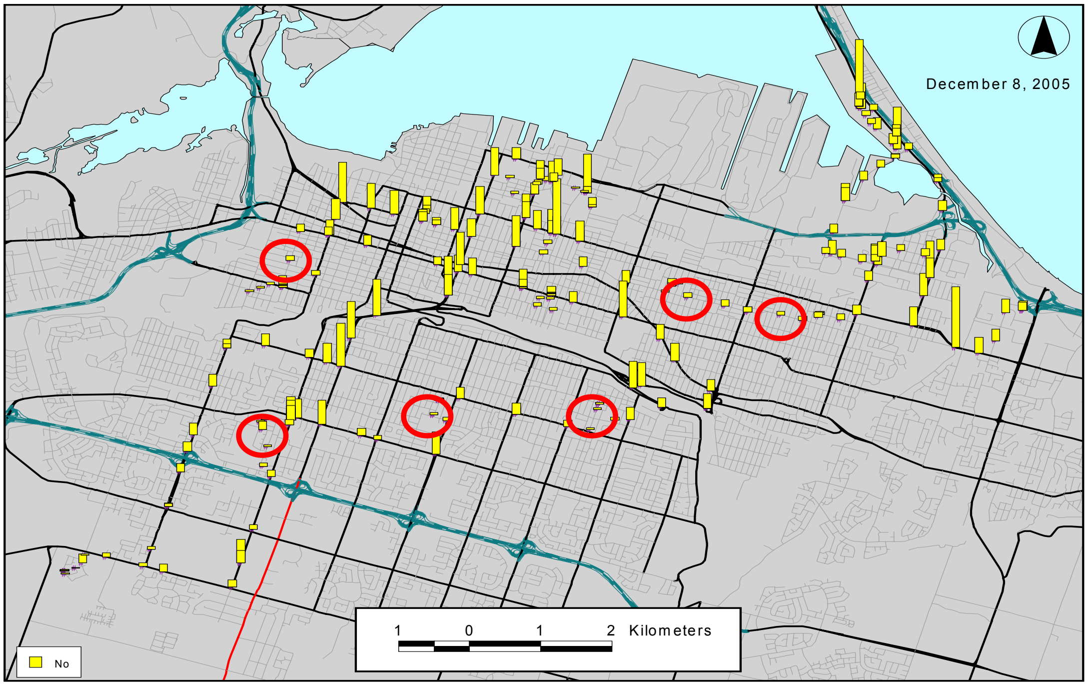


Figure 30 shows a map of Hamilton onto which has been superimposed the levels of nitric oxide (NO) in the air as measured by the air monitoring van at numerous locations in Hamilton. Nitric oxide is a combustion pollutant and is emitted directly by cars and trucks; as such, NO is an excellent measure of the impacts of vehicular pollution. Readings taken along 4-lane roads and at major intersections, together with a number of readings made in residential areas of the city are shown in **Figure 30** The greater the height of a yellow bar in **Figure 30**, the higher the level of NO measured.

Figure 30: Residential vs. Traffic-related Levels of Nitric Oxide (NO)

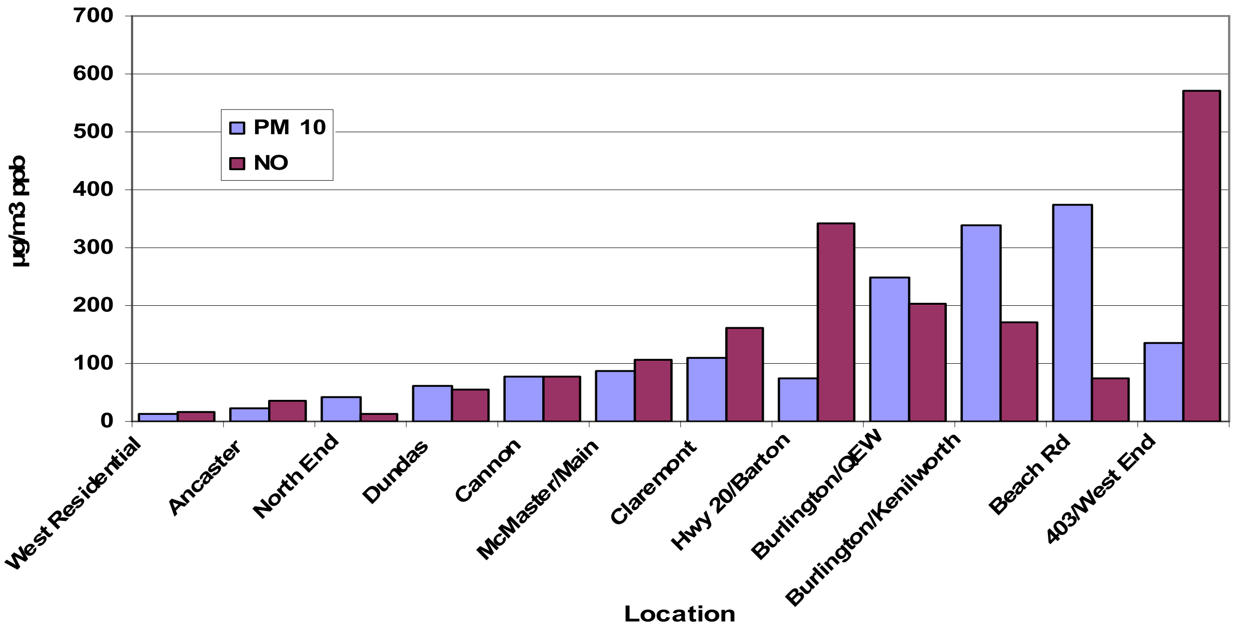


The areas circled in red in **Figure 30** are residential areas within the city; within these red circles the levels of NO are very low compared to the heights of some of the yellow bars associated with locations along major roads in the city. Clearly, residential areas experienced relatively low levels of traffic-related pollutants compared to levels measured along many major roads and major intersections within Hamilton.

Additional mobile monitoring work was begun in March 2007. In order to collect information in target areas, areas along the Highway 403 corridor from the west end of the city to Ancaster and some of the Mountain access roadways were measured. This air monitoring data showed that air quality modeling predictions were very consistent with the measured values; specifically, extremely high levels of NO (nitric oxide) were observed along the Highway 403 corridor from the junction at Main St. West and the 403 to the junction with the Lincoln Alexander Parkway.

A peak NO value of 586 ppb was measured along Highway 403. This NO level is the highest ever measured in Hamilton and is much higher than NO levels observed directly downwind of large industrial sources. The levels of NO measured on the Mountain accesses were much lower than those measured on Highway 403 and were not as high as had been predicted by the computer model. Note that the highest PM_{10} levels were measured in the east end of the city while the highest NO levels were measured in the west end.

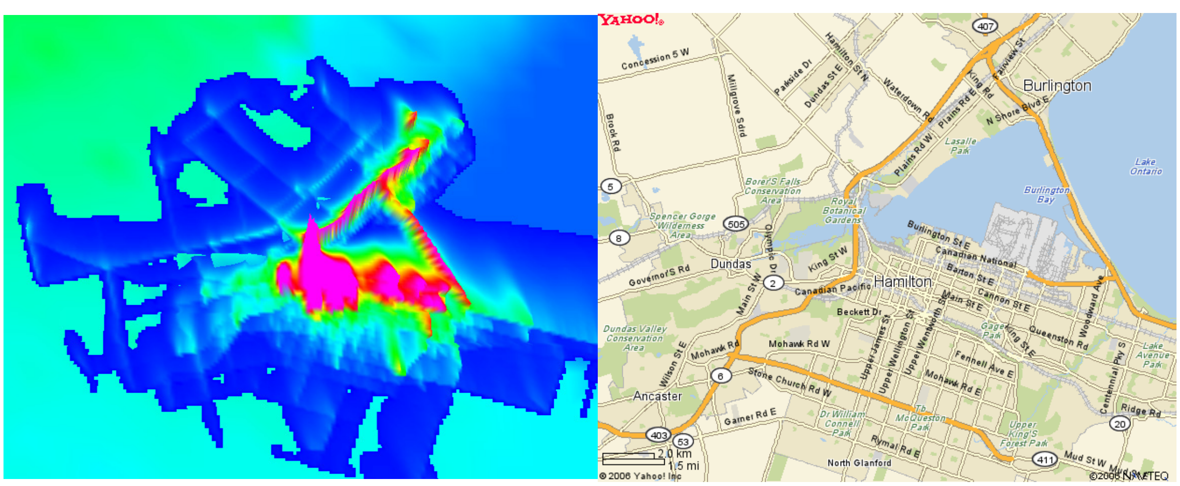
Figure 31: Levels of PM_{10} and NO Along Roads in Hamilton



The data in **Figure 31** are organized in order of increasing levels of either PM_{10} or NO. The levels were lowest in residential areas (i.e., areas with low vehicular impacts) and highest in areas with the highest vehicular traffic. These levels are typical levels of exposures for humans working or driving in these areas. For clarity, this figure does not include any locations with high fugitive dust contributions. The primary sources of PM_{10} in these samples are combustion sources, particularly vehicles.

Modelling of traffic emissions across the city had indicated that higher pollution incidences would be expected in the east end of the City around the QEW/Hwy 20 intersection, on the Claremont mountain access complex and in the west end around the Hwy 403/ King/Main/Aberdeen intersections. See **Figure 32**

Figure 32: "High Pollution Triangle" - Modeled Impacts of Traffic Air Pollutants in Hamilton

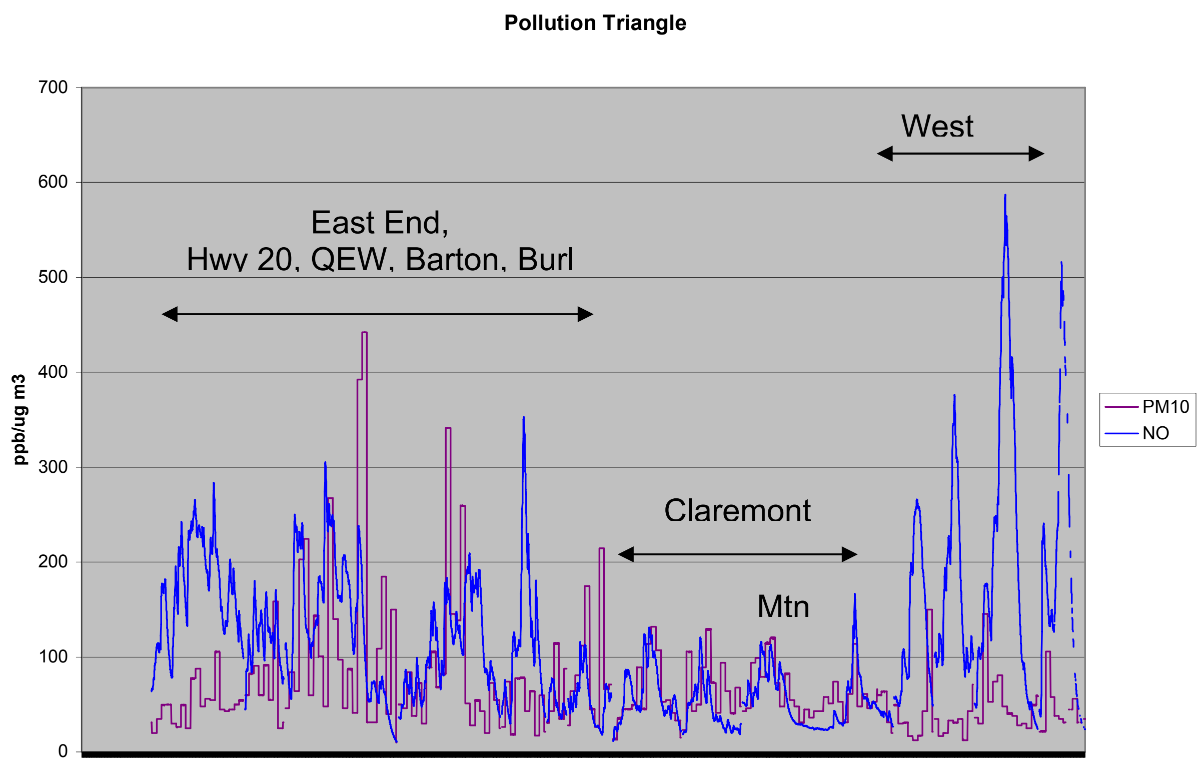


Courtesy of: Julie Wallace, Ph.D., Centre for Spatial Analysis, McMaster University.
Hamilton reference map courtesy of Yahoo Maps 2007 (www.maps.yahoo.com).

Figure 32 was generated by the Centre of Spatial Analysis at McMaster University using the air pollutant data obtained in the Phase 1 mobile monitoring work and incorporating the data into traffic models. **Figure 32** is an estimate of traffic related pollution. A map has been provided to reference the locations on the air quality model. The “high pollution triangle” is bordered by Highway 403, Highway 6, Highway 20 and the Lincoln Alexander Parkway. The model includes Main Street, King Street and Burlington Street in Hamilton.

Special sampling runs were conducted over a number of days and under different meteorological conditions to evaluate these results and compare the levels of pollutants in these three areas (see **Figure 33**).

Figure 33: Sampling in High Pollution Triangle, Compilation of 6 Sampling Days



The Claremont Access and Jolly Cut mountain accesses did not show pollutant levels significantly different from other well traveled roadways, peaking at 132 ug/m^3 for PM_{10} and 158 ppb for NO. However, these concentrations are still well above the residential levels on the mountain of 26 ug/m^3 PM_{10} and 12 ppb NO.

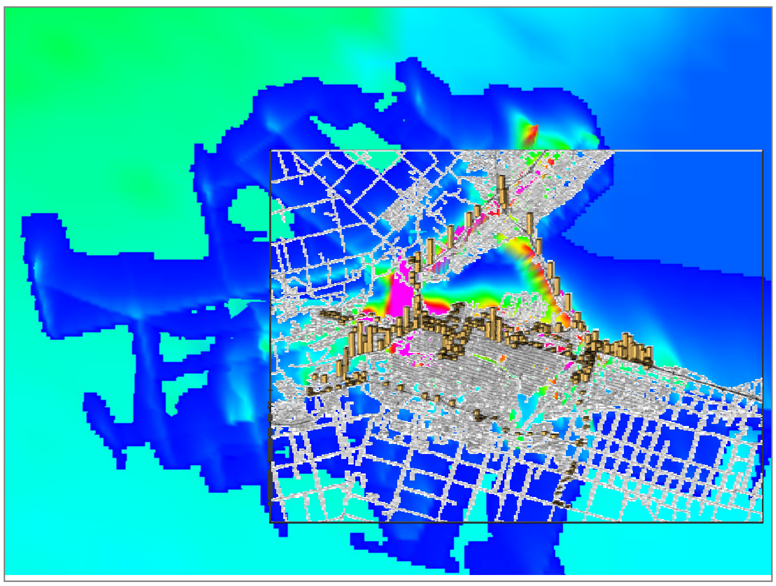
In the 403 Highway valley in the west and on the 403 Ancaster hill, very high levels of NO were detected, reaching a peak of 586 ppb. These are in fact the highest NO levels measured to date in Hamilton, higher than those measured near industrial sources. The maximum value for NO_x (NO + NO_2) was 660 ppb.

In the east end, the area covered by Hwy 20, QEW, Barton and Burlington Streets also showed significantly elevated levels of pollutants. In this area the NO peaks were observed at 348 ppb; however PM_{10} values were very elevated with a maximum value of 442 ug/m^3.

Figure 34 below shows the excellent correspondence between modelling and monitoring for traffic emissions. The yellow bars represent monitoring results for NO and the colour gradient represents the modeled results for NO.

Figure 34: Correspondence between Modelling and Monitoring Data for Traffic-related NO.

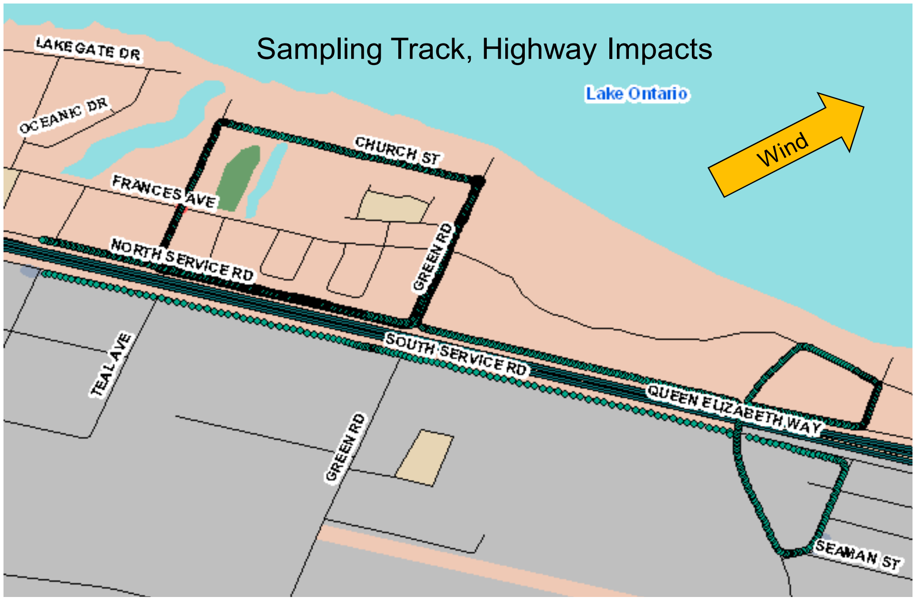
McMaster Model – Rotek Mobile Data
Monitoring/Modeling Interaction



Some of the highest levels of air pollutants in the Hamilton area were measured along local highways, the QEW and Highway 403. Mobile monitoring data also suggests that noise barriers along highways not only reduce noise levels but also result in substantial reductions in exposures to combustion-derived air pollutants.

Pollutant levels were measured under steady wind conditions both upwind and downwind of the Queen Elizabeth Way highway (**Figure 35**). Levels were also measured on a transect at different distances downwind from the highway to assess downwind impacts.

Figure 35: QEW Highway, Land Use Patterns (Residential Pink), Sampling Locations (Green/BlackLine)



While gathering data parallel to highway on the downwind side, at one point there was a sudden drop in measured values of vehicle related air pollutants. It was realized that the reason was the sheltering effect of a high noise barrier on the residential side of the QEW. Further scans confirmed these significant reductions in pollutant levels, see **Figures 36 & 37**.

Figure 36: Noise Barrier Effect, NO, NO_2 and NO_x with and without Noise Barrier.

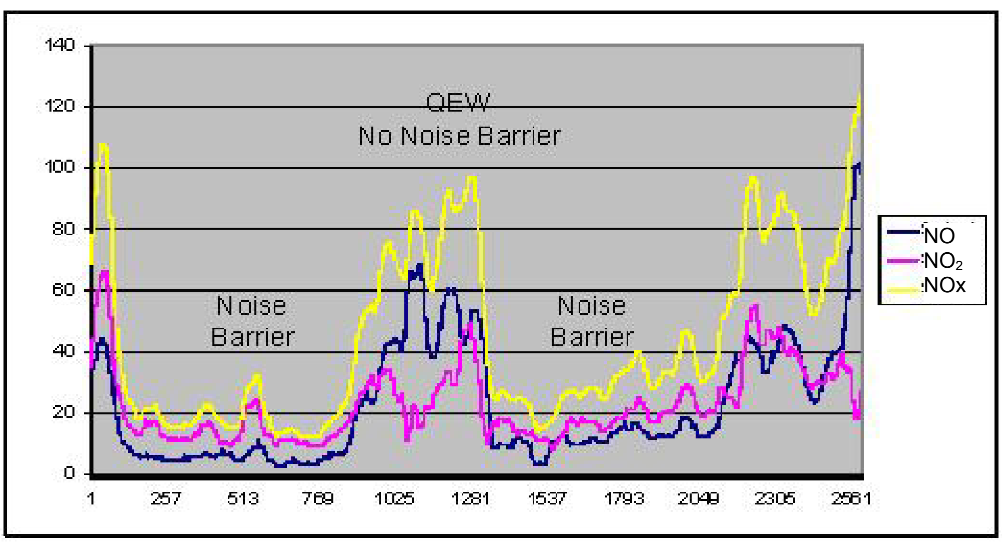
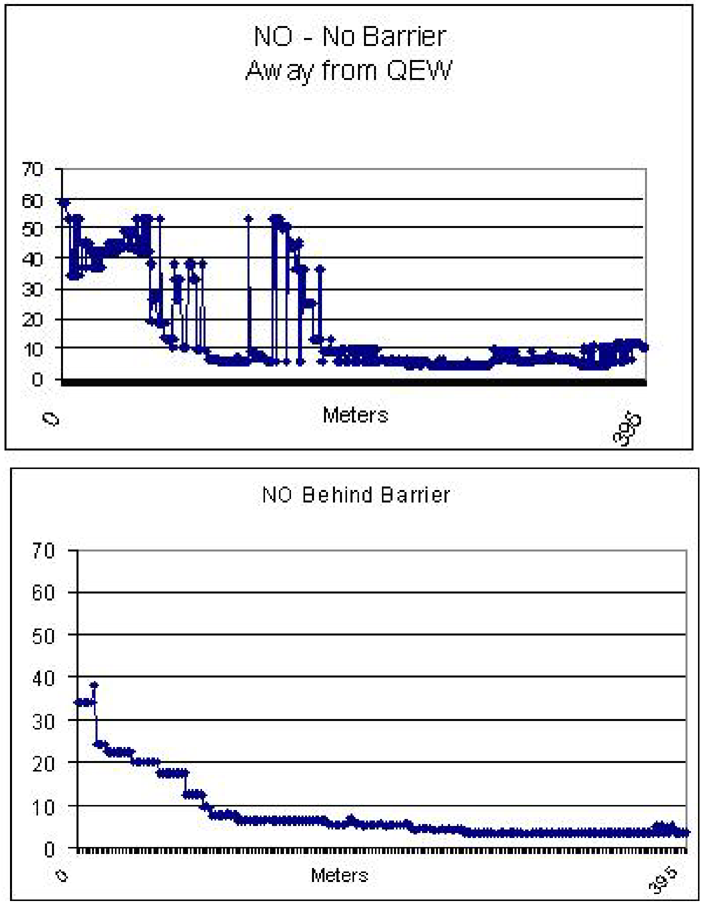


Figure 37: NO Levels Downwind of Highway in Presence and Absence of Noise Barrier



Temperature Inversions, Traffic Emissions & Health Impacts

One phenomenon that can result in dramatically increased levels of air pollution is a meteorological event called a temperature inversion. During a temperature inversion air pollutants become "trapped" under an invisible blanket of air which prevents the normal dispersion of air pollutants. This "trapping" can be dramatic and can result in very poor air quality very rapidly. Temperature inversions occur primarily during the spring and fall months (and even during the winter months) when there is a greater probability of large temperature changes over a short period of time. Temperature inversions occur most frequently when the ground has cooled very rapidly (usually on a calm, clear night in the fall, winter or spring); under these conditions a layer of cold air develops close to ground level.

If conditions are just right and the weather changes bringing in warmer air (usually from the south-west), the warm air may form a layer above the cold air, thereby trapping the cold air below it. This "trapped air" condition usually occurs below the escarpment. Pollutants released into the "trapped" cold air cannot disperse as they normally would and remain trapped in the cold air layer near ground level. In this way pollutant levels can rise very rapidly and can reach very high levels within an hour or two.

An inversion is a very stable meteorological situation and can last for a few hours to several days. During these events, pollution (and human health impacts) can reach high levels.

In the mobile monitoring study, the impacts of individual pollutants have been examined, using different compounds as tracers for different sources, e.g., SO_2 for industry sources and NO for traffic sources. Since we know the relative health impacts of each pollutant, we can calculate predicted total health effects for these pollutants. The pollutant effect metrics used were those reported by Jerrett and Sahsuvaroglu in their May 2003 report to *Clean Air Hamilton* "A Public Health Assessment of Mortality and Hospital Admissions Attributable to Air Pollution in Hamilton" (School of Geography and Geology and McMaster Institute of Environment and Health). The latter health impacts were determined based on an assessment of the data in over 250 scientific publications linking air quality to public health.

Figure 38 shows the land use patterns, including residential use, around a major intersection in East Hamilton and the sampling track used to obtain upwind and directly downwind measurements as well as the concentrations in the residential area.

Figure 38: Queenston Road and Centennial Parkway Intersection, Land Use Patterns and Mobile Monitoring Sampling Route (Red Line).

Figure 39: Health Impacts Predictions Near the Intersection of Queenston Road and Centennial Parkway in Hamilton

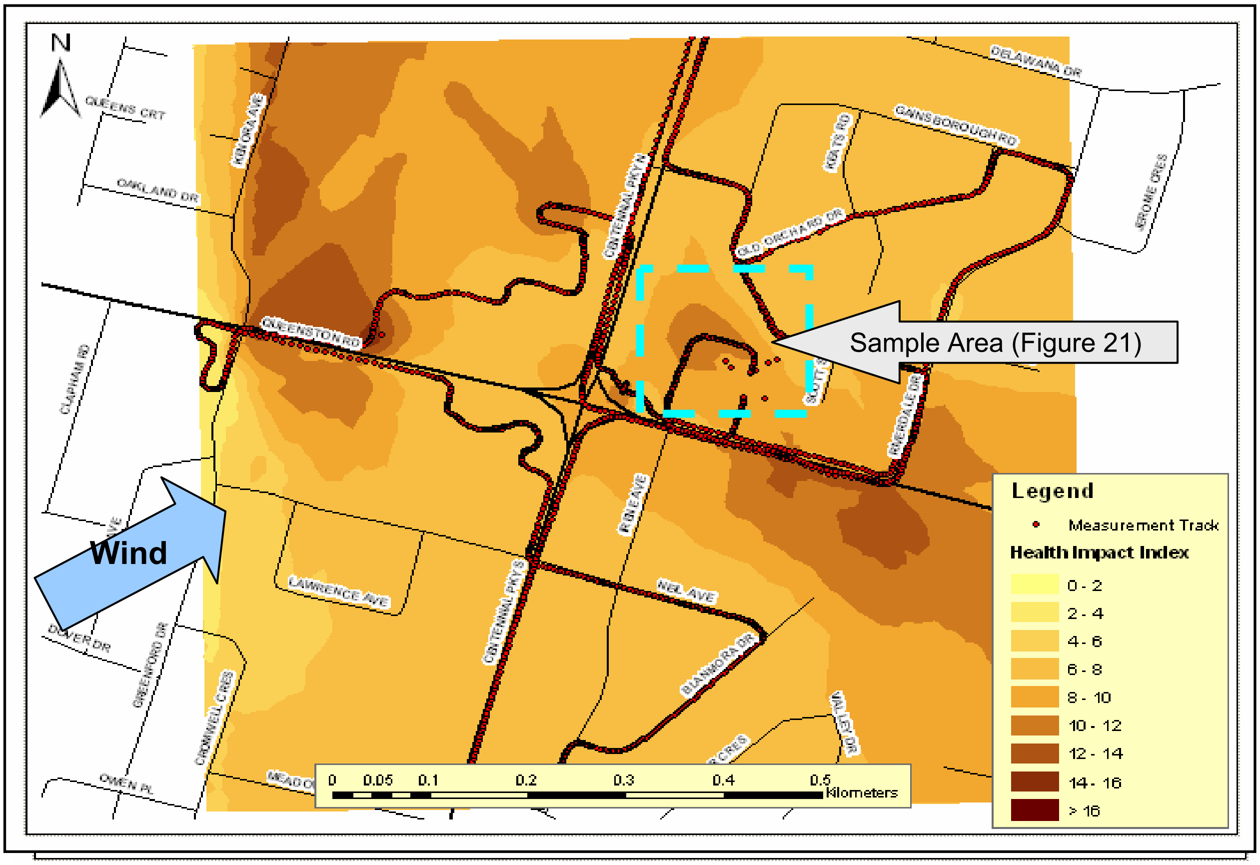


Figure 40: Health Impacts, by Percentage, Downwind from Intersection.

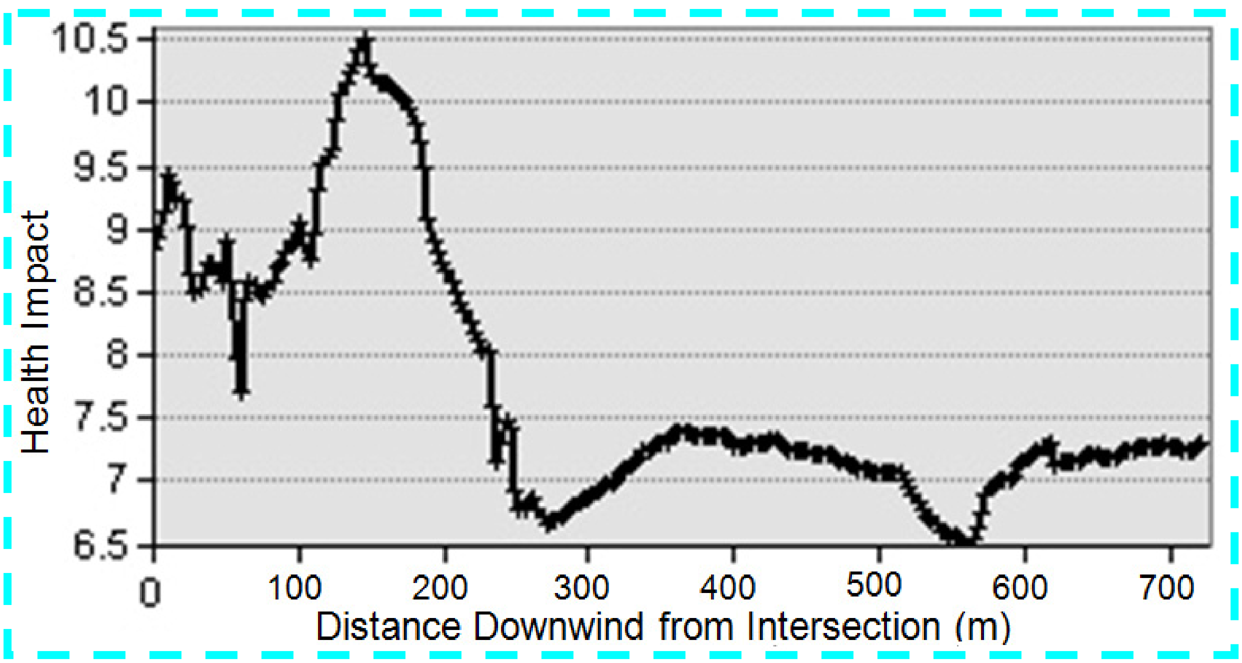


Figure 39 shows the intersection of Queenston Road and Centennial Parkway in the east end of Hamilton. The brown dots show the locations where air pollutant data were collected along the path of the mobile monitoring vehicle as it was driven along roads in the area. The wind direction during this sampling period is shown as a pale blue arrow. The air pollutant data obtained from the brown dot locations were used to calculate the pollutant levels over the entire area. Then the resulting air quality "map" was used to calculate the health effects map shown as **Figure 39**: the darker the colour on the map, the greater the health effects impact.

Figure 40 shows the calculated health impact as a function of downwind distance from the intersection. It is clear from **Figure 40** that there are elevated health impacts due to the combination of air pollutants when you are located downwind of a busy intersection. From this figure, the most significant increase in health impacts occur between 100m to 200m downwind from the intersection of Queenston Road and Centennial Parkway. Health effects impacts are expressed as annual mortality percentage increases as if there had been constant exposures at these levels throughout a year; while this is clearly not the case, these values are still very useful as comparisons but should not be used as absolute values. In other words, these "images" are snapshots which represent short-term exposures.

Figure 41, 42 & 43 below show the relationships between industrial emissions, traffic emissions and the resultant health impacts on an inversion day. In addition to the impacts of industrial emissions on both the lower and the upper city, the emissions of contaminants from mobile sources (particularly from vehicles on major roads and highways) are also very significant.

Figure 41: Health Impacts Due to Air Pollution on an Inversion Day with Light Winds From the Northeast.

(The green line shows the path of the mobile monitoring vehicle).

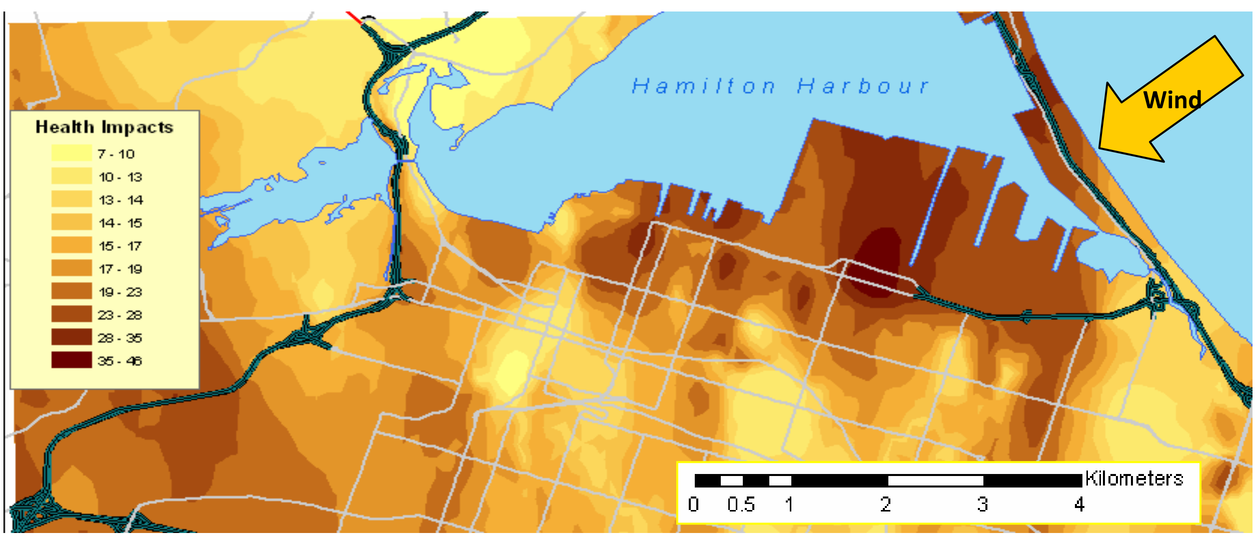


Figure 42: Prevailing Winds (from Southwest) Normal Day: Average Health Impacts*

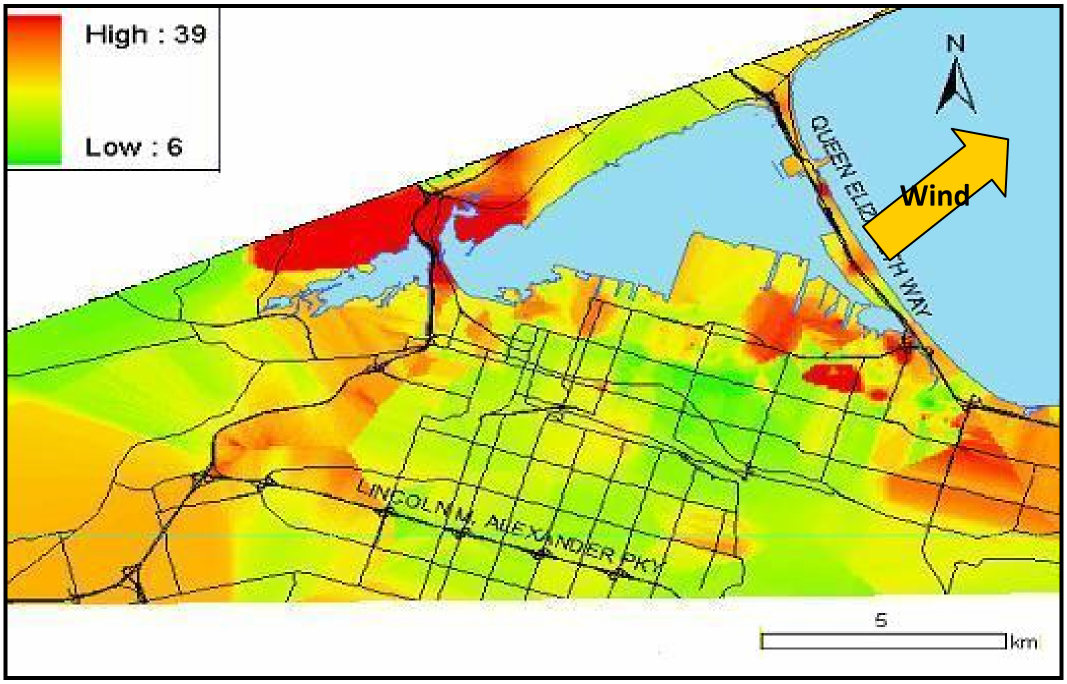
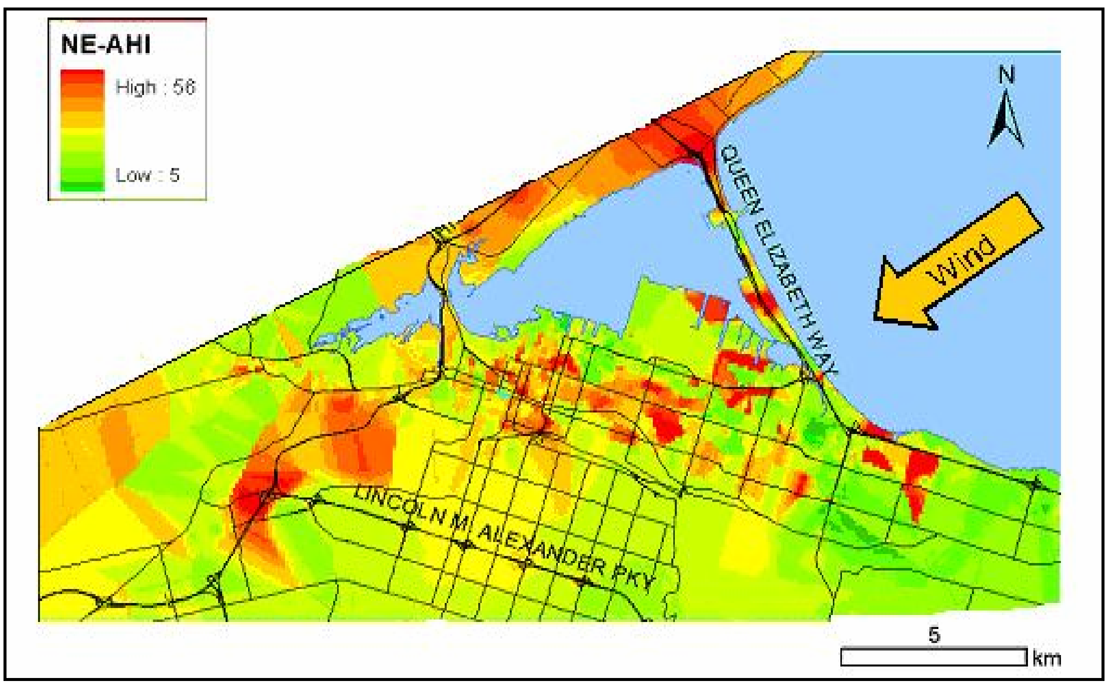


Figure 43: Inversion Day with Northeast Winds: Average Health Impacts



* Please note that these pictures are interpolation surfaces and not the result of detailed models. As a result, they need to be interpreted with caution, particularly at the edges where no sampling data are currently available, e.g. Burlington. In these cases the program may extrapolate to higher pollutant levels than actually exist and additional measurements would need to be made.

Figures 42 and 43 show the predicted health impacts across the City of Hamilton on two different types of wind days. **Figure 42** shows a composite of 15 sampling days under "normal" conditions, i.e. prevailing winds from the south west. **Figure 43** is a composite picture from 8 north east wind/inversion days with winds from the NE industrial area blowing back across the city. These maps are based on mobile monitoring data collected between 2005 and 2007. Clearly, during north east wind/inversion conditions there are significant impacts on much greater numbers of citizens and at higher health impact levels over wider areas. This also shows that both traffic and industry effects are significant under these atmospheric conditions of inversion days and all available means should be taken to reduce these effects.

Please note that these pictures are interpolation surfaces and not the result of detailed models. As a result, they need to be interpreted with caution, particularly at the edges where no sampling data are currently available, e.g. Burlington. In these cases the program may extrapolate to higher pollutant levels than actually exist and additional measurements would need to be made.

Note the relatively low levels of health impact on the Lincoln Alexander Parkway (the Linc), compared to Highway 403, despite the presence of numerous sections on the Linc with high berms at the roadside and presumably low dispersion. This is probably due to the low frequency of large truck traffic on the Lincoln Alexander, compared to the very heavy truck traffic on the 403. All these measurements were taken before the Red Hill Creek Expressway opened.

In addition the Highway 403 incorporates a steep grade so that diesels are under extra load. The Clean Air Task Force in the U.S. has published a series of videos on the internet which dramatically illustrate the localized air pollution impacts of different vehicles, particularly large diesels, see http://www.catf.us/projects/diesel/noescape/videos.php

Appendix G: Partnerships

Hamilton Air Monitoring Network (HAMN)

The Hamilton Air Monitoring Network is operated by a consortium of 22 companies in Hamilton. HAMN is responsible for operating, maintaining and upgrading all 19 industrial air monitors in Hamilton. The network must operate in accordance with the Ministry of the Environment's standards for quality and reliability. The Ministry of the Environment has direct, real-time access to all continuous monitoring data from the network.

HAMN supplies air quality monitoring reports to the Ministry of the Environment on a regular basis and all reports are audited by Ministry of the Environment staff to ensure a consistent and high quality of data. This monitoring network is a rather unique partnership in Ontario because of the diversity of the member companies and the broad range of contaminants monitored and reported.

The Hamilton Industrial Environment Association (HIEA)

The Hamilton Industrial Environment Association is a group of local industries that seeks to improve the local environment – air, land and water – through joint and individual activities, and by partnering with the community to enhance future understanding of environmental issues and help establish priorities for action. More information can be found at www.hiea.org.

The Greater Toronto Area Clean Air Council (GTA-CAC)

The City of Hamilton and *Clean Air Hamilton* are members of the Greater Toronto Area Clean Air Council. This provides Hamilton an opportunity to participate in a dialogue on air quality with other municipalities in southern Ontario. The Greater Toronto Area Clean Air Council is an intergovernmental working group that promotes the reduction of air pollution emissions and increased awareness of regional air quality issues in the Greater Toronto Area through the collective efforts of all levels of government. More information can be found at www.cleanairpartnership.org/gtacac.

Hamilton Area Eco-Network (Eco-Net)

The Hamilton Area Eco-Network (Eco-Net) is a non-profit organization created to network the area's environmental organizations and build their capacity. The purpose of the Eco-Net is to enhance and enable the work of member organizations that are committed to protecting, conserving, restoring and promoting a clean, healthy, sustainable environment for present and future generations. More information on Eco-Net and member organizations can be found at http://www.hamiltoneconet.ca/

Appendix H: Glossary of Terms

Abatement – process of putting an end to, or reducing, the amount of harmful substances released into the environment.

Air Quality Health Index (AQHI) – a health protection tool that is designed to help you make decisions to protect your health by limiting short-term exposure to air pollution and adjusting your activity levels during increased levels of air pollution. The index is calculated based on the concentrations of selected air contaminants and their relative health impacts.

Air Quality Index (AQI) - an indicator of air quality, based on hourly pollutant measurements of some or all of four air pollutants: sulphur dioxide, ozone, nitrogen dioxide, and fine particulate matter. However, only the highest relative value of one these four is used to calculate the AQI by the Ministry of the Environment.

Asthma – a respiratory condition in which the airway constricts when triggered; go to The Asthma Society of Canada at www.asthma.ca / Canadian Lung Association at www.lung.ca for more information.

Benzene – a volatile organic compound (VOC) found in coke oven emissions and gasoline that is capable of producing cancer in humans.

Benzo[a]pyrene (BaP) – pollutant capable of causing cancer in animals and humans; BaP is one member of a large class of chemical compounds called polycyclic aromatic hydrocarbons (or PAH). BaP and other PAH are products of incomplete combustion of carbonaceous fuels such as wood, coal, oil, gasoline, diesel fuel, etc. BaP and PAH are major constituents of coal tar and coke oven emissions.

Black fallout – black particulate matter that has fallen to earth after being emitted into the air.

Carbonaceous fuels – fuels that are rich in carbon.

Cardiovascular – refers to the heart and associated blood vessels; see ‘Backgrounder on Cardiovascular Disease’ on page 11.

Car Share – a model of car rental where people rent cars for short periods of time, often by the hour. They are attractive to customers who make only occasional use of a vehicle, as well as others who would like occasional access to a vehicle of a different type than they use day-to-day. The organization renting the cars may be a commercial business or the users may be organized as a democratically-controlled public agency, cooperative, or *ad hoc* grouping.

Car Pool - is the shared use of a car by the driver and one or more passengers, usually for commuting. Carpoolers use member's private cars, or a jointly hired vehicle, for private shared commuting to and from work or appointments. The vehicle is not used in a general public transport capacity such as in car shares, shared taxis or taxicabs.

Climate change – refers to the long term change in average weather patterns resulting from the release of substantial amounts of greenhouse gases (GHGs), such as carbon dioxide, methane, nitrous oxide, etc. into the planet's atmosphere. These emissions alter the chemical composition of the atmosphere, resulting in intensification of the earth's natural greenhouse effect.

CO – carbon monoxide; a toxic, colourless, odourless, and tasteless gas; produced as a by-product from the combustion of carbon-containing compounds.

Criteria Air Contaminant (CAC) – an air pollutant such as PM_{10}, $PM_{2.5}$, SO_x, NO_x, VOC, CO, and NH_3 (Ammonia).

eCO_2 – a generalized measurement of the global warming impact of emissions based on the most common greenhouse gas, CO_2.

Fugitive dusts – dusts that arise from non-point sources including road dusts, agricultural dusts, dusts that arise from materials handling, construction operations, outdoor storage piles, etc.; fugitive dusts are significant sources of fine particulate matter.

Greenhouse gases (GHGs) – gases in the atmosphere that reduce the loss of heat into space and therefore contribute to increasing global temperatures through the greenhouse effect.

Idling – when vehicles are left running while parked; produces pollution which contributes to problems like climate change and smog.

Inversion – see 'Temperature Inversions, Traffic Emissions & Health Impacts' on page 105.

Micron – shortened term for micrometre; one millionth of a metre.

$\mu g/m^3$ – micrograms per cubic metre; a measure of the concentration of a chemical or substance in the air.

Mobile monitoring – air sampling protocol used to make continuous measurements of air levels of contaminants using monitoring equipment that is moveable or mobile. Traditional air monitoring uses air monitoring equipment that is fixed in one location. Mobile monitoring allows measurements of air emissions to be performed at various locations while traveling across a City or parts of a City. The mobile monitoring unit can also be parked to make longer term measurements at one or more locations.

MOE – Ministry of the Environment; for more information visit: www.ene.gov.on.ca

Mobile sources – vehicles (cars and trucks) that emit pollutants into the air.

National Pollutant Release Inventory (NPRI) – Canada's legislated, publicly-accessible inventory of pollutants released, disposed of and sent for recycling by facilities across the country; for more information visit www.ec.gc.ca/pdb/npri/npri_data_e.cfm.

NO_x – nitrogen oxides; nitrogen dioxide (NO_2) and nitric oxide (NO) are the two nitrogen oxides that are classified as common air contaminants. NO is released directly by vehicles and can be used as a tracer for vehicle combustion emissions. NO is readily converted into NO_2 in the atmosphere.

O_3 – Ground-level ozone; component of smog; severe lung irritant; generated when combustion emissions such as nitrogen oxides and volatile organic compounds react in the presence of sunlight, via a complex set of chemical reactions.

Plume – a form or shape of air pollutant emissions in the air (e.g., emissions from an industrial stack, vehicle exhaust form a tailpipe, etc.) that may be visible to the human eye or invisible depending on the mixture of air pollutants.

PM_{10} – inhalable particulate; airborne particles that have mean aerodynamic diameters of 10 μm (micrometres) or less; has been clearly and consistently linked to respiratory and cardiovascular health impacts in humans.

$PM_{2.5}$ – respirable particulate; airborne particles with mean aerodynamic diameters of 2.5 μm (micrometres) or less; has been more strongly linked to health impacts than PM_{10}.

PM_1 – very small particulate; airborne particles with mean aerodynamic diameters of 1 μm or less.

Point of impingement – A defined point or points on the ground or on a receptor, such as nearby buildings, set at a defined distance from a facility, located outside a company's property boundaries, at which a specific limit for air pollutants must be met.

Polychlorinated biphenyls (PCBs) – a class of organic compounds that was used in electrical transformers and capacitors until its use was banned in the 1970's due to the toxicity of PCBs.

Polycyclic aromatic hydrocarbons (PAH) – chemical compounds emitted when carbon-based fuels such as coke, oil, wood, coal and diesel fuel are burned. Some PAH are known to be carcinogens. PAH are also major constituents of coal tar and coke oven emissions.

Ppb – parts per billion; one part per billion is one weight unit of chemical in one billion (10^9) weight units of water, soil, etc. For example, if you added 10 drops of vodka to the water in an average backyard swimming pool (16 feet by 32 feet containing 80,000 litres of water), the concentration of ethanol in the pool would reach an average concentration of approximately 1 part per billion.

Prevailing winds – trends in speed and direction of wind over a particular point on the earth's surface; upwind is the direction the wind is coming from; downwind is the direction that the wind is blowing toward.

Smog –the brownish-yellow haze that typically hovers over urban areas during the summer. Its two main contaminants are ground level ozone (O_3) and small airborne particles; the word comes from a combination of the words 'smoke' and 'fog'. Smog events can occur during any season of the year particularly due to inversion events.

Smog advisory – see 'What is a Smog Advisory?' on page 18.

SO_2 – sulphur dioxide; a respiratory irritant principally emitted by industrial processes.

Telecommute – a work arrangement whereby a worker can work anywhere using telecommunication technologies and avoid the daily commute to a workplace.

Total Reduced Sulphur (TRS) – a measure of the sulphur-containing compounds that are the basis of many of the odour complaints related to steel mill operations, particularly coke oven emissions, blast furnace emissions and slag quenching operations. At 10 parts per billion (ppb), many people can detect TRS as an odour similar to rotten eggs.

Total Suspended Particulate (TSP) – includes all particulate material with aerodynamic diameters less than about 45 micrometres (μm).

Trans-boundary air pollution – originating from sources in the mid-western United States, pollutants are brought to Ontario by prevailing winds.

Transportation Demand Management (TDM) – see "7.1.1Transportation Demand Management" on page 46.

Urban Heat Island - a metropolitan area which is significantly warmer than its surrounding rural areas. Heat islands form as vegetation is replaced by asphalt and concrete for roads, buildings, and other structures necessary to accommodate growing populations. These surfaces absorb - rather than reflect - the sun's heat, causing surface temperatures and overall ambient temperatures to rise.

VOCs – volatile organic compounds; organic chemical compounds, some of which may have long or short term health effects. Sources of VOCs include enamel paints, solvents, spray cans, gasoline, etc.; major sources of VOCs are plants and trees.

Walkability – the measure of the overall walking conditions in an area; factors affecting walkability include, but are not limited to land use mix, street connectivity, and residential density.

***Clean Air Hamilton*, June 2009**

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