CleanAir HAMILTON

2005-2006 Progress Report

May 2007

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Executive Summary

- *Clean Air Hamilton* is a community initiative that promotes and supports improvements to air quality in the City of Hamilton. It has a diverse membership with representation from environmental organizations, 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 companies operating in Hamilton; and
    - Promoting behavioural changes among individuals living and working in Hamilton.

- While air quality in Hamilton has improved substantially over the years, the levels of air pollution remain higher than or comparable to other communities in southern Ontario.

- In 2005 Phase 1 of a mobile monitoring study of Hamilton was conducted for the City and *Clean Air Hamilton*; Phase 2 began in 2006. These studies show that the highest pollutant exposures occur near arterial roads and highways due to transportation emissions.

- A broadly-held perception continues that the City's industrial sector is the major contributor to poor air quality within the City; reductions in emissions from transportation emissions (personal and commercial vehicles) and in fugitive dust management are needed to make significant improvements to local air quality.

- Fugitive dusts, i.e., dusts from roads, construction sites and open commercial operations, particularly in the industrial areas of the City, have been shown to be significant sources of fine particulate material. *Clean Air Hamilton,* the Ministry of the Environment and the City are working actively with local business owners and site operators in Hamilton to reduce their fugitive dusts.

- In 2006, the City supported Green Venture in undertaking an Idling Awareness Education Campaign that targeted the community, schools and private fleets. Idling vehicles not only waste fuel but also contribute significantly to elevated levels of pollutants that are cause for concern for drivers, vehicle occupants, cyclists, joggers and pedestrians.

- In 2006, black fallout and particulate impacts were reported on residential properties in areas of the City of Hamilton. The Ministry of the Environment continues to investigate and will share information with the community through *Clean Air Hamilton* and Environment Hamilton.

- Climate Change is an area of environmental concern. The linkages between measures to reduce greenhouse gas emissions and improvements to local air quality will be explored at the **2008 Upwind Downwind Air Quality Conference: Climate Change & Healthy Cities** hosted by *Clean Air Hamilton* in Hamilton on February 25th and 26th, 2008.

- *Clean Air Hamilton* continues to encourage actions by the City, industries, and citizens to reduce air pollutants and improve local air quality in their operations and transportation choices. *Clean Air Hamilton* continues to work actively to cultivate partnerships with organizations that have goals that are consistent with those of *Clean Air Hamilton* and the City.

1.0 Introduction

Clean Air Hamilton presents the 2005-2006 Progress Report on Air Quality to Hamilton City Council. This report presents the activities undertaken by *Clean Air Hamilton* in 2005 and 2006 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. This document consists of a 43-page report and six appendices:

- Appendix A presents the associated health impacts of air pollutants in Hamilton and Ontario;
- Appendix B presents updated Air Quality Trends for Hamilton and comparisons of Hamilton's air quality indicators to some cities in Ontario;
- Appendix C presents emission sources in Hamilton;
- Appendix D presents the linkages of transportation and air quality;
- Appendix E presents the programs that *Clean Air Hamilton* has undertaken and will undertake in 2007 and
- Appendix F presents some of the partnerships that *Clean Air Hamilton* is involved with.

1.1 Background

The former 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.

These reports are available online at: http://www.cleanair.hamilton.ca/

1.2 Successes Related to Contributions

Clean Air Hamilton has received attention regionally, nationally and internationally for its outstanding leadership and commitment to improving local air quality. The *Clean Air Hamilton* website receives over 600 hits a week and enquiries on *Clean Air Hamilton's* work have come from Canada, the U.S. and around the world. Many innovative initiatives have emerged, directly and indirectly, from this program.

The City of Hamilton currently provides an annual budget of $80,000/year in support of *Clean Air Hamilton* and its activities. This money is matched many times over by funding provided by partner institutions and by the in-kind support of volunteers in the community. It has been estimated that *Clean Air Hamilton*'s volunteers provide time, energy and air quality expertise that is worth about $400,000 per year to the City and the citizens of 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 surveys, anti-idling strategies, overload permits for trucks, and Smart Commute), planning (GRIDS), fugitive dust abatement, tree planting, impacts of emissions from wood burning stoves, education initiatives and community air quality awareness.

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

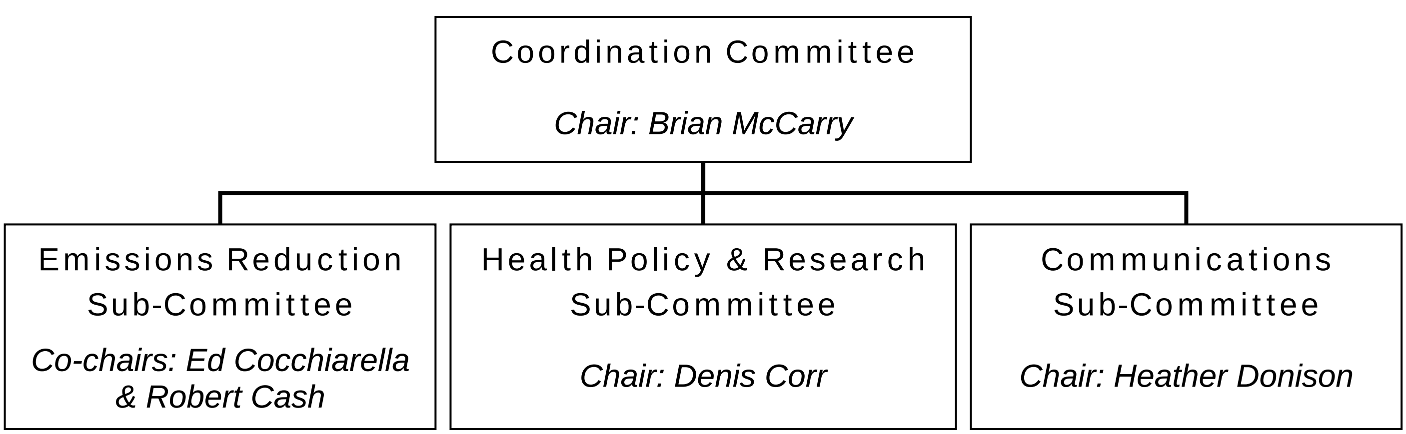
Clean Air Hamilton has identified the following goals to guide its work over the next 2 to 5 years:

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

2.3 Structure, Membership and Participation

The structure of *Clean Air Hamilton* includes the Coordination Committee and three subcommittees: Communications Subcommittee, the Emissions Reduction Subcommittee, and the Health Policy & Research Subcommittee.

Figure 1: Organizational Structure of *Clean Air Hamilton*



2.4 Co-ordination Committee Membership in 2005 and 2006

Dr. Brian McCarry	McMaster University, Chair
Robert Cash	Archer Daniels Midland
Ed Cocchiarella	Dofasco Inc.
Dr. Denis Corr	McMaster University/Rotek Environmental
Heather Donison	Green Venture
Rob Hall	Public Health Services, City of Hamilton
Chris Hill	Public Works, City of Hamilton
Phil Jensen	Ontario Ministry of the Environment
Brenda Johnson	Environment Hamilton
Geoff Lupton	Public Works, City of Hamilton
Paul Mason	Planning & Economic Development, City of Hamilton
Christina Melon	Citizen
Natasha Mihas	Public Health Services, City of Hamilton
Dr. Ted Mitchell	Citizen
Brian Montgomery	Planning & Economic Development, City of Hamilton
Hossein Naghdianei	Environment Canada
Steve Robichaud	Planning & Economic Development, City of Hamilton
Andy Sebestyen	Hamilton Steel
Carl Slater	Ontario Ministry of the Environment
Antonino Spoleti	Public Works, City of Hamilton
Steve Walsh	Public Health Services, City of Hamilton

Clean Air Hamilton is dependent upon the voluntary contributions of its committee members. In order to continue to make gains in air quality improvements in Hamilton, *Clean Air Hamilton* will have to continue to supplement the voluntary contributions of members with a 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 recruit 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 to improve air quality in Hamilton. *Clean Air Hamilton* is interested in working with individuals and with representatives from schools and school boards, community groups and others who partner on one or more actions identified by a *Clean Air Hamilton* subcommittee. 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.

3.0 Hamilton Air Quality

3.1 Air Pollution Health Impacts

Poor air quality is associated with a range of health effects impacts, including eye, nose and throat irritation, difficulty breathing, coughing, wheezing, and the exasperation of existing conditions like asthma. Also, some segments of the population, including 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 arise from *cardiovascular* illnesses (**See Figure 2 below**).

Figure 2: Air Pollution Health Impacts in Hamilton

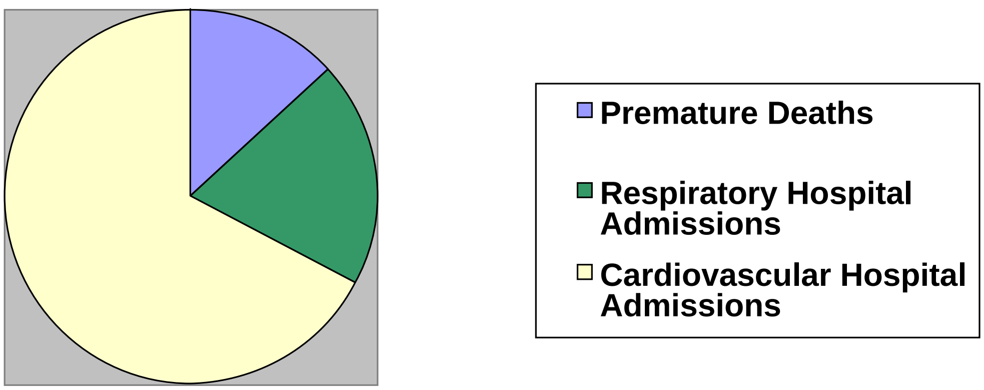


Table 1: Summary of Premature Deaths, Respiratory and Cardiovascular Hospital Admissions Associated with Air Pollutants, Hamilton, 1997

Pollutant	Premature Deaths	Respiratory Hospital Admissions	Cardiovascular Hospital Admissions	Totals
O_3	36	44	191	271
NO_2	27	48	176	251
PM_{10}	14	27	49	90
SO_2	16	20	26	62
CO	3	NA	38	41
Totals	**96**	**139**	**479**	**714**

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 blockage (build-up of *plaques*) and hardening (*arteriosclerosis*) of the arteries. When the blood vessels supplying blood to the heart are affected, the medical condition is called *coronary artery disease*. If blood flow is stopped for some reason, a heart attack (*myocardial infarction*) will likely occur.

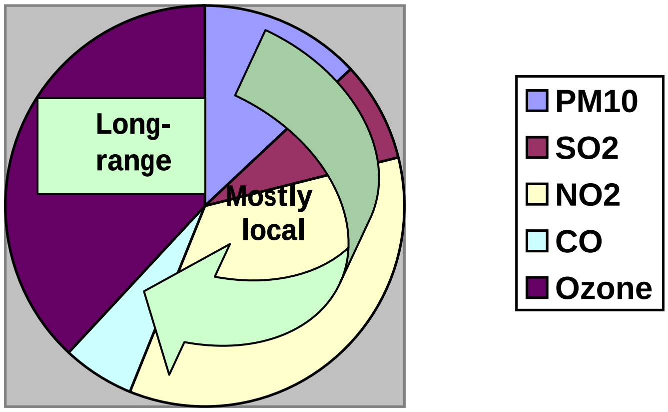
The accumulation of plaque and the hardening of arteries is chronic, and typically progresses for decades without symptoms. In about 50% of cases, the first symptom of the disease is a sudden heart attack.

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

To assess the acute effects of pollutant exposures near major roadways, one study examined the association between exposure to traffic pollution and the occurrence of heart attacks. This study found that exposure to traffic was twice as frequent one hour before the heart attack, compared to any other time. The strength of the association between cause and effect is also strong for those on public transit, so it is not plausible that the effects of exposure to traffic can be attributed solely to the stress of driving. Cyclists were also followed through the study, and cycling was also associated with an increased risk, after controlling for the physical exertion of pedalling. Previous studies have suggested that, despite the increased depth and rate of breathing associated with cycling, cyclists' exposure could be half of the typical exposure in a car or bus. This may be due to cyclists' ability to move away from polluted microenvironments (i.e., congested intersections) more quickly than cars or buses. It may also be due to the availability of bicycle routes which are located away from major arterial roadways.

New investigations regarding the chronic health effects of air pollutants also shed light on the increased risk that poor air quality (particularly $PM_{2.5}$, particulate matter less than 2.5 microns in diameter) has on the development of cardiovascular diseases. 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%. Another important new finding 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 within cities plays an equally significant role. Specifically, greater street connectivity and increasing the 'walkability' of neighbourhoods decreases driving, and decreases the amount of air pollution associated with automobile emissions. Since most sources of particulate matter are local (**see Figure 3 below**), Hamilton can take measures to reduce the burden of illness associated with poor air quality.

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



The increased risk of cardiovascular disease due to air pollution may seem insignificant when compared to the established cardiovascular risk factors (diet, exercise and smoking). However, because everyone is affected, even conservative risk estimates translate into a substantial increase in total mortality within the population. The Ontario Medical Association (OMA) estimated the Illness Cost of Air Pollution (ICAP) for Ontario in 2005 at $16 B. This estimate had been increased substantially from the OMA's 2000 report, based on evidence on the chronic effects of exposure to air pollution (**See Appendix A**).

Clean Air Hamilton has long advocated for a health-based Air Quality Index. It is important to recognize that neither of the aforementioned studies related exposure to air pollution against the current Ontario Air Quality Index, which is used to forecast Smog Advisories. This highlights the need to dispense with the idea of a single pollution threshold, below which there is no health risk. To assist with the adoption of a health-based vision for air quality issues, Health Canada has developed and piloted an Air Quality Health Index (AQHI). The new AQHI is different from the current Air Quality Index (AQI) in that it combines the effect of three different components of air pollution (NO_X, O_3, and $PM_{2.5}$) into the reading. Moving forward, *Clean Air Hamilton* will continue to monitor the development of the Air Quality Health Index, ensuring that Hamilton is prepared to use the new index and forecasting methods when they are ready for use.

3.2 Hamilton Air Quality – Trends and Comparisons

Examination of the trends in ambient air quality in Hamilton over the last decade shows that there have been significant reductions in the air levels of some pollutants such as benzene, total reduced sulphur, benzo[a]pyrene, while other pollutants, such as PM_{10}, $PM_{2.5}$ and SO_2 have changed very little **(see Appendix B for details)**. Many of these reductions have resulted from actions taken to reduce emissions from the industrial sector and, to a lesser extent, the transportation sector.

Unfortunately, less progress has been made on improvements in air levels of NO_2 and ground level ozone; ozone levels have shown a trend that has been steadily increasing over the past decade **(see Appendix B)**.

When we compare levels of air pollutants in Hamilton to levels of the same pollutants in other southern Ontario communities over the past 15 years, it appears that:

- The levels of nitrogen oxides (NO_x) in Hamilton are similar to or slightly higher than other cities in southern Ontario (except Toronto);
- 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 in other Southern Ontario cities. Rural areas of Ontario often experience the highest levels of ground-level ozone during smog events;
- The levels of sulphur dioxide (SO_2) in Hamilton tend to be somewhat 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 **(see Appendix B)**.

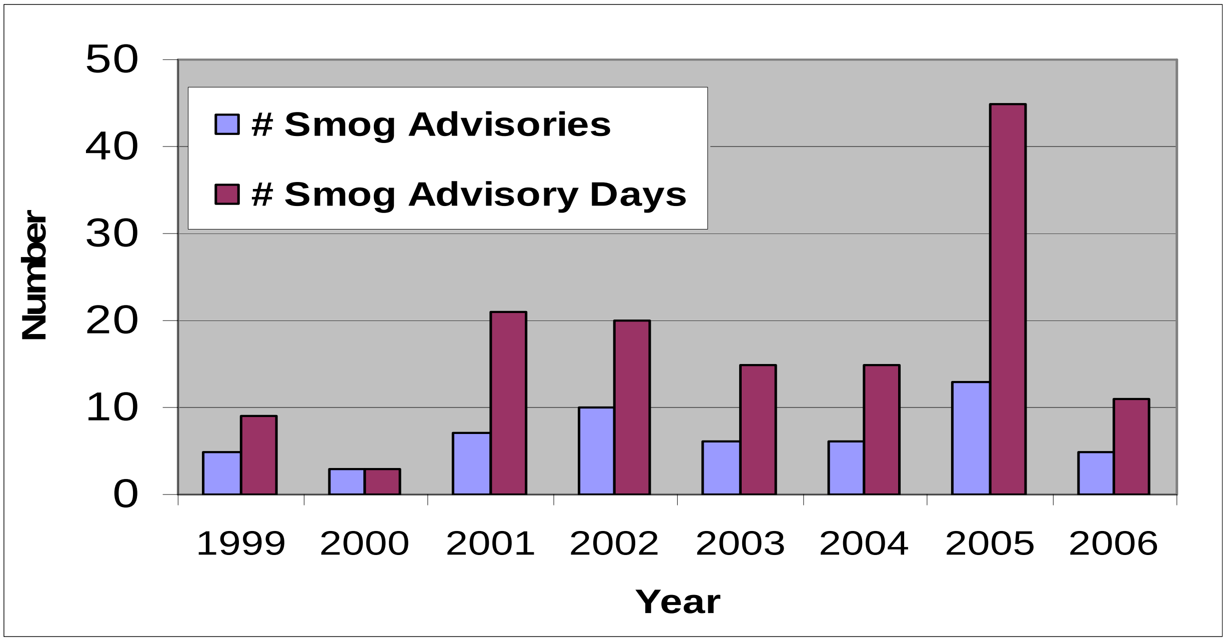
The air quality in Hamilton is impacted by a combination of factors that do not co-occur in other communities in southern Ontario:

- The roads in and around Hamilton are heavily used and the air quality is adversely impacted by mobile emissions from local drivers and commuters (primarily gasoline-powered vehicles) and transport trucks (diesel-powered vehicles);
- Hamilton is home to a number of small, medium and large industries;
- Hamilton's location at the west end of Lake Ontario, the local topography and prevailing weather conditions contribute to situations wherein air pollutants levels below the escarpment are often higher than levels above the escarpment.
- Hamilton is also affected by trans-boundary air pollution (primarily ground-level ozone and air particulate from sources in the mid-western United States) in a manner similar to the pollution experienced in 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.

3.3 Smog Advisories and Smog Advisory Days

A smog advisory is issued by the MOE when the Air Quality Index (AQI) reaches or exceeds a value of 50; a smog advisory day is declared when it is *predicted* that it is likely the AQI may reach or exceed 50 on an upcoming day. In 2006, there was a decrease in the number of smog advisories and smog advisory days declared in Hamilton (compared to the numbers over the past five years; see **Figure 4**). Only 5 smog advisories and 11 smog advisory days were declared in 2006 by the Ontario Ministry of Environment for the City of Hamilton. This number was significantly fewer than in 2005 when 13 smog advisories were issued from the Ministry of the Environment and a total of 45 smog advisory days were declared for the City of Hamilton.

Figure 4: Number of Smog Advisories in Hamilton between 1999 and 2006



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 August 23, 2002, smog advisories were issued for ground-level ozone only.

For the first time since the inclusion of $PM_{2.5}$ in the Smog Alert program in August of 2002, Ontario issued a winter smog advisory. In February 2005, an intense 5-day smog episode occurred due to elevated $PM_{2.5}$ levels. This episode was followed by the earliest smog advisory issued due to ozone in April 2005. The fall of 2005 also included a widespread $PM_{2.5}$ episode across Ontario in the month of October, at a time well outside the traditional smog season in the previous October (October 2004), Hamilton experienced an AQI reading over 100 for a period of couple of hours due to very high levels of $PM_{2.5}$. The high particulate levels were the result of a brief temperature inversion event that resulted in poor air quality impacts primarily in the downtown core.

What is a Smog Advisory?

The Ontario Ministry of Environment monitors the air quality and provides a rating of the air quality called the Air Quality Index (AQI). Smog advisories are issued to the public when widespread elevated (AQI > 49) and persistent smog (ozone and or particulate matter) levels are forecasted to occur within the next 24 hours, or if elevated weather conditions conducive to elevated smog levels are forecast to continue for several hours.

The AQI is determined based on the highest value of any one of the key air contaminants – $PM_{2.5}$, 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 due to high ozone levels whereas in the spring and fall the smog alerts are issued primarily due to high levels of particulate material.

Figure 5: 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?

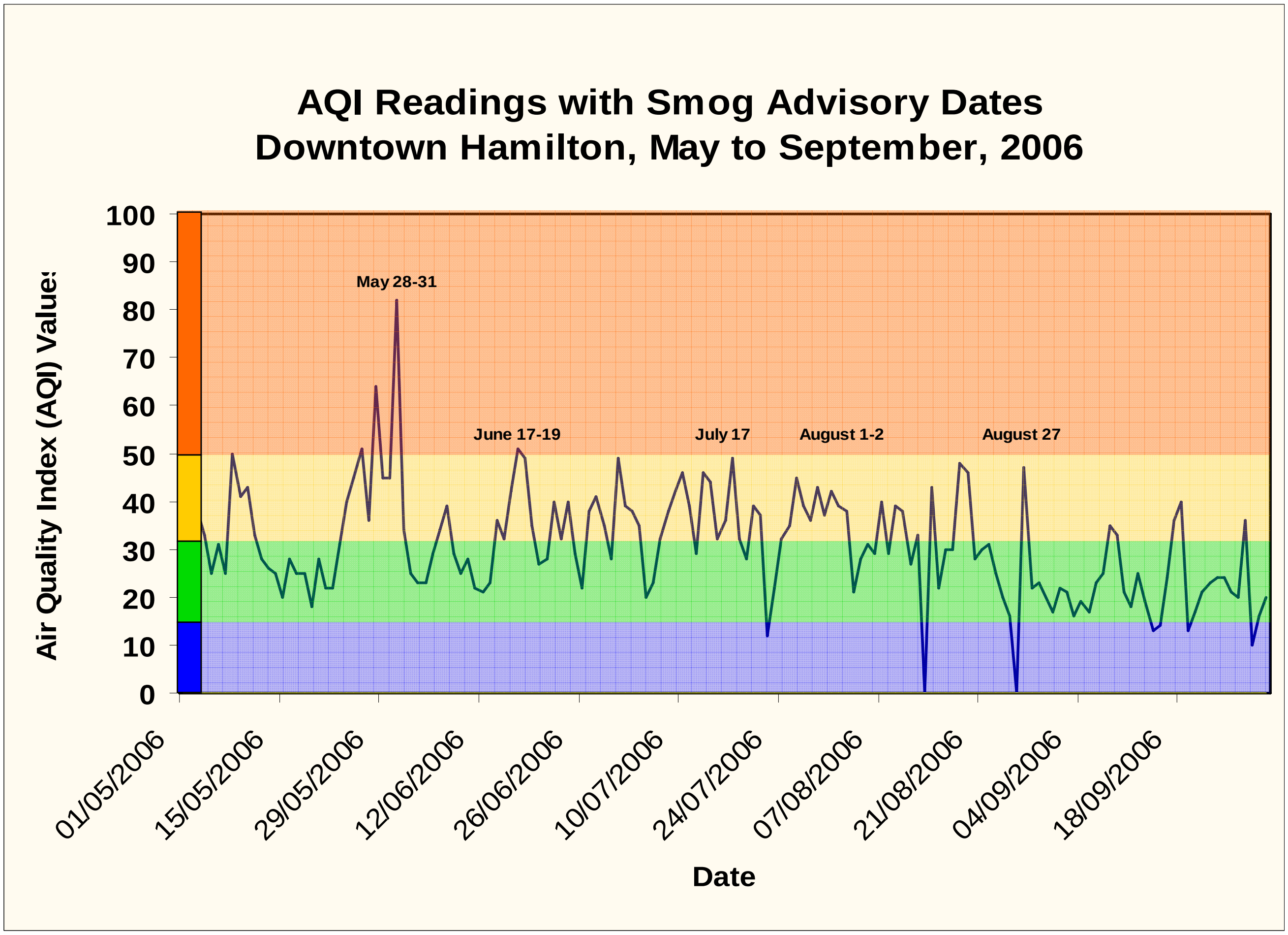
- If the air quality value is below 32, the air quality is considered relatively good.
- If the AQI value is in the range of 32 to 49 (moderate category), there may be some adverse effects in sensitive individuals.
- An index value in the 50 to 99 range (poor category) may result in some short-term adverse 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

Figure 6 shows the peak daily Air Quality Index (AQI) readings measured at the downtown Hamilton AQI Station for the period May 1, 2006 to September 30, 2006. The data from the two other AQI stations in Hamilton (located in Hamilton West and on the Mountain) are very similar to the data collected at the downtown site. All three sites are operated by the Ontario Ministry of the Environment.

The figure below shows the dates of the five smog advisory periods. The peak AQI levels (data shown below) indicate the highest AQI value observed for that particular day. The AQI ranges (**shown in Figure 5 above)** have been added to the figure along with shading to indicate the AQI range value for each day.

Figure 6: Peak Air Quality Index Values at the Downtown Hamilton AQI Station (May 1 to September 30, 2006)



3.3.1 A Primer on Smog Events and Temperature Inversions

Gaseous air pollutants (NO_X, VOCs) can react during the day 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., stratospheric ozone which is found ~20-40 km above the earth's surface); the latter ozone is important in absorbing harmful ultraviolet radiation from the sun and thus reducing the levels of ultraviolet light at 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.

On hot, sunny days stagnant air conditions can develop during which air pollutant concentrations can rise dramatically because there are no winds to disperse the pollutants. Under these conditions pollutants remain close to the earth's surface rather than rising and dispersing into the atmosphere, which is the usual case. Another cause of dramatically increased levels of pollution is a temperature inversion. During a temperature inversion the trapping of air pollutants is even more dramatic and the air quality can deteriorate 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 time period due to the large difference in temperatures between the cold lake water and the warm land. The smog advisories which are called during the spring and the fall almost always coincide with an inversion event.

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 at ground level. If the weather changes and warmer air moves into the Hamilton area, this warm air (which usually moves in from the south-west) sometimes forms a layer above the cold air and traps the cold air. This "trapped air" condition usually occurs below the escarpment. Any pollutants released into the "trapped" cold air cannot disperse and remain trapped in the cold air layer near ground level. In this way pollutant levels can rise very rapidly and reach very high levels within an hour or two. These temperature inversions are unstable and may last for a couple of hours to a day or so before they break up and the pollutants become dispersed. During a multi-day inversion event in October, 2004 the $PM_{2.5}$ levels in downtown Hamilton reached high values that resulted in an AQI measurement of 103, the highest AQI value ever recorded in Hamilton.

Levels of respirable particulate matter can also reach very high concentrations in the air during the winter, resulting in winter smog alerts. In short, concentrations of certain air pollutants can reach high levels at any time of the year and trigger smog alerts. Smog alerts highlight the need to take actions to improve air quality throughout the year, not just during the summer when most smog alerts occur.

3.4 Emission Sources in 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. 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. Further details or data on emissions sources in Hamilton can be found in **Appendix C.**

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

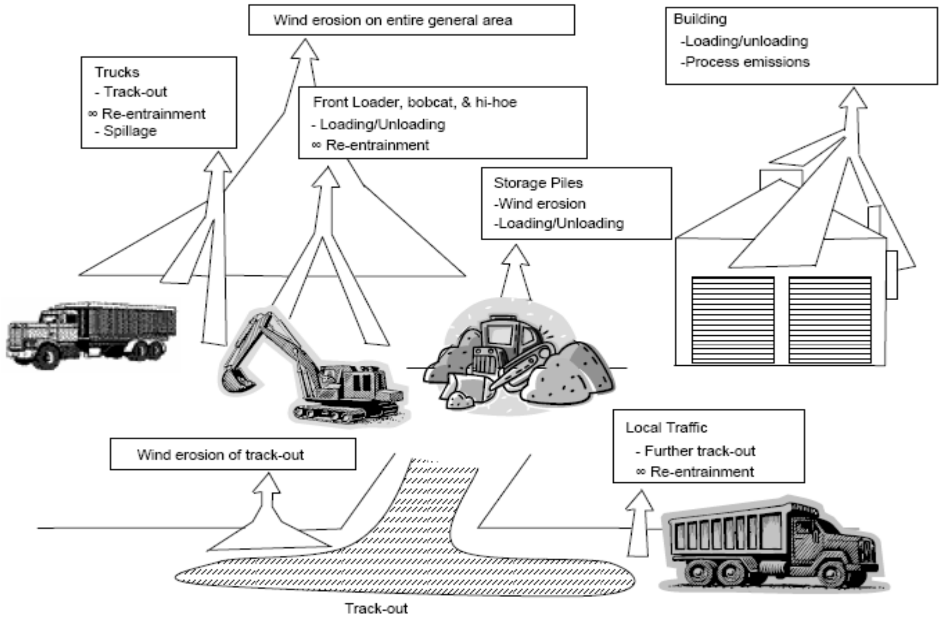
- The transportation sector (i.e., mobile sources such as cars and trucks) is the leading source of NO_x emissions within the City of Hamilton, followed closely by the industrial sector; surprisingly, off-road sources represent about 65% of all emissions from the transportation sector;
- The industrial sector is the leading source of directly-emitted $PM_{2.5}$, followed by road dust and area sources such as fireplaces, home heating and small businesses;
- Road dust, construction activities and area sources such as fireplaces and home heating are the leading sources of PM_{10}, followed by industry sources ;
- The industrial sector is the leading source of SO_2 ; and
- The industrial sector is the leading source of volatile organic compounds (VOCs), followed by releases due to general solvent use by companies and individuals; emissions from the transportation sector are also a major source of VOCs.

3.5 Fugitive Dusts

Clean Air Hamilton has identified fugitive dusts, including road 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 outdoor storage piles, etc **(see Figure 7).** 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 relatively 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 "emission" or a concern for human health.

Figure 7: Possible Sources of Fugitive Dust*



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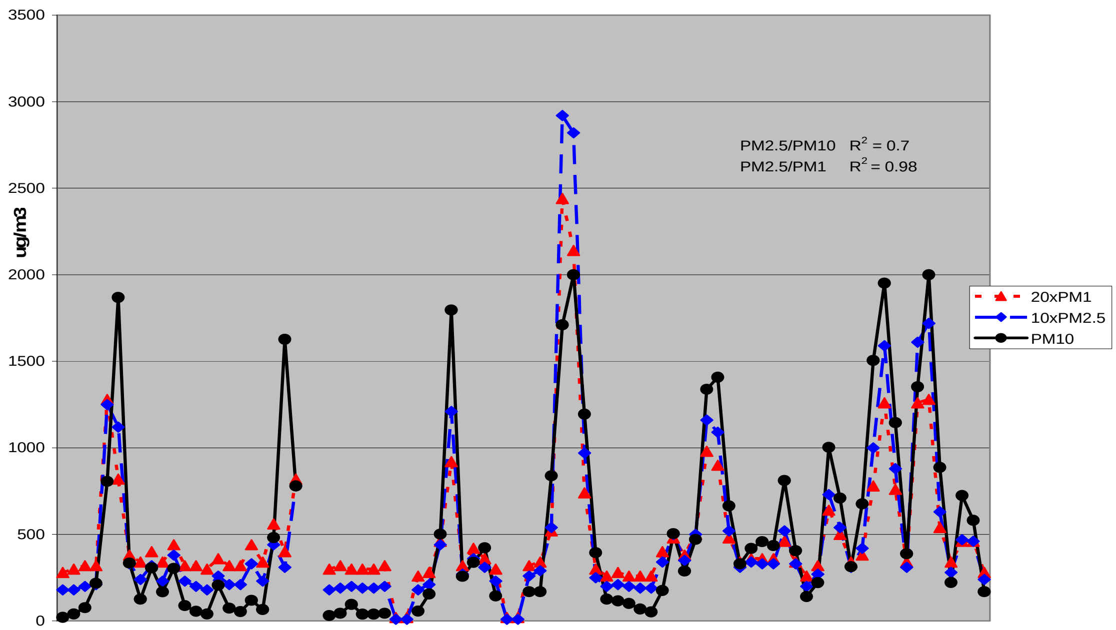
Courtesy of the Ministry of the Environment, 2006

Road dusts consist of particulate matter from vehicle exhausts, tire wear, pavement wear, brake pad wear, etc.; road dusts can be a result of track-out from construction sites and industrial sites (particularly from unpaved roads), blow-off from construction sites, and the deposition of materials from the air, including industrial particulates and vehicle emissions. Severe, local road dust impacts occur routinely along roadways in industrial areas, particularly during business hours when truck traffic is heaviest. The chemical composition of these dusts is also problematic, given the nature of the emissions from nearby industries and the deposition of these emitted materials onto roadways. Road dusts can contain elevated levels of toxic substances, including metals such as chromium, manganese and iron and organic contaminants such as polycyclic aromatic hydrocarbons (PAH) and polychlorinated biphenyls (PCBs).

In 2005, Phase 1 of a mobile monitoring study conducted for *Clean Air Hamilton* and the City, it was 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). Levels of PM_{10} that exceed 100 µg/m^3 are considered to have negative health effects in most people. Not only are PM_{10} levels routinely well above this value (by up to 20 times), the correlation between particles of different sizes (PM_{10}, $PM_{2.5}$ and PM_1) is very strong **(Figure 8)**.

Road dusts have traditionally been regarded as nuisances; 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 the people living and working on the properties proximate to these roads. *Clean Air Hamilton* is working to reduce road dusts and road dusts impacts on the community through education activities, monitoring programs and partnerships with various agencies and industries to reduce road dusts at source and thus the burden of road dust impacts on the citizens of Hamilton.

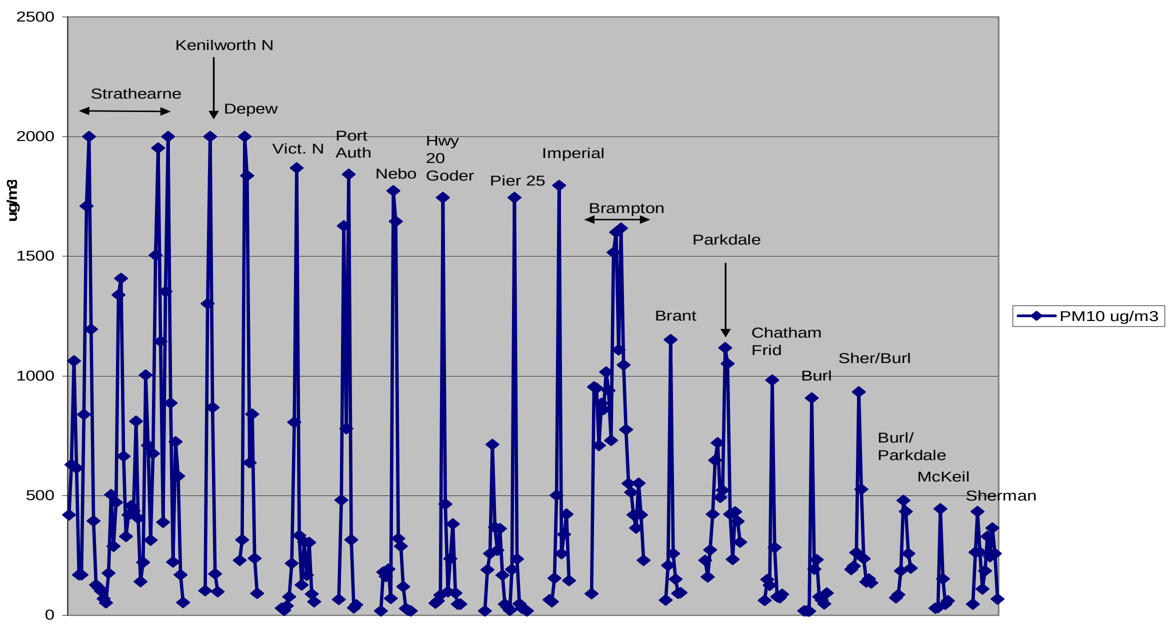
Figure 8: Re-suspended Road Dust: Strong Covariance of PM_{10}, $PM_{2.5}$ and PM_1



Fugitive dust control is an important responsibility at all industrial sites, particularly industries that handle or store large amounts of particulate-containing materials, such as bulk storage facilities and the aggregate industry. On-site management of soils and dusts has a direct influence on the amount of dusts generated and dispersed into the air as a result of normal plant operations; unpaved roads and unpaved areas on-site can result in the tracking of significant amounts of materials onto 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.

Figure 9 shows a composite of real-time PM_{10} data obtained near 18 different locations in the City where visible clouds of road dust were observed during the mobile emissions 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 9: PM_{10} Road Dust Track-out, 18 Locations, 14 Sources Monitored



In December 2006, a Fugitive Emissions Workshop was held in Hamilton to provide local business owners and site operators with information regarding fugitive dusts and their associated health and environmental impacts. Organizers of the workshop included the Ministry of the Environment, Hamilton Industrial Environment Association, The City of Hamilton, the Hamilton Port Authority, and *Clean Air Hamilton*. The workshop was attended by over 50 attendees, presenters and local dust abatement service providers.

In 2006 and 2007 the City's Public Works Department is replacing its entire complement of older street sweepers with new equipment chosen because of its proven ability to control and remove PM_{10} and $PM_{2.5}$ contained in road dust. This followed participation in extensive research and testing undertaken by the City of Toronto, which has had a considerable influence on the technology of street sweeper design in North America.

3.6 Black Fallout in Hamilton

During the latter part of the summer and during the fall of 2006, there were a number of reports from citizens of black fallout and particulate impacts on residential properties in the north end and east end of the City of Hamilton.

Ministry of the Environment staff from the Hamilton District and Regional office undertook sampling at some of the residential properties. As well, ministry staff carried out detailed inspections of various industrial operations known to be sources of particulate emissions. These efforts were summarized in a report entitled “Summer 2006 Black Fallout Incidents in the City of Hamilton” which was released on November 29, 2006 and made available on the *Clean Air Hamilton* web site (see www.cleanairhamilton.ca).

On December 7, 2006 a public information session was held at Sir Winston Churchill High School where the Ministry presented the key findings of the black fallout incidents. These findings were:

- Multiple sources would have contributed to the summer and fall 2006 fallout impacts.
- Monitoring equipment did not detect increases in particles in the air that would identify an unusual discharge or the source(s) of the emissions.
- Field inspections did not reveal any unusual operations.
- Samples contained carbon materials typically found in the local urban setting.
- Analyses of various samples showed low to modest levels of carbon materials which were variously characterized as 5-20% carbon black, 5-20% coke, 5-20% coal, 5-20% soot or 5-30% coal dust.

The plan to address future impacts of particulate fallout in Hamilton includes:

- A faster, more direct procedure to have Ministry of the Environment staff in Hamilton respond to public reports of particulate impacts on their property.
- A commitment to share information sooner through linkages with the community, which includes involving *Clean Air Hamilton* and Environment Hamilton.
- A plan to reduce the chances that emissions from several sources will combine to cause a problem by:
    - Requiring companies to speed up and refine their plans for controlling pollution sources that may contribute to fallout.
    - Requiring other sources of industrial particle emissions to speed up and refine their plans for controlling such pollution as fugitive emissions and road dusts.
- A plan to continue monitoring air quality, collecting and analysing samples and working closely with ministry and local experts to solve these problems.

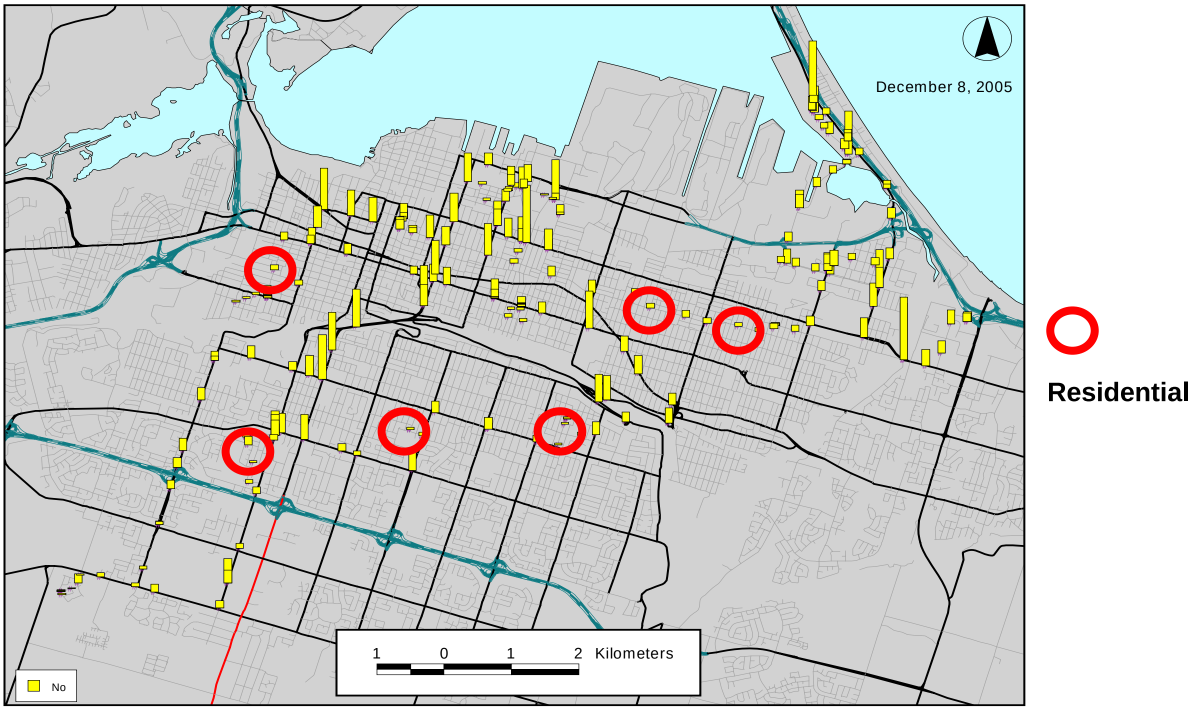
3.7 Transportation Sector – Linkages between Air Quality and Public Health

Phase 1 of a Mobile Monitoring Study was undertaken in late 2005 and early 2006 as a pilot project to determine the impacts of industrial emissions and transportation emissions on the air quality in Hamilton. Preliminary data from this study was presented in the previous *Clean Air Hamilton* report and some recent findings from this study are presented here. Phase 2 began in late 2006 and is continuing into 2007 (see **Section 4.2**).

Fixed air quality monitoring stations provide a good picture of the average exposures to contaminants. However, many people work and live much nearer to industrial and transportation sources compared to the locations of these air monitoring stations. In other words, exposures to contaminants near major roads (i.e., 4-lane streets) and industrial sites may be much greater than would be indicated by data from fixed air monitoring stations.

Measurements during the Phase 1 of the Mobile Monitoring Study demonstrated unequivocally that the majority of direct exposures of Hamilton citizens to pollutants are traffic-related emissions. **Figure 10** 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. Not only were readings taken along 4-lane roads and at major intersections, but there were a number of readings made in residential areas of the city, areas well away from the major roads. The greater the height of a yellow bar in **Figure 10**, the higher the level of NO measured.

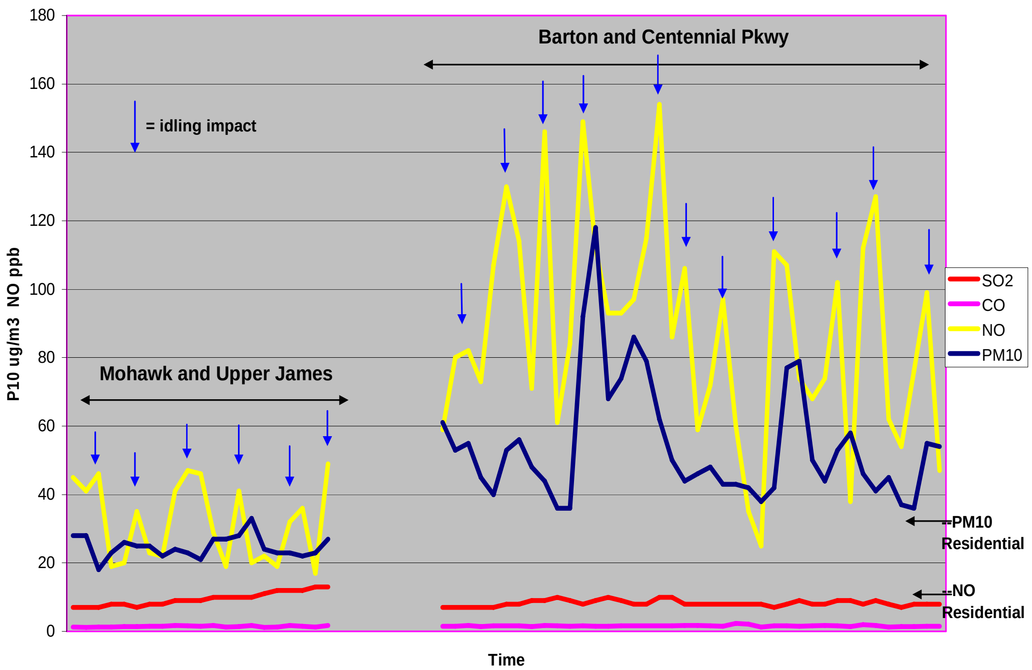
Figure 10: Residential vs. Traffic-related Levels of Nitric Oxides (NO)



The areas circled in red in **Figure 10** 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. The residential areas experienced relatively low levels of traffic-related pollutants compared to the levels measured on many major roads and major intersections within Hamilton.

Figure 11 shows the real-time air pollution data collected by the mobile monitoring unit, when the unit was parked downwind of two major intersections in Hamilton – (1) the intersection of Mohawk Road and Upper James Street and (2) the intersection of Barton Street and Centennial Parkway. When vehicles stopped at the stop light, the ambient levels of nitric oxide (NO) and particulate material (PM_{10}) increased dramatically and appear as peaks on the figure with blue arrows. Once the traffic light changed and the vehicles drove away, the ambient levels dropped dramatically until the traffic light changed and vehicles stopped and idled at the stop light. For comparison purposes, the average levels of NO and PM_{10} in residential areas is included at the bottom right-hand side of the figure.

Figure 11: Air Pollutant Levels Measured near Two Major Intersections in Hamilton



3.8 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 emissions alter the chemical composition of the atmosphere, resulting in an intensification of the earth's natural greenhouse effect.

Climate change can be caused by natural processes, such as a change in the sun's strength, and by human activities. Scientific consensus has been reached that due to increased fossil fuel use and permanent forest loss since pre-industrial times, atmospheric concentrations of greenhouse gases have grown significantly, leading to accelerated changes in our climate.

In 2007, the United Nations International Panel of Climate Change (IPCC) released its fourth annual report (the first in several to be released in 2007) which concluded that man-made activities such as the burning of fossil fuels and to a lesser extent intensive agriculture are "very likely" — more than 90 per cent certain — to have an impact on climate change. These findings were the unanimous conclusion of a large number of the world's foremost climate experts.

Increasing awareness of climate change and its associated impacts such as extreme weather patterns and detrimental impacts on local air quality has resulted in municipalities starting to reduce the amounts of greenhouse gas produced by their operations and services, as well as programs to educate the public on climate change.

In 2006, the City of Hamilton began work towards a Corporate Air Quality and Climate Change Strategic Plan to reduce the greenhouse gases and associated air pollutants from its municipal operations. The plan is available at:
www.myhamilton.ca/myhamilton/CityandGovernment/ProjectsInitiatives/V2020/ClimateChange

Measures to reduce greenhouse gas emissions will translate directly into local air quality improvements. While it is widely recognized that reductions in fossil fuel combustion will reduce greenhouse gas emissions, it is less well known that the by-products of combustion (PM, NOx and CO) which cause the health impacts in humans will also decrease. Hence, greenhouse gas reduction strategies will result in immediate health benefits.

4.0 *Clean Air Hamilton* and City of Hamilton Air Quality Programs

4.1 Upwind/Downwind 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 Upwind Downwind Air Quality Conference: Climate Change & Healthy Cities** will be held on February 25th and 26th, 2008 at the Hamilton Convention Centre. The two-day conference aims to provide a forum to enable an improved understanding of air quality and climate change issues and impacts to cities, human health and the economy. This conference will provide an opportunity to discuss the types of actions governments, industries and citizens will need to take in order to make significant progress to address climate change. Details of this conference and registration information are available at: http://www.cleanair.hamilton.ca/updown/udconf.asp

The **2006 Upwind/Downwind Air Quality Conference: Cities, Air and Health,** the fourth biennial conference, was held on February 27th and 28th, 2006 and was hosted by *Clean Air Hamilton*, the McMaster Institute of Health and the Environment, and the City of Hamilton. Details of the conference are available in the 2004-2005 *Clean Air Hamilton* Progress Report. Presentations made at the 2006 Conference can be downloaded from: http://www.cleanair.hamilton.ca/updown/udconf.asp.

4.2 Mobile Monitoring Study - Phase 2

The purpose of the second phase (Phase 2) of the mobile monitoring study is to obtain a more comprehensive picture of the ambient air quality in Hamilton. Phase 1 of the study (see the *Clean Air Hamilton* 2004 – 2005 report and the discussion in **Section 3.7** of this report) clearly demonstrated the power and utility of a mobile monitoring survey compared to air quality data obtained from fixed air monitoring stations.

Because one can move the air sampling instrumentation into precisely the location desired to make relevant air quality measurements, one can determine the keys factors such as distances from emission sources and wind direction that can dramatically affect exposures to air pollutants. From the Phase 1 work it became clear that data from mobile surveys reflect the extraordinary variability of source emissions and the broad range of exposures to air pollutants that citizens of Hamilton experience during their day-to-day lives.

Fixed air monitoring stations tend to be placed in locations that are well removed from the influences of specific air emission sources, that is, locations that provide an average of the fluctuating air quality in a city; the locations of fixed monitoring sites are selected to provide averaged air quality data that is representative of the overall area and not of specific locations. Recent studies from around the world have shown that short-term, peak exposures that are experienced near to air emission sources can have serious detrimental health impacts in some individuals. The mobile monitoring approach seeks to collect data on these peak levels of air pollutants and thus peak human exposures.

Figure 12: Mobile Air Monitoring Unit

Figure 12 shows the mobile unit that was outfitted with a number of real-time air monitors. For Phase 2 of this project the monitoring systems in the mobile unit 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. The GPS unit was also upgraded to provide better time resolution of the positioning data.

Clean Air Hamilton and the City of Hamilton, in partnership with the Ministry of the Environment and Environment Canada, are providing financial support for the second phase of this mobile emissions study. Phase 2 of the study will provide more comprehensive monitoring data across the city and more complete analysis of the collected data. The Phase 2 study will allow more time for pollutant monitoring, increase the area, and increased frequency of monitoring compared to the work done in Phase 1.

As well, different climatic conditions (e.g., smog events, temperature inversions) and pollution sources (e.g., emissions from idling school buses and idling vehicles at drive-through restaurants) will be measured to obtain additional information on the impacts of transportation and idling vehicles on the local air quality in Hamilton.

An important part of the Phase 2 study will be the sharing of findings to the public and decision makers; the goal is to use the air pollutant data to improve city-scale air quality modelling and to encourage decision makers to take air quality control actions that will show real benefits to the health of Hamiltonians. The mobile monitoring data and the recommendations arising from Phase 1 of this project have been presented to a number of citizen groups, decision makers and at air quality conferences and events, including *Clean Air Hamilton*, the City's Economic Development and Planning Committee (EDPC) and the Committee of the Whole of Hamilton City Council, the Greater Toronto Clean Air Council, the 2006 Upwind/Downwind Conference, the Hamilton Industrial Environmental Association, the Commuter Challenge kickoff event, the McMaster University Spatial Analysis and Occupational Health Seminar series, the Fugitive Dust Workshop, Ministry of Environment and City of Hamilton staff. Aldermen, decision makers and stakeholders expressed a very high level of interest in the results of the Phase 1 work.

The McMaster Spatial Analysis Laboratory has partnered with *Clean Air Hamilton* and Rotek Environmental Inc. to perform advanced geographic information system (GIS) analyses of the Phase 1 data for better visualization of the data. The Spatial Analysis Group will continue to provide logistical and interpretive support during the Phase 2 study.

Figure 13: Resuspended Road Dust on a Roadway in an Industrial Area of Hamilton

Figure 13 is a photograph showing the resuspension of road dust caused by a dump truck driving along a dirty roadway in an industrial area of Hamilton. Scenes like this are rather common in the industrial areas of the city. **Figure 8** (discussed in **Section 3.5** of this report) showed that there was a very strong correlation between the levels of the harmful portions of airborne particulate material, namely PM_{10}, $PM_{2.5}$ and PM_1. Thus, road dust is not just a nuisance; it is a public health issue. **Figure 14** shows the locations of some of the higher levels of road dust-derived PM_{10} in the city.

Figure 14: Locations of High Levels of Resuspended Dusts across Hamilton

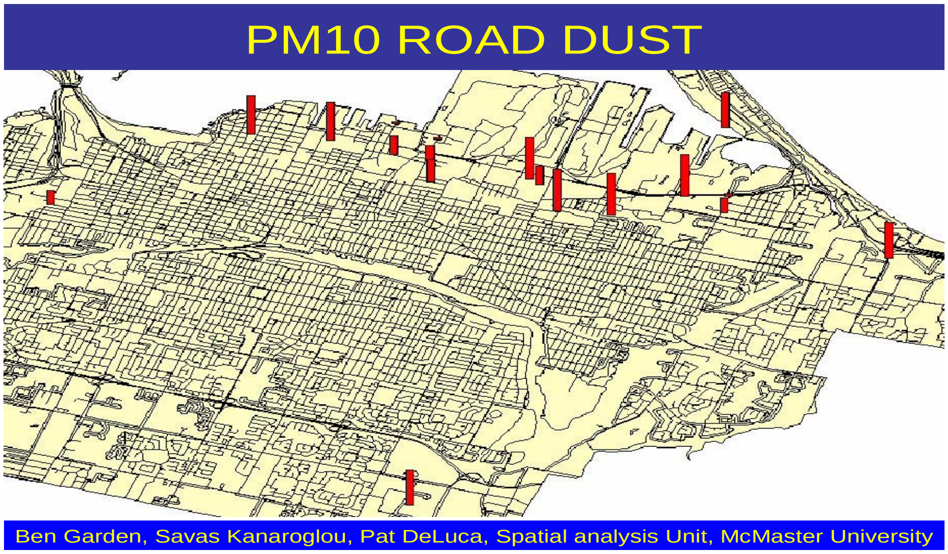
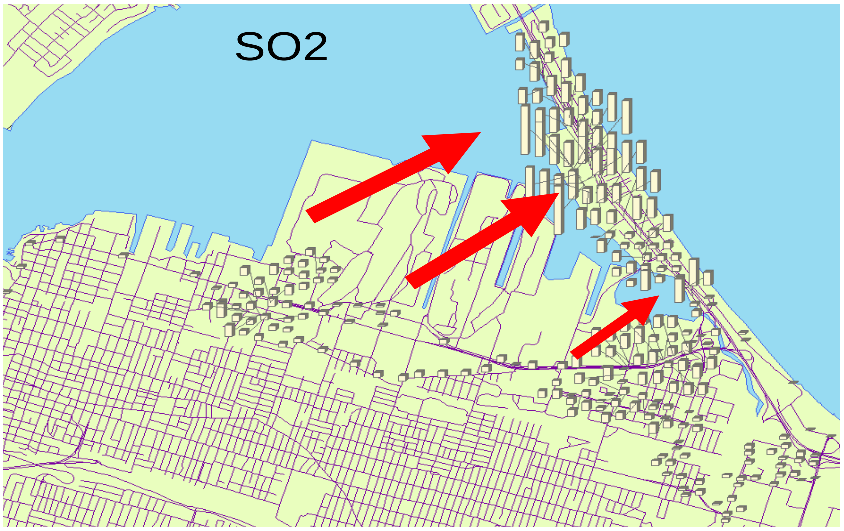


Figure 15 shows GIS-referenced data for sulphur dioxide (SO_2) levels measured by the mobile monitoring unit on a day when winds blew steadily from the southwest (as indicated by the red arrows on Figure N). The sulphur dioxide (SO_2) impacts under these wind conditions are greatest on the Beach Strip. Figures like **Figure 15** clearly demonstrate the spatial variability of the levels of sulphur dioxide across the city. It is not possible to obtain this amount of spatial information from a fixed monitoring station or even a network of stations. These types of monitoring data are being used to refine air quality modeling programs. This modeling information will be used at the local level to provide better estimates of the health impacts of air pollution at the local level rather than at the city level.

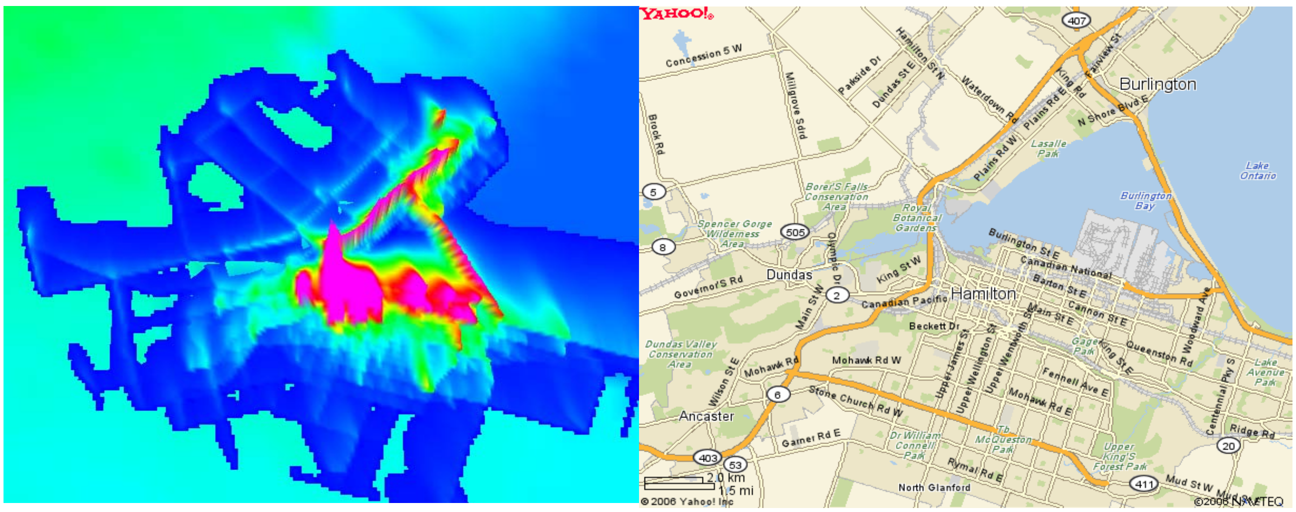
Figure 15: Levels of Sulphur Dioxide (SO2) with Winds from Southwest



A Monitoring/Modeling Workshop was organized at the Spatial Analysis Laboratory at McMaster on November 22nd, 2006 to bring together experts in GIS, modeling and air monitoring together with government staff to discuss cooperative use of air quality data and air quality models. Representatives from McMaster University (from the School of Geography and Earth Sciences and the departments of Chemistry and Engineering Physics), Rotek Environmental, the Ontario Ministry of the Environment, the City of Hamilton and Golder Associates participated in presentations and discussions. It was agreed to continue to share data and refine monitoring target areas and times through the use of advanced air quality models.

Air quality models (see **Figure 16**) indicated that high levels of traffic-related air pollutants were predicted in the West end and Claremont Access areas as well as in the East end of the city.

Figure 16: "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 16 was generated by the Centre of Spatial Analysis at McMaster University using the air pollutant data obtained in the Phase 1 work and incorporating the data into traffic models. **Figure 16** 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.

As a result of these modeling predictions, the mobile monitoring program was altered to include sampling the target areas identified by the modeling results; these areas included the Highway 403 corridor from the west end of the city along the highway toward Ancaster and some of the Mountain access roadways. Preliminary air monitoring data (**Figure 17**) and showed that air quality modeling predictions (**Figure 16**) were very consistent; that is, extremely high levels of NO (nitric oxide) were found along the Highway 403 corridor from the junction at Main St. West and the 403 to the junction with the Lincoln Alexander Parkway.

Figure 17 shows real-time PM_{10}, NO and NO_2 data collected on March 9, 2007 as the mobile monitoring unit made measurements from the east end of Hamilton across the city to Dundas and Ancaster, including the section along Highway 403 mentioned above. A peak NO value of 586 ppb was measured along this stretch of the 403 highway. The NO levels measured along this highway corridor are the highest NO levels measured to date in Hamilton and are 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 highest PM_{10} levels were measured in the east end of the city while the highest NO levels were in the west end.

Figure 17: Air Pollutant Levels Measured Over Five Hours on March 09 2007

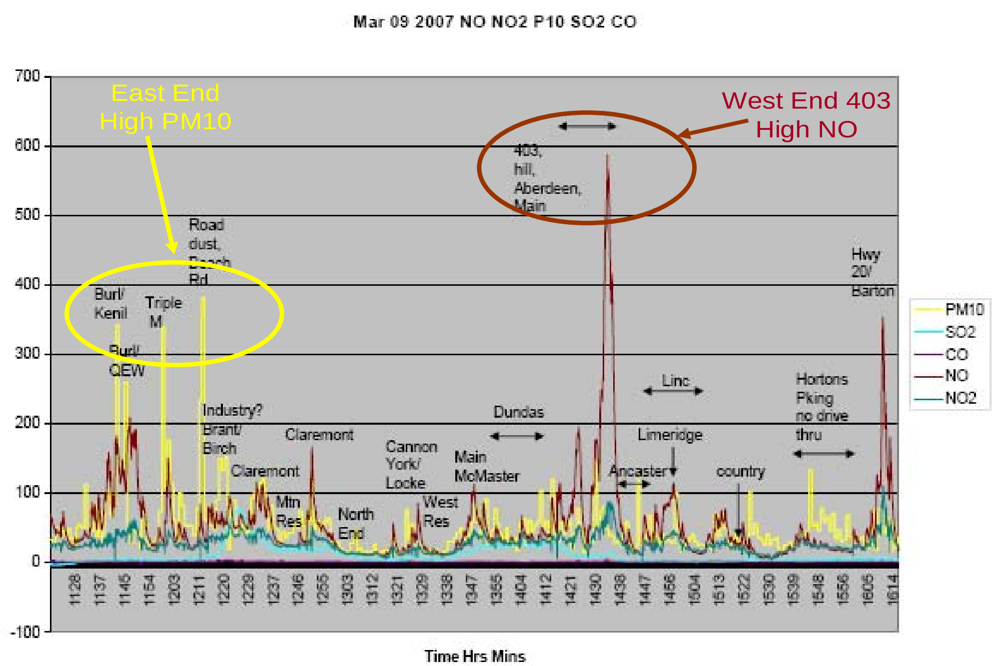
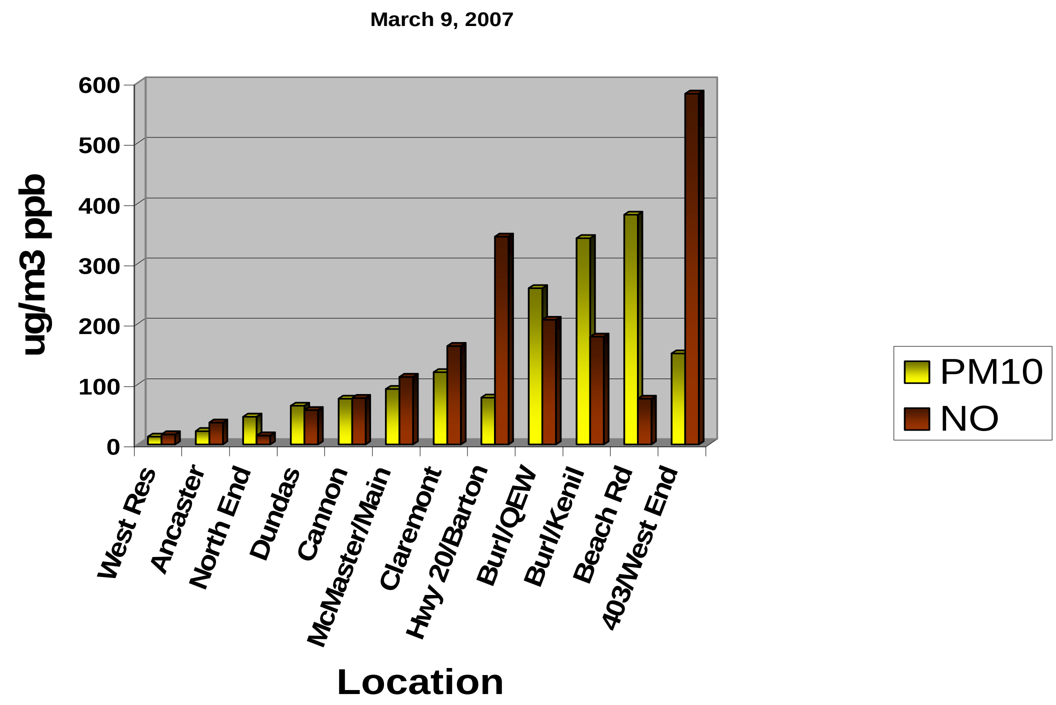


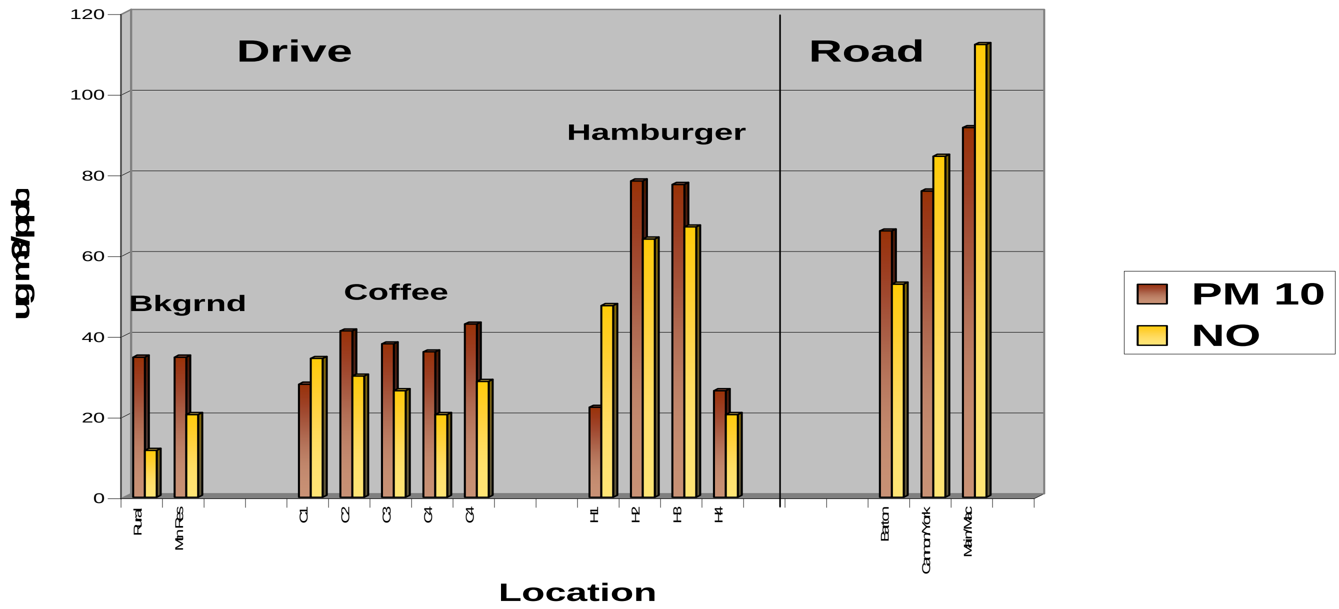
Figure 18 is a bar graph of some of the peak data points from **Figure 17**. The data in **Figure 18** is organized in order of increasing levels of either PM_{10} or NO. The levels were lowest in residential areas or areas with low vehicular impacts and highest in areas with the highest vehicular emissions. These levels are typical levels of exposures for humans working or driving in these areas. For clarity, this figure does not include the high fugitive dust locations measured previously.

Figure 18: Pollution Levels by Location



City staff and community groups have expressed concern about the impacts of emissions from idling vehicles at fast food drive-thru restaurants and coffee shops. Sampling was conducted downwind at a number of coffee shop and fast food/hamburger drive-thru facilities. Preliminary data from this part of Phase 2 of the mobile monitoring survey (**Figure 19**) show that there do not appear to be large impacts downwind of drive-thru restaurants. Concentrations are equivalent to or less than those measured along roads. For example, the levels of NO downwind of some drive-thrus reached peaks of 70 ppb, while NO levels along Main Street West routinely reached 110 ppb; on Highway 403 going up the hill toward Ancaster the NO levels reached almost 600 ppb, almost 10-fold higher than the highest levels downwind of drive-thrus .

Figure 19: PM_{10} and NO Levels near Drive-Thrus Compared to Roads



Sampling on an atmospheric inversion day, with light winds from the East to North East has shown that sulphur dioxide (SO_2) plumes from the industrial sector can reach all the way across the city into Dundas. Since SO_2 is mainly an industrial emission, it can be used as an indicator of industrial impacts across the City; that is, in areas with elevated levels of SO_2, other contaminants may also be at elevated levels. Under these conditions it is probable that these other contaminants are also being produced from sources in the same area as the sources of SO_2.

Table 2: Correlation of Different Contaminants in Inversion Plume with SO_2.

Pollutant	PM_1	$PM_{2.5}$	PM_{10}	CO	NO	NO_2	NO_X
Correlation of Pollutant Concentation with SO_2	0.53	0.57	0.38	0.53	0.42	0.64	0.50

Table 2 shows the covariance of a number of pollutants with SO_2. Due to the large influence of vehicle emissions on NO levels and road dust re-entrainment on particulate levels near major highways, the data collected in the east end near the QEW and Highway 20 and in the west end near Highway 403 were removed from the data set used to create Table 2. The remaining mobile monitoring SO_2 data were then correlated with a range of different contaminants measured simultaneously with SO_2.

Interestingly, the highest correlation was observed between SO_2 and NO_2. This correlation is likely because NO emissions are quickly oxidized to NO_2 in the atmosphere as the plume of pollutants travels across the City. The importance of this observation is that NO_2 is considerably more toxic to humans and animals than NO. The finer particle fraction, such as $PM_{2.5}$ and PM_1, also show reasonable correlations with the SO_2 data. These finer particles are considered to be more toxic than PM_{10}. In other words some transformed airborne contaminants are more problematic health wise than direct combustion emissions. Additional sampling will be completed on smog and atmospheric inversion days when pollutant levels can reach rather high levels for brief periods.—Detailed GIS analyses of these data sets will be conducted in the later stages of the Phase 2 study to provide "pictures" of the pollutant levels across the city of Hamilton.

4.3 Hamilton's Green Fleets

The City of Hamilton is one of the leading municipalities in Canada to replace vehicles in their fleets with greener alternative vehicles. Hamilton's Green Fleet Implementation Plan was created to reinforce the City's commitment to improving air quality, preventing climate change and implementing one of the country's leading low-emissions fleets.

Figure 20: City of Hamilton's Green Fleet

As part of the Plan, Hamilton has replaced 60 sedans and pickup trucks with hybrid electric vehicles (HEVs). The City will introduce renewable fuels, such as five percent bio-diesel, for the City's diesel fleet in the spring of 2007.

Hamilton has replaced 15 older style street sweepers with new regenerative-air street sweepers; these new sweepers are the most efficient sweepers in removing dusts from streets and have involved a major change in sweeper design. The City's Transit division has also purchased 12 new diesel-electric hybrid buses which, when added to the existing fleet of natural gas buses, will contribute to Hamilton's air quality goals.

4.4 Idling Awareness Campaign

In 2006, *Clean Air Hamilton*, Green Venture and city staff developed an idling awareness campaign directed at the broader community. The campaign aims to encourage behavioural change among those who live and work in Hamilton, through education, awareness and commitment-seeking.

The campaign aims at reducing greenhouse gas emissions that contribute to climate change and reducing emissions that produce air quality concerns in localized areas. The components of the campaign include: a community wide education campaign, a school education campaign to encourage parents who pick up or drop off children at schools to reduce their idling, and engaging private fleets.

4.4.1 The *Idling Stinks* Campaign

The primary goal of the Idling Stinks Campaign is to raise awareness about the negative impacts of emissions from idling vehicles in the Hamilton community; 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 2006, Green Venture implemented several methods of communicating the anti-idling message in their successful community awareness campaign, including:

- Distribution of approximately 90 posters to libraries, community centres, community policing centres, City of Hamilton municipal service centres, and Hamilton’s Emergency Medical Services (EMS) stations.
- Displays and information provided at events including the Festival of Friends, Westitalia, the Dundas Cactus Festival, the Emmanuel United Church Community BBQ, the Catholic Parents’ Conference, OPIRG/HCF Youth Conference, Car-Free Week, and King George Elementary Teacher/Parent Night. Forty-two pledges to reduce idling were collected at these community events and countless information cards were distributed to members of the public.
- Seven idling blitzes and interventions have been undertaken thus far in the campaign. Locations included the Hamilton GO station, Mohawk College, McMaster University, Westdale Village and 4 elementary schools. Approximately 14 mock tickets were distributed during theses blitzes and many more information cards were handed out to educate drivers about idling.

- 22 volunteer Clean Air Ambassadors were recruited to deliver the anti-idling message in Hamilton and assist in the campaign.

- The development of an informative anti-idling website at: www.greenventure.ca/cc.asp?ID=161

4.4.2 School Awareness Program

There are approximately 200 schools in Hamilton including all of the Catholic, public, private elementary and secondary schools. Thus far the school campaign has focused on engaging and educating parents and guardians who drop off or pick up their children at schools.

In 2006, all 200 schools in Hamilton received requests to join the idling awareness campaign. Overall, 29 schools participated by erecting signs, inserting idling information in their school newsletters, receiving ticket blitzes and interventions and other activities such as assemblies. Sixty-two anti-idling signs (see **Figure 21**) were posted at 19 schools in Hamilton.

Figure 21: Anti-Idling Sign

Green Venture, with the support of Public Health, City Councillors, and *Clean Air Hamilton* engaged directly with the Hamilton-Wentworth District School Board (HWDSB) and the Hamilton-Wentworth Catholic District School Board (HWCDSB). Presentations were delivered to superintendents and trustees at the HWDSB as well as environment representatives at the HWCDSB. In the case of the HWCDSB, this led directly to many schools' participation in the campaign.

4.4.3 Private Fleets

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 for between 20-60% of their operating time. The average long-haul truck idles away $1,800 worth of fuel every year.

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, approximately 132 private fleets in the goods movement, moving, taxi, limousine and bus and some construction sectors were contacted. They were provided with idling information and Green Venture gauged their interest in an idling campaign. Unfortunately the response level was poor.

However, a survey of selected private fleet managers and engagement with the Hamilton Chamber of Commerce's Transportation Committee has revealed useful information on addressing idling in private fleets. This information will inform future campaigns and Green

Venture will continue to promote those businesses that are addressing actively measuring and restricting their vehicles' idling.

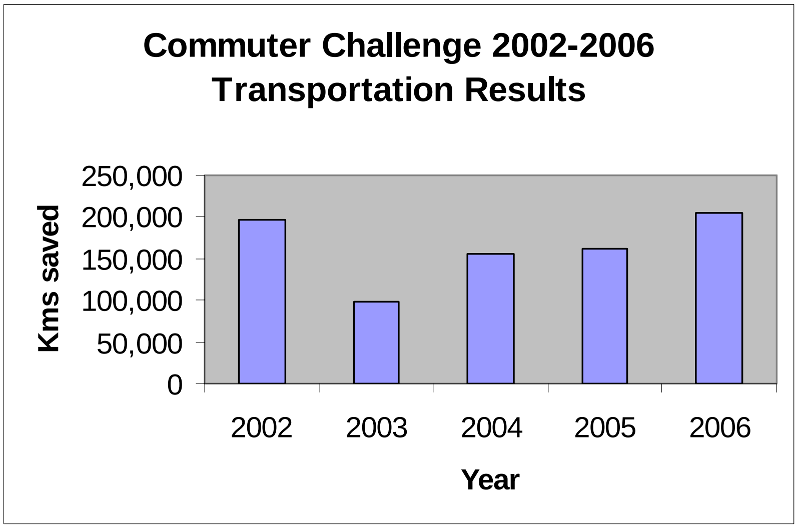
4.5 Commuter Challenge

The Commuter Challenge is a week-long, friendly competition between Canadian cities to reduce 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 improving air quality and slowing climate change. The Commuter Challenge raises awareness of alternative transportation choices and demonstrates how they improve air quality and reduce greenhouse gas emissions.

In 2006, Hamilton celebrated six years of Commuter Challenge successes. The City of Hamilton first participated in the Commuter Challenge in 2000 when 41 companies and over 700 individuals made the commitment to commute in a sustainable manner. In 2006, the total number of participants in Hamilton since the program's inception passed the 10,000 mark!

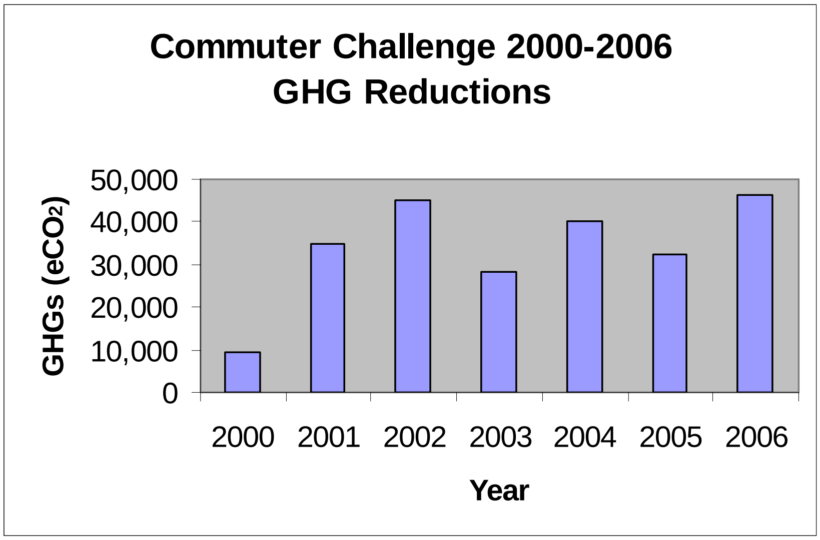
Figure 22: Reduction in travel distance by single occupancy vehicles



In 2006, 246 City employees participated in Commuter Challenge. Over the course of the week, City staff collectively traveled 31,500 kilometres using sustainable modes of transportation. This change in modes of transportation prevented the release of about 41,518 grams of air pollutants and 8,497 kilograms of greenhouse gases (i.e., eCO_2) from entering the atmosphere.

City-wide, over 1,700 individuals and 27 organizations participated in the community-based Commuter Challenge campaign organized by Green Venture in 2006. Over the course of the week, Hamiltonians collectively traveled 205,757 kilometres using sustainable modes of transportation, stopping the release of 224,610 grams of NO_X and 46,263 kilograms of greenhouse gases (i.e., eCO_2) from entering the atmosphere. The Commuter Challenge demonstrates the measurable impact of active and sustainable transportation on our air quality and climate.

Figure 23: Reduction in Greenhouse Gas Releases due to the Commuter Challenge



4.6 Smart Commute

Travel (or transportation) demand management (TDM) helps us get the most from our transportation systems. TDM can help reduce traffic congestion, defer or eliminate the need for new infrastructure, and improve air quality. The City of Hamilton has been active in the creation of the GTA Smart Commute Association that will implement a number of regional and local TDM measures.

TDM encourages:

- The use of alternative travel modes (e.g., walking, cycling, taking public transit or carpooling) that consume fewer resources; reduces traffic congestion, therefore reducing pollution and greenhouse gases.
- Alternative work hours that allow employees to travel outside peak hours to avoid traffic congestion.
- Good trip planning to reduce travel distances by choosing closer destinations or combining several trips into one trip.
- Telework (work from home or a remote location) arrangements between employers and employees to reduce the number of commuters and allow employers to reduce both office space and employee parking (therefore reducing real state costs).

The Smart Commute Association (SCA) has been responsible for creating and developing a Transportation Management Association (TMA) strategic approach which can help municipalities develop and maintain sustainable transportation initiatives through Transportation Demand Management (TDM) strategies.

A valuable tool has been developed called the Carpool Zone Website (www.carpoolzone.ca). The website offers a map-based trip editor, match ratings and new match indicator, multi-trip match mapping, Route-based matching, and carpool names. The website has recruited an additional 16 new employers throughout the GTA and Hamilton, with over 3500 users forming 230 carpools. The carpool zone website alone has had a result of 78 tonnes of verified GHG emission reductions, and over 300 tonnes of estimated GHG emission reductions.

The Smart Commute Association is investigating ways to work with the Province and the Greater Toronto Transportation Authority to maximize the benefits resulting from Provincial investments in transportation. Some of these investments have been made while others are planned for; these include expanding transit service in the GTA and implementation of high-occupancy vehicle lanes on Highways such as 403 and 404 and Q.E.W.

The Hamilton Transportation Management Association, to be called Smart Commute Hamilton, is being developed through the networking and assistance measures of City staff, in order to help foster individual employer trip reduction programs. Currently, workshops and stakeholder meetings are being conducted in order to determine the feasibility of a TMA in Hamilton.

4.7 Energy Efficiency Activities

4.7.1 EnerGuide for Houses Program

The EnerGuide for Houses program was developed by Natural Resources Canada in 1998 to help homeowners make retrofit upgrades that improve the comfort and energy efficiency of their homes. The EnerGuide for Houses' aim is to identify potential home energy savings and to offer a grant incentive for home retrofits. Green Venture is a delivery agent for the EnerGuide for Houses program.

Certified inspectors visit homes and provide customized plans to improve home energy efficiency and provide homeowners with detailed, easy-to-understand information as well as an energy rating for their home.

In 2006, the EnerGuide for Houses program contributed to a reduction of 830 tonnes of CO_2 emissions, an average of 1.5 tonnes per household, by recommending and supporting home retrofits. This represents an 8% increase over the 2005 program results. Thanks to the program, Hamilton homeowners received $150,000 in grants for energy efficiency.

In 2006, the federal government cancelled the EnerGuide for Houses program. At the same time Horizon Utilities and Union Gas developed a program with Green Venture to target low income households in Hamilton; this program continued the EnerGuide for Houses audits and participants were provided with energy saving products like compact fluorescent light bulbs and low flow aerators. Over forty audits for the new program were scheduled in November and December 2006.

Green Venture is working with Green Communities Canada and the Ontario Power Authority to develop an Ontario-wide low income energy efficiency program that focuses on electrically heated homes in 2007. This program will build on the successes of its predecessors in reducing greenhouse gas emissions.

4.7.2 Energy Conservation Day

The City of Hamilton held an Energy Conservation Day on October 18th, 2006, to promote energy awareness. The Office of Energy Initiatives in the Public Works Department handed out approx. 2200 energy savings kits to residences and city employees. The kits, supplied by Union Gas and Horizon Utilities, included two low-flow shower heads, bathroom and kitchen aerators, an LED nightlight, two 13-Watt CFL Bulbs and conservation tips handbooks.

Reducing your personal CO_2 Output

By taking the following actions you can reduce your personal CO_2 emissions:

1. Replace 2 frequently used light bulbs with compact fluorescent bulbs. reduction: 100kg CO_2/year
2. Tune-up your furnace, add house insulation, caulk and weather strip reduction: 1,000kg CO_2/year
3. Use a low-flow showerhead and wash clothes in cold water reduction: 380kg CO_2/year
4. Use an energy-efficient refrigerator. reduction: 180kg CO_2/year

The average Canadian emits 5 tonnes (5,000 kgs) of CO_2 per year.

4.8 Wood-burning Stoves

Wood heating has a long history in Canada and, with new wood-burning technologies, more households are returning to using wood as a source of renewable energy. Woodstoves are, by nature, a relatively high-polluting source of heat, and they contribute significantly to winter smog levels in both urban and rural areas. Air pollution from fireplaces and wood stoves contains particulate matter and more than 100 other chemical compounds and pollutants. In Canada, residential wood heating is responsible for 29% of fine particulate emissions. Burning a woodstove for nine hours is equivalent to a car traveling 18,000 km!

In 2005, *Clean Air Hamilton* began educating Hamiltonians about wood-burning stoves, efficient wood burning and their effects on health and air quality. The *Clean Air Hamilton* website features "Wood Burning – What You Need to Know" with linkages to Environment and Natural Resources Canada's Burn it Smart program: http://www.cleanair.hamilton.ca/Burn-it/wood-burning.asp. In the winter of 2007, a display was featured at City Hall with information on how woodstoves impact air quality, how individuals can ensure their woodstove is efficient or emitting low levels of pollutants, how to properly store wood and the dos and don'ts of burning wood.

4.9 Tree Planting Programs

4.9.1 Hamilton Tree and Park Foundation

Trees act as carbon sinks that can off-set the release of greenhouse gases; they provide shade that can mitigate the "urban heat island effect"; they offer shade that can protect people from the damaging effects of the sun's ultra-violet light; they can provide cool retreats for people during heat waves; and they remove many pollutants from the atmosphere.

There is growing interest in Hamilton to protect, enhance and promote the health of urban forests and to renew and improve the local system of municipal parks, natural areas and related facilities.

Building on this momentum, a stakeholder group was formed in 2006 to facilitate the development of a Hamilton Trees and Park Foundation. Members of this group include the City of Hamilton, Environment Hamilton, the Mountainview Residents' Association, Green Venture, and the Hamilton Community Foundation.

4.9.2 Heritage Tree Planting Program

The City has partnered with *Clean Air Hamilton*, the Hamilton Industrial Environmental Association (HIEA), the Royal Botanical Gardens, the Bay Area Restoration Council (BARC), the Hamilton Waterfront Trust, Halton Conservation and the City of Burlington to reintroduce tree species that are native to the Hamilton area. The project involves collecting seeds from surviving trees, propagating them in a greenhouse, and then planting the seedlings in and around the Hamilton Harbour.

In 2006, 78 trees were planted along the Hamilton Beach Waterfront Trail, 10 trees were planted along the Burlington Waterfront Trail, and 35 trees were planted in the North East Shoreline Fish & Wildlife Site. The heritage tree-planting program first began in 2005, with the planting of 100 trees along the Bayfront Park Trail.

5.0 Conclusions and Recommendations

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

- **Trans-boundary Air Pollution.** Originating from sources in the mid-western United States, about 50% of pollutants in Hamilton arrive by prevailing winds; Hamilton is impacted in a manner similar to many other communities in south-western Ontario;
- **Transportation Sources.** The roads in and around Hamilton are heavily used by automobiles and diesel trucks; while the increased numbers of miles driven by commuters and the increased truck traffic has been offset by the improved efficiencies of vehicles, emissions from transportation sources result in very high local levels of pollutants near major roads and highways;
- **Industrial Sources.** Hamilton is home to a large number of industries from the large, integrated steel mills to medium-size and small industries; road dusts and track-out from industrial sites are a major contributor to airborne particulate material in industrial areas of the City; and
- **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.

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.

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

- Encourage Hamiltonians to change their behaviour with respect to idling personal and commercial vehicles. Anti-idling practices should be promoted near "hot spots," such as schools, community centres and public buildings around the City.

- 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.

- Recognize that climate change as an important issue that is linked directly to sustainability and to recognize that local air quality improvements will result from taking actions to reduce greenhouse gas emissions.

- Increase public awareness through education that smog advisories are year-round occurrences, not just summer season events, and to develop policies and practices to reduce smog year-round.

- Continue to take a broad suite of actions to improve local air quality 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 2007, *Clean Air Hamilton* will continue its recognized work in addressing 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 work 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: Air Pollution Health Impacts – Hamilton and Ontario

In 2005, the Ontario Medical Association (OMA) updated their estimated cost of illness associated with air pollution in Ontario. This update of their 2000 report showed higher impacts on public health and reflected an improved understanding of these health effects, including new studies on the chronic effects of exposure to air pollution.

The OMA report showed the estimated cost of illness as both a dollar figure, as well as the projected health outcomes, including premature deaths, hospital admissions, emergency room visits, and minor illnesses. In 2005, air pollution caused an estimated 5,800 premature deaths, almost 17,000 hospital admissions and almost 60,000 Ontarians to visit hospital emergency rooms. The adverse health impacts in Ontario each year from trans-boundary air pollution include more than 2,700 premature deaths, almost 12,000 hospital admissions, and almost 14,000 emergency room visits.

The OMA report estimates the cost of air pollution to the economy of Ontario at $16 B per year! This figure is an extraordinary cost which includes health costs, lost time from work, lost productivity in the workforce, etc. While the OMA did not provide a breakdown of these costs for Hamilton, the local figure would be around $1 B, based on the proportion of the local population (~600,000) to the 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 3**.

Table 3: 2005 Illness Cost of Air Pollution – Regional Data for Hamilton-Wentworth Regional Municipality (Source: Ontario Medical Association)

	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 Ontario Medical Association estimated that the economic impact of smog in Hamilton on individual health in 2005 was $2.13 M in health care costs and $1.73 M in lost work productivity.

The 2005 OMA report is supported by the *Clean Air Hamilton*'s 2003 air pollution health assessment report that was prepared by Michael Jerrett and Talar Sahsuvaroglu of the McMaster Institute of Environment and Health for the City of Hamilton. The Jerrett report estimated that of the five key air pollutants – nitrogen dioxide (NO_2), ground-level ozone (O_3), inhalable particulate matter (PM_{10}), sulphur dioxide (SO_2) and carbon monoxide (CO) – were contributors to human health effects impacts. Two of these pollutants (NO_2 and O_3) alone account for over two-thirds of the adverse human health outcomes **(see Table 4).** These estimates were based on comparisons of recent, large-scale health studies with Hamilton's air quality data and health statistics. This approach allowed the identification of the contributions of key air pollutants that contribute to adverse human health impacts.

Table 4: Summary of Premature Deaths, Respiratory and Cardiovascular Hospital Admissions Associated with Air Pollutants, Hamilton, 1997

Pollutant	Premature Deaths	Respiratory Hospital Admissions	Cardiovascular Hospital Admissions	Totals
O_3	36	44	191	271
NO_2	27	48	176	251
PM_{10}	14	27	49	90
SO_2	16	20	26	62
CO	3	NA	38	41
Totals	**96**	**139**	**479**	**714**

Appendix B: Air Quality Indicators - Trends & Comparisons

Air Quality Trends in Hamilton

The graphs in this Appendix illustrate trends in key air quality parameters in Hamilton over the past 10-15 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. Emissions from most of the major industrial pollution sources have been reduced significantly during this period. While additional improvements in industrial emissions are certainly possible, the cost of implementation of the technologies to achieve these goals is much greater. Pollution abatement technologies and strategies continue to be implemented by companies within the industrial sector and these process upgrades are resulting in measurable improvements to Hamilton's air quality. *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, 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.

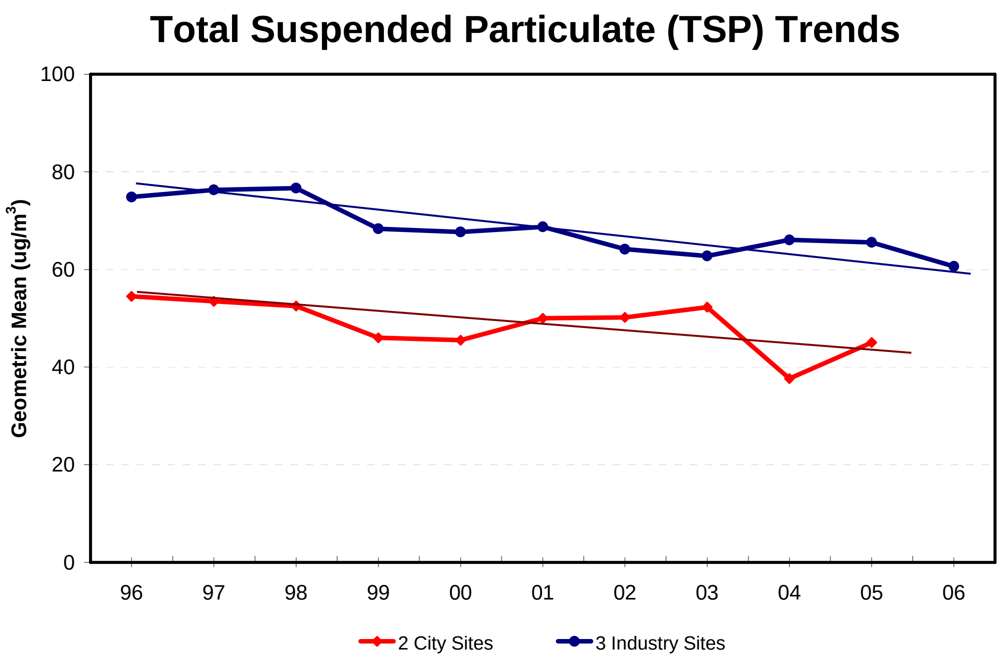
The air quality in Hamilton is affected by emissions and activities from both inside and outside our region. The 1997 Hamilton Air Quality Initiative (HAQI) reports stated that about 50% of the pollutants in Hamilton's airshed were due to sources outside the Hamilton region; indeed, the primary, non-local 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 recent report from the Ontario MOE (June 2005) 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 15% since 1995. A substantial portion of TSP is composed of road dust, soil particles and emissions from industrial activities and transportation sources.

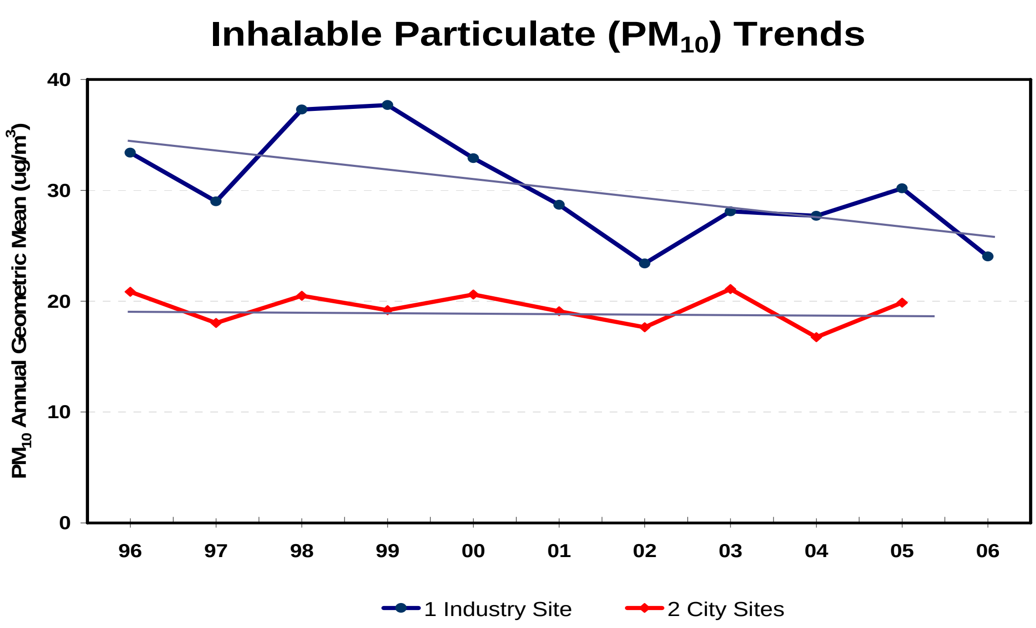
Included in the TSP category are Inhalable Particulates (PM_{10}) and Respirable Particulate ($PM_{2.5}$). By subtracting the PM_{10} or the $PM_{2.5}$ value from the TSP value it is possible to determine the net amount of particulate material in the air with sizes between about 45 µm and either 10 µm 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. The ambient levels of PM_{10} in Hamilton have remained relatively constant for the past decade. It has been estimated that: between 40 and 70% of the PM_{10} in Hamilton's air originates from outside the community; between 15 and 30% originates from urban sources such as vehicles and wood-burning fireplaces; and between 10 and 45% originate from industries that operate in the City. In areas of the city near the industrial sectors the contributions of industrially generated PM_{10} is greater.

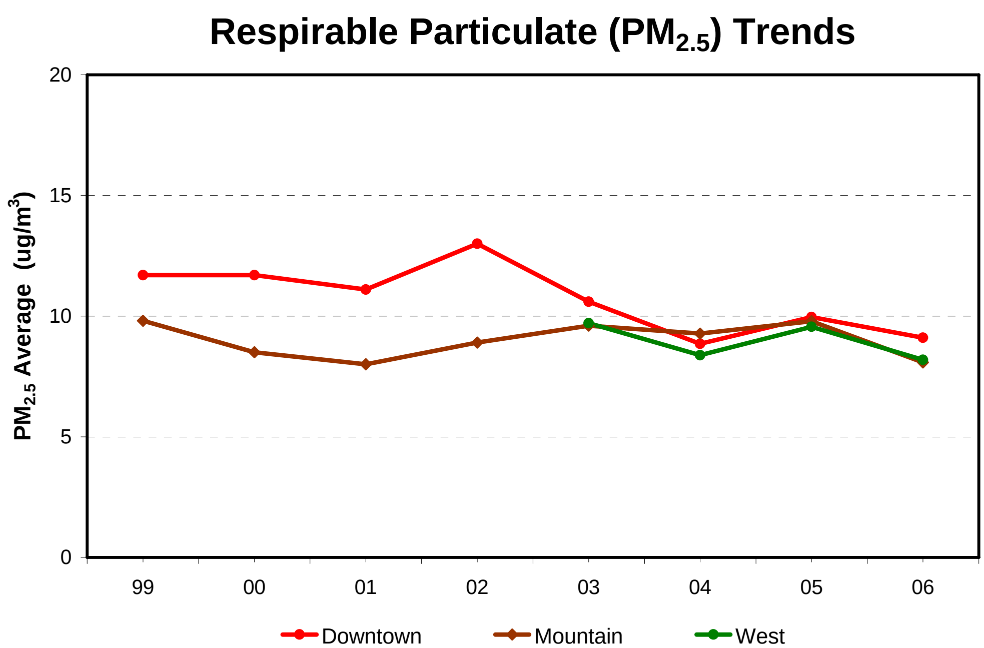
The modest decrease in TSP levels over the past 10 years while laudable has not been reflected in a parallel decrease in the PM_{10} data. The reason for this difference in trends lies in the sources of TSP and PM_{10}. TSP is derived primarily from industrial activities and road dust re-entrainment by vehicles; efforts to control fugitive emissions by industries and increased attention to street sweeping to reduce road dust have led to much of the reduction in TSP over the past decade. On the other hand, the PM_{10} fraction is derived primarily from vehicle exhaust emissions and the finer fraction of road dust. Car and truck traffic numbers have remained constant in Hamilton over recent years and this is reflected in the unchanging trend in PM_{10} over the past decade both in the industrial areas and the city areas.



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

The Province of Ontario has recently begun to monitor 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}.

Respirable particulate matter ($PM_{2.5}$) is the fraction of air particulate that is responsible for essentially all of the deleterious health effects associated with air particles. Most of the particles associated with automobile exhaust and diesel exhaust have sizes in the 0.1 to 0.3 µm range; these combustion sources constitute about 30-50% of the mass of $PM_{2.5}$. It is this fraction of particles which contains over 95% of all small organic compounds. There has been a scientific debate over just what causes these health impacts on humans. It has not been established conclusively whether it is the $PM_{2.5}$ particles alone, the organic compounds associated with these particles or some combination of the particles themselves and the organic substances that is responsible for the respiratory and cardiovascular health impacts attributed to particulate material.



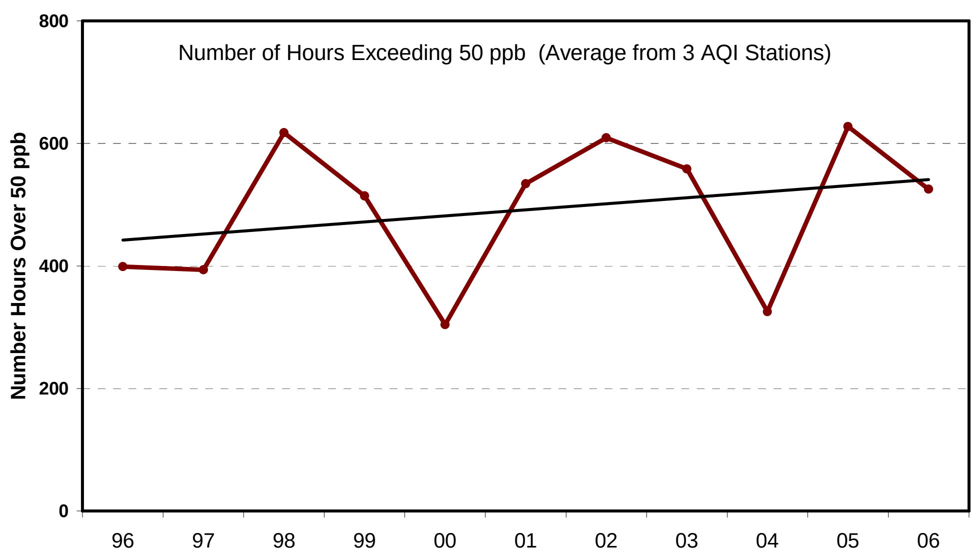
Ground Level Ozone

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. Consequently, air levels of ozone are higher in warmer seasons than in colder seasons. Air levels of ozone, which have varied substantially from one year to the next in response to varying weather conditions, appear to be increasing over time.

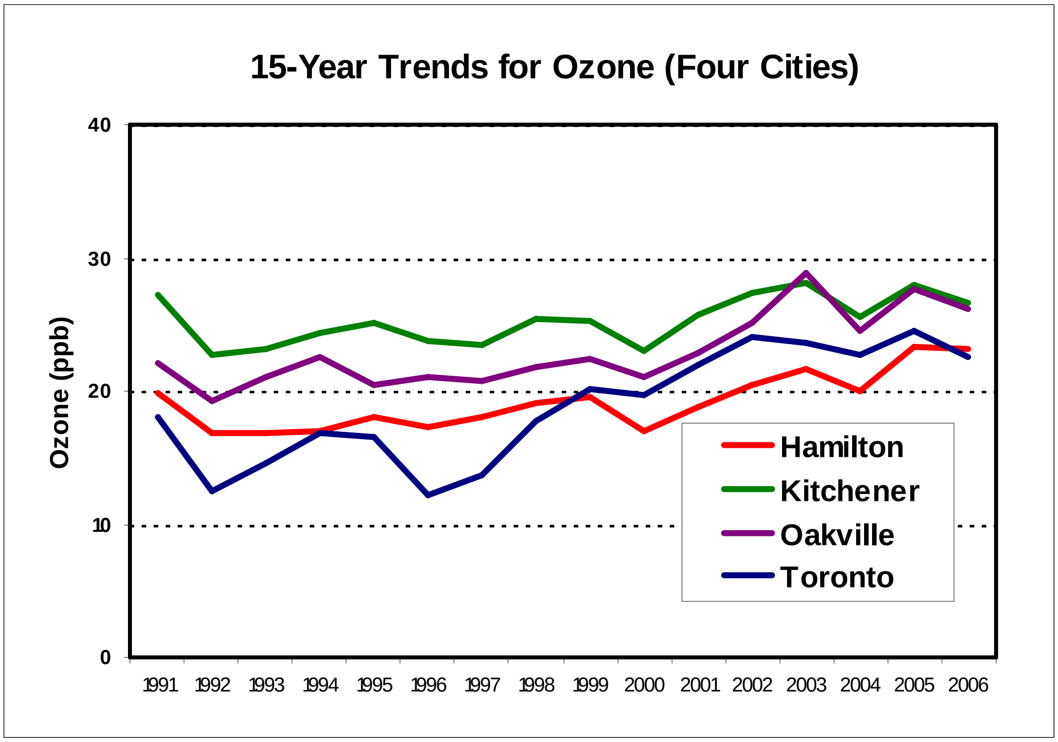
The formation of ground level ozone takes several hours once the pollutants reach the atmosphere. As a result emissions from sources within Hamilton cause the formation of ground level ozone in areas downwind of Hamilton. A substantial portion of the ozone that affects southern Ontario during smog episodes in the summer months originates from distant, upwind sources in the United States.

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.

Ground Level Ozone Trends



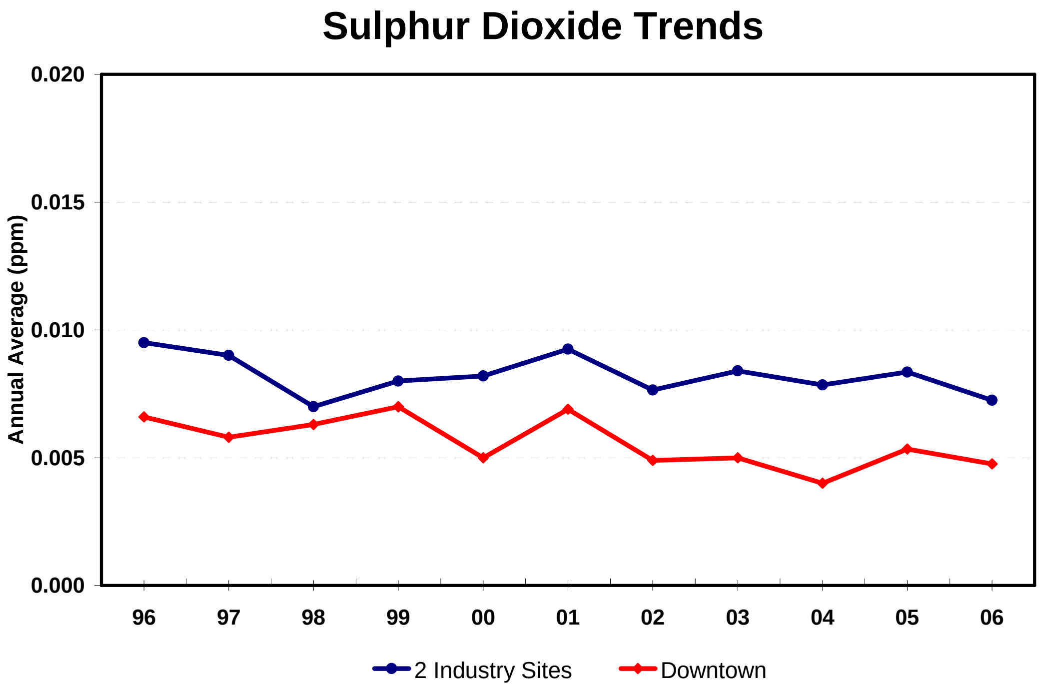
Over the past 15 years the concentrations of ground level ozone across southern Ontario have increased. The increases seen in Hamilton during this period are similar to the trends observed in Oakville, Kitchener and Toronto. In recent years Hamilton has experienced lower ozone levels than the other three cities. Ozone levels in Hamilton have consistently remained 20-25% below those observed at the Kitchener site.



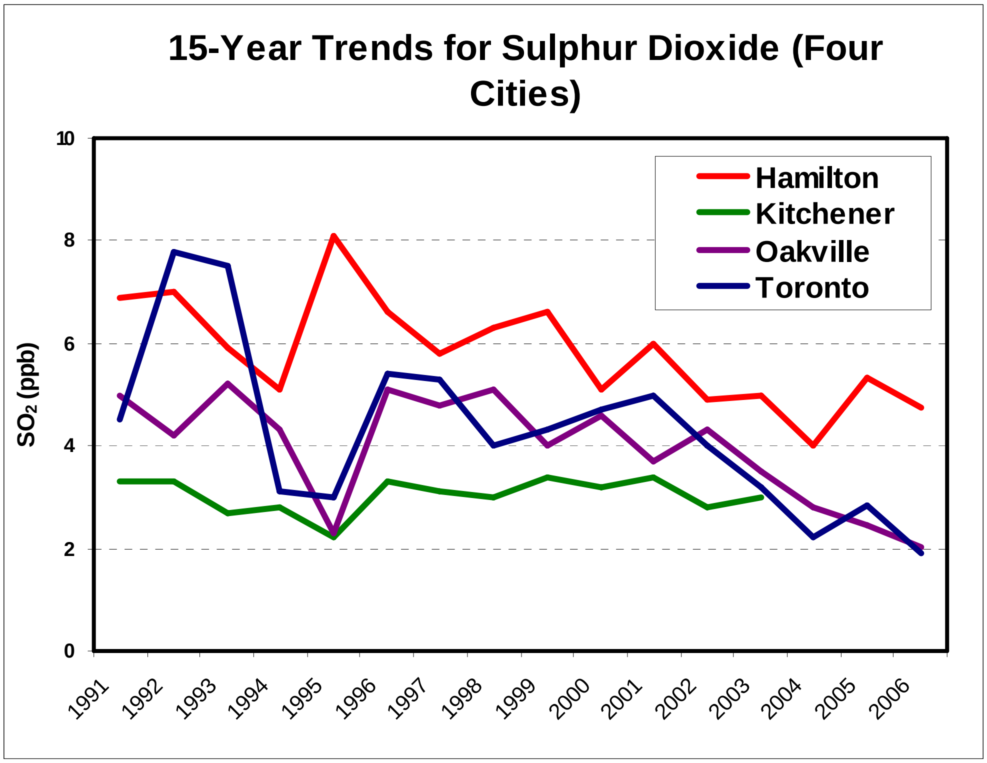
Sulphur Dioxide

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. The new federal regulations to limit the sulphur content in diesel fuel to 15 parts per million by 2007 should have an impact on ambient SO_2 levels once these measures take full effect in 2007.

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.



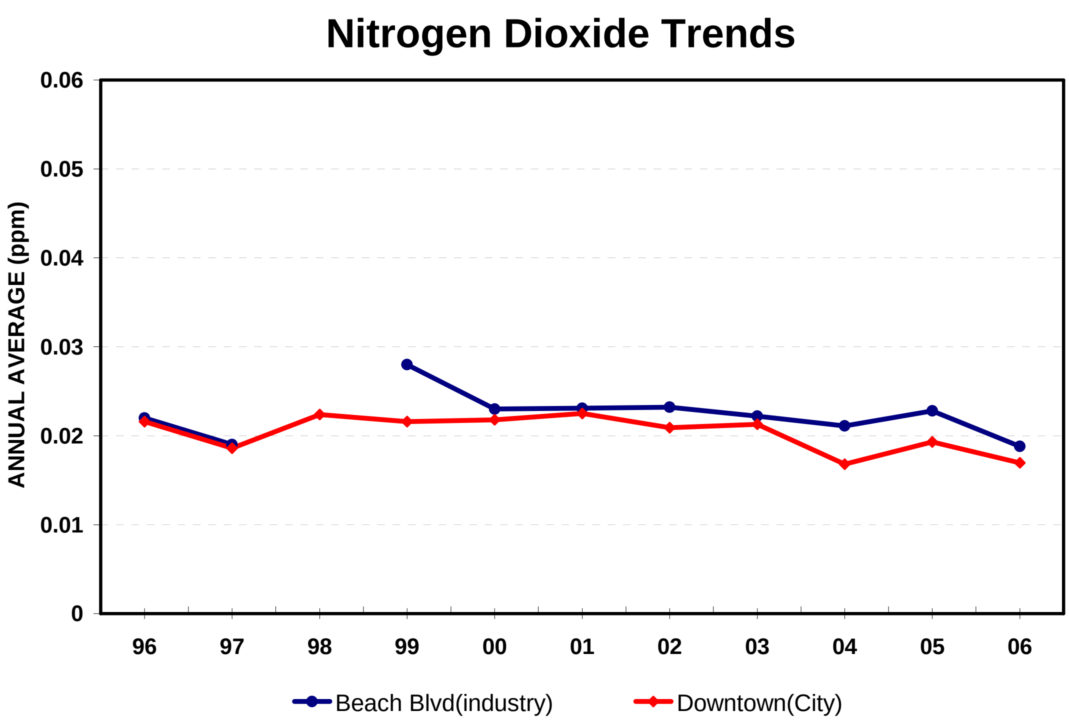
The graph below shows a comparison of the fifteen-year trends in sulphur dioxide levels in four southern Ontario cities. The levels in Hamilton are higher than the other cities due primarily to the industrial emissions that are unique to Hamilton. The sulphur dioxide levels in Oakville and Toronto are similar, reflecting similar compositions of local sources, primarily transportation sources.



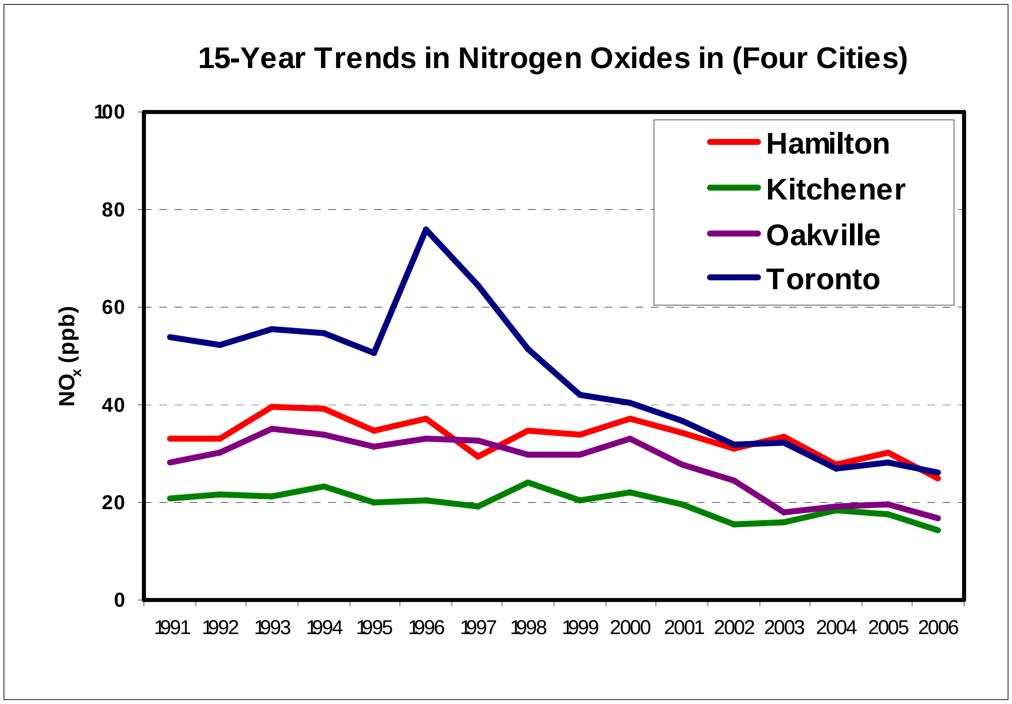
Nitrogen Dioxide

Nitrogen dioxide (NO_2) is responsible for a significant share of the air pollution-related health impacts in Hamilton. Little progress has been made to reduce air levels of NO_2 over the last decade. NO_2 is formed in the atmosphere from nitric oxide (NO) which is formed 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.



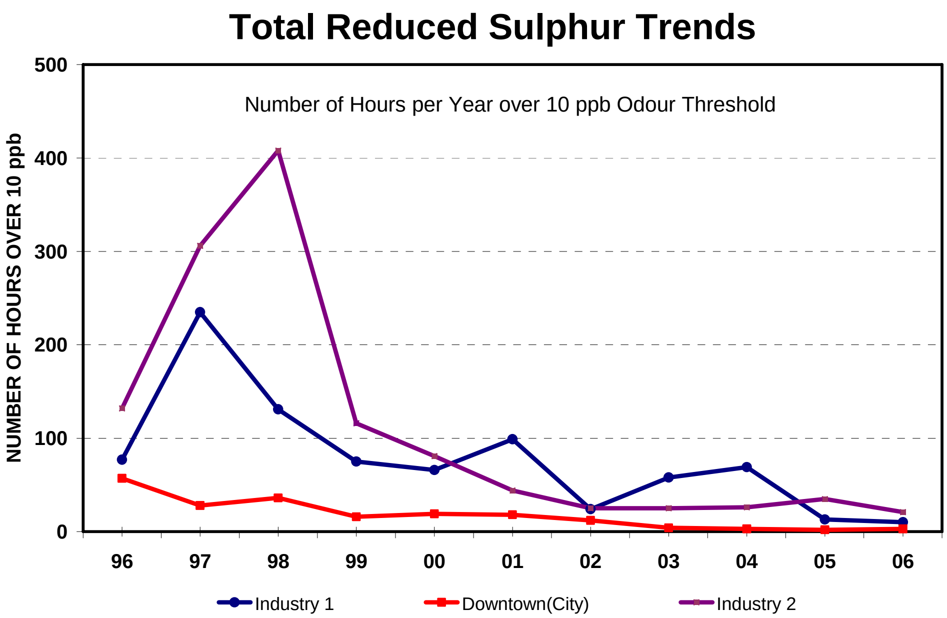
When we compare the 15-year trends in air levels of NO_x in Hamilton to NO_x levels in other Ontario cities that have no significant industrial contributors (only vehicular emissions), the levels in Hamilton have remained steady whereas the levels have decreased in Oakville and Toronto during this period. The NO_x level is the sum of the levels of NO and NO_2. While average NO_x levels in Toronto have decreased significantly in recent years, the average NO_x levels in Hamilton changed little over the past 10 years and are now about the same as those observed in Toronto.



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.

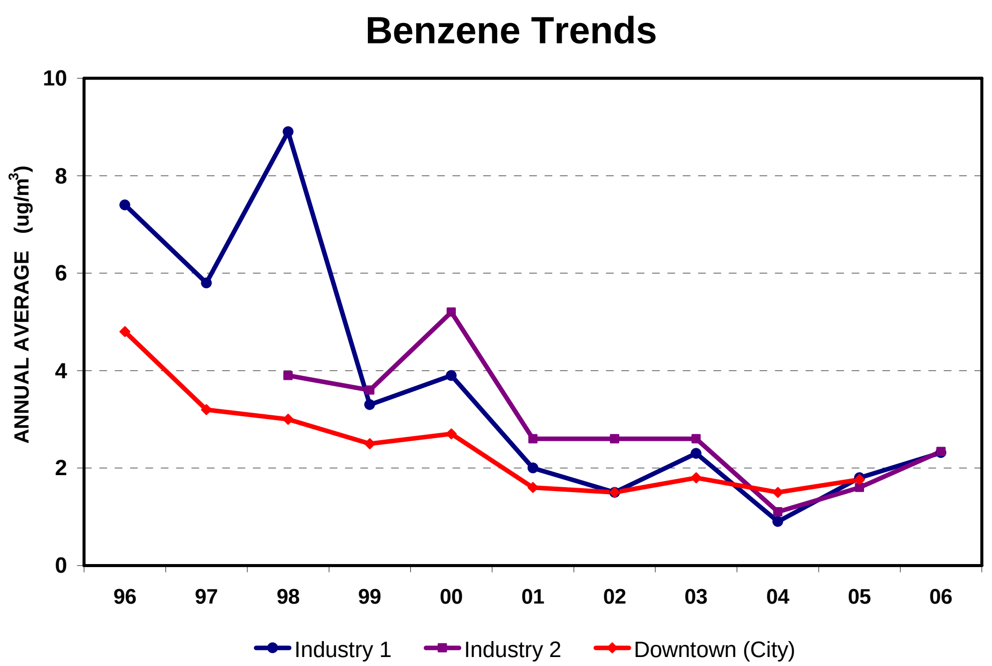
Hourly exceedances of the 10 ppb odour threshold have been reduced by between 70-90% since the mid-1990s due to significant changes in the management and operation of the coke ovens and blast furnaces. In particular, changes to slag quenching procedures have had the greatest effect on reducing odour-causing 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 Hamilton have now dropped to levels comparable to levels in other Canadian and Ontario cities of comparable size.

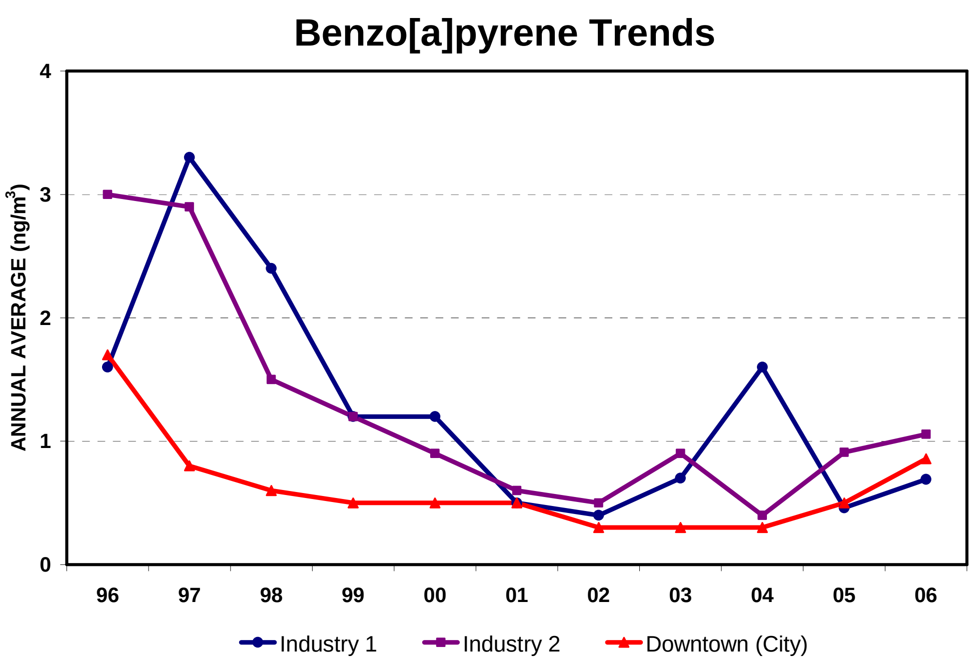


Benzo[a]pyrene

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 may 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.

The downtown (city) sampling site has BaP levels that are typical of many other Ontario cities. This result shows that transportation sources are now the number one cause of PAH emissions to the atmosphere.



Appendix C: Emission Sources in Hamilton

All of the information needed to produce a comprehensive, current inventory of emission sources within the City of Hamilton is not available. **Table 4**, derived from Environment Canada's 2001 Criteria Air Contaminant emissions database, lists total emissions by source type. **Table 5,** derived from the National Pollutant Release Inventory (NPRI), provides the totals of all reported sources of key air pollutants as reported by a selection of local industries. The primary reason that there is not a complete emissions inventory for Hamilton (or any city in Canada) is that many small and medium-sized companies are not required to report their emissions to either Environment Canada to the NPRI Program. Although reporting is mandatory there is no conclusive way to determine whether the estimates are accurate or even reasonable. As illustrated in **Figures 24, 25, 26, 27 and 28** below, these data suggest that:

- The transportation sector is the leading source of NO_X emissions within the City of Hamilton, followed closely by the industrial sector; surprisingly, off-road sources represent about 65% of all emissions from the transportation sector **(Figure 26)**;
- The industrial sector is the leading source of directly-emitted $PM_{2.5}$, followed by road dust and area sources such as fireplaces, home heating and businesses **(Figure 24)**;
- Road dust, construction activities and area sources such as fireplaces and home heating are the leading sources of PM_{10}, followed by industry sources **(Figure 29)**;
- The industrial sector is the leading source of SO_2 **(Figure 25)**; and
- The industrial sector is the leading source of volatile organic compounds (VOCs), followed by releases due to general solvent use by companies and individuals and emissions from the transportation sector **(Figure 28)**.

Table 5: Estimated Emissions by Source, Hamilton, 2001 (Tonnes/year)

Source	PM_{10}	$PM_{2.5}$	SO_2	NO_X	VOCs	CO
Industrial	10,167	2,764	25,771	10,903	28,540	501,768
Area Sources*	4,212	1,571	427	1469	6,908	8,566
Transportation (Off-Road)* * (On-Road)	879 (523) (256)	810 (482) (241)	1,638 (464) (191)	14,217 (7271) (6320)	10,282 (5514) (4105)	107,808 (68572) (41330)
Road Dust***	6,992	1,366	NA	NA	NA	NA
Total	22,250	5,145	27,836	26,589	45,244	618,142

Ref: RWDI Inc. (2004). Transportation Master Plan - Air Quality Policy Paper (May 2004 Draft). Prepared by the IBI Group for the City of Hamilton.

* Includes fireplaces & furnaces in homes & businesses & general solvent use.
** Excludes marine, railroad and aircraft emissions; includes vehicles and equipment used for construction, farming, and lawn and garden maintenance.
*** Road dust includes fine particulate matter from vehicle exhaust, tire wear, construction sites and industrial sites that can become airborne when disturbed.

Sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) are air pollutants that can harm human health directly; these compounds are transformed in the atmosphere to sulphate and nitrate particulate material; these particles are in the size range that is classed as $PM_{2.5}$. Nitrogen oxides (NO_x, mainly NO and NO_2) can also react with volatile organic compounds (VOCs) in the atmosphere to produce ground level ozone.

Figure 24: Emission Sources by Sector, Particulate Matter ($PM_{2.5}$), Hamilton, 2001 (%)

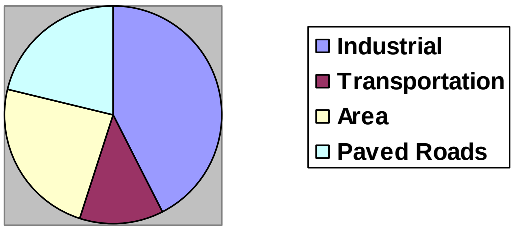


Figure 25: Emission Sources by Sector, Sulphur Dioxide, Hamilton, 2001 (%)

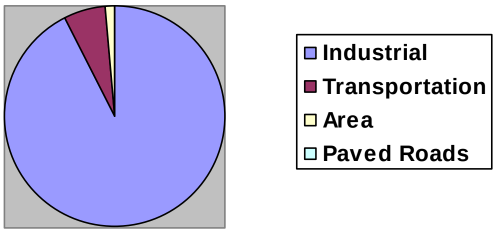


Figure 26: Emission Sources by Sector, Nitrogen Oxides, Hamilton, 2001 (%)

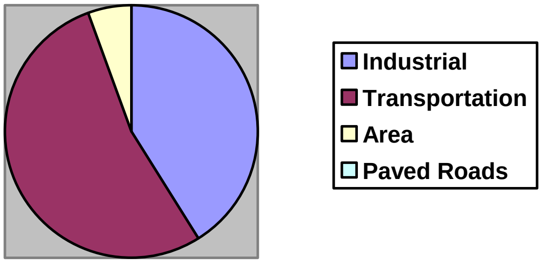


Figure 27: Emission Sources by Sector, Carbon Monoxide, Hamilton, 2001 (%)

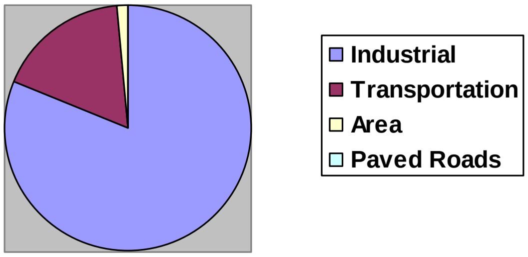


Figure 28: Emission Sources by Sector, Volatile Organic Compounds, Hamilton, 2001 (%)

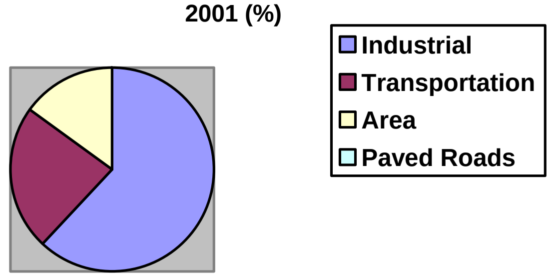


Table 6: Total Emissions by Source Category for Hamilton (NPRI, 2004)

Source Category	*CO*	*SO_X*	*NO_X*	*PM_{10}*
Industrial	16,443	11,088	8,414	5,430
Fuel Combustion	9,428	421	1,659	1,707
Transportation	58,490	871	12,766	1,037
Incineration	377	40	173	2
Miscellaneous	197	0	0	118
Open Sources	0	0	0	21,669
Total Tonnes	**84,934**	**12,421**	**23,012**	**29,963**

Figure 29 - NPRI Total Emissions by Contaminant and Source (2004)

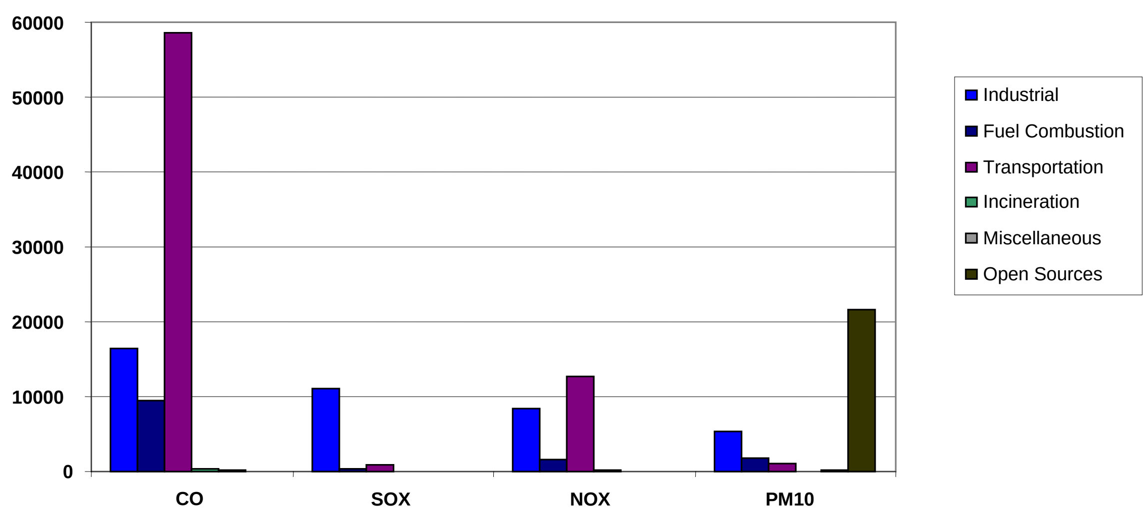


Table 6 shows the total emissions data from the National Pollutant Release Inventory (NPRI), broken down by source category. The table shows CO as the air pollutant with the largest emissions. Transportation is the largest source of CO, with three times greater emissions than point source industrial emissions. Open sources (including road dust) are the largest contributor to PM_{10} releases to the air.

Transportation is also the largest source of NO_x (12,766 tonnes), although industrial sources are of a similar magnitude (8,414 tonnes). The top three transportation sources for NO_X are Air Transportation, at 1,219 tonnes, Marine Transportation at 558 tonnes and Heavy Duty Diesel Vehicles at 440 tonnes. Thus, the NPRI data show industrial NO_X sources exceeding heavy duty diesel emissions by a factor of 20.

Overall, the NPRI data for Hamilton shows 56 point sources of PM_{10}, 14 sources of CO, 13 sources of NO_X and 9 sources of SO_2. In light of these data, the percentage contributions by source class in Hamilton are as follows:

- **Carbon Monoxide**
  69% Transportation, 19% Industry
- **Sulphur Dioxide**
  89% Industry, 7% Transportation
- **Nitrogen Oxides**
  56% Transportation, 37% Industry
- **PM_{10}**
  73% Open Sources/Road Dust, 18% Industry

Appendix D: Transportation & Air Quality

Due to recent advances in health-based research, a better understanding of the contributions of oxides of nitrogen and ozone to the health impacts associated with air pollution has developed. This knowledge has shifted the attention of health professionals towards the transportation sector, which is recognized as the leading source of nitrogen oxides in almost every community and a significant contributor to the formation of ground-level ozone.

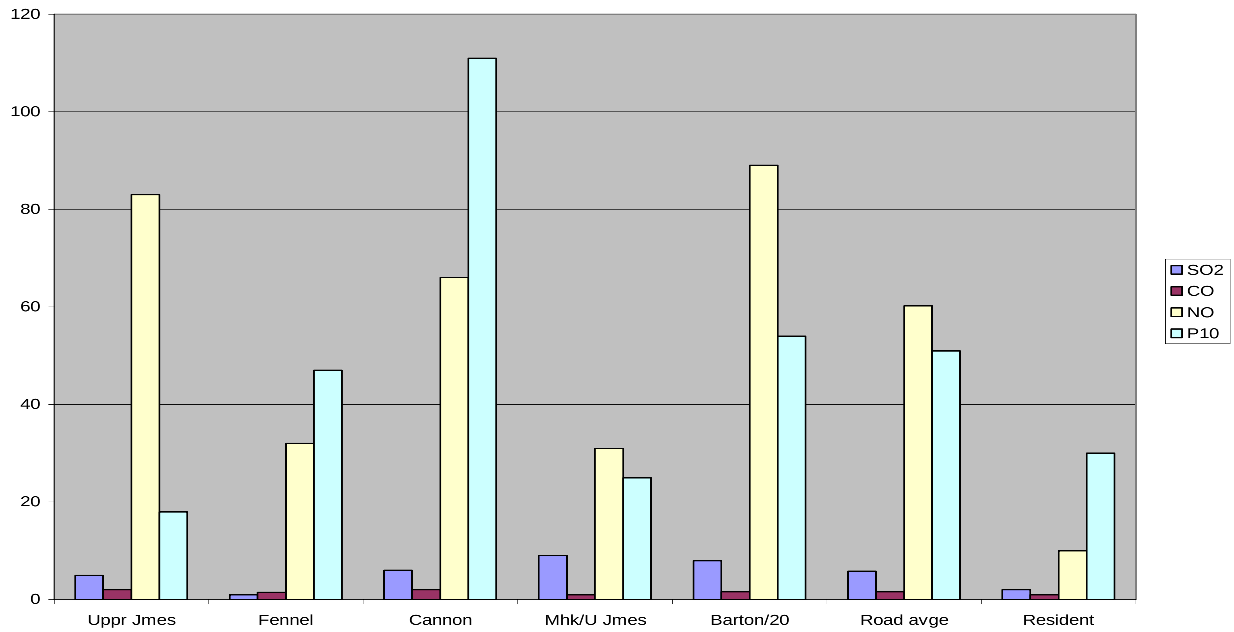
In recent years, a number of studies have examined the health impacts associated with living near major traffic corridors, such as major highways (e.g., the 400-series highways and the Queen Elizabeth Way) and four-lane roads in urban areas (e.g., Main Street, King Street, Centennial Parkway, etc.). These studies have shown consistently that levels of air pollutants measured near and along these major roadways are significantly higher than levels at locations well away from these sites. Furthermore, pollution-related health impacts are greater among people who live or work near busy roadways.

In 2005 a mobile monitoring study of Hamilton was conducted for the City and *Clean Air Hamilton* to examine a range of issues related to the levels of ambient pollutants near roadways. This study showed clearly that the highest pollutant exposures (on average) occur due to transportation emissions. Arterial roads and highways contribute substantial amounts of air contaminants to areas directly downwind of these roadways.

Pollutant concentrations were found to decrease quite quickly with increasing distance from roadways; however, concentrations of pollutants on or near roads and the resultant exposures while driving can be very high, due to the close proximity to direct emissions from diesel and gasoline vehicles. Routinely on busy roads, levels of 300 $\mu g/m^3$ of PM_{10} and 150 ppb (parts per billion) of NO were measured, while ambient levels in residential areas were found to be between 20-40 $\mu g/m^3$ of PM_{10} and 4-20 ppb NO. Thus, peak roadway concentrations of these pollutants exceed levels in residential areas by factors of 20-50 times.

These pollutant levels are cause for concern because of the health impacts for drivers, vehicle occupants, cyclists, joggers and pedestrians. Persons who are most susceptible to these pollutants, i.e., the very young, the very old and those with compromised respiratory or cardiovascular systems, should be especially careful to limit their exposures.

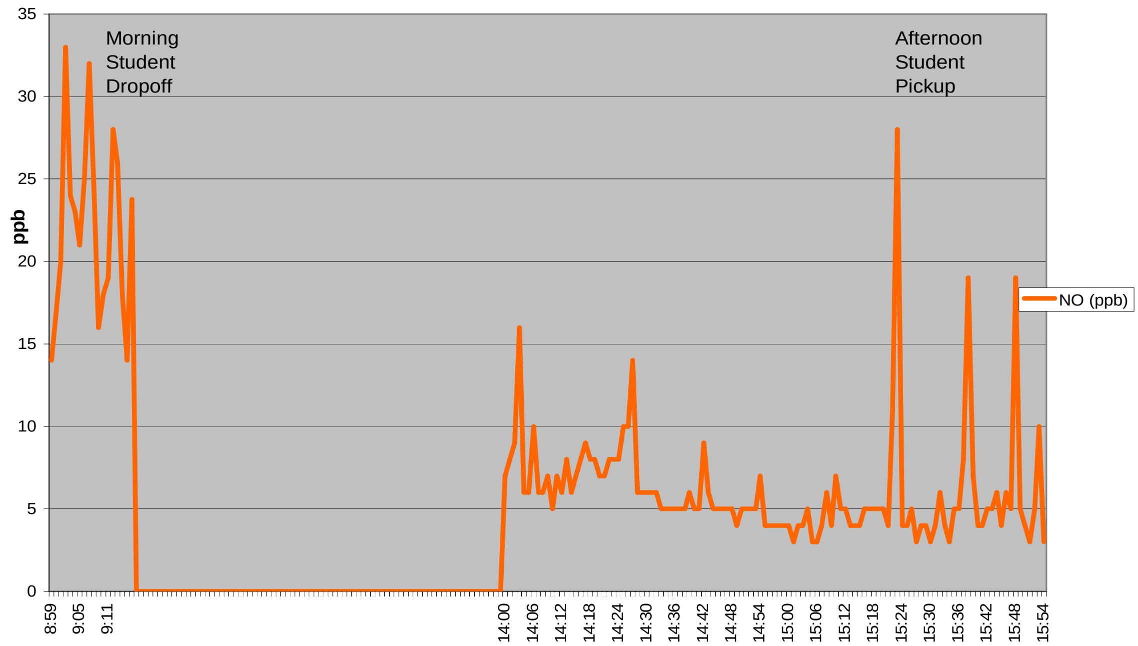
Figure 30: Mobile Monitoring Study - Levels of Certain Air Contaminants near Major Roads vs. Streets in Residential Areas in Hamilton



Idling vehicles, whether at traffic lights or elsewhere, not only waste fuel but also contribute significantly to elevated levels of pollutants. Dramatic rises in pollutant concentrations were measured downwind of intersections while vehicles were stopped at traffic lights. Motorists stopped at red lights on busy roads can be exposed to peak values of air pollution 50 times higher than they would on a quiet street.

Even levels of nitrogen oxides (NO) outside schools can reach very high levels because of cars idling at the curb **(see Figure 31)**. The mobile sampling data showed an average of 24 ppb NO in the morning with idling, but in the afternoon, when vehicle owners were aware of the sampling vehicle and turned their vehicles off, the NO levels remained at 4-5 ppb with the exception a few brief spikes in NO levels.

Figure 31: Nitrogen Oxide Levels Measured Outside a Hamilton School



Resuspended road dust is a very significant source of inhalable particulate, PM_{10}, and respirable particulate, $PM_{2.5}$. Historically, these dusts have been regarded as nuisance dusts and considered mainly as an aesthetic problem rather than an "emission" or a concern for human health. The mobile monitoring study data showed ambient levels of over 2000 $\mu g/m^3$ PM_{10} and 300 $\mu g/m^3$ $PM_{2.5}$ in dust clouds on industrial roads. Severe, local road dust impacts occur routinely in industrial road areas during business hours, when the truck traffic is heaviest. The combination of dirt track-out onto roads and heavy truck traffic along these roads causes large quantities of dust to be resuspended. The chemical composition of these dusts is also problematic, given the nature of the emissions from nearby industries and the deposition of these materials on roadways.

Mobile monitoring studies such as the present study provide a very different "picture" of the sources and impacts of air pollution compared to the view derived solely from data obtained at fixed monitoring stations. The mobile monitoring data emphasizes the need to continue these sorts of studies and the need to reduce air pollution associated directly and indirectly with the transportation sector, i.e., both direct vehicular emissions and road dust re-entrainment.

Appendix E: 2005/2006 *Clean Air Hamilton* Projects

Table 7: Status of Community-Based Projects, *Clean Air Hamilton*, 2007

Project	Activity	Source Targeted	Audience Targeted	Purpose, Opportunities, Pressures	Possible Partners	Status
Encourage Car-pooling, Public Transit & Telecommuting with Corporate Policies	Promoting Policy Shift	Transport CAC & GHG	Businesses & Institutions	Client base developed from Commuter Challenge; Council Expectations; GV experience.	GV HEIA	Completed (On-going)
Encourage Alternate Modes of Transportation	Promoting Behavioural Shift	Transport CAC & GHG	Individuals – High School Students	Reach audience at age of influence; Extend commuter challenge to new audience.	GV PH	Completed (on-going)
Discourage Idling	Promoting Behavioural Shift	Transport CAC & GHG	Individuals – Public School students & parents	Council expectations; Community demand; CAH priority	GV PH Works	Initiated (On-going)
Educate kids re: AQ/CC & Energy Use in Transportation & Residential Sectors	Promoting Behavioural Shift	Transport & Area CAC & GHG	Individuals – Public School children & parents	Meet demand by teachers for teaching aids; Educate kids at influential age; Reach adults through kids	GV GTA CAC 20/20 Eco-schools	2007
Promoting Energy Efficiency among home owners.	Promoting Behavioural Shift	Area CAC & GHG	Individuals - home owners	Encourage increased energy efficiency among residents; Drive action	GV	Completed (On-going)
Clean Air Day Media Event to Highlight Positive Actions	Promoting Awareness	All Sectors	Community	Fill the media void created if move away from Commuter Challenge; Increase public awareness	GV City CAH	2007
Establish a Tree Foundation to Support Tree Programs in the City	Adaptation Incentive Program	Area CC Adapt	Individuals – home owners	Supported by Council and the community; Build "Carbon Sink"	GV	Initiated

Key: GV=Green Venture PH=Public Health HC=Health Canada EC=Environment Canada
CAC=Criteria Air Contaminants GHG=Greenhouse Gases

Note: Program funding and choices will depend upon funds available from other sources/partners.

Table 8: Status of Research and Policy Projects, *Clean Air Hamilton*, 2007

Project	Activity	Source Targeted	Audience Targeted	Purpose, Opportunities, Pressures	Possible Partners	Status
Mobile monitoring of PM on traffic corridors	Monitoring	Fugitive Industrial & Road Dust	Decision-makers	Identify where increased street cleaning may be needed; identify sources of "road dust" for abatement.	Env Can MOE HAMN	On-going
Monitoring PM/ NO_2 on Traffic Corridors	Monitoring	Transport CAC	Decision-makers	Support street cleaning purchase; Provide air data that can be correlated with traffic corridor health study.	MOE EC HC PH	On-going
Correlate Air Data for Traffic Corridors to Health Data	Health Assessment	Transport CAC	Decision-makers	Clarify the source of health risks associated with traffic corridor; Drive policy	McMaster HC	On-going
Re-introduce Air Pollutant Index as Tool to Trigger Industrial Action	Develop Monitoring Tool	Point Toxics & CAC	Business	Develop tool that can trigger immediate action by industry in poor air quality situations; Drive action when needed; Protect health.	McMaster MOE EC PH	2007
Estimate GHG & CAC with Municipal Operations & Reduction Options	Emission Analysis	Point, Area & Transport GHG & CAC	Municipal Government	Support review of City's Corporate Clean Air & Climate Change Plans; Meet Council Demands; Leverage funding and in-kind worth about $30,000 from GTA CAC	GTA CAC MOE EC City Depts	On-going
Collect community data for CALPUFF Modeling	Data Collection & Modeling	All Sectors CAC	Policy Makers	Support development of a municipal Clean Air Plan; Determine priorities; Leverage funding worth about $40,000 from GTA CAC.	GTA CAC City Depts MOE EC	Initiated
Collect community data according to GIS for modeling	Data Collection	All sectors CAC	Policy Makers	Support development of a municipal Clean Air Plan; Meet Council demands; Determine priorities.	McMaster MOE EC City Depts	Under consideration
Develop Asthma Index	Health Warning Tool	All sectors CAC	Community	Develop tool to warn vulnerable populations; Drive policy	McMaster	Under discussion
Link Real-Time Air Quality Data from HAMN to CAH Website	Information Tool	All Sectors	Community	Provide data for the public, *Clean Air Hamilton*, City.	HAMN	Under discussion

Appendix F: 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.

***Clean Air Hamilton*, May 2007**

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