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CleanAir HAMILTON

AIR QUALITY PROGRESS REPORT 2009

June 2010

Table of Contents

Executive Summary

- *Clean Air Hamilton* is a community initiative to improve air quality in the City of Hamilton. It has a diverse membership with representation from environmental organizations, industry, businesses, academic institutions, and different levels of government. Initiated in 1998, *Clean Air Hamilton* works to improve air quality in Hamilton by:
    - Initiating research on air quality;
    - Providing policy advice to all levels of government;
    - Encouraging emission reductions among individuals and companies operating in Hamilton; and
    - Promoting behavioural changes in companies, government, institutions and individuals in Hamilton that will reduce energy consumption and improve air quality.
- Over the past ten years, there have been dramatic improvements in air quality in Hamilton. These changes have contributed to better health for citizens as well as improved perceptions of the City.
- Year-to-year changes in pollutant levels have been steady and incremental. The overall percentage decreases over the past decade show a significant improvement in many pollutant categories at the downtown air monitoring site: 52% reduction for Total Suspended Particulate (TSP), 38% for Inhalable Particulate Matter (PM_{10}), 37% for Respirable Particulate Matter ($PM_{2.5}$), 36% for Nitrogen Dioxide (NO_2), 50% for Sulphur Dioxide (SO_2), 99% for Total Reduced Sulphur odours, 53% for Benzene and 67% for PAH (Benzo[a]pyrene).
- Weather patterns and reduced levels of economic activity have contributed to overall decreases in pollutant levels in 2009 in some areas of the city. However, the long-term decreases in air pollutants continue due to the concerted actions of individuals, organizations, industries, the City of Hamilton and other levels of government to reduce their air emissions.
- It is widely perceived that the City's industrial sector is the major contributor to poor air quality in Hamilton, and that reductions in industrial emissions should be a primary focus of local air quality improvement actions. Significant reductions in industrial emissions have been realized, and more needs to be done to achieve emissions levels that match international best practices. The pollutant burden due to emissions from mobile sources (personal and commercial vehicles), energy sources, road dust re-entrainment and fugitive dusts must also be reduced significantly if we are to continue to make meaningful improvements to local air quality.
- Recent health research findings suggest that the fine particulate matter fraction ($PM_{2.5}$) is strongly associated with cardiovascular disease including heart attacks. Inhalable particulate matter (PM_{10}) and SO_2 which are closely associated with the risk of childhood asthma can also weaken natural immune responses, resulting in higher rates of respiratory infections. Further research regarding the chemical components of PM and their potential health effects is needed; specific size fractions of PM are responsible for different health impacts.
- Mobile monitoring studies conducted in Hamilton showed that much higher pollutant exposures occur near arterial roads and major highways due to emissions from mobile sources which include cars, light duty trucks and heavy-duty trucks.

- A study examining health impacts data in Hamilton from 2001 to 2003 showed that there was a strong relationship between the incidence of community-acquired pneumonia in the elderly and exposures to two pollutants, fine particulate matter ($PM_{2.5}$) and oxides of nitrogen (NO_x). The potential for health linkages to sulphur dioxide (SO_2) were examined but no linkage was found. Mapping of these data onto the Hamilton roadway network strongly suggested that the increased exposures to these two pollutants that occurred when residents lived near major roadways was directly linked to an increased incidence of pneumonia in the populace.
- Expansion of the fixed air monitoring network combined with continued mobile monitoring can identify community "hot spots" in Hamilton and enhance the knowledge of local air emission sources and their impacts. This monitoring work assists in the development of policies and initiatives to reduce local emission sources in the community.
- A well-conceived air quality health index and community smog plan would provide the public with useful information about current air quality conditions and strategies they can use to reduce their exposures to pollutants. Hamilton's Public Health Services in partnership with Clean Air Hamilton are pursuing implementation of an air quality health index in Hamilton.
- Health impacts of transportation-related pollutants should be considered in transportation planning and urban design in the City.
- There are a number of sustainable transportation initiatives in the City ranging from car sharing, carpooling, and driver and transit education to increased active transportation through policies that encourage cycling and walking, that help reduce air emissions and improve health. These initiatives should be continued to address a significant source of local air emissions from transportation.
- Community greenhouse gas (GHG) emissions in 2008 are estimated at 13.1 million tonnes. Land use and transportation planning decisions should be made with consideration of GHG emissions. Municipal and community involvement in reducing emissions of GHG (from commercial and personal transportation sources, commercial and residential energy sources, etc.) is necessary to reduce climate impacts.
- The City needs to maintain support for strategies and actions that will improve local air quality, reduce greenhouse gas emissions, and increase energy conservation. These strategies should also be aimed at increasing the level of dialogue within community groups on the health impacts of poor air quality and the best actions and lifestyle changes that will lead to air quality improvements for all citizens.
- *Clean Air Hamilton* continues to encourage activities undertaken by the City, industries and citizens to reduce air pollutants and greenhouse gas emissions, and improve local air quality in their operations and transportation choices. *Clean Air Hamilton* actively cultivates partnerships with organizations that have air quality improvement goals that are aligned with those of *Clean Air Hamilton* and the City of Hamilton.

1.0 Introduction

Clean Air Hamilton is pleased to present the 2009 Progress Report on Air Quality to Hamilton City Council. This report presents local air quality trends and the activities undertaken by *Clean Air Hamilton* in 2009 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.

Over the past ten years, there have been dramatic improvements in air quality in Hamilton. These changes will have contributed to better health for citizens as well as improved perceptions of the City.

Year-to-year decreases in pollutant levels have been steady with cumulative percentage decreases over the past decade showing the following significant reductions at the downtown air monitoring site: 52% reduction for Total Suspended Particulate (TSP), 38% for Inhalable Particulate Matter (PM_{10}), 37% for Respirable Particulate Matter ($PM_{2.5}$), 36% for Nitrogen Dioxide (NO_2), 50% for Sulphur Dioxide (SO_2), 99% for Total Reduced Sulphur odours, 53% for Benzene and 67% for PAH (Benzo[a]pyrene).

These significant improvements in air quality have occurred across the City over the past ten years due to the concerted actions of individuals, organizations, industries, the City of Hamilton and other levels of government. Weather patterns and reduced levels of economic activity may have contributed to the overall downward trend in 2009 but the long-term downward trend is robust. Efforts to reduce pollutant emissions must continue with the long-term goal of decreasing human exposures in Hamilton to levels below those of citizens in the larger Ontario cities.

1.1 Background

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

In 1997, the HAQI made 25 recommendations to improve air quality in Hamilton. Over the past 11 years, *Clean Air Hamilton* and partners have made significant progress in addressing and responding to these, recommendations (see the **2008 Clean Air Hamilton Report** for a detailed review).

Air quality reports prepared and published by the HAQI in 1997 and 1998, as well as the collection of *Clean Air Hamilton* Annual Reports from 2000 to 2008 are available here: www.cleanair.hamilton.ca/default.asp?id=71

1.2 Impact

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

On October 2009, the *Clean Air Hamilton* website was relaunched and redesigned to allow easier access for individuals seeking information on air quality, health impacts, climate change, community activities and research on air quality.

On Monday, February 22, 2010, 243 delegates attended the 2010 Upwind Downwind Conference. The Conference was hosted by *Clean Air Hamilton* and the City of Hamilton, and was held at the Hamilton Convention Centre. The Conference title, "Air Knows No Boundaries" aptly reflected the Conference goals of sharing practical solutions for air quality improvement, discussing transboundary pollution issues and highlighting the potential impacts of climate change in the fields of health, planning, municipal action and partnerships. A free exhibition called the "Green Solutions Marketplace" was organized to accompany the Conference. This exhibition was also open on Sunday, February 21, 2010 and featured a number of speakers including Jay Ingram, co-host of the Discovery Channel's 'Daily Planet.'

Members of *Clean Air Hamilton* have engaged City Council and the community in decision-making and issues related to air quality, including transportation (e.g., mobile monitoring studies, anti-idling strategies, Hamilton Truck Route study, Rapid Transit), planning (e.g., mobile monitoring, Urban Official Plan), air monitoring (e.g., mobile monitoring, Hamilton Air Monitoring Network), education initiatives and community air quality awareness (e.g., 2010 Upwind Downwind Conference, Living for the Environment 2009 Conference, and the *Clean Air Hamilton* website).

2.0 *Clean Air Hamilton*

2.1 Vision Statement

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

2.2 Goals of *Clean Air Hamilton*

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

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

2.3 *Clean Air Hamilton* Membership 2009

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

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

Clean Air Hamilton is committed to recruiting new members who have the time, expertise and interest in air quality issues to work in a committee-based format to find ways to improve air quality in the City. *Clean Air Hamilton* is particularly interested in engaging with committed individuals who want to undertake research to improve air quality in Hamilton. *Clean Air Hamilton* is interested in working with individuals and with representatives from industries, schools and school boards, community groups and others who partner on one or more actions identified by *Clean Air Hamilton*.

Interested individuals should contact the City of Hamilton's Air Quality Coordinator by telephone at (905) 546-2424 ext. 1275 or by e-mail: cleanair@hamilton.ca

2.4 Strategic Activities - 2009 and Beyond

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

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

The 2009 *Clean Air Hamilton* Report presents the actions undertaken in 2009 by members of *Clean Air Hamilton* and our partners to address these strategic issues. Details of these activities can be found in **Appendix A**.

2.5 Financial and In-Kind Contributions

The City of Hamilton currently provides an annual contribution of $80,000/year in support of *Clean Air Hamilton* and its activities. This money is leveraged by the funding provided by partner institutions and by the in-kind support of community volunteers who donate their time and expertise. In 2009, *Clean Air Hamilton*'s partners and volunteers provided $169,525 in in-kind and financial support. *Clean Air Hamilton*'s 2008 financial report is available in **Appendix B**.

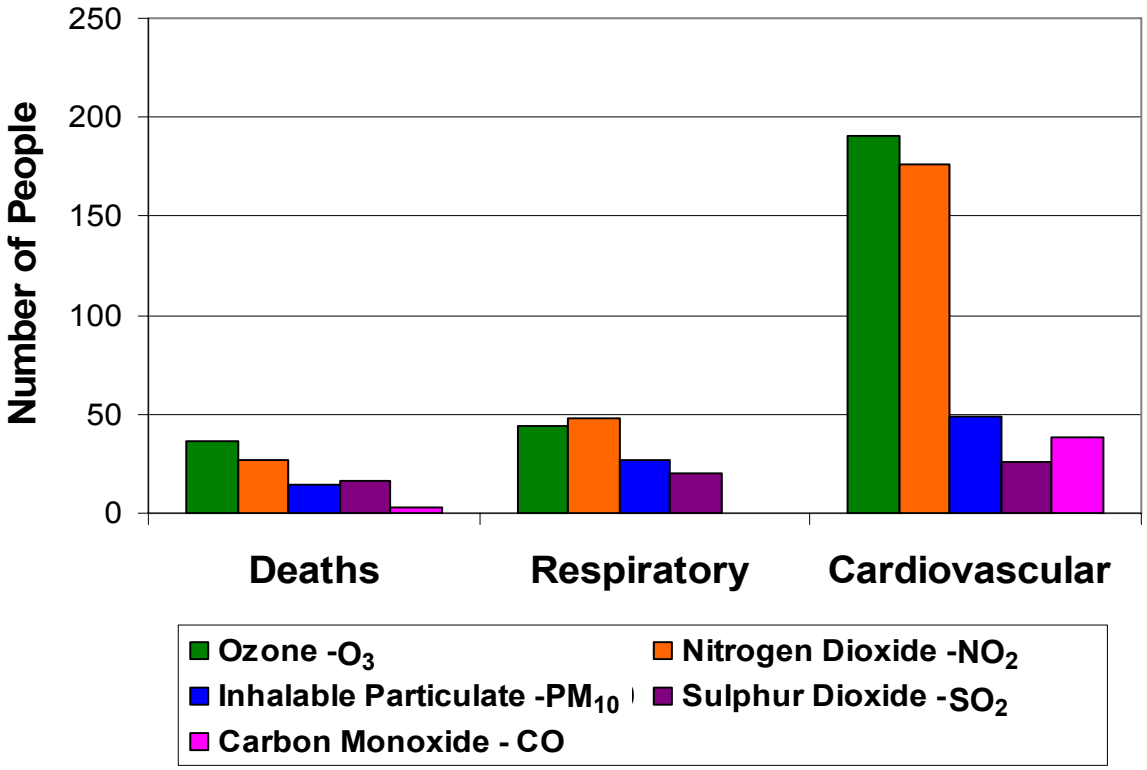
3.0 Air Quality in Hamilton

3.1 Air Pollution Health Impacts – Hamilton and Ontario

While the correlation between exposure to air pollution and related mortality is well established (OMA, 2005), current research is seeking to better understand and quantify the impacts on a range of targeted health risks and their association with specific air contaminants.

Poor air quality is associated with a range of health impacts including eye, nose and throat irritation, breathing difficulties, and cardiovascular disease (refer to the **2007 Clean Air Hamilton Report** for a detailed review). *Clean Air Hamilton*'s 2003 Air Quality Health Assessment Study estimated that 5 key air pollutants – nitrogen dioxide (NO_2), ground level ozone (O_3), fine particulate matter (PM), sulphur dioxide (SO_2) and carbon monoxide (CO) contribute to approximately 100 premature deaths and 620 hospital admissions in Hamilton each year.

Figure 1: Health Impacts by Pollutant in Hamilton, 2003



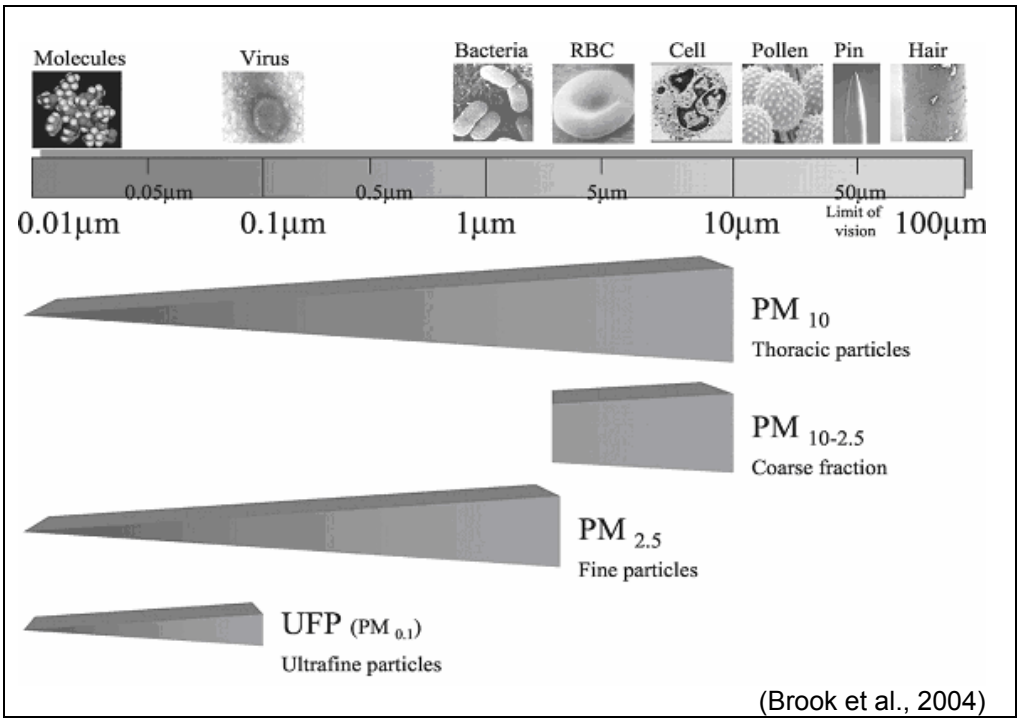
There has been a renewed interest of late in the health impacts of fine particulate matter and recent research has demonstrated how particle size and the chemicals associated with these particles are linked with specific health effects outcomes (Haynes, 2010). However, notwithstanding the renewed focus on PM exposures, it is important not to lose sight of the fact that PM is responsible for only about 15% of the health impacts associated with ambient air exposures in humans. It is also worth remembering that both gaseous pollutants, NO_x (NO plus NO_2) and SO_2, undergo chemical conversions in the atmosphere to afford nitrate and sulphate particulate; indeed, during the summer months about one-half of all fine particulate in the air is

composed of nitrate and sulphate salts. The health effects of these salt particulates are considered as particulate health effects, not gaseous health effects.

Particulate matter (PM) is a general term used to describe a heterogeneous mixture of liquid and solid particles smaller than 45 µm (micrometres). Unlike other criteria air pollutants (NO_2, SO_2, CO, O_3), PM is qualified by its size rather than by its chemical composition. To understand the associated health effects, PM is classified based on the upper limit of the mean aerodynamic diameter of the particles. The term "Total Suspended Particulate" (TSP) refers to all particles with mean diameters less than 45 µm. 45 µm is just about the smallest particles size we can observe with the naked eye. Particles with mean sizes of 10 µm or less are classified as PM_{10}. PM_{10} is a subset of TSP and usually constitutes 40-50% of the mass of TSP. Similarly, particles with mean diameters less than 2.5 µm, 1 µm and 0.1 µm are identified as $PM_{2.5}$, PM_1 and $PM_{0.1}$, respectively (see **Figure 2**). Within size categories of PM (for example, PM_{10} vs. $PM_{2.5}$), it is important to remember that chemical composition still plays a role with regards to health outcomes.

PM can originate from dusts and soil particles, smoke, and pollen. Significant anthropogenic sources of PM_{10} include re-suspended road dusts and dusts associated with unpaved industrial work sites while particles from sources such as vehicles, other combustion sources and fires fall in the finer classifications $PM_{2.5}$ and even PM_1 (Newbold, 2009). The origins of the fine particles in urban areas tend to be anthropogenic combustion sources, primarily gasoline and diesel fuel combustion emissions (Abelsohn, 2002). This finding was recently corroborated by Guo et al. (2010), who concluded, "outdoor $PM_{2.5}$ reflected the impact of vehicular emissions".

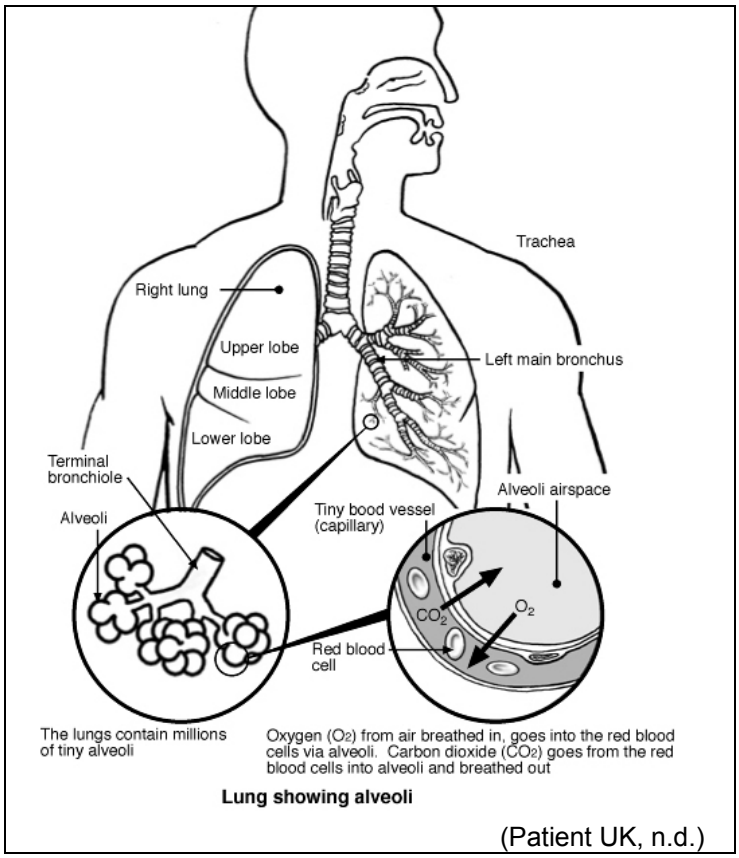
Figure 2: Comparison of Relative Sizes of Particles



(Brook et al., 2004)

PM_{10} are sufficiently small that they can be inhaled and this size range is called 'inhalable particulate.' $PM_{2.5}$, also often called 'fine particulate' or 'respiratory particulate,' when inhaled, travels deeply into the lung, reaching the alveoli, the air-blood gas exchange sacs throughout the lung (refer to **Figure 3**). Lastly, ultra-fine particles (or $PM_{0.1}$) readily pass through the alveoli and enter the bloodstream (HPHS, 2009).

Figure 3: Lung Deposition of Particulates



(Patient UK, n.d.)

Recent research findings suggest that the fine particulate fraction ($PM_{2.5}$) is more strongly associated with cardiovascular disease (Laumbach & Wood, 2010), and lower birth weights in newborns (HPHS, 2009), whereas PM_{10} (and SO_2) is more closely associated with the risk of childhood asthma (Clark et al, 2010). Exposure to the courser fraction of PM_{10} (i.e., $PM_{10\text{-}2.5}$) can weaken natural immune responses, resulting in higher rates of respiratory infections (HPHS, 2009). The particle size does not, however, exclusively influence the health effects. The different fraction sizes (PM_{10} & $PM_{2.5}$) generally have different chemical properties, and different exposure patterns (Lippmann, 2010). One recent study found a stronger association between $PM_{2.5}$ and cardiovascular disease when the constituents of the PM were organic carbon or sulphates (Haynes, 2010). Carbon-based PM may also carry carcinogenic chemicals like benzo[a]pyrene, and trace metals like lead, cadmium and nickel are more concentrated in the fine fraction of PM (Newbold, 2009) than the courser fraction. A number of studies conducted in different geographic locations have detected differential health impacts from PM depending on chemical composition (Brook, 2010). Further research regarding the chemical components of PM and their potential health effects is needed. It is becoming clearer that the specific chemical composition of PM as well as its particle size, may have varied and differential impacts for health status. (Lippmann, 2010).

Despite the fact that air quality has steadily improved across Ontario over the past 15+ years (Air Quality Ontario, 2010), the health impacts of ambient air exposures are projected to increase, largely due to the increased knowledge about these health effects and aging of the population (Canadian Medical Association, 2008). Public Health Services (PHS) has a critical role to play with regards to evidenced based education, advocacy and ensuring targeted messaging is available and accessible. Consequently, it is important for Public Health departments not only to advocate for policies that can reduce emissions, but also to identify the most vulnerable populations, and to ensure these individuals are educated on adaptive behaviours that can minimize individual exposures to all pollutants, including PM.

3.2 Air Monitoring - Hamilton

Air monitors collect outdoor air quality data across the City of Hamilton and this data is compared to provincial and federal air quality standards. Other uses of this data are to identify sources of air pollutants, and to evaluate the potential impacts of air emissions on human health.

Traditional air quality monitors are located at fixed locations across the City. In Hamilton, there are two fixed air monitoring networks: (i) the Provincial Air Quality Index (AQI) monitoring stations (situated in West Hamilton, on the Mountain and Downtown), which are operated and maintained by the Ontario Ministry of the Environment (MOE), and (ii) the Hamilton Air Monitoring Network (HAMN) stations, which are part of an industry-funded network with monitoring stations located in the industrial area of Hamilton. Two of the MOE's AQI sites also provide space for equipment owned by Environment Canada as part of its National Air Pollution Surveillance Station (NAPS) network.

Hamilton is the pioneer in Canada in undertaking a program of mobile air quality monitoring. The mobile monitoring van can roam city-wide to measure local air quality conditions at street level. Mobile monitoring began in Hamilton in 2004 as a pilot project funded by the City and *Clean Air Hamilton*. The van and equipment are the result of a partnership between Clean Air Hamilton, MOE, Environment Canada and Rotek Environmental.

Additional air monitoring is conducted by the local MOE Office and includes routine particulate monitoring and short-term survey work. The MOE continued to assess particulate impacts around two operations, one in Flamborough and one on the South Mountain. The MOE also funded continuous particulate monitors to the Hamilton Air Monitoring Network (HAMN). The MOE Trace mobile Atmospheric Gas Analyzer (TAGA) van conducted short surveys near the Glanbrook landfill in 2009.

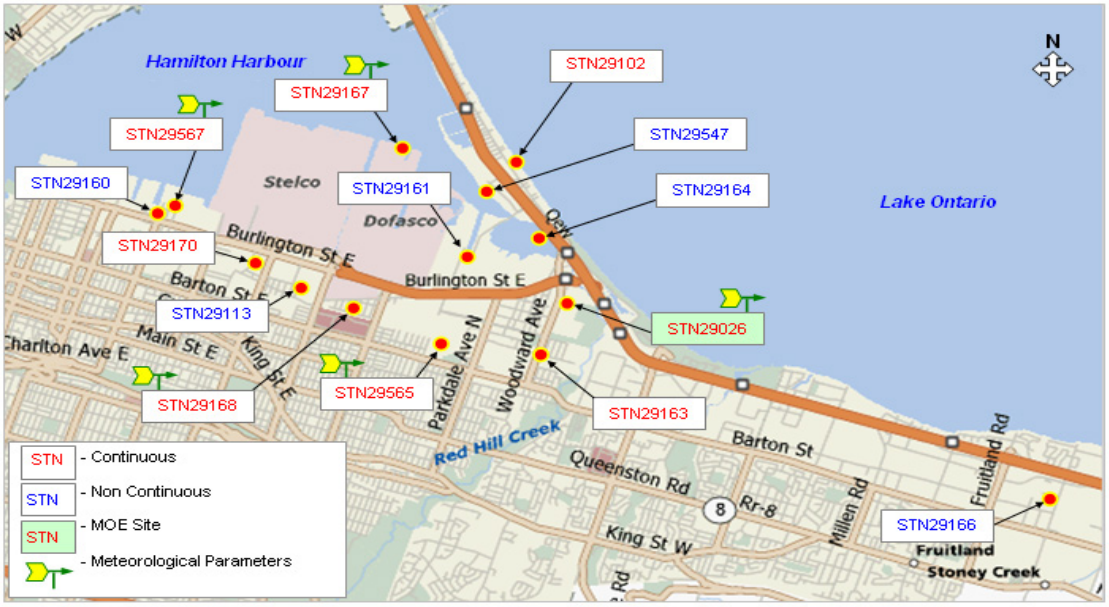
Air monitoring in Hamilton tends to be focussed on the east end industrial sector. Through mobile monitoring in 2005, additional industrial areas in Hamilton were identified (see **Section 3.5**) that are not actively monitored or connected to the existing monitoring network. In addition, mobile monitoring and health research (see **Section 5.0**) have identified gaps in the capturing of air pollution data and associated health impacts in neighbourhoods and transportation corridors across Hamilton. There is recognition that expansion of the fixed network combined with continued mobile monitoring can identify community "hot spots" in Hamilton and enhance the knowledge of local air emission sources, as well as, their impacts, and assist in the development of policies and initiatives to reduce local emission sources in the community.

The air quality data from the MOE's three AQI stations are available here: www.airqualityontario.com/reports/summary.cfm

3.2.1 Hamilton Air Monitoring Network

The Hamilton Air Monitoring Network (HAMN) is an industry-funded, local air monitoring network, comprised of 22 local companies who have committed to the assessment of air quality in Hamilton on a regular basis. A map of the air monitor network can be seen in **Figure 4**. On-going operating costs and expenses related to the upgrading of air monitoring equipment and instruments are borne by industries within the network. The network provides air quality reports to the Ontario Ministry of the Environment (MOE) on a regular basis. All air quality data and reports are audited by the MOE to ensure a consistent and high quality level of data. The MOE also conducts regular audits of the equipment at the HAMN sampling sites.

Figure 4: Map featuring the Hamilton Air Monitoring Network



In June 2009, a website providing the public access to real-time air monitoring data collected by the HAMN was launched (**www.HAMNair.ca**). This website was developed as a partnership between *Clean Air Hamilton*, HAMN, the City and the MOE. Since its launch, the website has received 4,410 hits.

3.2.2 Mobile Monitoring

Between late 2004 and 2009, mobile monitoring surveys were undertaken for *Clean Air Hamilton* to obtain a comprehensive picture of the air quality across the City of Hamilton. In particular, air quality and health impacts due to traffic emissions and atmospheric inversions conditions were studied (see **Section 5.1**). Recent mobile monitoring studies from around the world have shown that the short-term peak exposures experienced near air emission sources can have serious detrimental health impacts in some individuals.

Mobile monitoring data differs significantly from data collected at fixed air monitoring stations. Mobile monitoring vans can roam city-wide or measure local air quality conditions on the 'micro' scale; for example, emissions from cars and trucks along major roads and at traffic intersections result in significantly elevated levels of pollutants compared to levels measured on side streets or in residential areas. Mobile monitoring is very useful in gathering air quality data at locations with specific air quality issues. In other words, mobile air sampling at the "street level" reflects the exposures of individuals to these pollutants at ground level. Conversely, fixed air monitoring stations are deliberately located well away from major roads and known emission sources to avoid undue influence on the data by such sources. Fixed air monitoring stations give an accurate measure of the air quality at that location; these data are also meant to give a good indication of the ambient air quality throughout the local area.

The mobile monitoring vehicle is outfitted with a Global Positioning System (GPS) detector and modified to support a data acquisition system and a data storage system. Data can be collected using various real-time monitors on board the vehicle to measure nitrogen oxides (NO_x), sulphur dioxide (SO_2), airborne particulate matter (PM), and carbon monoxide (CO) simultaneously. **Figure 5** shows the mobile unit outfitted with the real-time air monitors. Monitoring systems are outfitted with a data collection system that is capable of simultaneously storing air pollutant data and GPS data. The GPS data is used in collaboration with an enhanced geographic information system (GIS) program to allow the mapping of air pollutant data locations.

Figure 5: Mobile Air Monitoring Unit and the Real-time Display on a Laptop Computer

The first of a series of peer-reviewed papers in the Journal of Environmental Monitoring Reporting on the mobile monitoring data was published in March 2009. The first paper can be found at: http://www.rsc.org/Publishing/Journals/EM/article.asp?doi=b818477a

3.2.3 Certificates of Approval and the Alternative Standards Process

Ontario Regulation 419/05 (O. Reg. 419/05) is the key piece of legislation that addresses air quality in the province. The regulation imposes air standard concentration limits for contaminants. The Ministry of the Environment regularly looks at adding standards to the regulation or making standards more restrictive. Ontario currently has air standards for 124 contaminants and guidelines for over 200 more. Proposed standards for an additional eight contaminants – uranium, nickel, chromium and their compounds, benzene, polycyclic aromatic hydrocarbons (PAH), 1,3-butadiene, dioxins and dioxin-like compounds, and manganese and its compounds - were announced in July 2009 and a decision on implementation of these new standards is pending in 2010.

Certificates of Approval (Air) (CofA) are the main tool that the Ministry of the Environment uses to control emissions of contaminants into the air by industrial facilities. An approval is granted based on the specific facility and the controls proposed for the air emissions. This approval is issued if the facility and the controls are expected to only emit contaminants into the air below the concentration limits set out in O.Reg 419/05. Since a CofA is required before a facility can be built, the assessment and approval is often based on the modeling of air emissions to determine the air quality at a point off the property which would be considered a sensitive point. Unless explicitly exempted, most industrial processes and equipment that discharge to the air require a CofA in order to operate.

What is a contaminant?

The term 'contaminant' is defined under the Environmental Protection Act as any solid, liquid, gas, odour, heat, sound, vibration, radiation or combination of any of them resulting directly or indirectly from human activities that causes or may cause an adverse effect. The definition of a contaminant is very broad. Examples include particulate emissions from a process, solvent emissions from a painting line, nitrogen oxides from combustion sources, or sound and vibration from a metal stamping operation. The Ministry of the Environment does not require that compounds have published criteria to be considered contaminants. Unless explicitly exempted, most industrial processes and equipment, and modifications to industrial processes and equipment that discharge contaminants require approval. Under O. Reg 419/05 heat, sound and vibration are now excluded.

While the CofA is based on the modeled prediction that air quality standards will be met, there could be circumstances where a facility or equipment is not operating properly and air standards are exceeded. If air standards are not met or if conditions on the CofA are not met, the Ministry of the Environment will take action to require that corrective measures be taken to bring the operation into compliance with air standards and CofA conditions.

For further information on air regulation and standards visit:
www.ene.gov.on.ca/en/air/ministry/index.php#ts

For information on Certificates of Approval (Air) visit:
www.ene.gov.on.ca/en/business/cofa/airnoise.php

Under O. Reg. 419/05, new or more stringent standards are phased in over time. The first of set of new or more stringent air quality standards for industrial facilities in Ontario took effect on February 1, 2010. A facility that is not able to meet the standards within the prescribed timeline may request approval for a site-specific alteration of the air standards, while it implements emission controls and an Action Plan of projects that will enable it to meet the standards over time and strive towards continuous improvement. The MOE introduced the alteration of air standard (or alternative standards) process to acknowledge time, technical, and economic factors related to the

significant adjustments and investments needed to comply with the standards (MOE, 2007). An altered air standard may be approved for a period of up to five years, or up to ten years in extenuating circumstances. Furthermore, O. Reg. 419/05 provides that a facility may also re-apply for an alternative standard.

According to Ontario's Environmental Registry (April 2010), 7 companies have requested altered air standards under the EPA, O. Reg. 419 (see **Table 1**).

Table 1: Ontario Companies who have Requested Alterations to an Air Standard under O.Reg. 419/05

Organization	Date of Request	City	Status
Royal Polymers Limited	December 2006	Sarnia	Plant closed during 2008. File closed.
Oxy Vinyls Canada Inc.	March 2007	Niagara Falls	Approval issued January 2009.
Vale Inco Limited	October 2008 (to be updated with further information)	Sudbury	Decision on hold due to production stoppage.
ArcelorMittal Dofasco Inc.	October 2008 (updated September 2009)	Hamilton	Approval pending. Decision to be completed Spring 2010.
U.S. Steel Canada Inc.	October 2008 (to be updated with further information)	Hamilton	Decision on hold due to production stoppage. Efforts currently underway to update request.
U.S. Steel Canada Inc.	October 2008 (to be updated with further information)	Nanticoke	Decision on hold due to production stoppage.
Xstrata Copper (Canada) Ltd.	October 2008	Timmins	Approval issued February 2010.

A request for the alteration of an air standard must (at a minimum) include the following information:

- **Emission Summary and Dispersion Modeling (ESDM) Report** -results from a modeling/monitoring study, and an assessment of the magnitude and frequency of exceedence of the standards.
- **Technology Benchmarking Report (TBR)** -assessment and ranking of technical methods for reductions in contaminant concentrations and provide an assessment of feasible technologies.
- **Economic Feasibility Analysis (Optional)** -cost of technically feasible mitigation options, and comparison to the cost of reductions in off-property concentration of various options.
- **Action Plan** -schedule of dates/timelines.
- **Public Consultation Report** -results from the mandatory public meeting with the local community.

An important element of the alteration of standards process is public transparency. Therefore, the requestor for an alteration to an air standard must engage in public consultation efforts to ensure that:

- Stakeholders are aware of the barriers to the implementation of air standards and any potential incremental health or environmental risks associated with altering the standard.
- Community members are given an opportunity to understand the barriers for the facility in complying with the standards at this time.
- Stakeholders/Community members are given an opportunity to review the proposed Action Plan.
- Community members understand the regulatory framework and have an opportunity to comment on the proposal by the facility for an altered standard and the outcome reached by the facility in terms of corrective actions to address the issue, through the Environmental Registry.
- The community is given an opportunity to provide input into the risk-based, decision-making process both before the request is submitted and through the Environmental Bill of Rights process after the request is submitted to the MOE.
- Stakeholders know where information is available and whom to contact for answers to their questions.

ArcelorMittal Dofasco Inc. has consulted directly with the public through the hosting of two public meetings held in October 2008 and September 2009, and through a webpage (www.dofasco.ca/bins/content_page.asp?cid=1852-285730-285790) set up by the company. This web site provides information concerning the submitted request with the ability for the public to contact the manager if further information is required. ArcelorMittal Dofasco Inc. also participates in a community stakeholder committee chaired by the MOE, that has met several times over the past year to advise the public about O.Reg 419/05, the alteration of standards process and to review the request and Action Plan proposed by the company to reduce emissions. The public was also able to comment on the submitted request through two postings made to the Environmental Registry in December 2008 and December 2009.

In summary, if a facility receives approval for the alteration of an air standard, the facility is operating in compliance with O. Reg. 419/05. The altered standard becomes the legally enforceable standard for that facility for the time period of the approval. The decision on whether or not to approve a site- specific altered standard includes an extensive technology benchmarking assessment which compares the facility to other facilities and evaluates best available technologies or practices to minimize emissions. A site-specific altered standard approval can also include conditions relating to actions to be undertaken by the company to reduce emissions over the duration of the approval. O. Reg. 419 states that the altered air standard is only in effect if the facility is complying with the conditions imposed in the approval. There is also authority to issue a notice that revokes the approval of the alternative air standard. Compliance and/or enforcement action is also possible. Ultimately, the goal of the altered standard regime set out in O.Reg. 419 is continuous improvement of emissions that will occur as new technologies become available or economic circumstances change.

For further information on Alternative Air Standards visit:
www.ene.gov.on.ca/en/air/ministry/index.php#alt

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

Examination of the trends in ambient air quality in Hamilton over the last decade or so (see **Appendix C**) shows that there have been large reductions in the air levels of some pollutants, such as total reduced sulphur. The ambient levels of other pollutants, such as particulate material (PM_{10} and $PM_{2.5}$), nitrogen oxides (NO_x) and sulphur dioxide (SO_2) have also decreased slowly over this period. These reductions are a result of actions taken by companies within the industrial sector in Hamilton to reduce their emissions. Levels of other pollutants have also been reduced more modestly over the last decade; these pollutants are due primarily to transportation sources, the roadway system due to road dust resuspension and various other sources of fugitive dusts (refer to **Section 3.6**). Year-to-year changes have often been incremental but the overall percentage improvements in the past decade show a highly significant difference for downtown levels. Finally, the levels of ground level ozone (O_3) during the summer months have shown an upward trend, primarily due to long-range transport of pollutants into southern Ontario from the mid-west of the United States.

Recent levels of air pollutants in Hamilton, compared to levels of the same pollutants in other southern Ontario communities over the past 16 to 19 years (see **Appendix C**), show that:

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

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

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

Global economic slowdown through 2008 and 2009 was felt in the City of Hamilton. Major industry reduced or stopped production. This decrease in economic activity would also result in less vehicle traffic and potentially less rail and port activity. Ministry staff analyzed the air monitoring data from the Hamilton Air Monitoring Network (HAMN) and the ministry's Air Quality Index (AQI) stations to assess if the changes in industrial activity had a measurable affect on local air quality.

For the air monitoring data that is measured using real time continuous recording instruments the slowdown period was selected as March through September 2009. For the air monitoring data that is measured using samples collected over 24 hours the slowdown period was selected as November 2008 to May 2009. There were two reasons for this; first, these 24 hour samples are collected on a less frequent basis than daily and second, at the time of the report (October 2009), data was only available up to May 2009. The slowdown periods were compared to the same time frames in previous two years.

The Niagara/Land station is mostly influenced by US Steel and other particulate sources during winds from the northeast or east. There is clear evidence that air quality improved during the slowdown period. PM_{10} particulate decreased by 40%. The Total Suspended Particulate (TSP) half hour standard was exceeded 10 hours in 2009 versus 73 hours in 2008 and 219 hours in 2007. Sulphur Dioxide levels decreased by 25%. Total Reduced Sulphur (TRS) decreased 40% and there were 8 hours above odour thresholds in 2009 versus 38 hours in 2008 and 29 hours in 2007. Benzo-a-pyrene decreased by 55%. Benzene decreased by 50%.

The Beach Boulevard air station is mostly influenced by emissions from Arcelor-Mittal-Dofasco, Eastport Drive industrial facilities and transportation sources including the QEW. There is clear evidence that air quality improved at this site during the slowdown period. PM_{10} particulate decreased by 30%. The TSP half-hour standard was exceeded 77 hours in 2009 versus 206 hours in 2008 and 191 hours in 2007. Nitrogen oxides decreased by almost 35%. Sulphur dioxide levels decreased by 25%. For TRS there were 2 hours above the odour threshold in 2009 versus 9 hours in 2008 and 11 hours in 2007. Benzene levels showed a modest decrease of 5%.

The Downtown AQI station provides data that is a good representation of overall air quality in the City as a result of emissions from all potential sources including industry and transportation. There is also clear evidence that air quality improved during the slowdown period at this site. $PM_{2.5}$ particulate levels decreased by 30%. Nitrogen oxides decreased by almost 20%. Sulphur dioxide decreased by 25%. Carbon Monoxide decreased by 15%. Benzo[a]pyrene decreased by 60%. For the TRS continuous monitoring data there was only 1 hour above the odour threshold in 2009, 2008 and 2007. The AQI was never in the 'poor range' (i.e., AQI value over 50) in 2009 compared to 15 hours in 2008 and 42 hours in 2007. The maximum AQI reading for $PM_{2.5}$ in 2009 was 48 compared to 86 in 2008 and 78 in 2007.

The West End AQI station (located near the Main Street West exit from Highway 403) is predominantly influenced by transportation sources. The numbers of hours that the AQI was in the poor range due to $PM_{2.5}$ were none in 2009 compared to 21 in 2008 and 37 in 2007. These data are an indication of reductions in emissions from all sources including transportation.

The Mountain AQI station (located at Vickers and East 18th Ave.) provides general background air quality data that is not affected to any great extend by industrial emissions or emissions from major transportation routes. The number of hours the AQI was in the poor range due to $PM_{2.5}$

there were none in 2009 compared to 11 in 2008 and 37 in 2007. This is again an indication of reductions of emissions from all potential sources, including transboundary sources.

The Strathearne Avenue North station is influenced by a number of industrial sources depending upon wind direction. PM_{10} particulate levels decreased by 40%. The improvement was observed primarily during those periods when winds came from the northeast. The MOE's TSP half-hour standard was exceeded 6 hours in 2009 compared to 36 hours in 2008 and 46 hours in 2007.

The data reported above for TSP and PM_{10} is based on continuous monitoring instruments. There are also 6 HAMN stations and two ministry stations that measure TSP using samples collected over 24 hours. The two ministry stations also measure PM_{10} using samples collected over 24 hours. To get a perspective on the overall impact, the data from these stations was combined and compared. TSP decreased by 30% across the City and PM_{10} decreased by 20%. The daily objective for TSP was exceeded 7 times in 2009 compared to 22 in 2008 and 32 in 2007.

In total, these data analysis show that during the period of the short-term economic slowdown the air quality in Hamilton was improved over the air quality in 2007 and 2008. This improvement is likely due to reduced emissions from industries, vehicles, rail sources and ships. It is worth noting that the economic downturn was continent wide and indeed world wide so that long range transport of air pollutants would also be reduced, contributing to these local effects and improvements. For instance, the Mountain AQI station experienced significant reductions although it would not be expected to have major direct industrial impacts. The overall long-term trends in air emissions (See **Appendix C**) across the City have been decreasing significantly over the past 10 years due to the concerted actions of individuals, industries, organizations and government.

3.4 Smog Advisories and Smog Advisory Days

What is a Smog Advisory?

The Ontario Ministry of Environment (MOE) monitors the air quality in Ontario and provides a rating of the air quality called the Air Quality Index (AQI). A smog advisory is issued by the MOE when the Air Quality Index reaches or exceeds a value of 50; a smog advisory day is declared when it is predicted that it is likely that the AQI may reach or exceed 50 on an upcoming day or the AQI has already reached a value over 50 and is expected to remain above 50 for the advisory period. There are three AQI stations in Hamilton that provide the air quality index data used to calculate the AQI. Smog advisories are issued to alert the public when widespread elevated levels of air pollution exist (i.e., when AQI values exceed a value of 50). Such conditions exist during persistent smog episodes and are commonly characterized by high levels of ozone and/or particulate matter in a regional context. Local advisories may be issued for just Hamilton, if local emissions are expected to cause AQI values of 50 or higher usually due to particulate matter.

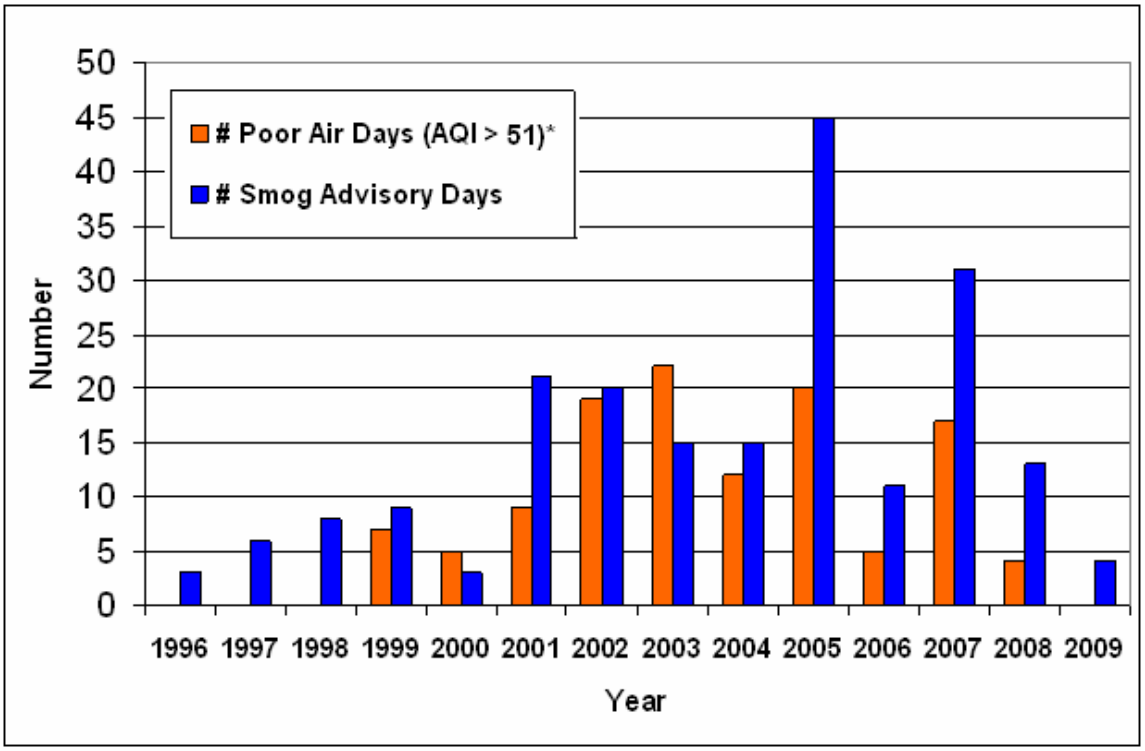
The AQI is determined based on the highest value of any one of four key air health-related contaminants – Particulate matter ($PM_{2.5}$,) nitrogen oxides (NO_x), sulphur dioxide (SO_2) or ground-level ozone (O_3). In the summer months smog days and air quality advisories are usually issued based on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

Gaseous air pollutants such as nitrogen oxides and volatile organic compounds (NO_X, VOCs) can react under the influence of sunlight to afford a complex mixture of chemical products, including ground-level ozone (O_3). This mixture of pollutants is commonly called smog. The ozone that forms one of the constituents of smog is called ground-level ozone to distinguish it from the ozone in the stratosphere (i.e., the ozone which is found ~20-40 km above the earth's surface); stratospheric ozone is important in absorbing harmful ultraviolet radiation from the sun and thus reducing the levels of ultraviolet light that reach the earth's surface. Ozone is a severe lung irritant and when inhaled along with respirable particulate matter and other pollutants such as nitrogen oxides, the impacts on the lungs of susceptible individuals, such as the elderly and the young, can be dramatic.

In 2009, 4 smog advisory days were declared by the Ontario Ministry of Environment (MOE) for the City of Hamilton (see Figure 6). None of these smog advisory days were considered poor air quality days (AQI > 51) which may be due to a number of influences including weather conditions and a cool summer, and the global economic slowdown through 2008 and 2009 which was felt in the City of Hamilton. Major industry and energy producers reduced or stopped production and less personal vehicle and goods movements occurred.

Figure 6 below shows the numbers of smog advisory days and poor air quality days over the past ten years. Poor air quality days are defined as days where the Air Quality Index was greater than 51 for at least 1 hour during the day.

Figure 6: Number of Poor Air Quality Days and Smog Advisory Days in Hamilton between 1999 and 2009



Data from Downtown Hamilton Air Monitoring Station

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

Table 2: AQI Ranges (MOE)

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

What do the MOE's AQI readings mean in terms of health impacts?

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

For further information, consult the MOE's Air Quality site: www.airqualityontario.com

3.4.1 Smog Response

When a smog advisory is declared, the Ministry of the Environment (MOE) notifies the City, who reduces its corporate emissions according to the Corporate Smog Response Plan. Actions undertaken by the City include encouraging staff to take transit, to car pool, and to walk or cycle to work. The City also notifies all contractors of the smog advisory and encourages them to adjust their work schedules accordingly, to reduce the use of cleaners, solvents and oil-based

paints, to reduce the use of gas-powered equipment and vehicles, and employees may work from home where permitted.

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

For more information on actions that individuals and employers can undertake to reduce emissions and improve local air quality, visit: www.cleanair.hamilton.ca/default.asp?id=23

3.4.2 Air Quality Health Index and Community Smog Response

Clean Air Hamilton has long advocated for the development of a health-based Air Quality Index; a well-conceived health index would provide the public with useful information about current air quality conditions and provide the public with strategies they can use to reduce their exposures. The Government of Canada has developed an Air Quality Health Index (AQHI) and is in the process of piloting the use of this index in selected cities across Canada prior to a nation-wide adoption of the AQHI in a few years. The Government of Canada's new AQHI is calculated in a different manner compared to the current Air Quality Index (AQI) that is reported by the Ontario Ministry of the Environment. The three key air pollution contributors to health effects impacts are nitrogen oxides (NO_X), ozone (O_3), and respirable particulate material ($PM_{2.5}$). In the case of the MOE's AQI, only the highest reading of these four contributors is used to calculate the AQI for a given hour of the day. It has been recognized for several years that the health impacts of air pollutants are additive; it makes sense to use all four contributors in determining health effects impacts. This latter approach has been used in *Clean Air Hamilton*'s health studies. This approach is also embodied into the Government of Canada's new AQHI.

The AQHI has been introduced in the City of Toronto and the Halton, Peel, York and Durham Regions. *Clean Air Hamilton,* in partnership with Hamilton Public Health Services, is keen to bring the AQHI reporting system to Hamilton and are working with the Government of Canada to bring this new air quality health index to Hamilton.

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

In the 2008 Clean Air Hamilton Report, Clean Air Hamilton identified the need to develop a community health smog plan to increase communication on smog days to vulnerable members of the community. For example the Smog Plan would encourage physicians to caution patients with respiratory or cardiac difficulties to take special precautions on smog days and smog advisory days, particularly when there are low dispersion conditions, whether these events are weather-related or result by virtue of valley-type effects. In response to this identified need in the community and to the Government of Canada AQHI, Hamilton Public Health Services has been

working to develop a smog communications plan and promotion campaign to be implemented in Spring, 2010.

The campaign will be divided into two phases over two years. Phase 1 of the campaign will take place between May and December 2010. Phase 1 will consist of communication and promotion of health information to high risk residents of the City of Hamilton about the health effects of exposure to air pollution. These messages will provide general information about smog and its health significance, and will provide clear direction on actions that can be taken by individuals to help protect themselves from the effects of poor air quality. Phase 1 will also include the development of partnerships with stakeholder organizations and the media and the development of print resources to be distributed to physician offices. On the public relations side there will be the launch of a website, and the development of an advertising campaign that will utilize billboard and bus shelter ads, HSR ads, radio advertisements on 4 popular Hamilton radio stations and newspaper ads designed to get this important message to the citizens of Hamilton.

Phase 2 of the campaign will begin in April 2011. First, there will be the launch of the daily Air Quality Health Index (AQHI) readings for Hamilton on Environment Canada's website. Second and equally important, will be the release of a communications package on the AQHI which will provide answers to questions (who, what, where, when, why and how) about the AQHI in language that citizens can understand and apply to their particular situation. This second phase will continue to leverage partnerships with local stakeholder organizations and the media; an advertising campaign and additional resources such as print, website, etc. will be used to continue to build an overall awareness and understanding of the AQHI.

3.4.3 Local Poor Air Quality Notification

The Ministry of the Environment (MOE) has taken action to improve local air quality through having roughly 30 industries curtail emissions and control dust-generating activities on days when local air quality is poor, due to certain types of particles in the air (fine particulate matter) above a certain level. This system was developed by the MOE in partnership with the City of Hamilton Public Health Services, McMaster University Institute of Environment and Health, *Clean Air Hamilton* and the Hamilton Industrial Environmental Association (HIEA). Participating companies would be told when local air quality is poor due to fine particulate matter above a certain level. The companies then implement their plans to reduce local sources of fine particulate matter. This would help the local situation even though it will not change what is coming in from elsewhere (transportation, cross border/long range sources, upwind sources, etc.).

This action was put in place because it is possible for local air quality to be poor even if other areas are not. The main reason for this is a weather event known as a "temperature inversion". Normally, higher air is cooler than air near the ground. In a temperature inversion, higher air is warmer and acts as a cap over the ground level air. In this condition the air is usually very still. So due to the cap and the still air, any local emissions from industry, transportation or other sources tend to build up more than usual.

Inversions can be caused by very still air combined with the unique local geography of a sharp rise in elevation (the Niagara Escarpment), and the lake breeze from Lake Ontario. They are most likely to occur in spring and fall. In a typical year, Hamilton experiences 1-3 such events lasting 1-2 days; although events lasting up to 5 days have been known to occur.

The system of reporting on and taking action for local poor air quality is different from the MOE's Air Quality Index (AQI). The MOE's existing province-wide system of smog alerts is based on the AQI.

During a Local Poor Air Quality Event, industries would be asked to voluntarily undertake control measures and curtail activities with a strong focus on reducing emissions of particulate matter to air. This could include wetting or covering materials piles (e.g. coal, gravel), postponing materials-handling, increasing property and road cleaning, and curtailing some production processes.

The focus of the notification system is on fine particulate matter (PM) because there is a significant amount that is locally-generated. Therefore, any local efforts to reduce air pollution in general will be beneficial since all forms of locally-generated air pollution are trapped during inversions. When fine PM goes over a certain level, and when the forecast predicts inversion conditions will last for at least 6 hours, and when wind direction is such that emissions from the industrial core are being blown toward populated areas of the city, participating industries would be notified to implement their plans to reduce local sources of fine PM.

3.4.4 Black Fallout

Air quality monitoring data trends have shown an overall decrease in the levels of air borne particulate matter as per **Appendix C** of this report. The Ministry of the Environment (MOE) has been addressing concerns in the last few years related to an increased number of black fallout complaints. Although it is not generally considered a contaminant that poses a health concern, it is a nuisance issue that the MOE is committed to address.

The MOE has implemented a 24-hour response process to enable the MOE to rapidly respond to incidents and identify likely sources of fallout as it is occurring. This heightened level of response has also resulted in a number of incidents being referred to the Investigations and Enforcement Branch (IEB) of the MOE for investigation. The MOE has hired three additional inspectors to further increase the direct oversight of industrial emitters in the City of Hamilton and continues to regularly target industrial emitters for proactive regulatory inspections as part of its annual operational plan.

The MOE has recognized a need to work more closely with industry and the community at large to proactively address these issues. MOE partners with the Hamilton Industrial Environmental Association (HEIA), *Clean Air Hamilton*, the Hamilton Air Monitoring Network (HAMN), McMaster University, the City of Hamilton, as well as the local community. These partnerships have allowed the MOE the use of a network of strategically located air monitoring stations to assist in identifying air quality issues and determining when incidents occur.

Other projects, including the results of the MOE's summer 2008 passive dustfall sampling program, greatly increase the MOE's understanding of the most likely causes and sources of black fallout. In late 2009, the MOE purchased new, state-of-the-art air monitoring equipment capable of measuring airborne particulate levels in real time. The new equipment can be set up at different locations to arrive at a better understanding of the causes and sources of black fallout. It is currently being tested and will be operational some time in 2010.

3.5 Emission Sources within Hamilton

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

Figure 7: The Air Pollution Picture

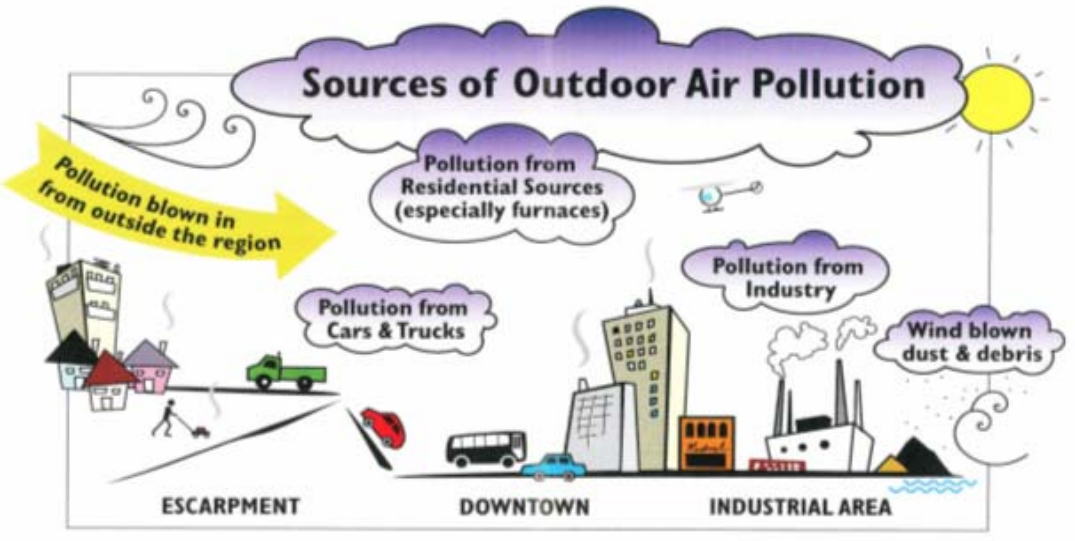


Table 3: NPRI Total Emissions by Source Category for Hamilton (2006)

Source Category	CO	SO_x	NO_x	PM_{10}	$PM_{2.5}$	VOC
Industrial	32,226	15,485	10,610	2,934	2,084	2,175
Fuel Combustion	7,387	428	1,513	1,135	1,119	1,498
Transportation	186,278	417	22,230	1,017	804	11,501
Incineration	39	24	11	0	0	7
Miscellaneous	37	0	0	138	138	6,495
Open Sources	54	19	36	69,452	8,917	611
Total Tonnes	**226,021**	**16,373**	**34,400**	**74,676**	**13,062**	**22,287**

Figure 8: NPRI Total Emissions by Contaminant and Source (2006)

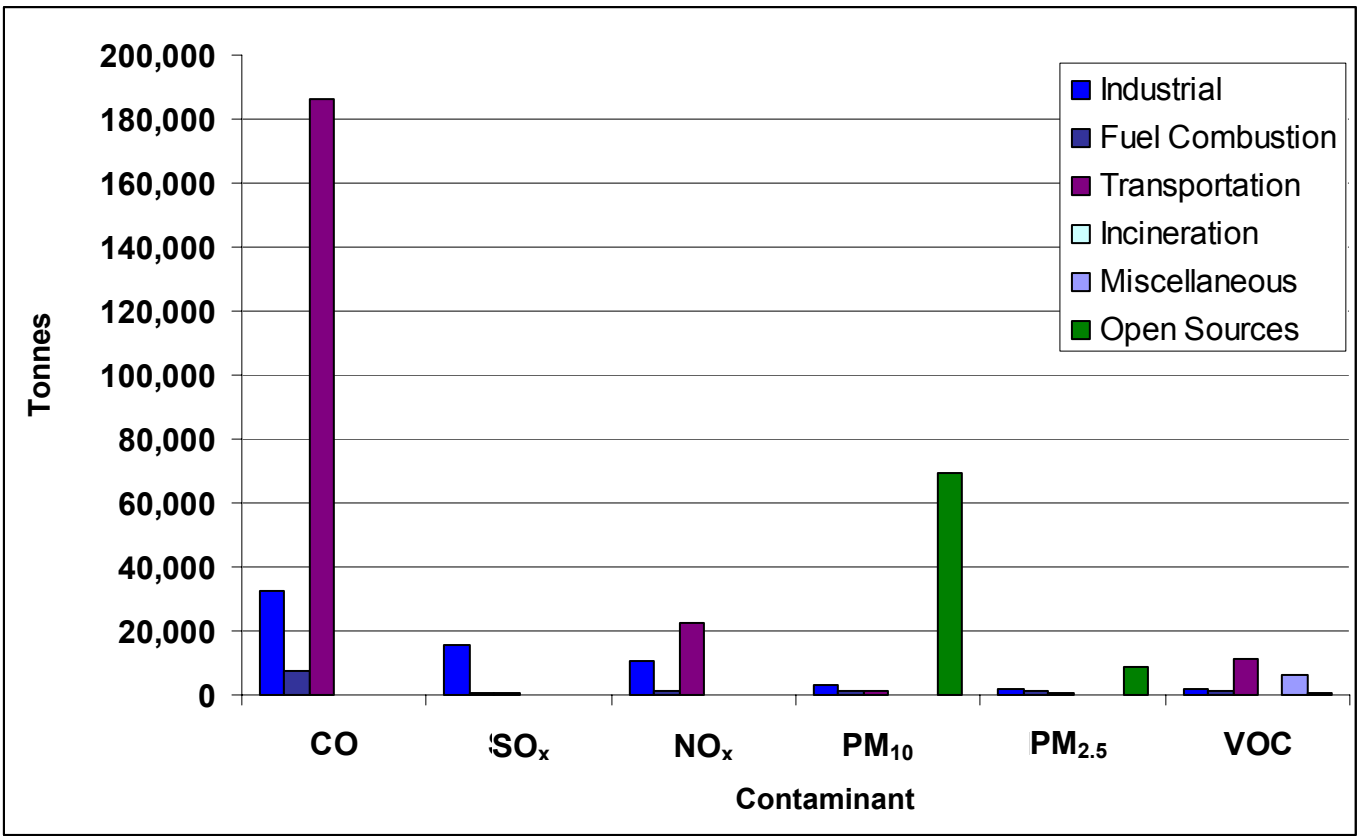
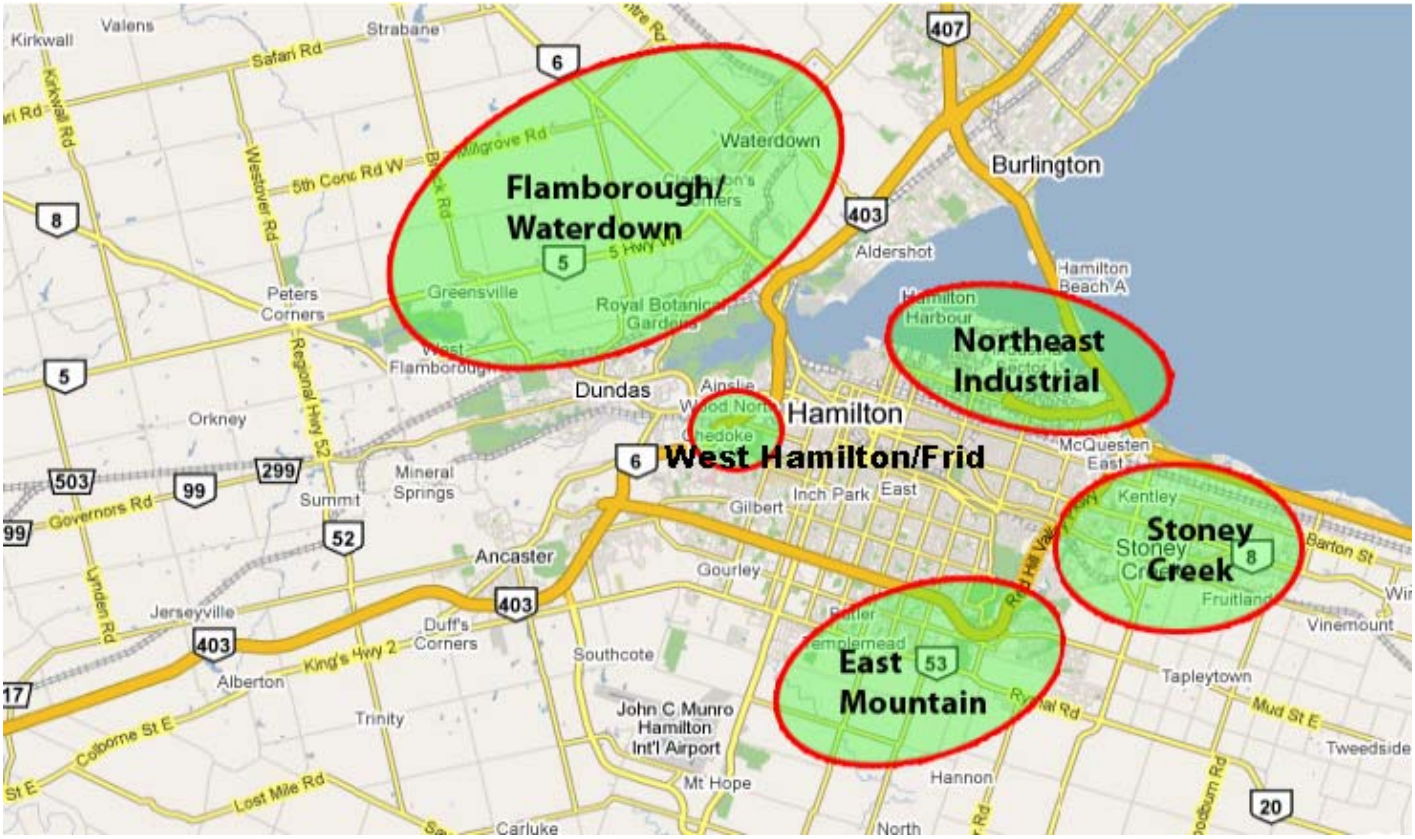


Table 3 and **Figure 8** show the total emissions data from the NPRI, broken down by source category, and indicates carbon monoxide (CO) as the air pollutant with the largest emissions. Based on available emissions inventory data from the Ministry of the Environment and Environment Canada, it is possible to conclude that:

- The transportation sector (i.e., mobile sources, such as cars and trucks) is the leading source of nitrogen oxide (NO_x) emissions within the City of Hamilton, followed closely by the industrial sector;
- Road dust, construction activities and area sources, such as fireplaces and home heating are primary sources of $PM_{2.5}$ and PM_{10}; followed closely by the industrial sector;
- The industrial sector is the leading source of sulphur dioxide (SO_2) in Hamilton (~90%); and
- The transportation sector is the leading source (~60%) of volatile organic compounds (VOCs); the remaining VOCs are releases due to general solvent use by companies and individuals.

In 2005, a mobile monitoring study (see **Section 5.1**) conducted for *Clean Air Hamilton* identified and ranked sources of air pollutants in Hamilton. Historical fixed-site air monitoring data and NPRI data for Hamilton (2004) were used to develop a target list of sources of health-impacting air pollutants and locations for the mobile study. Five separate industrial areas were identified in the city, as seen in **Figure 9**: Flamborough/Waterdown (aggregates), East Mountain (aggregates), West Hamilton/Frid (mixed industrial and University), Northeast Industrial Area (heavy and mixed industrial) and Stoney Creek (mixed industrial and aggregates).

Figure 9: Emission Sources by Region in the Hamilton Area

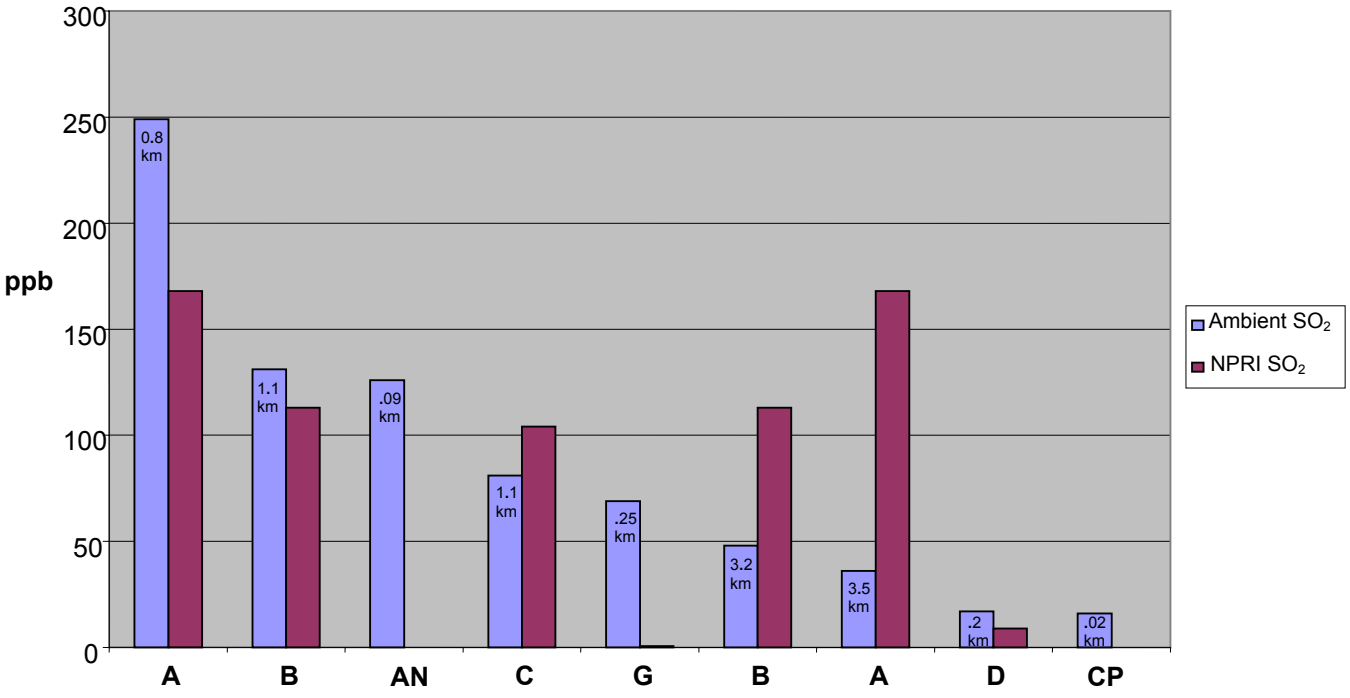


Mobile scans for the pollutants were performed in traverses across the City, at selected industrial areas, and at traffic intersections. The monitored industrial point sources included large integrated steel industries, steel by-products processors, recycling/scrap operations, foundries, chemical plants,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

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

Figure 10 shows a comparison of the ambient SO_2 levels (blue bars) measured using the mobile monitoring vehicle when the vehicle is situated downwind of a number of companies in Hamilton. The maroon bars indicate the relative releases of SO_2 as reported by these companies to the NPRI. Since measurements were made at locations with varying distances from the sources, distances (in km) are also indicated.

Figure 10: Comparison of Ambient SO_2 Levels Measured near Industries with Reported NPRI Data for SO_2 Releases



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

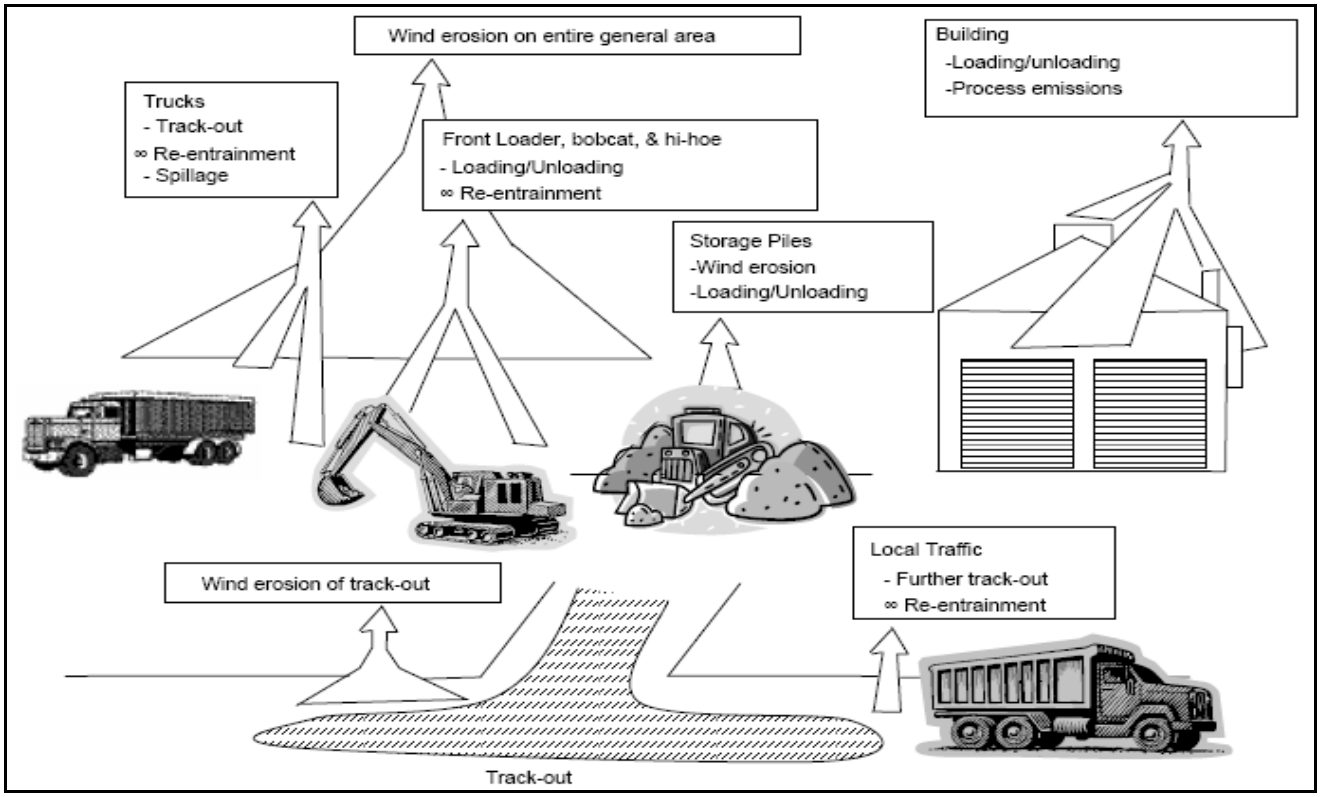
In some cases, the NPRI emissions from integrated steel companies and a carbon black manufacturer have orders of magnitude higher than smaller companies. However, these large companies have long distances to points of impact and sufficient dilution occurs so that the monitored ambient levels are comparable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

3.6 Fugitive Dusts

Clean Air Hamilton has identified fugitive dusts as a significant source of airborne particulate matter in Hamilton. Fugitive dusts are dusts that arise from non-point sources and include road dusts, agricultural dusts, and dusts that arise from materials handling, construction operations, handling of outdoor storage piles, etc. (see **Figure 11**). The compositions of fugitive dusts and road dusts vary depending on the materials used or stored, adjacent land uses, local emission sources and traffic loads.

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

Figure 11: Common Sources of Fugitive Dusts



(MOE, 2006)

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

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

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

Industries need to implement dust control best practices on their sites to prevent dusts and soils from becoming airborne and to implement best practices to prevent or reduce the amounts of materials being tracked-out from their site. These practices include paving roads on-site, particularly the stretch of road that leads directly off-site, routine maintenance of on-site roads using street sweepers, installation of wheel wash stations at the exit to the property to remove dirt before trucks drive on City roads, etc.

In 2006, a Clean Air Hamilton and MOE sponsored workshop was held for stakeholders to explain the deleterious effects of resuspended dusts and present improved cleanup and dust control methods. Vendors of control methods and equipment were also present. Visual improvements have resulted and a study is underway to quantify air quality improvements in the industrial area.

3.7 Wood Burning

When burned properly, sustainably harvested wood from well-managed woodlots can be an effective fuel for home heating. However, poor practice and older inefficient burning appliances rarely allow for complete combustion and a by-product is unburned fuel or wood smoke.

Wood smoke is made up of a complex mixture of air harming chemical substances including PM_{10}, $PM_{2.5}$, volatile organic compounds (VOCs), sulphur oxides (SO_x), nitrogen oxides (NO_X), carbon monoxide (CO), carcinogenic compounds (polycyclic aromatic hydrocarbons, benzene, formaldehyde, dioxins), carbon dioxide (CO_2) and water vapour. Toronto Public Health (2002) estimated that residential wood burning accounts for 11 percent of the $PM_{2.5}$ found in Ontario's air, 0.8 percent of the total particulate matter (TPM) and 15 percent of the VOCs.

A number of Canadian and U.S. jurisdictions are reviewing the practice of wood burning for residential heating. The City of Montréal has adopted a by-law banning the installation of wood burning appliances in new or existing buildings, except for wood pellet burners.

In 2009, in an effort to reduce harmful air emissions from residential burning in Hamilton, Green Venture initiated Wood Burning 101. This education program provides current information to the public on wood burning issues including a review of standards, the law, advanced technology appliances, proper maintenance and best wood burning practices.

Wood burning is subject to a variety of laws, regulations and standards depending upon jurisdiction:

- Federal – safety standards for appliances sold in Canada by the Canadian Standards Association (CSA); standards for low emission appliances developed by U.S. Environmental Protection Agency (EPA)

- Fire Protection and Prevention Act giving rise to the Ontario Fire Code regulates indoor appliances and installation and open air burning (O. Reg.213/07 Article 2.6.3.4.)
- Ontario Building Code – regulates construction of fireplaces, indoor appliances and installation
- Municipal By-Laws – regulate the use of indoor appliances

The most efficient wood/pellet burning appliances utilize advanced combustion technology and are rated as low emissions by the CSA/EPA. There have been great improvements on traditional conventional fireplaces and wood stoves manufactured since 1990 as evidenced in the accompanying **Table 4**.

Table 4: Wood Burning Appliance Emission Factors (kg/tonne)

Appliance	CO	NO_x	SO_x	VOC	TPM	PM_{10}	$PM_{2.5}$
Fireplace; Advanced Technology	70.4	1.4	0.2	7.0	5.1	4.8	4.8
Fireplace; Conventional Without Glass Doors	77.7	1.4	0.2	6.5	19.3	18.5	18.4
Fireplace; Conventional With Glass Doors	98.6	1.4	0.2	21.0	13.5	13.0	12.9
Central Furnace/Boiler (inside)	68.5	1.4	0.2	21.3	14.1	13.3	13.3
Central Furnace/Boiler	68.5	1.4	0.2	21.3	14.1	13.3	13.3
Central Furnace/Boiler (outside)	68.5	1.4	0.2	21.3	14.1	13.3	13.3
Fireplace Insert; Advanced Technology	70.4	1.4	0.2	7.0	5.1	4.8	4.8
Fireplace Insert; Catalytic	70.4	1.4	0.2	7.0	5.1	4.8	4.8
Fireplace Insert; Conventional	115.4	1.4	0.2	21.3	14.4	13.6	13.6
Woodstove; Advanced Technology	70.4	1.4	0.2	7.0	5.1	4.8	4.8
Woodstove; Catalytic	70.4	1.4	0.2	7.0	5.1	4.8	4.8
Woodstove; Conventional	100.0	1.4	0.2	35.5	24.6	23.2	23.2
Woodstove; Conventional, Not Air-Tight	100.0	1.4	0.2	35.5	24.6	23.2	23.2
Woodstove; Conventional, Air-Tight	115.4	1.4	0.2	21.3	14.4	13.6	13.6
Other Equipment	115.4	1.4	0.2	21.3	14.4	13.6	13.6
Pellet Stove	8.8	1.4	0.2	1.5	1.2	1.1	1.1

(WLAP, 2005)

Even advanced, efficient and cleaner burning appliances will result in harmful emissions when improperly installed, maintained or operated. Ultimately, the fuel wood itself must be clean and properly seasoned.

The related issue of outdoor 'open air' or backyard burning was also addressed in Wood Burning 101. Despite strict controls by the City of Hamilton, Open Air Burning By-Law #02-283, inefficient, highly polluting and sometimes illegal open air burning still occurs in the community.

For information on Wood Burning visit:
www.air.greenventure.ca/woodburning-101

3.8 Cumulative Effects

Addressing the cumulative effects of air contaminants is an issue that is receiving a lot of attention in Ontario lately, particularly in the context of regulatory permitting (ECO, 2009). In 2008, the Ontario Court of Appeal refused to appeal a Divisional Court decision which upheld neighbours' rights to challenge a cement company's Certificate of Approval to burn alternative fuels such as municipal waste and used tires (Lafarge Canada Inc. v. Ontario (Environmental Review Tribunal), (2008), 36 E.E.L.R. (3d) 191 (Ont. Div. Ct.). In effect, many stakeholders have expressed concern about how consideration of cumulative effects can be integrated into Ontario's air permitting process.

Ontario's current air quality standards do not establish a process to require or even allow decision-makers to consider the potential cumulative air emissions impacts. The lack of an appropriate or meaningful acknowledgement of cumulative effects is especially significant for multi-pollutant, multi-facility areas, pollution in areas with significant background levels of pollutants and in areas with pollutant levels from local resources that exceed pollutant standards.

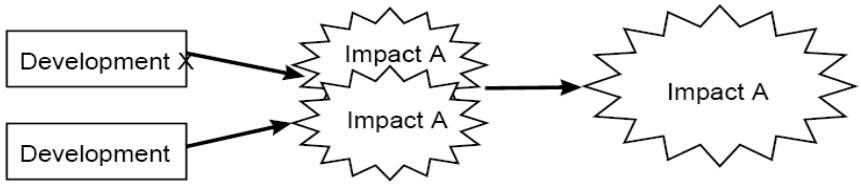
In order for the Ministry of the Environment (MOE) to address the cumulative effects of air contaminants, a common, reasonable, and objective working definition of *cumulative air impacts or effects* must be developed.

Table 5: Definitions of Cumulative Effects

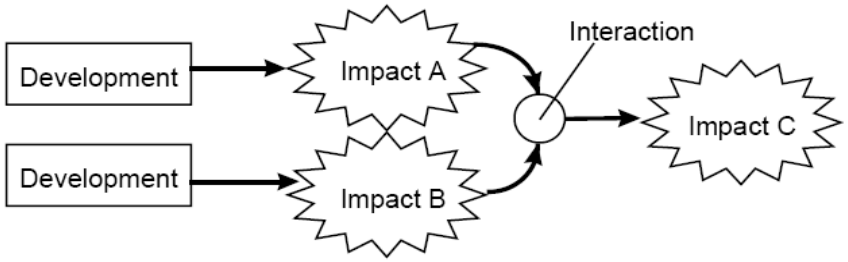
Government of Canada and the Canadian Environmental Assessment Agency	**Cumulative effects are changes to the environment that are caused by an action in combination with other past, present and future human actions** (ECO, 2009)**.** • Simple definition: intended specifically for single-project assessments as opposed to regional planning • Borrows the broad definition of "environment" as used in the Canadian Environmental Assessment Act (CEAA), 1999 • Cumulative effects can be additive or synergistic, direct or indirect (CEAA, 1999): **Additive effects:** when the magnitude of combined effects is equal to the sum of individual effects **Synergistic effects:** when the result from interactions between two or more projects is greater than the sum of individual project effects **Direct effects**: caused by the action and occurs at the same time and place I**ndirect effects**: caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable
United States Council on Environmental Quality	**Cumulative effects are the impacts on the environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable actions regardless of what agency (federal or non-federal) or person undertakes such other actions** (EPA, 1999)**.**
European Union	The following definitions overlap and are not agreed definitions but developed for the purposes of the Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions by the European Commission (1999):

Indirect impacts: **impacts on the environment, which are not a direct result of the project, often produced away from or as a result of a complex pathway.**

Cumulative impacts: **impacts that result from incremental changes caused by other past, present or reasonably foreseeable actions together with the project.**



Impact interactions: **the reactions between impacts whether between the impacts of just one project or between the impacts of other projects in the areas.**



Cumulative effects are caused by the accumulation and interaction of multiple stressors affecting the parts and the functions of ecosystems. Of particular concern is the knowledge that ecological systems sometimes change abruptly and unexpectedly in response to apparently small incremental contributions of net effects. As seen in **Table 5**, numerous definitions of cumulative effects exist. While the definitions are not identical, they all suggest that the assessment of cumulative effects presents some unique challenges regarding the magnitude of change pollutants, the sources, pathways or routes of exposures and time.

Challenges or opportunities that arise from the discussion of defining cumulative effects and impacts include the following:

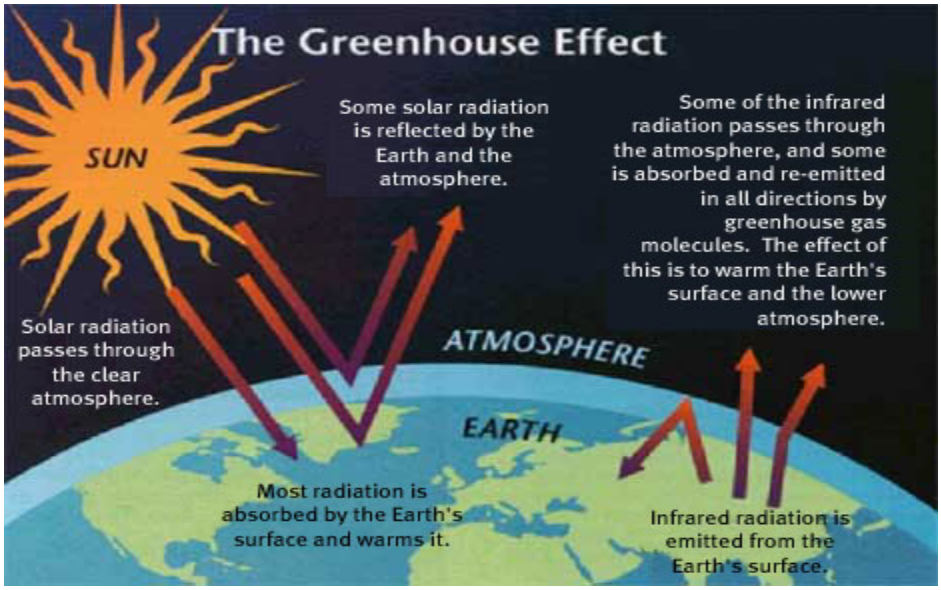
- Predicting future resource use and impacts → determining the minimum data requirements that will allow defensible and robust impact predictions
- Setting criteria for judging significance of cumulative effects → i.e. threshold effects and irreversible changes in the use of critical resources will generally be key concerns
- Scope: how far into the past? → Time at which the lease of land for the development was made?
- Scope: how far into the future? → Based on the result of decommissioning?
- Lack of understanding of the fate of contaminants in atmosphere, bioaccumulation or persistence, synergistic/antagonistic effects

Determining the cumulative environmental consequences of an action requires delineating the cause-effect relationships between the multiple actions and the resources, ecosystems, and human communities of concern (Noble, 2006). Scoping is the key to analyzing cumulative effects. The scope sets appropriate boundaries for analysis geographically and temporally to identify relevant past, present, and future actions. In other words, incorporating cumulative effects analysis through the assessment of the life cycle of effects puts humans in context with the broad definition of environment. Also, the significance of considering the past, present and future actions and conditions encourages long-term strategic planning. A real world, local example of cumulative effects is the respective contributions of long range transported pollutants, local industry and transportation to Hamilton air quality.

4.0 Linkages between Climate Change and Air Quality

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

Figure 12: The Greenhouse Effect



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

Table 6: Greenhouse Gases and their Atmospheric Lifetimes

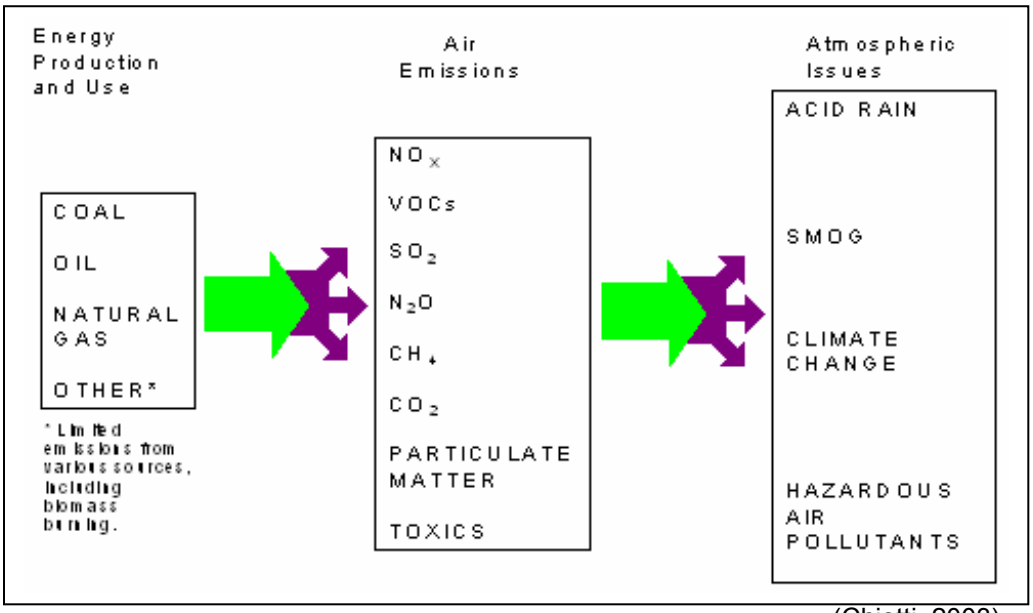
Greenhouse Gas	Lifetime in the Atmosphere
Carbon dioxide (CO_2)	5 to 200 years
Methane (CH_4)	12 years
Nitrous oxide (N_2O)	114 years
Sulphur hexafluoride (SF_6)	3,200 years
Carbon tetrafluoride (CF_4)	50,000 years

(Center for Science in the Earth System & ICLEI, 2007)

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

When carbonaceous fuels are burned for energy and heat carbon dioxide, particulate matter, nitrogen oxides, sulphur oxides and carbon monoxide are released into the air. Carbon dioxide is responsible for global climate change while the other pollutants affect local air quality and local health. Ozone, also an important air quality and health parameter, is not released to the atmosphere directly; rather ozone is produced when the above components interact under the influence of sunlight.

Figure 13: Combustion of Fossil Fuels for Electricity, Home Energy, Transportation, Industry, and Municipalities results in Air Emissions and Atmospheric Issues



(Chiotti, 2003)

Higher temperatures due to climate change result in increasing demands for electricity (often coal-combustion generated electricity) for air conditioning; thus, on hot days the levels of air pollutants are sometimes driven higher by energy demands. If Canada met its Kyoto targets, fossil fuel consumption would be almost 25% lower than it is today; the average air quality would improve by about 25% due to reductions of combustion by-products, which result from our need for energy.

Poor air quality, combined with heat stress from hotter weather, poses serious health challenges to the most vulnerable in society, the very young and the elderly. Climate Change will have significant impacts on human health. Health Canada (2008) has identified eight significant health concerns related to Climate Change (**Table 7**). They include health effects from increased smog episodes, illnesses and deaths caused by heat and cold waves, water- and food-borne contamination, diseases transmitted by insects, health effects of stratospheric ozone depletion, and extreme weather events.

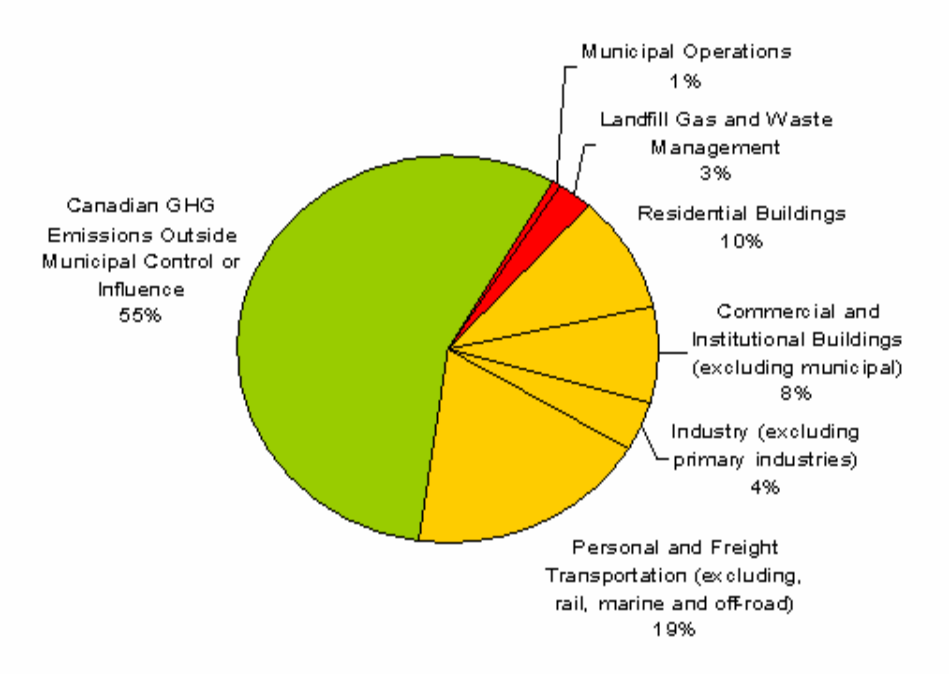
Table 7: Health Canada's Impacts from Climate Change and Variability (2008)

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

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

According to the Federation of Canadian Municipalities (FCM), just less than half of Canada's 2006 greenhouse gas emissions (315 Mt or million tonnes) are under the direct or indirect control or influence of municipal governments. Municipalities directly control decisions that produce some 24 Mt of greenhouse gas emissions from municipal operations, residential waste, and landfill sites. Greenhouse gas emissions under the indirect control (regulatory, public policy, and community awareness) of municipal governments total 291 Mt (refer to **Figure 14**).

Figure 14: Canadian GHG Emissions Directly & Indirectly Controlled by Municipalities Compared to Total National Emissions (2006)



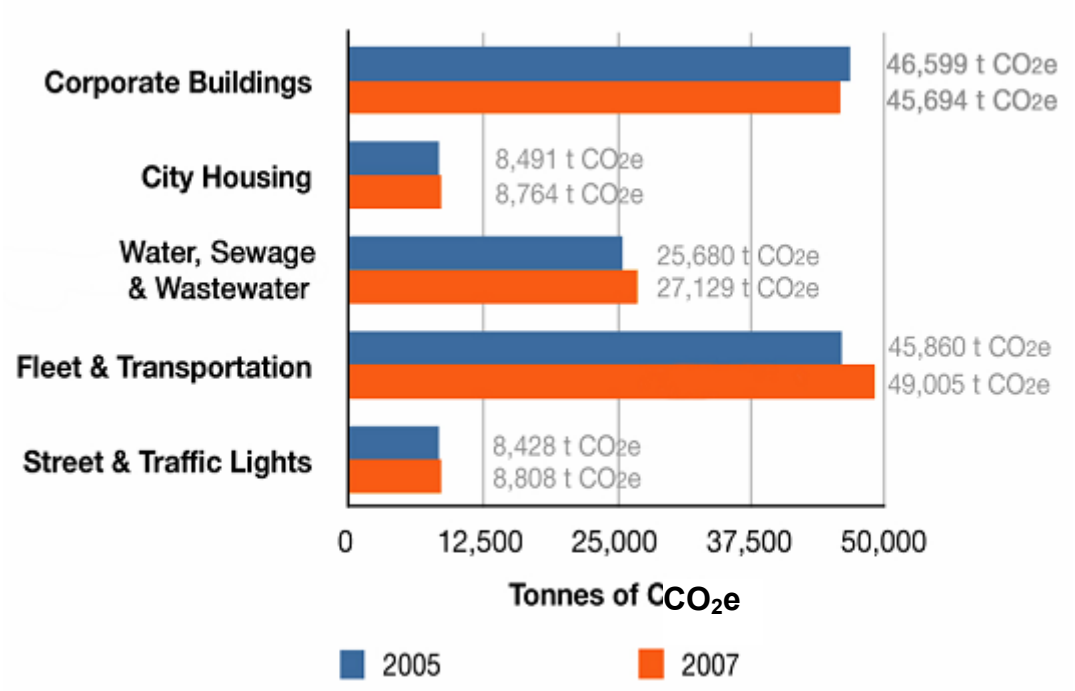
(Federation of Canadian Municipalities, 2009)

4.1 City's Corporate Air Quality and Climate Change Inventory

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

In 2009, the City of Hamilton undertook a greenhouse gas emissions inventory for its operations and the community as part of the FCM Partners for Climate Protection Program. The inventory was also undertaken to measure how the City was doing in reducing its greenhouse gas emissions compared to the emissions targets (refer to **Figure 15**).

Figure 15: Change in Municipal Emissions from 2005 to 2007



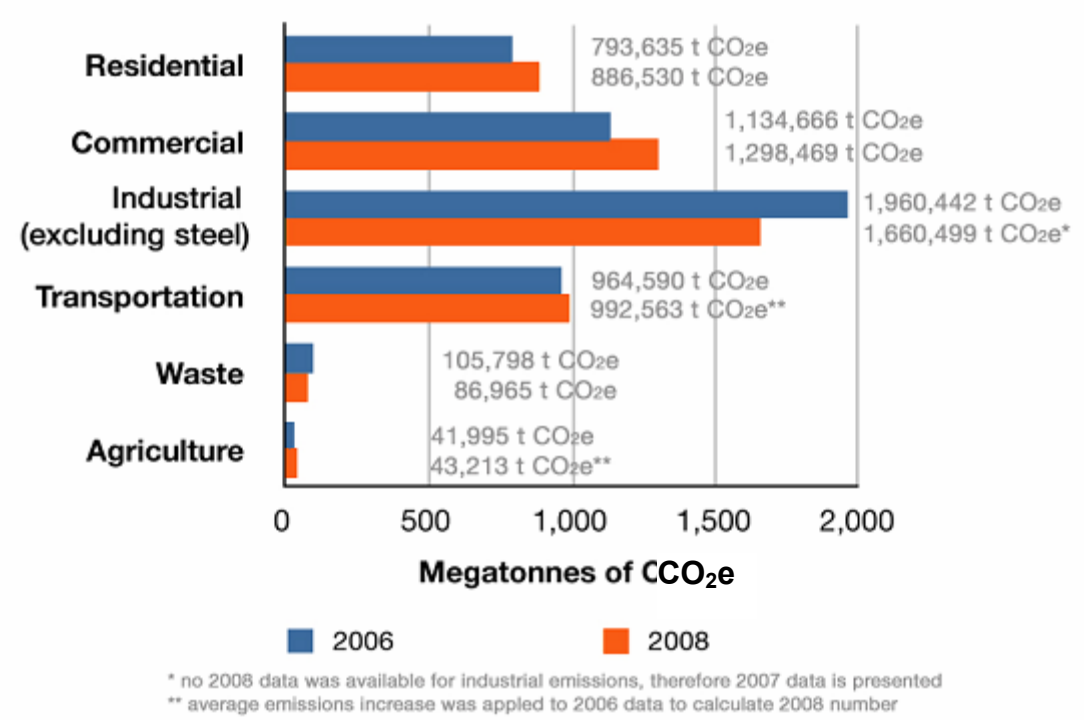
In 2005, municipal operations in Hamilton emitted 135,058 tonnes of greenhouse gases from City-owned vehicles (fuel usage – natural gas, electric and gas) and buildings (energy usage for heating and cooling and lighting), contracted fleets, wastewater treatment, small engines, and travel habits of City employees. In 2007, total emissions increased by 3.2% to 139,401 tonnes of greenhouse gas emissions due largely to growth in the community and an increase in coal generation in the provincial energy supply (20% of the provincial energy mix was coal-fired in 2007 versus 18% in 2005). Increased emissions in the Fleet & Transportation sector due to increased transit service, is necessary to reduce community and employee transportation emissions.

Since 2007, the City has been undertaking a number of initiatives to further reduce its emissions, such as the Glanbrook landfill gas collection system, the Corporate energy policy, the installation of LED traffic lights, the Green Fleet program, and the Woodward Biogas Cogeneration Facility.

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

Community greenhouse gas emissions in Hamilton are estimated at 13,131,097 million tonnes in 2008 (refer to **Figure 16**). This was an increase of 2.9% from the 2006 emissions levels of 12,758,652 million tonnes.

Figure 16: Change in Community Emissions from 2006 to 2008



Reductions of emissions from the industrial sector (-15%) and the waste sector (-18%) were not enough to offset the significant increases in GHG emissions from the energy usage in residential and commercial sectors, due to the increase in natural gas consumption and an increase in coal-fire electricity in the provincial energy mix. Transportation sources are also a significant source of GHG and air pollutant emissions and continue to increase in Hamilton.

Municipal and community involvement in reducing sources of GHG emissions – commercial and personal transportation, commercial and residential energy usage, land-use development – in Hamilton is critical. Provincial policies on phasing out coal-fired electricity and encouraging renewable alternative energy in the provincial energy mix and the MoveOntario 2020 Rapid Transit Action Plan will also affect the reductions in Hamilton's emissions.

4.2 Hamilton Climate Change Champions

In 2009, Green Venture, Environment Hamilton, and the City partnered to help individuals and business become Climate Change Champions by committing to actions that will achieve greenhouse gas (GHG) emissions reductions of 10% by 2012 and 20% by 2020.

Hamilton's Climate Change Champions consist of 24 local organizations from elementary and secondary and post-secondary schools, small and medium-sized businesses, community centres,

media, faith groups, and government, committed to cutting their energy use and help combat climate change at the same time.

The aim of the program was to prepare custom-made action plans to help the Champions cut their energy, waste and water use, which saves money, and helps the environment at the same time.

This on-going program has contributed to reducing 373 tonnes of local GHG emissions through the work of the 24 champions and the engagement of 2,748 people in Hamilton.

For more information and to join the Hamilton Climate Champions, visit:
www.hamiltonclimatechange.ca

5.0 Transportation Emissions - Linkages to Air Quality and Human Health

5.1 Mobile Monitoring Research

Mobile monitoring surveys were undertaken for *Clean Air Hamilton* between 2004 and 2009, to obtain a comprehensive picture of the air quality across the City of Hamilton, in particular air and health impacts due to traffic emissions and atmospheric inversions conditions. Preliminary data from these surveys were presented in previous *Clean Air Hamilton* reports (2005 to 2008) and some of the findings are presented here.

For complete information on the mobile monitoring research, please visit:
www.cleanair.hamilton.ca/default.asp?id=26

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

Figure 17: Mobile Sampling Areas (2007)

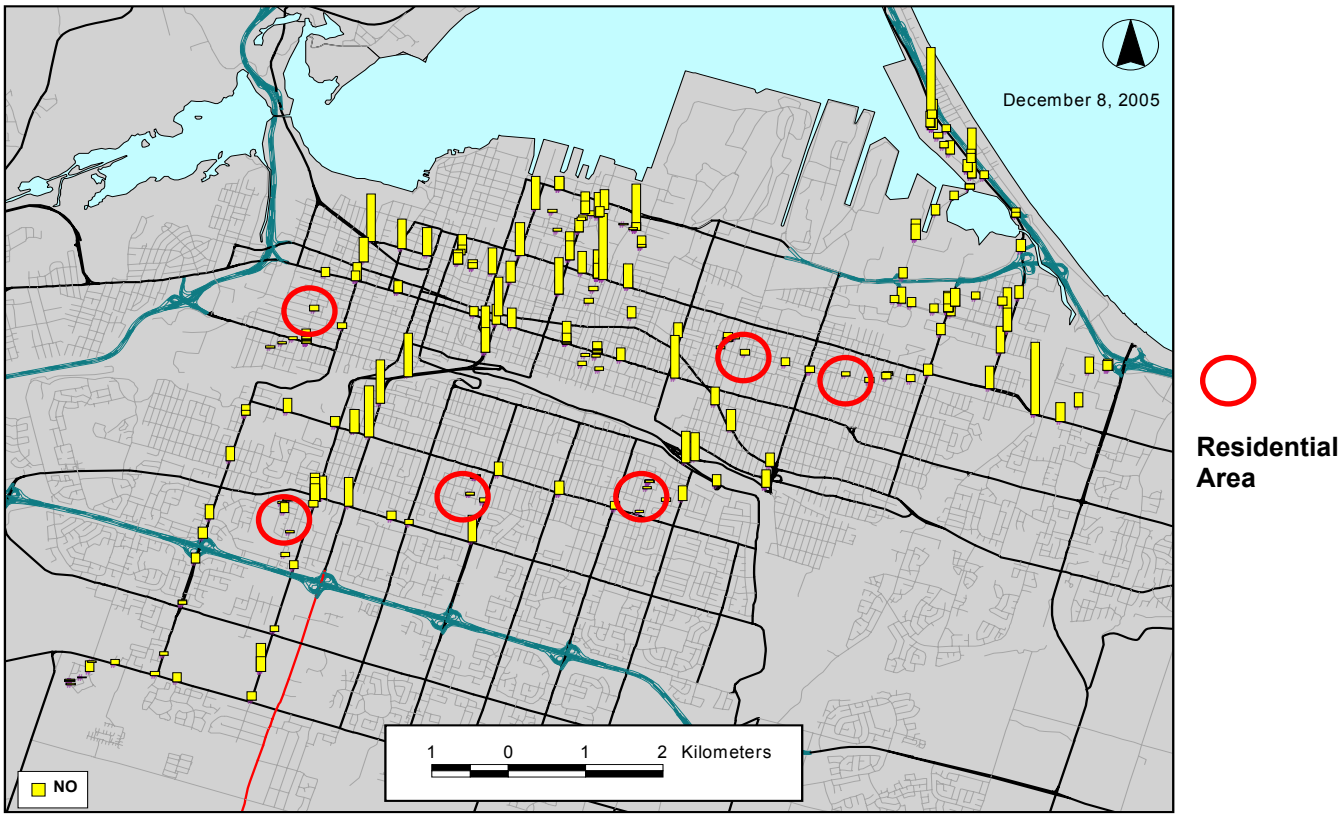
Main Road Sampling Track

5.1.1 Residential vs. Traffic-Related Emissions

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

Figure 18 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. NO is a combustion pollutant and is emitted directly by cars and trucks; as such, NO is an excellent measure of the impacts of vehicular pollution. The greater the height of a yellow bar, the higher the level of NO measured.

Figure 18: Residential vs. Traffic-related Levels of Nitric Oxide

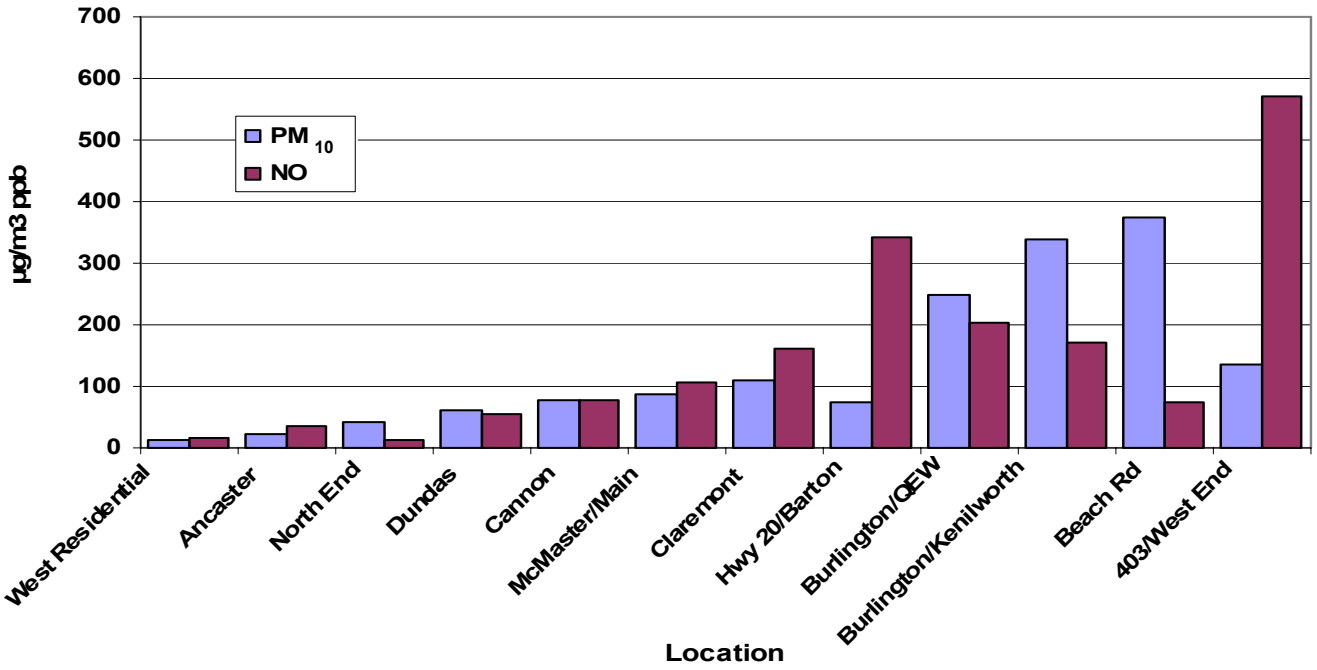


The areas circled in red in **Figure 18** are residential areas within the city where NO data were collected using mobile sampling methods; within these red circles, the levels of NO (small yellow bars) are about 10-fold to 40-fold lower than the levels of NO measured on and along major roads (large yellow bars). These data clearly show that people in residential areas experience relatively low levels of traffic-produced pollutants (such as NO) compared to levels experienced by people living and working along major roads and near major intersections. These data were collected in Hamilton but are typical of the levels of traffic-derived pollutants measured in other cities around the world.

Additional mobile monitoring work in 2007 showed that extremely high levels of NO were observed along the Highway 403 corridor from the junction at Main Street West to the junction with the Lincoln Alexander Parkway. A peak NO value of 586 ppb was measured along Highway 403 on a typical mid-summer afternoon. This NO level is the highest ever measured in Hamilton and is much higher than NO levels observed directly downwind of large industrial sources. This data shows that emissions from motor vehicles, when measured along a major highway or major traffic artery, can be very high and represent the high exposures to contaminants individuals can be exposed to when riding in motor vehicles on major roads and highways.

These readings and other data collected during our mobile monitoring studies are compelling evidence that traffic-derived pollutant levels in urban areas (such as Hamilton) are highly variable and depend on many factors, including numbers of vehicles, the mix of cars and trucks, the distance from the major road or highway, etc. In other words, the pollutant levels in a busy urban centre vary over a 10-fold to 100-fold range depending on the factors discussed above.

Figure 19: Levels of PM_{10} and NO Along Roads in Hamilton



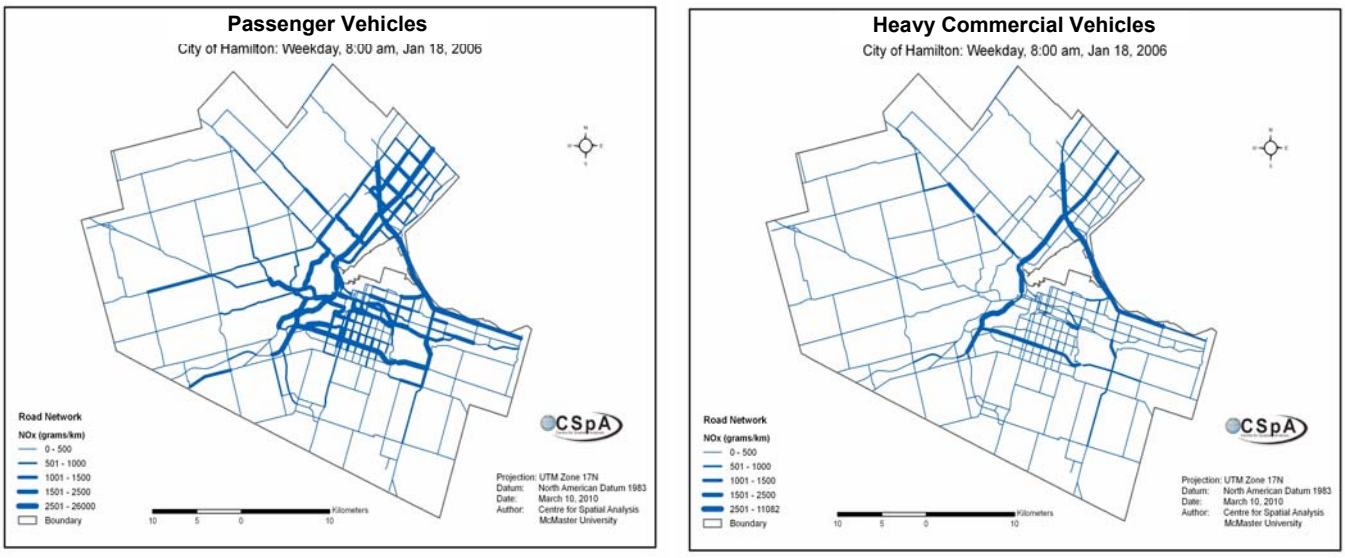
The data in **Figure 19** are organized in order of increasing levels of either PM_{10} or NO. The levels of both pollutants were lowest in residential areas (i.e., areas with low vehicular impacts, West Residential, Ancaster, North End), greater on major roads (Cannon, McMaster/Main, Claremont) and greatest in areas with the highest vehicular traffic counts (i.e., along busy major roads and a highway). These levels are typical levels of exposures for humans working or driving in these areas. For clarity, this figure does not include any locations with high fugitive dust contributions. The primary sources of PM_{10} in these samples are combustion sources, particularly vehicles. The impacts of truck traffic on ambient PM_{10} and NO are particularly noteworthy in areas known to have high truck traffic (Burlington/QEW, Burlington/Kenilworth, Beach Road).

5.1.2 Modelling Vehicle Emissions on Major Roads and Highways in Hamilton

The McMaster Centre for Spatial Analysis (Centre) was contracted by Environment Canada to model the particulate and nitrogen oxides emissions from cars and trucks in a number of Canadian cities for every hour of every day in 2006. The Centre recently completed this analysis of these emissions from vehicles (both cars and trucks) on the Hamilton road network. This research required data on the traffic counts of cars and trucks on the major roads and traffic arteries in Hamilton, knowledge of the types of vehicles on the roads and their emissions factors, the temperature at each hour of the year 2006, etc. The results of this study have provided the first comprehensive insights into the patterns of vehicular emissions in Hamilton. This work provides answers to many questions that have been asked over the years by air quality researchers, the public and politicians. These questions include "What are the relative contributions of cars and trucks to the vehicular emissions in Hamilton?", "How do vehicular emissions change over the course of the day?", "Where are truck emissions the worst?" and "Are weekday and weekend traffic emissions the same?"

Figure 20 shows the modelled nitrogen oxides emissions (NO_x but is almost exclusively nitric oxide, NO) for Passenger Vehicles (left panel) versus Heavy Commercial Vehicles (right panel) on the Hamilton roadway system for a weekday at 8 a.m. These calculations were performed for 2006, that is, prior to the opening of the Red Hill Expressway so emissions from this expressway are not part of this study. The patterns of emissions of particulate material and oxides of nitrogen were very similar. In this discussion, only data for nitrogen oxides will be shown; the rationale for this choice is that about one-third of all health effects due to air pollution in Hamilton are the result of exposures of nitrogen oxides while the impacts from exposures to particulate material are about three times less than those due to nitrogen oxides.

Figure 20: Modelled NO_x Emissions for Cars and Trucks at 8 a.m. on a Weekday

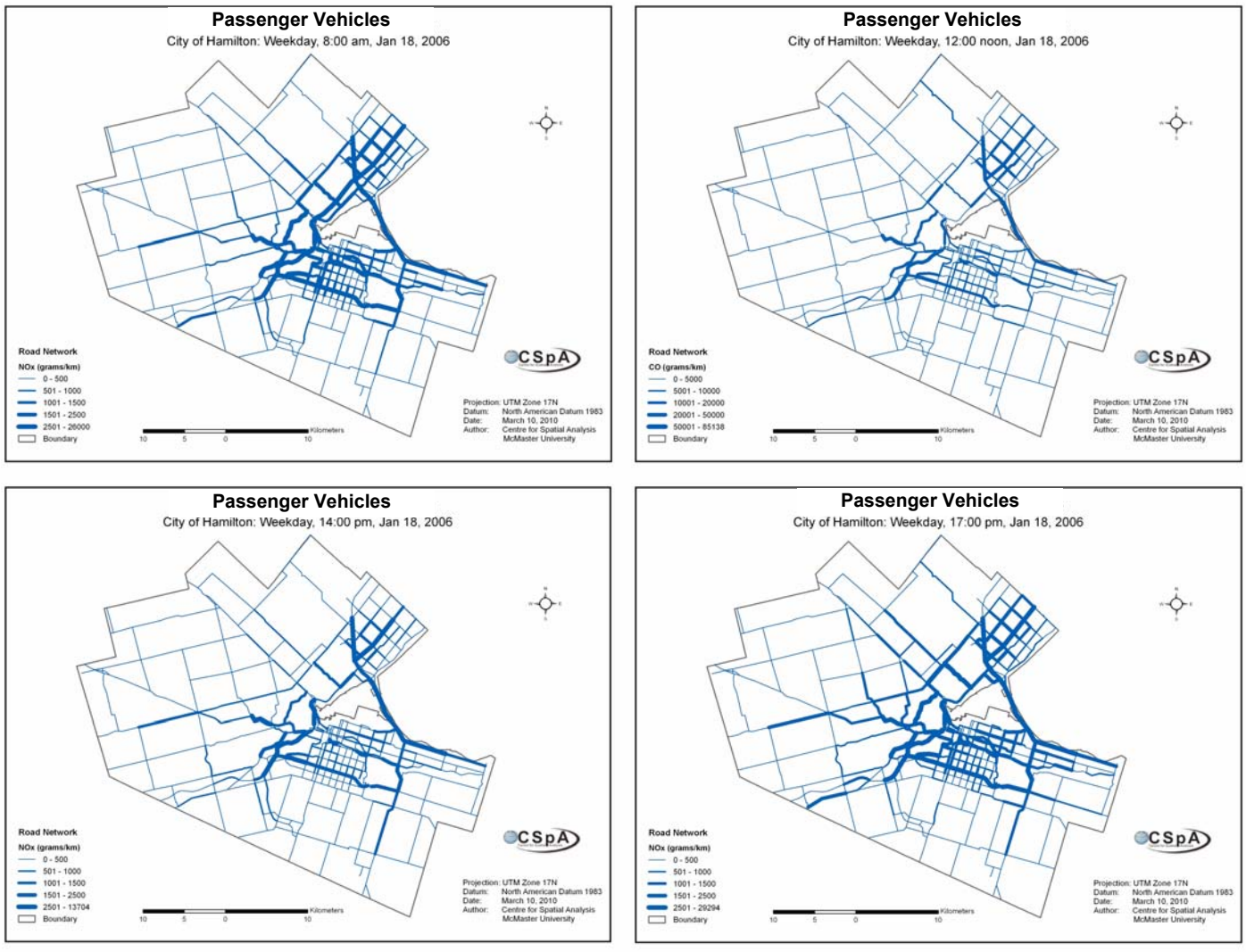


The relative contributions from passenger vehicles to the overall emissions of NO_x across Hamilton are significantly greater than emissions from heavy trucks. Emissions from heavy trucks are localized primarily to the major highways surrounding the city (QEW, Highway 403, Highway 6 and the Linc). In other words, the primary sources of human exposure to oxides of nitrogen in Hamilton are emissions from passenger cars and light trucks. However, those who live or work

near major truck routes and highways will experience higher vehicle-related pollutant exposures (due to both cars and trucks) than people who live and work in less heavily travelled areas. The extent of the contribution to NO_x emissions due to cars and light trucks will come as a surprise to many. While the highest NO_x levels are associated with major highways, it is obvious that emissions from cars on the street network are also significant, particularly during periods when streets are most congested. In this respect, Hamilton is no different from most large urban centres.

The pattern of NO_x emissions for cars and trucks during the course of a typical work day was also examined in this study. **Figure 21** shows the NO_x emissions only for passenger vehicles on the Hamilton roadway system at four selected times during a work day: 8 a.m., noon, 2 p.m. and 5 p.m. The pattern of NO_x emissions at 8 a.m. (during the morning rush hour) and at 5 p.m. (during the evening rush hour) are not surprisingly similar. The modelled emissions at noon and 2 p.m. are substantially lower than during the rush hours. The emissions from highways are always greater than emissions from the street network due to heavier traffic volumes. Weekday NO_x emissions peaked between 7 a.m. and 9 a.m. and between 4 p.m. and 7 p.m. The NO_x emissions between 10 p.m. and 6 a.m. were the lowest of the day and were typically about 20 times lower than the peak during rush hours (data not shown). The emissions of fine particulate material ($PM_{2.5}$) were also modelled and these trends followed patterns very similar to the NO_x profiles.

Figure 21: Comparison of NO_x Emissions for Passenger Vehicles during a Weekday



The mobile monitoring data discussed above provided a unique opportunity to compare real-time measurements of NO_x and $PM_{2.5}$ with values predicted by the transportation model developed by the Centre for Spatial Analysis. Overall, the agreement between the modelled and measured values is extremely good in those areas of the City where these comparisons can be made. In the future we will continue to collect air quality data using mobile monitoring in more areas of the City and along major highways so we can compare the modelled emissions data with measured values. Hamilton is one of a very small number of places in the world that has the capacity to conduct mobile monitoring and traffic emissions modeling. Such models are particularly useful when evaluating scenarios involving proposed changes in traffic patterns or the impacts of moving to more fuel-efficient vehicles or vehicles that do not release contaminants.

5.1.3 Study of Ambient Air Pollution and Community-acquired Pneumonia

In January 2010 a research study was published by a highly regarded group of researchers that examined whether there was a relationship between the occurrence of community-acquired pneumonia in older adults and ambient exposures to atmospheric pollutants, specifically nitrogen oxides (NO_x), fine particulate material ($PM_{2.5}$) and sulphur dioxide (SO_2). This study used air quality and health outcomes data from Hamilton from 2001-2003.

The researchers needed to estimate the contaminant exposures of those enrolled in the study. To do this they took Hamilton air quality data and used modern interpolation techniques to estimate pollutant levels across the city. The air quality data for $PM_{2.5}$ and NO_x, along with the locations of the homes of the 'cases' and the 'controls' enrolled in the study are shown in **Figures 23 and 24**, respectively.

Figure 22: Estimated Levels of $PM_{2.5}$ across the Hamilton Region

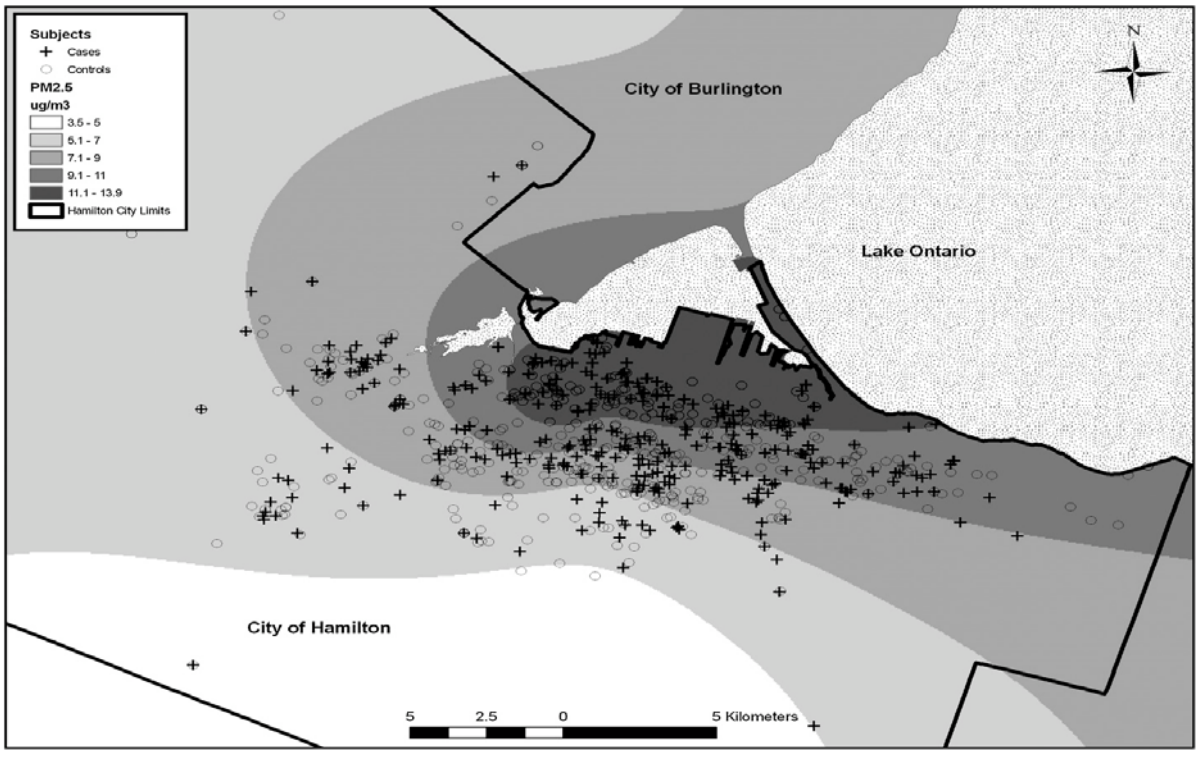
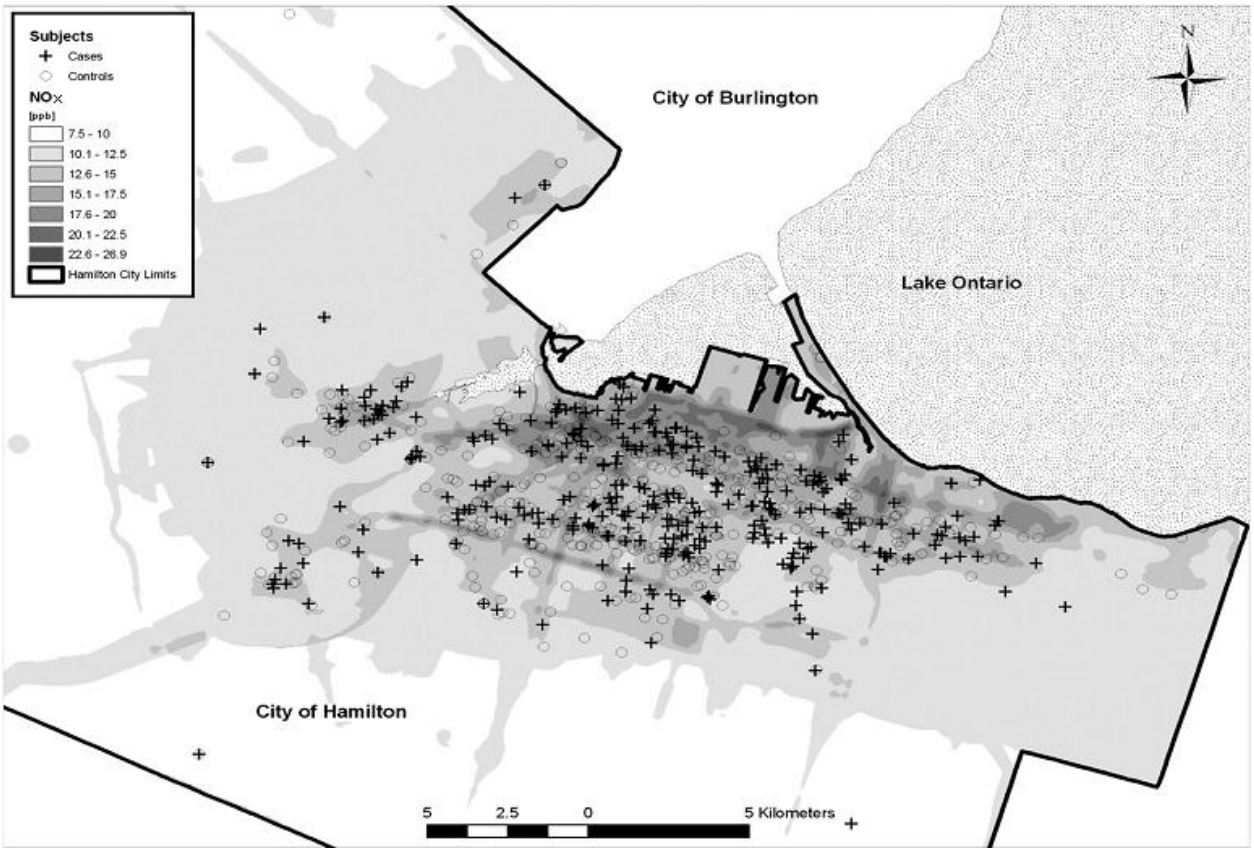


Figure 23: Estimated Levels of NO_x across the Hamilton Region



The interpolated $PM_{2.5}$ levels (**Figure 22**) around the Hamilton area show the highest levels in the downtown and the industrial areas of the city with zones of $PM_{2.5}$ levels decreasing as you move into the less urbanized areas surrounding the city. The region of the city roughly below the escarpment from Highway 403 on the west to Lake Ontario was estimated to have average $PM_{2.5}$ levels above 11 $\mu g/m^3$. Above the Escarpment, the $PM_{2.5}$ levels decreased in steps of 2 $\mu g/m^3$ as you move south or west away from the escarpment. The $PM_{2.5}$ levels in West Hamilton, Dundas and Ancaster ranged from 7-9 or from 9-11 $\mu g/m^3$, depending on the relative proximity to downtown Hamilton.

The interpolated NO_x map (**Figure 23**) showed a rather different and surprisingly detailed 'picture' of the nitrogen oxide levels in Hamilton. This map shows clear patterns of high NO_x levels that correspond to the more travelled roadways and highways in Hamilton. Indeed, the regions of highest NO_x levels bear an uncanny resemblance to the roadway maps of modelled NO_x levels predicted by the work done by the Centre for Spatial Analysis for Environment Canada (**Figure 22**). Some of the highest NO_x levels are associated with Burlington Street, the downtown area, the area west of downtown near Highway 403, etc. The higher level of detail in the 'NO_x map' is the result of a very detailed NO_x sampling campaign wherein some of the researchers involved in this study deployed about 200 passive samplers across the Hamilton region in 2003; these 'high resolution' sampling data allowed these researchers to show the highly non-uniform nature of NO_x levels across the City.

The study showed that there was a strong relationship between incidence of community-acquired pneumonia in the elderly and exposures to two of the three pollutants, $PM_{2.5}$ and NO_x, but not with SO_2.

5.1.4 GeoConnections Project

In order to enhance the usefulness of the Mobile Monitoring data a major data review and validation task was completed with GeoConnections funding. The GeoConnections program is jointly funded by the federal and provincial governments in order to make georeferenced data more widely available.

The final data archive is now available at the McMaster University Centre for Spatial Analysis website and comprises air pollution sampling data from 2005-2009, covering the Greater Toronto Area and Hamilton. The data includes different atmospheric conditions and seasons, including temperature inversions. The Mobile Air Monitoring data sets are converted to standardized Excel and Shapefile formats; a Master List of sampling days with explanations of sampling targets; detailed field notes; wind speed and direction data; and related reports and presentations, are also available.

The final data archive and all the additional features discussed above are available at: www.science.mcmaster.ca/geo/geo_co_wip/geoconnections/mobile%20monitoring%20study/
A Web Mapping Service (WMS) was added for users who may not possess geographic information system software but who still wish to view the data. This WMS can be accessed at: geomedia.mcmaster.ca/airhealthapp/default.aspx

These data will enable public health professionals and urban planners to make specific recommendations to improve the health of citizens. As an example, the strikingly high levels of air pollution found on highways in the vicinity of heavy truck traffic have led to the recommendation that drivers keep their ventilation systems on 'recirculate' in such conditions. This data should be more widely analyzed and incorporated into policy decisions, now that they are available on the Internet.

5.2 Active & Sustainable Transportation

5.2.1 Smart Commute and Transportation Demand Management (TDM)

Smart Commute Hamilton and the City of Hamilton's Public Works Transportation Demand Management (TDM) office were very active with a variety of new programs underway in 2009 (see **Table 8**) . The programs vary in nature from technical site analysis, TDM Guidelines and bike parking infrastructure projects to education, communications and event planning. The office has also been active in developing and improving relationships with partner organizations including Clean Air Hamilton, Public Health, Green Venture, Environment Hamilton, McMaster University, Hamilton Health Sciences, St. Joseph's Healthcare, Horizon Utilities, School Boards, Federal and Provincial offices, Workers Safety and Insurance Board, the Hamilton Chamber of Commerce and Arcelor-Mittal Dofasco:

- Since November 2009 the City of Hamilton is considered the fastest growing carpooling community in the Greater Toronto and Hamilton area with a 117% growth rate as of February 2010.

- Awarded a $47, 500 grant from the Ministry of Transportation TDM Grant Program for the Smart Commute Hamilton Pedestrian Initiative (which will be implemented in 2010/11)

- Assisting in the development of an Open Streets Event/Cyclovia event.
- Organized the second annual Transportation Summit themed "Hamilton: A Liveable City", which explores transportation issues and culture in Hamilton.
- Seeking partnerships with community groups and new employers to strengthen the outreach component of the initiative and to perform a greater number of site analysis and studies related to sustainable transportation infrastructure and commuting habits.

Table 8: 2009 TDM Program Descriptions and Status

Activity	Description	Status
MTO TDM Funding (2009 Application)	Received confirmation that the application for $47,500 from the MTO for the Hamilton Pedestrian Initiative was approved.	2009 application complete and approved.
Secure Bike Parking	Opened a facility in the Convention Centre Parkade in June 2009 (in addition to the facility at the York Blvd Parkade and McMaster University)	Ongoing construction of new facilities.
2009 Transportation Summit	Annual event hosted at the Hamilton Convention Centre on April 27, 2009 (see section 5.2.2)	Evaluation and Report Complete, 2010 Summit Planning has begun.
Expanded Subsidised Employer Commuter (EC) Pass program	TransitZone.ca will be used to manage employee requests for subsidised passes from various employers	Legal agreements need to be created and a finalized web interface developed to promote to all area businesses
Open Streets Hamilton	Planning began in 2009 to create an urban park, closed to car traffic for 2 Sundays per year (June and September) to support sustainable transportation and healthy communities.	Planning for June 6 and Sept. 26, 2010 events on James Street North from Cannon (or York) to Burlington St.
TDM Communications Plan	Work with the Communications for the Built Environment Working Group to communicate TDM principles to various groups, wards and communities in Hamilton.	Ongoing
Smart Commute Events	Events include Carpool Week (February 2009), Bike-to-Work Day (May 30, 2009), Commuter Challenge Week (see section 5.2.3) and Car-Free Day (Sept. 22, 2009)	On-going event planning and outreach.
Transportation Management Association (TMA)	Monthly meeting to engage community groups, city departments and engaged employers & institutions	Horizon Utilities became a full member in 2009 and Dofasco, a provisionary member in 2009. The Hamilton Chamber and School Boards were also engaged.
City Employee Orientation Package	TDM Material to be provide to all new staff was developed as an addition to the training manual.	On-going education through Human Resources
Active and Safe Routes to School	Undertaking inventories/audits/ walkabouts and assisting in trip/route planning	First 5 Pilot School Site Analysis complete
Bike Share Feasibility Study	Working with McMaster students on Feasibility of implementing a Public Bike Share in Hamilton	McMaster student's feasibility study completed in 2009 and will be presented in 2010
Emergency Ride Home program (See TDM)	Program to provide employees with the security that they can get home for an emergency and their taxi fee can be recovered.	Advertising the program internally and evaluating its success
Rural Roots	Transportation and Food Linkages – using public transit to access farms for food education and purchasing	Once per month bus service to local area farms
Bike Parking for Schools	Process applications for school bike rack grant money requests	5 schools signed up to program

CAN Bike Instruction to Hamilton	Work with Public Health and Recreation to establish CAN Bike Courses at various Recreation Centres	Conducted Stakeholder meetings and fact finding in 2009.
Metrolinx Partnership	Work with Metrolinx to deliver Smart Commute Programs including: Carpoolzone.ca Transitzone.ca Active Transportation Promotion GTHA-based Events	Ongoing work to plan events, work with employers, recruit employers, and report successes through surveys and statistical analysis.

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

5.2.2 Commuter Challenge

The Commuter Challenge is a national program that promotes walking, cycling, in-line skating, carpooling, telecommuting, and taking transit as sustainable options for travel. During the week of June 1 to June 5, Hamilton was one of 138 communities who participated in the 2009 Commuter Challenge. Workplaces and commuters were encouraged to travel to work by means of sustainable transportation and to record their trips on the national Commuter Challenge website (**www.commuterchallenge.ca**).

It is the 10th year of the Commuter Challenge in Hamilton. The program raises awareness for active and sustainable transportation, highlighting the associated health, economic and environmental benefits for the community.

Celebratory events were held each day of the Commuter Challenge week. All the events raised the profile of the Commuter Challenge and increased awareness of sustainable transportation modes. The events included: the Breakfast Launch, Transportation Fair, Walk to Work / School Wednesday, Totally Transit Thursday and two Bike to Work days.

An effective and comprehensive Communications Strategy to inform the public of the Commuter Challenge program and events was launched. Communications involved traditional forms of promotion through a website, radio ads and posters. It also included new approaches such as a new initiative to engage youth and the use of social media networks including Facebook.

At the conclusion of the Commuter Challenge week, Hamilton placed third provincially and eighth out of 138 cities in Canada with 1,636 participants, 75,500 avoided car kilometres and 15,900 kg of saved greenhouse gases. Thirty-eight companies participated with the Hamilton Commuter Challenge. Notable workplaces include McMaster University, the City of Hamilton and Hamilton Health Sciences for their outstanding commitment and participation in this year's challenge.

The success of the 2009 Commuter Challenge Week of events and competition translates into an increase in awareness of sustainable transportation and environmental stewardship. This program is an integral part of the outreach strategy for Transportation Demand Management of Hamilton's Transportation Master Plan. For these reasons, the Commuter Challenge or a similar recognizable program should continue.

5.2.3 Totally Transit

For the third year running, Green Venture partnered with the Hamilton Street Railway (HSR) to deliver "Totally Transit" to elementary aged students. Totally Transit is bus education that teaches Hamilton elementary-aged students how to properly utilize the HSR while making the connection between air quality, climate change and transportation. Through hands-on experience this one-of-a-kind program empowers students to feel confident about choosing transit and other forms of alternative and active transportation.

Totally Transit was delivered in combination with an EcoHouse Sustainability Tour as a half day program (Option 1); as a full day partnership program with Hamilton's Museum of Steam and Technology (Option 2); and as a standalone lesson held at participant schools or the Royal Botanical Gardens (RBG) education centre (Option 3).

From January to December 2009, Green Venture delivered 56 Totally Transit presentations for 29 Hamilton schools representing 1,409 students. For 70% of these offerings a chartered HSR bus was utilized to transport students and as a classroom for lesson delivery. The remaining 30% of students received Totally Transit during Earth Day Hamilton's four day EcoFest at the RBG where co-incidentally a further 141 Hamilton area students received this unique program.

Totally Transit continued to receive very positive reviews from participant teachers and students alike. Teachers remain supportive of linking real life skills to health and environmental awareness.

For more information on Totally Transit, visit: air.greenventure.ca/totally-transit

5.2.4 CarShare

Members of formal car sharing programs have access to a fleet of shared-use autos on an as-needed basis without the burden of owning a personal vehicle individually. Overall, car-sharing participants make less unnecessary car trips and use other modes of travel, thereby reducing their personal emissions.

Beginning in March 2009, Green Venture facilitated a series of public meetings to gauge and spur interest in a car-sharing program for Hamilton. From there, a core group of car-sharing proponents engaged the Grand River CarShare and together created the Hamilton CarShare.

On September 19, following a promotion and membership drive, the Hamilton CarShare, a non-profit car-sharing co-operative, launched its first three vehicles in downtown Hamilton.

As of March 2010, Hamilton CarShare had a total of 71 members, including 48 driving members and 23 associate members. Usage rates for the 3 fleet cars had an average of 31.5%, which exceeds the desired 30% usage rate.

Hamilton CarShare members access the vehicles on a self-serve, pay-per-use basis. Members can currently reserve their choice of 3 vehicles, which are located in Downtown/West Hamilton, often near home or work, and on transit routes. The City of Hamilton is providing 3 parking spaces to Hamilton CarShare, and the First Unitarian Church also provides a parking location.

Reservations for Hamilton CarShare vehicles can be for as little as 30 minutes or as long as needed. Gas and maintenance costs are included in the co-op's rates and insurance is $19/month.

By filling transportation network gaps with occasional car use, Hamilton CarShare helps support the use of greener transportation modes such as transit and cycling. Overall, driving is reduced. In the end, Hamilton CarShare helps members improve their personal and financial health, while mitigating climate change and increasing neighbourhood vibrancy.

To join Hamilton CarShare, visit www.hamiltoncarshare.ca, or for more information contact the co-op at 905-543-4411 or info@hamiltoncarshare.ca

5.3 Smart Driver

5.3.1 EcoDriver

In 2008, Green Venture began a program focused on drivers of light duty vehicles. The EcoDriver program was initially funded by Ontario's Ministry of the Environment Go Green Fund. In 2009, Natural Resources Canada committed additional funding to the successful EcoDriver program.

Driving produces tailpipe emissions that reduce air quality and contribute to climate change. EcoDriver encourages drivers to choose alternative transportation modes as often as possible. EcoDriver also recognizes that since people will continue to drive it is imperative that drivers learn and practice behaviour that will reduce their fuel usage and thereby reduce their vehicles' emissions and impacts on local air quality and global climate change. Through presentations, workshops, tire pressure clinics, media and effective materials the program aims to educate and encourage drivers to achieve fuel savings by promoting the following three core messages: Drive Fuel-Efficiently, Buy Fuel-Efficiently and Drive Less. The program also has a strong anti-idling component which is consistent with Hamilton's Idling Stinks Campaign (2006-2008) message that idling for more than 10 seconds requires more fuel than turning off and restarting the engine.

In 2009, a total of 19 group presentations reached 373 Hamiltonians where 234 participants made specific EcoDriving commitments. Clean Air Hamilton support enabled Green Venture to exceed the Ministry of the Environment and Natural Resources Canada target of 250 presentation participants.

EcoDriver tips:

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

5.3.2 Smog Patrol

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

In 2009, the MOE had a vehicle emission inspection blitz in the industrial core of Hamilton to address the role heavy-duty diesel trucks and other vehicles play in particulate emissions in Hamilton. Between July 28-29, 2009, 78 vehicles (light duty vehicles, heavy-duty vehicles and waste carriers) were inspected. Approximately 35% (27 vehicles) failed, 17 were issued tickets, 5 violation notices, 4 warnings, 1 order, and seized 2 vehicle plates.

6.0 Upwind Downwind Conference 2010: Air Knows No Boundaries

Every 2 years *Clean Air Hamilton* hosts the Upwind Downwind Conference, a 2-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 2010 Upwind Downwind Conference: Air Knows No Boundaries (Conference) was held on Monday, February 22nd 2010 at the Hamilton Convention Centre. The one-day conference aimed to provide a forum to enable an improved understanding of air quality and climate change issues and the impacts on communities, human health and the economy. To achieve these goals, the themes of the conference were “Transboundary (Cross border) Air Issues” and “Innovative and Practical Solutions” with adjoining themes of “Innovative Energy Future” and “The Carbon Neutral Future.”

The Conference invited 19 speakers from the fields of human health, science, public policy, federal and provincial government and community initiatives. Featured speakers included the Environmental Commissioner of Ontario, the Northeast States for Coordinated Air Use Management (NESCAUM), the National Aeronautics and Space Administration (NASA), the Canadian Urban Institute, and the Town of Eden Mills.

The 2010 Conference provided an opportunity to discuss the types of actions governments, industries and citizens will need to take in order to make significant progress to address air quality improvements and climate change impacts in the areas of cross border air policy, energy and carbon neutral living. The Conference attracted 243 attendees including staff at the federal, provincial and municipal levels, health practitioners, planners, academics, university, college and high school students, community groups and non-governmental agencies.

A 2-day Hamilton Green Solutions Marketplace (Marketplace) on Sunday, February 21, 2010 and Monday, February 22, 2010 was also a feature of the 2010 Conference. The Marketplace was free for the public to attend and featured 53 exhibitors who offered information, products and solutions to issues of air quality and climate change.

A prominent feature of the Marketplace was the Green Solutions Stage on Sunday, February 21, 2010. The Stage was a free venue for the public that featured topics on eco buildings and energy savings, local food cooking demonstrations, Cool Climate Science with Jay Ingram of the Discovery Channel’s “Daily Planet”, and a RevWear Fashion Show finale. Approximately 745 individuals from the public attended the Marketplace.

The Conference was covered by local radio stations (Talk820 and CHML), print media (Hamilton Spectator, Stoney Creek News, Ancaster News, Dundas Star News, Flamborough Review, Hamilton Mountain News, and Glanbrook Gazette, H Magazine, and View Magazine), local television (Cable 14, CHCHC), and Internet media.

Appendix D provides details on the 2010 Conference and Hamilton Green Solutions Marketplace.

Conference presentations are available at: www.cleanair.hamilton.ca/default.asp?id=47

7.0 *Clean Air Hamilton* Programs and Strategic Activities

7.1 Energy Conservation

7.1.1 Horizon Utilities

Horizon Utilities Corporation was honoured in 2009 with the prestigious Company of the Year Award by the Ontario Energy Association (OEA) for taking the groundbreaking step of being the first electricity distribution company in Ontario to publish a Sustainability-Based Annual Report. This report focuses on the social, environmental and economic dimensions of the company's business, and benchmarks its performance against the rigorous Global Reporting Initiative™ (GRI), an international standard for sustainability. Horizon Utilities is the first Ontario utility to report to the GRI standard and one of only 36 companies in Canada to do so for the 2008 reporting year.

Horizon Utilities' Sustainability Annual Report can be accessed here:
www.horizonutilities.com/HHSC/html/leadership/sustainableDevelopmentReports.jsp

7.1.2 *peaksaver*®[1] Program

Horizon Utilities, with support from the Ontario Power Authority (OPA), makes it simple for residents to conserve energy and ease the strain on the electricity system during summer peak demand times. The *peaksaver*® program allows residential and small commercial customers of Horizon Utilities with central air conditioning to help reduce the demands on Ontario's electricity system, through the installation of a free *peaksaver*® programmable thermostat to replace existing thermostats. During critical times of peak electricity demand (typically on hot summer days), a signal can be remotely sent by the OPA to cycle the central air conditioner's compressor (15 minutes on, then 15 minutes off) over a 4-hour period, to reduce the amount of electricity it uses. In 2009, 3485 *peaksaver*® programmable thermostats were installed.

To book an appointment call peaksaver® at 1-866-323-0206
For information on the *peaksaver*® Program or to sign up, visit:
www.horizonutilities.com/HHSC/html/conservation/con_OPApeaksaver.jsp

7.1.3 Power Savings Blitz

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

The Power Savings Blitz, a door-to-door, 2-year program provides up to $1,000 worth of installed electricity-saving products (primarily lighting), offered free of charge, to small business customers with loads under 50 kW. Customers are not obliged to purchase any equipment or pay any assessment fees in order to receive program-specific energy upgrades.

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

In 2009, a total of 3205 small businesses had received retrofit upgrades for improved indoor lighting with some customers reducing lighting expenditures by up to 50 per cent.

7.1.4 Electricity Retrofit Incentive Program (ERIP)

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

The Electricity Retrofit Incentive Program (ERIP) focuses on the areas of lighting, motors, heating, ventilation and air conditioning, and overall electricity systems. These areas cover the majority of and most important electricity upgrades businesses undertake. By taking advantage of this program, businesses can contribute to a cleaner environment and benefit from incentives and lowered operating costs. In 2009, Horizon Utilities' customers contributed 5635 kW in peak demand reduction through the ERIP program.

For more information, visit: horizon.erip.ca/retrofit/

7.1.5 Green Zone Business

Small business is plentiful and important to Hamilton's economic success. Within the greater business community, there is interest in creating sustainable businesses in a green economy. However, small businesses often have limited resources and expertise to research and develop their own environmentally sustainable business practices.

Working with small businesses, Green Venture began developing a program to help organizations with this task. At the program's core is a framework of actions, which, once implemented will make an organization eligible for certification as a Green Zone Business. The framework specifies mandatory and optional activities that enable a business to strive towards, and be increasingly recognized for continued improvement. A specified number of activities need to be completed in each of the following framework categories: community and staff engagement, air emissions reductions, pollution prevention, resource conservation, waste reduction and sustainable purchasing. Participant businesses benefit from energy efficiency cost savings, value added services for clients and promotional opportunities.

In the summer of 2009, the Stoney Creek Business Improvement Area (BIA) and the Ottawa Street BIA successfully implemented their Idle Free Zones as a proactive first step in accessing Green Zone certification for their individual member businesses. More than one hundred anti-idling awareness signs and even more flyers that are informational were posted by businesses in the BIAs. Both of these BIAs are to be commended for taking a leadership role in their communities to reduce unnecessary vehicle idling and in demonstrating positive corporate responsibility.

7.2 Tree Programs

7.2.1 Hamilton ReLeaf Network

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

The vision of the Hamilton ReLeaf Network is "Growing Communities One Tree at a Time…Greening Hamilton's Future". The Hamilton ReLeaf Network aims to facilitate the maintenance, restoration and enhancement of a healthy and sustainable green landscape in the Hamilton area by:

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

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

8.0 Conclusions and Recommendations

Over the past ten years, there have been dramatic improvements in air quality in Hamilton. These changes will have contributed to better health for citizens as well as improved perceptions of the City. Weather patterns and reduced levels of economic activity may have contributed to the overall downward trend in 2009 but the long-term downward trend in air emissions continues due to the concerted actions of individuals, organizations, industries, the City of Hamilton and other levels of government.

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

- Recent health research continues to identify new impacts of exposures to air pollutants ($PM_{2.5}$, PM_{10}, NO_x, and SO_2) on the health of citizens. The Clean Air Hamilton 2003 Health Study should be updated to reflect the current level of knowledge in air quality health research and to identify the monetary costs resulting from exposures to local air pollutants (both health care costs and costs due to lost productivity).

- Air monitoring allows for the collection of outdoor air quality data; these data can then be used to identify local sources of air emissions and to evaluate the potential health impacts on humans due to these exposures. Hamilton has a limited network of fixed air monitors at present; many areas of the city and a number of emissions sources are not adequately monitored, creating gaps in local knowledge of air quality and air emissions. Clean Air Hamilton has had as a long-term goal the expansion of the fixed air monitoring network in the city. When combined with data from mobile monitoring, the monitoring of new areas of the city and the identification of any community "hot spots" will be the result. This monitoring will also enhance the knowledge of local air emission sources and their impacts. This information will assist decision-makers in the development of policies and initiatives to reduce local emissions within the community and thereby the exposures of citizens.

- The Government of Canada has developed an Air Quality Health Index (AQHI). The AQHI has been introduced in the City of Toronto and the Halton, Peel, York and Durham Regions. *Clean Air Hamilton* has encouraged government agencies to bring the AQHI reporting system to Hamilton. This introduction appears to be poised for a launch in the spring of 2011.

- 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 their transportation planning and urban design practices.

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

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

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

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

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

In 2010, *Clean Air Hamilton* will continue to address air quality issues and their relationships to public health outcomes. *Clean Air Hamilton* will continue to develop relationships with City staff to ensure that air quality goals are integrated into the decision-making processes across divisions within the City. *Clean Air Hamilton* will continue to cultivate partnerships with organizations that have goals that are consistent with those of *Clean Air Hamilton* and the City.

Appendix A: 2009 *Clean Air Hamilton* Strategic Plan

CAH = *Clean Air Hamilton*; City = City of Hamilton; EC = Environment Canada; EH = Environment Hamilton; GV = Green Venture; HAMN = Hamilton Air Monitoring Network; HC = Health Canada; Horizon = Horizon Utilities; HSR = Hamilton Street Railway; McMaster = McMaster University; Rotek = Rotek Environmental; MOE = Ministry of the Environment; NRCan = Natural Resources Canada; PH = Public Health; TDM = Transportation Demand Management; UHI = Urban Heat island

Strategic Issue	Activity in the Community	Purpose, Opportunities, Pressures	Partners	Research	Communication	Actions	2009 Update
Public Health Protection	Heat Alert, Corporate Smog Plan	Concern for the public health in regards to air quality; expand health base for Air Quality Index (AQI)	HC, PH	Air Quality Health Index (AQHI)	How individuals can avoid health problems tie health based AQI	Introduce AQHI to Hamilton	2010- 2011 Actions
			HC, PH, school boards, Parks & Recreation; GV		Create a standard package for the community and corporate areas so they know what to do to protect health during inversion or smog days	Community Smog Plan	2010- 2011 Actions
			HC, PH, McMaster, Rotek, MOE, City	Air Quality Health Mapping		Air Quality Health Mapping on website, collaborate data with existing air monitors and mobile monitoring with health qualifiers	2010- 2011 Actions
			HC, PH, McMaster, Hospitals		Special package alerts for physicians and health care providers	Community Smog Plan	2010- 2011 Actions

	Health Impacts		PH, McMaster	Update 2003 CAH Health Study			2010- 2011 Actions
Active & Sustainable Transportation	Smart Commute; Transportation Management Association; TDM (City); Active & Safe Routes to Schools (PH); Metrolinx; Events: Car Free Day, Commuter Challenge, etc.	Encourage use of active and alternative means of healthy transportation, reduce emissions from personal transportation	Planning & Economic Development, Public Works (TDM), Cycling Committee, PH, Metrolinx, Smart Commute, local industry and businesses, local schools, institutional partners: McMaster, Mohawk College, Hamilton Health Sciences, St. Joe's Hospital	Feasibility to provide corporate telework; compressed work week/months; bicycle financing; secure bike parking, cycling amenities; preferential carpool parking; insurance rate reductions; transit pass programs; emergency ride home programs and bike share co-ops	Event Promotions, Transportation Fair, Attendance at Fairs and Community Events, Transportation Summit, Cycling workshops/event; overall promotion of alternatives; education and awareness of single occupancy vehicles, negative environmental impacts; use of the web including the promotion of carpoolzone.ca, employee emergency ride home program and EC transit pass promotions	Establish a Local TDM Association - Best practices for Hamilton businesses on promoting active and sustainable transportation; Travel Demand Analysis for workplaces using an employee survey and customized demand management plans; Policy Analysis and Advocacy; Events and Programs to reduce SOV use; education programs including Transportation 101	On-going 2008 +

		Reduced emissions from driving year round. Prioritize building on success and momentum.	GV, Commuter Challenge participants, Chamber of Commerce, HSR, School boards, GV, EH		Smart driving communication program	Promote behavioural shift	On-going 2008 +
	Totally Transit	Transit -change drivers into riders, get young people before they become drivers, make sure riders stay as riders	HSR, School boards, GV, EH			School bus education program at schools; promote behavioural shift	2008 - 2010
Smart Driver	Idling Stinks campaign, NRCan Idle free program, Idle by-law	Reduce unnecessary vehicle idling in Hamilton	GV, City		Information on idling and by-law	Promote behavioural shift	On-going 2007 +
	Drive Clean; Smog Patrol; Mobile Monitoring	Local impacts of diesel truck traffic	MOE, MTO, Public Works	Get data on diesel emissions from vehicles (mobile monitoring)	Outreach with truck industries; Smog Patrol	Smog Patrol Enforcement Blitz, remove diesel engines, have a form of regulation that would not allow dirty diesel engines within city boundaries	2010
	Hamilton CarShare	Reduce demand for vehicle ownership and therefore unnecessary trips	Guelph CarShare Co-op, People's Car, GV, EH		Engage interested Hamiltonians	Hamilton CarShare Co-op	On-going 2009 +

	Fleet Smart, Fuel Management 101 workshop	Reduced emissions focused on fleets	NRCan, GV			Organizing fleet workshops	Completed 2008
	Eco-driver	Promote green driving habits to drivers	GV, City, Green Communities		Green driving tips	Eco-driver program	Began 2009
	Idling in drive thrus	Reduce emissions	GV, EH, City, restaurants		Encourage idling signs at drive thrus	Encourage idling signs at drive thrus	2010 - 2011
Air Monitoring	HAMN required for industries to monitor airshed	All emitting industries should participate in HAMN	HAMN, MOE		Provide HAMN data online	Encourage MOE to undertake monitoring requirement in CofA	Began 2008
		Real time monitoring available to public	HAMN, MOE		Website	HAMN data available on CAH website	Completed 2009
		New and emerging monitoring technology, Light Detection And Ranging (LIDAR), Differential Absorption LIDAR (DIAL)	MOE	Examine technology and usage	Presentations, workshops		Completed 2008
		Mobile Monitoring	MOE, EC, City	Inversion days, health impacts data, health mapping, construction and fugitive dust		Continue mobile monitoring-health mapping, Red Hill Valley and Centennial Parkway	2004-2008, 2009-2011

Air Quality Communication	CAH Annual Report; CAH website; Upwind Downwind Conference; Displays; brochures	School boards involved; potentially get a representative on CAH committee	School boards	Indicators of local action on air quality that could be reported in addition to air quality parameters		School board rep on committee	2008
		Educate the public: what are the problems? How do they affect you? What can you do?	GV				2008 + On-going
		CAH is effective and efficient -must maintain support	City, MOE, EC, HC				On-going
	CAH website	Update and current, user-friendly and informative	Planning & Economic Development		Update material	Look at design, content, explore new server or hosting	Completed 2009
Climate Change	Corporate Air Quality (AQ) & Climate Change (CC) Plan; Climate Challenge (EH)	The linkages to AQ	Environment Canada, MOE, McMaster	Research linkages to AQ (CO, NO_x) and actions	Outreach on AQ & CC linkages	Air Pollutant and GHG Inventory	Completed 2009
		Subcommittee to look at city-wide CC issues	City, McMaster, GV, EH, Conservation Authority			Create a Community CC Action Plan	2010-2011

Emissions Reductions		Get an Air Pollution Index with abatement and enforcement	MOE, City	Research best practices	Create a standard package for the community and corporate areas so they know what to do to reduce emissions during inversion or smog days	Community Smog Plan	2010
		Develop Local Poor Air Quality Notification system that can trigger immediate action by industry in poor air quality situations; Drive action when needed; Protect health			Local Poor Air Quality Notification System (MOE)	Local Poor Air Quality Notification System (MOE)	2010
	Fugitive dust - construction areas	Addressing construction sources and industrial sources of fugitive dust	City, MOE, Rotek, Hamilton Construction and Development Associations	Mobile monitoring		Dust Abatement Workshop II	2010-2011
	Mow down pollution programs, Leaf blower education	Reduce usage of two-stroke engines, tie in with pesticide education	GV, Home Depot, Lowes, Home Hardware			Mow Down Pollution event	2010- 2011
	Burn It Smart, City Burning By-law	Educate the public on wood burning stoves, emissions and health	NRCan, EC, GV, City		Website - Wood Burning Stoves and applications in Hamilton	Website - Wood Burning Stoves and applications in Hamilton	2009
Energy Conservation	Horizon programs; Energy roundtable	Promotion / energy conservation & alternatives	Public Works, NRCan, Horizon, GV			Promotion / energy conservation & alternatives	On-going, 2009 +

	Generation Conservation curriculum-based program for Grade 5 students	Create a generation of energy conservers who understand the consequences of the wasteful use of electricity and the connection to climate change	School boards in area (e.g. Niagara), Hamilton libraries		Teacher workshops, teacher guides, student workbooks, classroom materials, posters, flyers		On-going, 2009 +
	Light exchange/bulb	Promotion / energy conservation & alternatives	Horizon, Public Works, GV, EH		Switch to CFL bulbs		On-going, 2009 +
	Appliance exchange		Horizon, Public Works				On-going, 2009 +
	Energy Audits	Energy conservation and savings (low income neighbourhood)	GV				On-going, 2009 +
Land Use Planning	Official Plan review; Provincial Policy Statement	Street design cycling lanes / parallel, pedestrian oriented streets, stop signs vs. roundabouts, driving patterns	Planning & Economic Development, Public Works, GV			Liveable Cities program	On-going, 2009 +

	UHI	Reduction of UHI in urban environments	Planning & Econ. Dev, PH, Public Works, GTA Clean Air Council, NRCan, MAH, HC	UHI strategies, green roofs, white roofs, mapping hot spots in Hamilton			2010
	Hamilton Community Energy Collaborative	Energy mapping in the community					2010- 2011
Tree Programs	Numerous tree planting programs in City (Red Hill Valley, Councillors, Street Planting, Earth Day, Ikea), Hamilton ReLeaf Committee	Trees improve air quality, fight climate change, lower heating and cooling costs, reduce water demand and store rainwater, increase happiness, slow traffic	GV, Conservation Authority, Public Works, Earth Day Hamilton, businesses	Develop a tree planting inventory for Hamilton; fill in gaps (i.e. low income neighbourhood)		Develop a tree networking body --Tree Roundtable to consolidate efforts = Hamilton ReLeaf Committee	2008

Appendix B: 2009 *Clean Air Hamilton* Financials

In 2009, the Air Quality Budget for the City of Hamilton and *Clean Air Hamilton* was $80,000. Financial contributions for other sources was $61,150. In-kind contributions including volunteer time and advisory role of *Clean Air Hamilton* members on programs was $108,375.

2009 *Clean Air Hamilton* Financial Report				
Project/Program	**Clean Air Hamilton Contribution ($)**	**Other Contribution ($)**		**Total ($)**
		Financial	**In-Kind**	
Eco Driver	$2,500	$17,000 – Ministry of the Environment (Go Green Fund) $5,000 – Natural Resources Canada $450 – Public Works (Central Fleet)	$475 – volunteer time	$25,425
Totally Transit	$5,000		$2,250 Hamilton Street Rail	$7,250
Car Share	$5,000			$5,000
Green Zone BIAs	$7,500		$350 – volunteer time	$7,850
Indoor Wood Burning	$1,000		$300 – volunteer time	$1,300
Mobile Monitoring		$22,000 – GeoConnections Grant $16,700 – Ministry of the Environment Grant	$36,000 – Rotek Env Inc.	$74,700
Advisory			$69,000 – Members	$69,000
TOTALS	**$21,000**	**$61,150**	**$108,375**	**$190,525**

On February 21 and 22, 2010, *Clean Air Hamilton* and the City hosted the 2010 Upwind Downwind Conference: Air Knows No Boundaries, and the Hamilton Green Solutions Marketplace at the Hamilton Convention Centre. The total cost of the 2010 Upwind Downwind Conference and Green Solutions Marketplace was $57,950. The total revenue was $45,075, which included $10,840 from registration fees, $3,735 from exhibitors and $30,500 from funding. City of Hamilton provided staff resources to procure sponsorship, coordinate logistics, facilitate meetings, process registrations and promote the Conference agenda ($50,000). In addition, the Ontario Professional Planners Institute assisted in distributing notices about the Conference ($3,000). Planning Committee members helped confirm speakers and facilitate Conference sessions. Volunteers helped on the registration desk during the Conference.

2010 Upwind Downwind Conference Funds/Grants

Organizations	Donation
Hamilton Planning Department	$50,000 **in-kind**
Hamilton Public Health Services	$10,000
Environment Canada	$8,000
Ontario Ministry of the Environment	$5,000
Ontario Professional Planners Institute	$3,000 **in-kind**
Health Canada	$2,500
Hamilton Industrial Environmental Association (HIEA)	$1,000
Rotek Environmental Inc.	$1,000
Horizon Utilities	$1,000
ArcelorMittal Dofasco	$1,000
McKibbon Wakefield Inc.	$500
McMaster Institute of Environment and Health	$500
TOTAL – CASH	$30,500
TOTAL – IN-KIND*	$53,000*
Total	**$83,500**

The revenues generated at the Upwind Downwind Conference are used in the planning and administration of future Conferences by Clean Air Hamilton.

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

Air Quality Trends in Hamilton

The graphs in this Appendix illustrate trends in key air quality parameters in Hamilton over the past 10-18 years. Longer term trends from about 1970 to the mid-1990s can be found in the 1997 HAQI reports.

For the longer term perspective, visit: www.cleanair.hamilton.ca/downloads/HAQI-Environmental-Work-Group-Final-Report-Dec-97.pdf

Since the mid-1990s, decreases in the levels of all pollutants in Hamilton (except for the long-range pollutant, ozone) have been steady year over year. The percentage decreases over the last 10 years are significant in many pollutant categories as measured at the downtown air monitoring site; these include a 52% reduction in Total Suspended Particulate (TSP) levels, 38% in Inhalable Particulate Matter (PM_{10}), 37% in Respirable Particulate Matter ($PM_{2.5}$), 36% in Nitrogen Dioxide (NO_2), 50% in Sulphur Dioxide (SO_2), 99% in Total Reduced Sulphur odours, 53% in Benzene and 67% in PAH (Benzo[a]pyrene).

Pollution abatement technologies and strategies continue to be implemented by companies within the industrial sector. *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 technologies when upgrading their pollution control equipment, when constructing new facilities or when retrofitting existing facilities. The goal should be to achieve or exceed the highest international standards. *Clean Air Hamilton* recommends that all citizens critically evaluate the fuel and energy efficiencies of any energy-consuming appliances, passenger vehicles and trucks when they are making these purchases.

In most of the graphs in **Appendix C**, one line represents the average ambient air levels in residential areas of the City, based on data from two or more air monitoring stations located at City sites. 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. Also included are data which compares Hamilton to other cities in Canada and around the world.

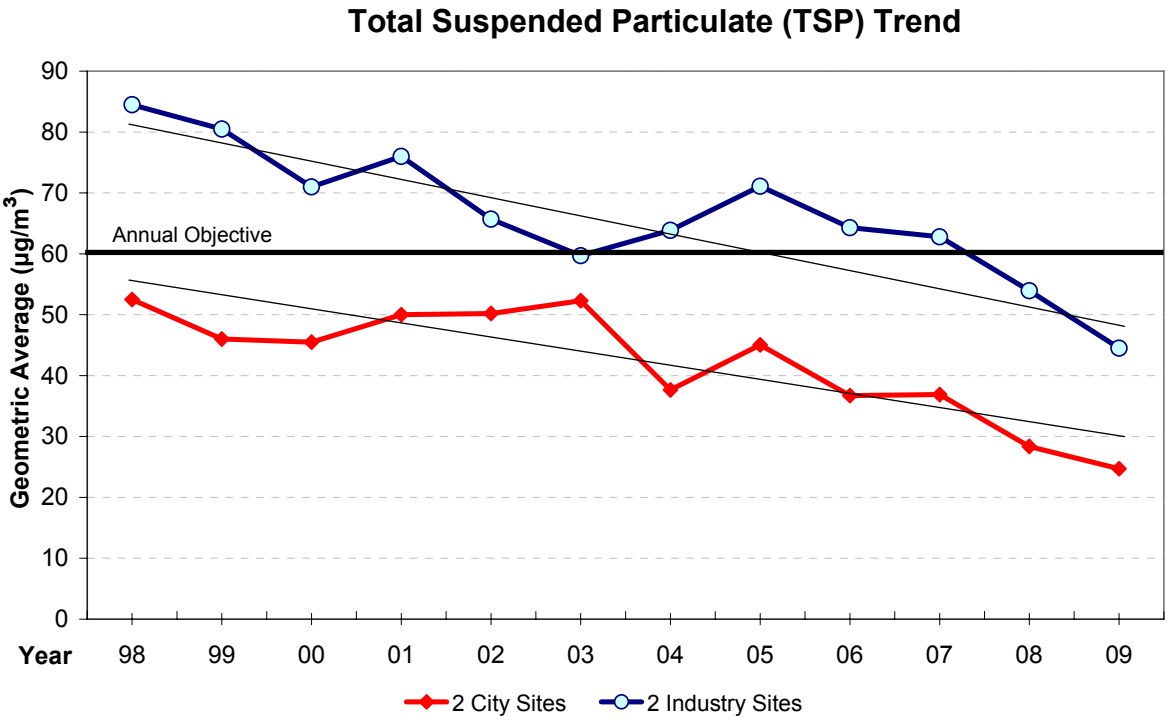
A 2005 report from the Ontario Ministry of the Environment showed the results of modeling estimates of the impacts of U.S. sources on Canada. These estimates were based on the analysis of large-scale weather patterns and detailed estimates of emissions from sources in mid-western U.S. states. These results 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 U.S. These sophisticated modeling studies were consistent with the estimates provided in the original HAQI study reports and to estimates done by Clean Air Hamilton more recently.

Particulate Material: Total Suspended Particulate (TSP)

Total suspended particulate (TSP) includes all particulate material with diameters less than about 45 micrometers (µm). A substantial portion of TSP is composed of road dust, soil particles and emissions from industrial activities and transportation sources. TSP levels have been decreasing steadily since the mid-1970s. Over the past decade, the TSP levels have decreased, on average, by about 3 µg/m^3 per year in the industrial areas and by about 2.3 µg/m^3 per year within the City. These decreases correspond to reductions between 40% and 45% over the past decade alone. These reductions have been realized due to a range of activities directed toward the reduction of industrial dusts, road dusts, track out from industries with unpaved sites, etc.

Included within the TSP category are inhalable particulates (PM_{10}) and respirable particulates ($PM_{2.5}$). 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, by subtracting the PM_{10} or the $PM_{2.5}$ value respectively, from the TSP value. 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.

The particulate levels in some cities around the world are significantly higher than Hamilton. For example, the average weekly TSP level at a site in southeastern Beijing between August 2005 and August 2007 was 370 µg/m^3! In the late autumn and winter during the dust storms, the TSP levels averaged about 500 µg/m^3 while the summer had the lowest TSP levels at about 250 µg/m^3. By contrast, Hamilton in 2006 had TSP levels of about 40 and 60 µg/m^3 at the downtown site and at an industrial site, levels that are about 6 and 9-fold lower than the Beijing annual average. The mean annual TSP value in an industrial area of Rio de Janeiro was 87 µg/m^3.

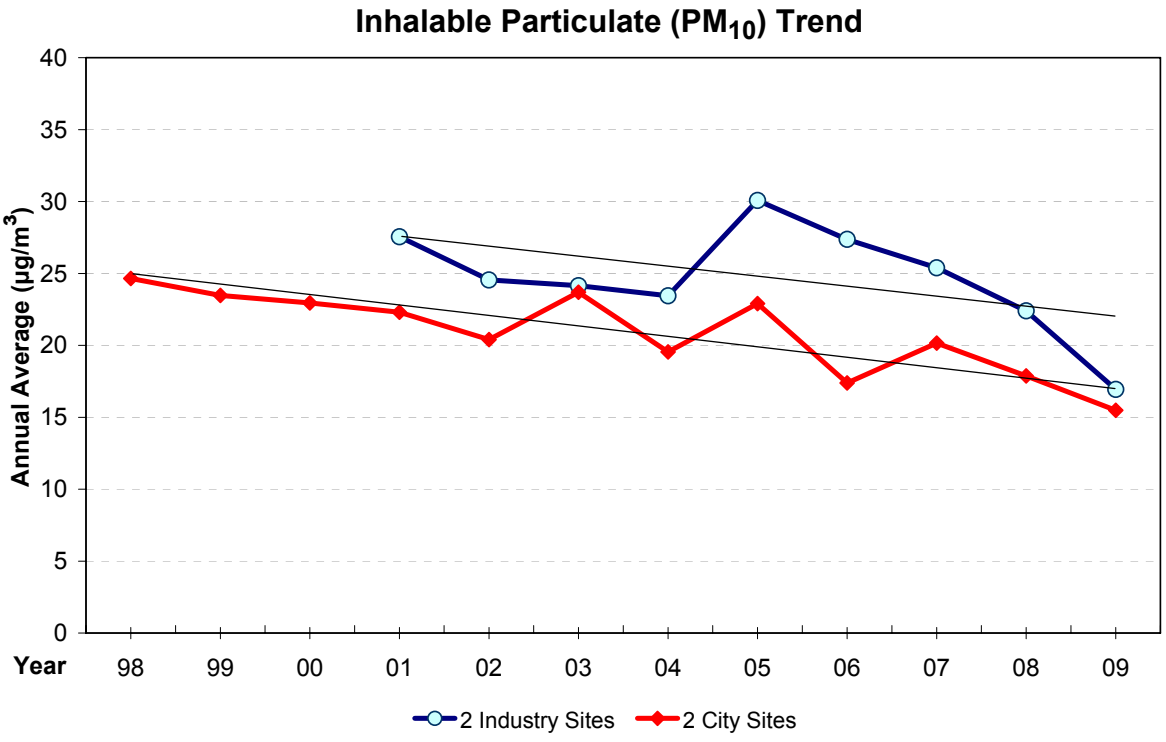


Particulate Material: Inhalable Particulate Matter (PM_{10})

Inhalable particulate matter (PM_{10}), the airborne particles that have diameters of 10 µm or less, is a portion of total suspended particulate (TSP). PM_{10}, which makes up about 40-50% of TSP in Hamilton, has been linked to respiratory, cardiovascular and other health impacts in humans. As with the TSP trend discussed above, ambient levels of PM_{10} at the City sites have decreased about 30% over the past decade, from about 25 µg/m^3 to about 15 µg/m^3. In areas near the industrial sectors, the levels of PM_{10}, while higher than in the downtown area, have shown the same steady decrease areas as in the downtown area.

PM_{10} is derived primarily from vehicle exhaust emissions, industrial fugitive dusts, and the finer fraction of re-entrained road dust. While car and truck traffic counts have remained roughly constant over the past decade the deceasing trend of PM_{10} is likely the result of a combination of better performance of the vehicle fleet, better management of dust track-out by industries, and the use of better street sweepers and street sweeping practices by the City. The vehicle fleet performance will have improved primarily due to lower particulate emissions from modern engines and the removal of some of the worst polluting vehicles under the provincial Drive Clean program. While the impact of the Drive Clean program is difficult to assess from a local emissions perspective, the removal of "smoking vehicles" from the road is one of the expressed goals of the program, in addition to ensuring that the Ontario vehicle fleet is performing efficiently.

As a point of comparison to Hamilton, the PM_{10} levels in non-industrial city of Porto, Portugal in 2004 were reported between 35 and 50 µg/m^3 at four 'urban traffic' and two 'suburban background' sites. These levels are roughly double those in Hamilton; moreover, all site experienced between 73 and 136 days a year when 24-hour PM_{10} levels exceeded 50 µg/m^3.

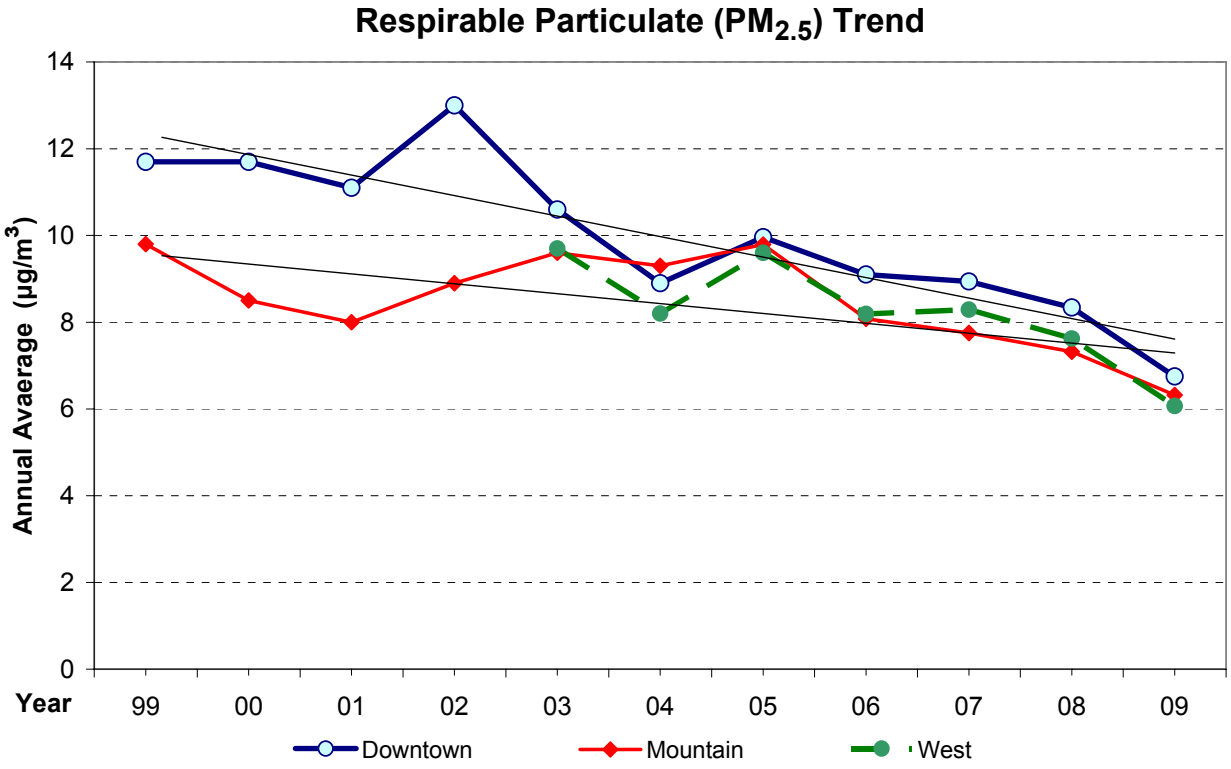


Particulate Matter: Respirable Particulate Matter ($PM_{2.5}$)

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

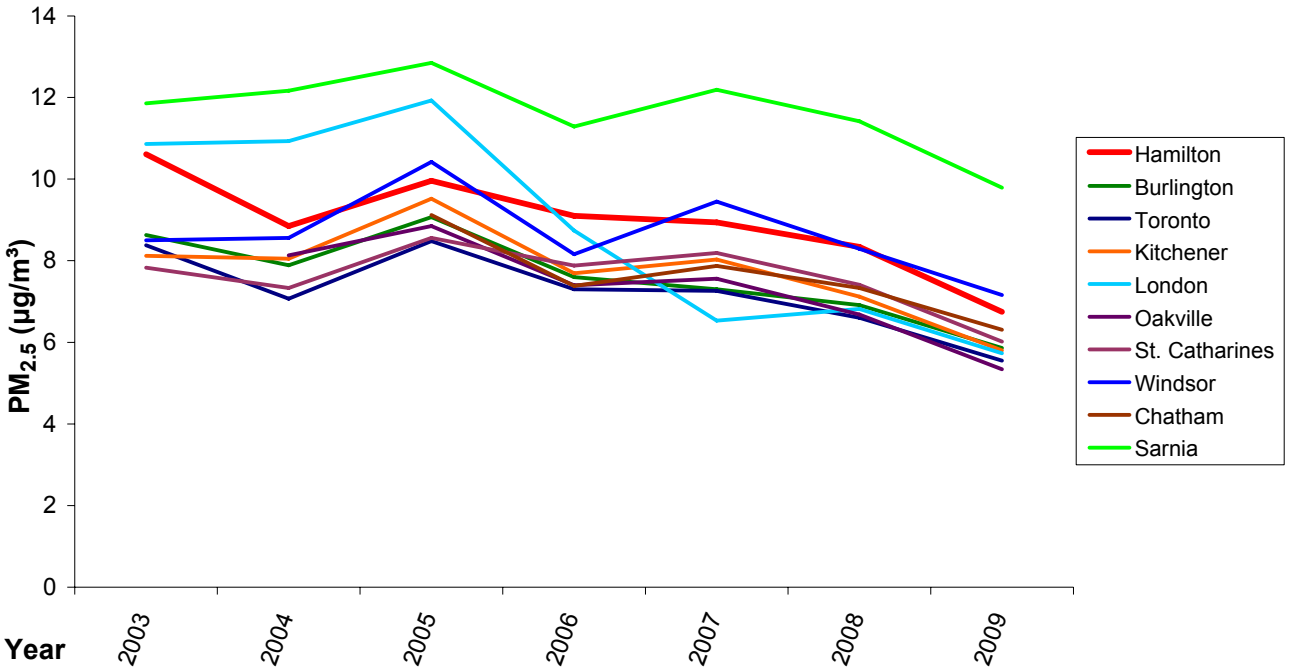
The trend in $PM_{2.5}$ has shown a decrease of about 35% since 1999 at the downtown and mountain AQI sites (consistent with the decreasing trends in TSP and PM_{10}), and corresponding to a steady decrease of about 3.5% per year. The $PM_{2.5}$ fraction of air particulate matter is recognized as being responsible for essentially all of the deleterious health effects associated with air particles. $PM_{2.5}$ has been declared a "toxic substance" under CEPA (Canadian Environmental Protection Act). Particulate matter associated with automobile exhaust, diesel exhaust and cigarette smoke have particle sizes between 0.1 and 0.3 µm; vehicle combustion sources constitute about 30-50% of the mass of $PM_{2.5}$.

There has been a scientific debate over just what causes the health impacts in humans due to exposure to the $PM_{2.5}$ fraction – the particles themselves or the chemicals on these particles. It is known that the $PM_{2.5}$ fraction contains over 95% of all particle-bound organic compounds in the air along with a substantial burden of metals. Most scientists now agree that exposure to the small particles and the organic substances is the likely cause of the observed respiratory and cardiovascular health impacts attributed to particulate material exposures.

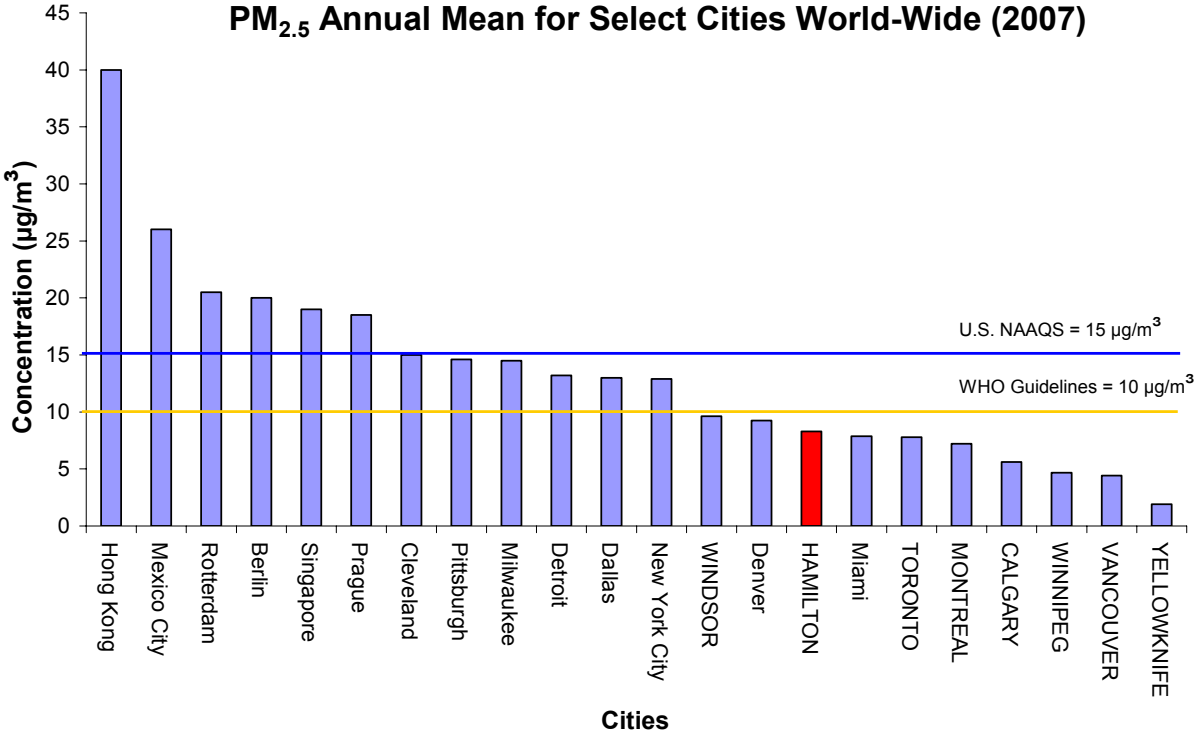


The graph below shows a comparison of ten-year trends in respirable particluate matter ($PM_{2.5}$) levels in ten Ontario cities. The decreasing trend in $PM_{2.5}$ in Hamilton is mirrored at other locations across southern Ontario.

7-Year Trends for $PM_{2.5}$ (Ten Ontario Cities)



The figure below compares the annual mean levels of $PM_{2.5}$ in Hamilton with 21 other Canadian and global cities for 2007. Of the Canadian cities compared, Hamilton registered the second highest $PM_{2.5}$ annual mean reading, with only Windsor registering a higher reading. While higher than most Canadian cities, Hamilton's annual mean levels of $PM_{2.5}$ remain below the World Heath Organization (WHO) air quality guidelines and the U.S. National Ambient Air Quality Standards (NAAQS). Out of the 22 cities compared, the five lowest annual mean levels of $PM_{2.5}$ were recorded in Canadian cities. The $PM_{2.5}$ levels in Hamilton, Toronto and Montreal are comparable, and are about one-half the levels in non-industrial European cities such as Prague and Berlin. The data used for this figure were provided by the Ontario Ministry of Environment.

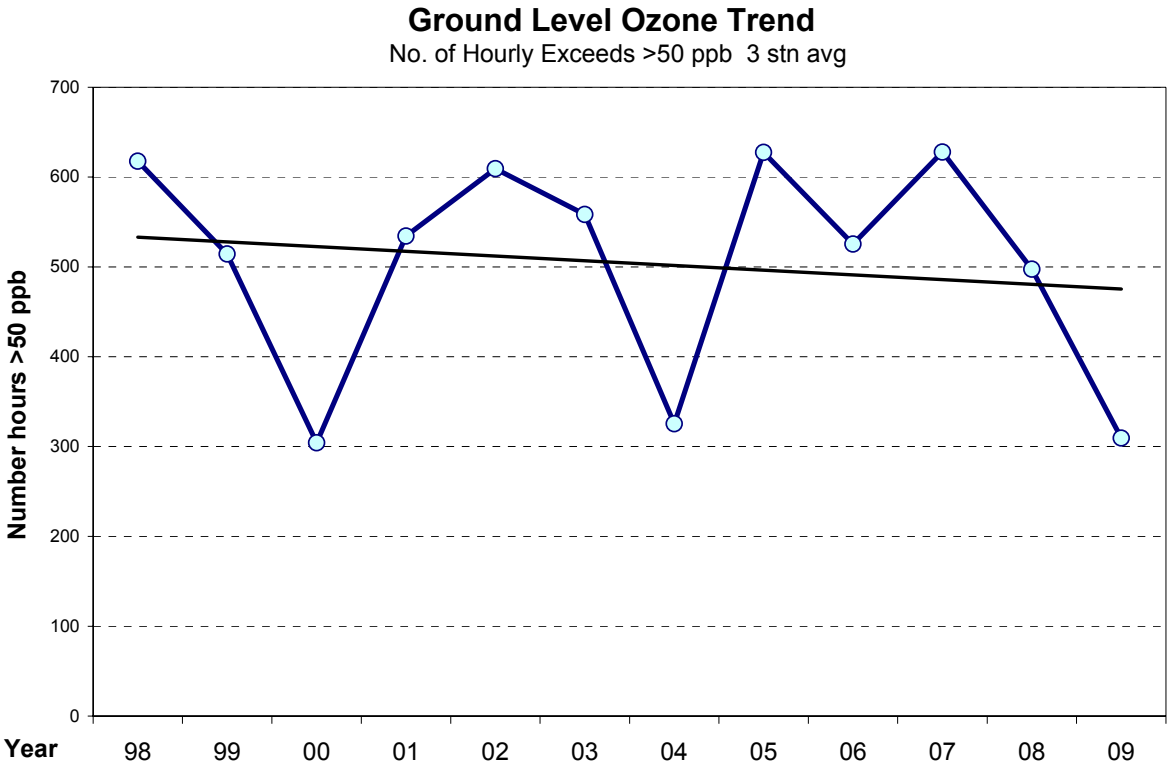

PM2.5 Annual Mean for Select Cities World-Wide (2007)
Concentration (µg/m3)
45
40
35
30
25
20
15
10
5
0
U.S. NAAQS = 15 µg/m3
WHO Guidelines = 10 µg/m3
Hong Kong
Mexico City
Rotterdam
Berlin
Singapore
Prague
Cleveland
Pittsburgh
Milwaukee
Detroit
Dallas
New York City
WINDSOR
Denver
HAMILTON
Miami
TORONTO
MONTREAL
CALGARY
WINNIPEG
VANCOUVER
YELLOWKNIFE
Cities

Ground Level Ozone (O_3)

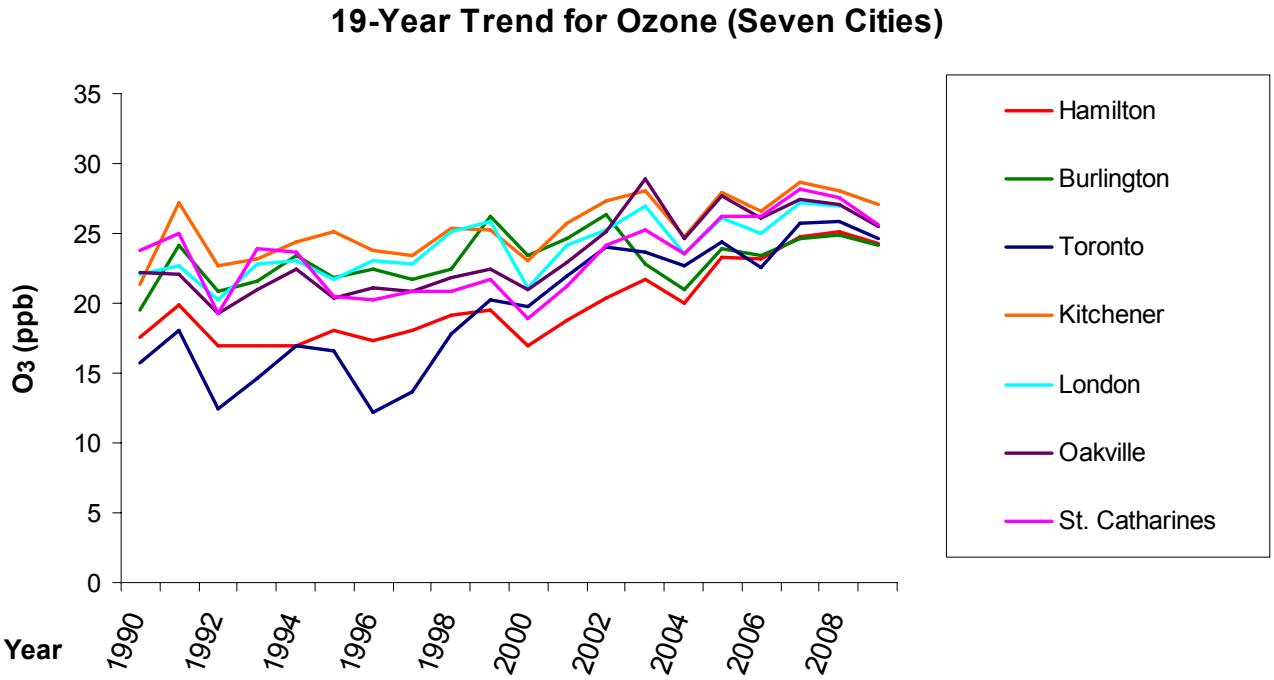
Ground level ozone (O_3 or tropospheric ozone) is formed in the atmosphere when air pollutants such as nitrogen oxides (NO_X) and volatile organic compounds (VOC) react in the presence of sunlight. Air levels of O_3 are higher in warmer seasons than in cooler seasons because the sunlight is more intense in the summer and the temperatures are higher. The trend in O_3 shows an increase has been highly variable over the past 10 years. Overall, the trend line for this period is roughly flat, in contrast to the steadily decreasing trends in the other pollutants.

Unlike all other pollutants none of the O_3 measured in Hamilton was generated from Hamilton-based sources. The formation of O_3 takes several hours once the pollutants have been released to the atmosphere. Thus, the O_3 measured in Hamilton was produced from emissions released from sources upwind of Hamilton. Conversely, emissions from sources within Hamilton will result in the formation of O_3 in areas downwind of Hamilton. A substantial portion of the O_3 that affects southern Ontario during smog episodes in the summer months originates from distant, upwind sources in the United States, including releases from coal-fired power plants, vehicles and urban activities in those regions.

Ground level ozone should not be confused with “stratospheric ozone” or “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 stratospheric ozone is commonly known as the ozone layer because over 91% of the ozone in Earth’s atmosphere is present here. The term “ozone depletion” refers to a decrease in the levels of stratospheric ozone due to man-made emissions, particularly halogenated refrigerants that have now been banned. Stratospheric ozone and changes in the ozone layer have not yet been linked to impacts of combustion emissions.



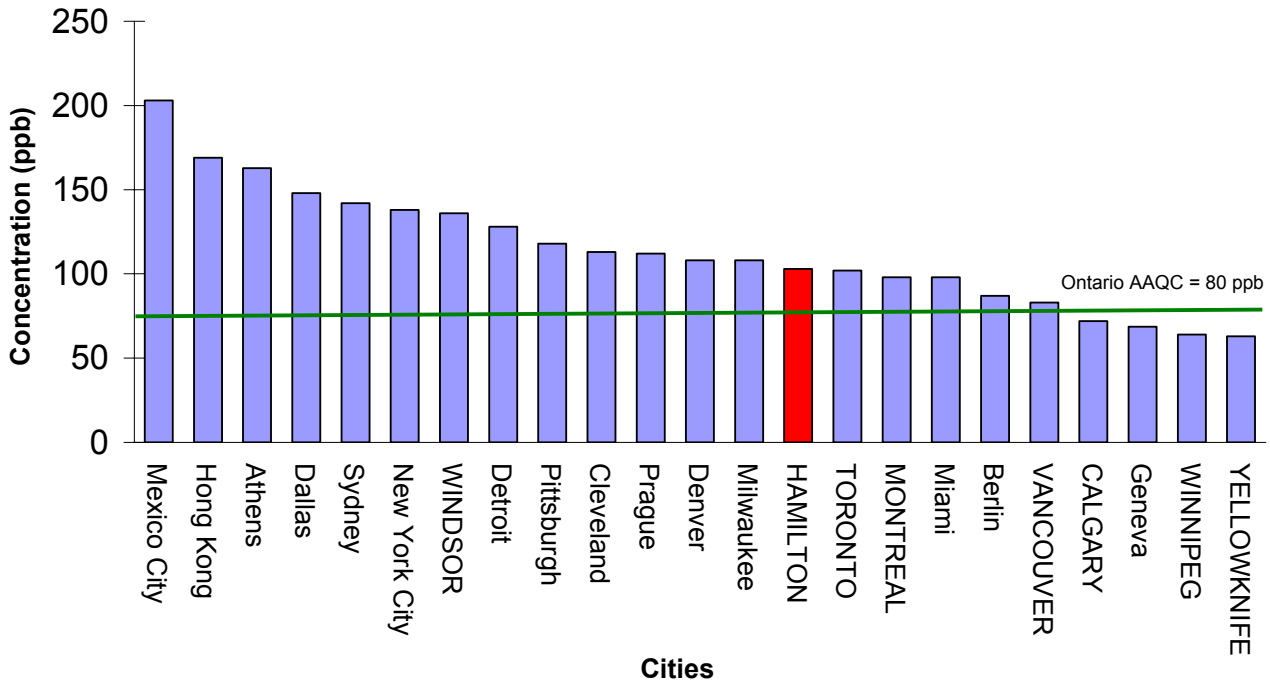
The trend in O_3 in Hamilton is mirrored at other locations across southern Ontario. Over the past 19 years the concentrations of O_3 across southern Ontario have increased between 10 and 30%, depending on the city. The levels of O_3 observed across southern Ontario in recent years are consistently higher and more similar than what was observed one and two decades ago. This trend is somewhat worrisome given the increase in health effects impacts associated with increased O_3 exposures.



As discussed previously, the formation of O_3 results from pollutants generated outside Hamilton and southern Ontario. In the figure below, the cities with higher ozone one-hour maximum concentrations (e.g., Windsor, Detroit, and Cleveland) are located near the Ontario/US border. These higher levels are indicative that transboundary pollution has a significant role in O_3 formation. The Ontario Ambient Air Quality Criteria (AAQC) of 80 ppb for O_3 has been unmet by the three Ontario cities compared below. Only four of the 23 cities compared were able to meet these criteria. Addressing O_3 pollution in cities will be a challenge and will require collaborations between countries.

Interestingly, Vancouver just exceeds the Ontario AAQC guideline; however, all of the O_3 measured in Vancouver is generated from local emissions sources, not from long-range-transport. The take-home message for southern Ontario is that about one-half of the O_3 in southern Ontario is generated from locally generated emissions, of which we have control. The data used for this figure was provided by Ontario Ministry of Environment.

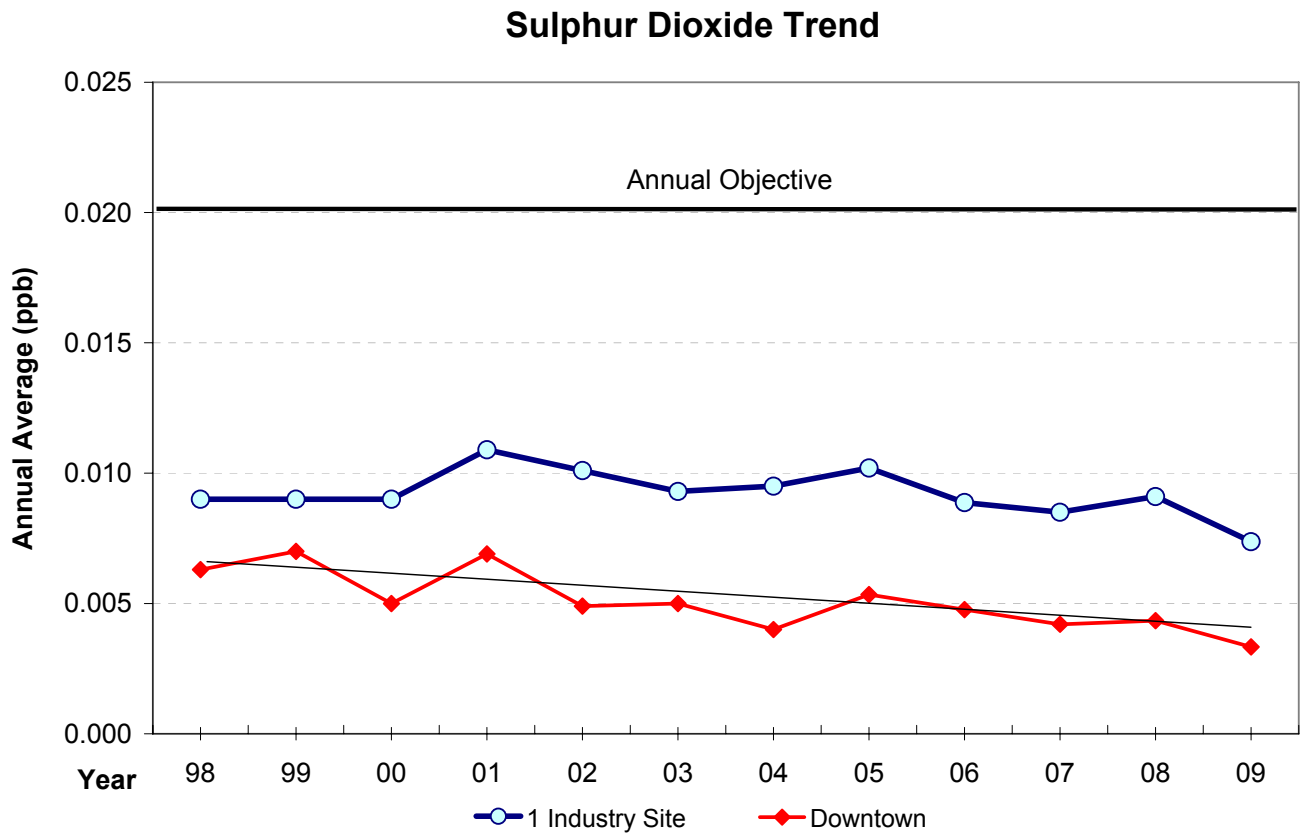
Ozone One-Hour Maximum Concentrations for Select Cities World-Wide (2007)



Sulphur Dioxide (SO_2)

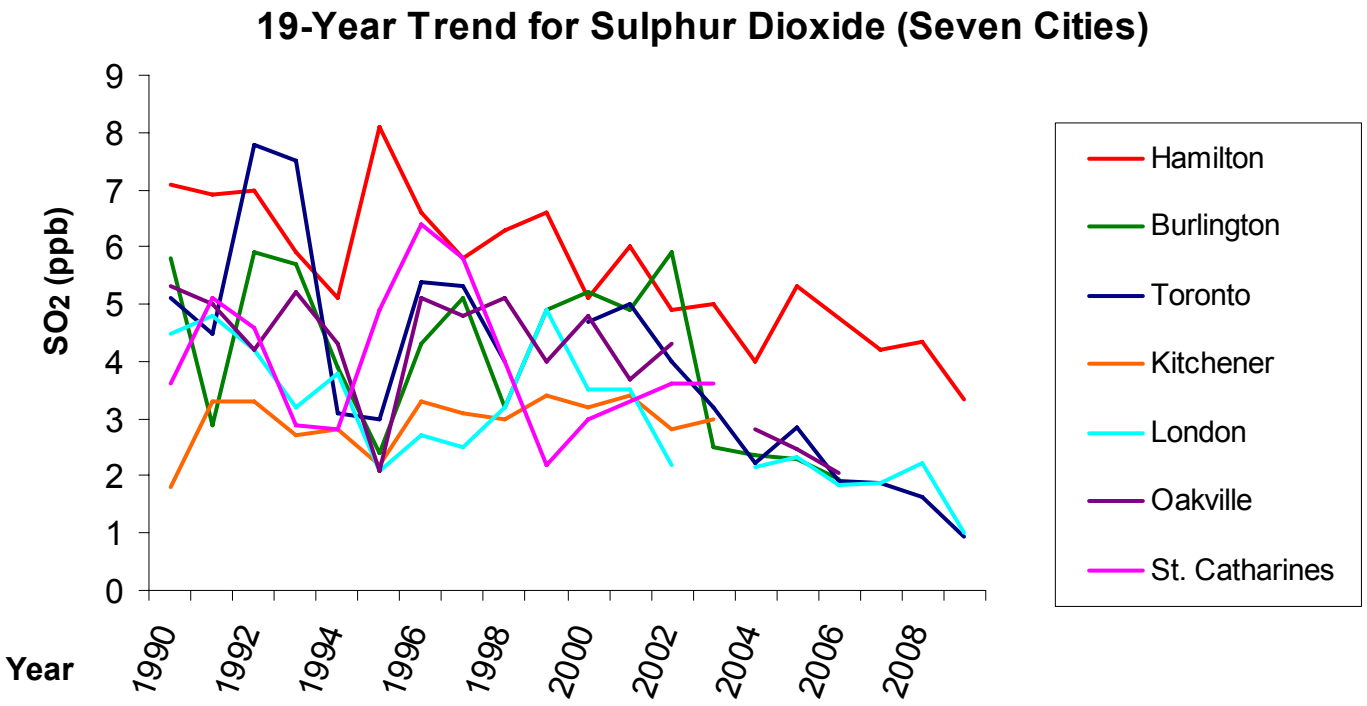
Over 90% of the sulphur dioxide (SO_2) in Hamilton is the result of industrial processes within the City. Significant improvements in air levels of SO_2 were made in the 1970s and 1980s. Since 1998, there has been a gradual and continuous decline in air levels of SO_2. During this period SO_2 levels have decreased by about 40% in the downtown area and by about 30% in the industrial areas. These reductions reflect actions taken to reduce SO_2 emissions from the steel industry. Combustion of fossil fuels (particularly diesel fuel) containing sulphur was a major source of SO_2 in Canada until federal regulations enacted in 2007 reduced the sulphur content in diesel fuel to 15 parts per million (ppm) from the former average sulphur content of about 350 ppm.

Sulphur dioxide is not only a respiratory irritant but this oxide is converted in the atmosphere over several hours to sulphuric acid (H_2SO_4), which is then converted into sulphate particles (SO_4). These particles average about 2 µm in diameter and constitute part of the respirable particulate fraction ($PM_{2.5}$) in the air. These particles tend to be acidic in nature and cause lung irritation when inhaled. Thus, the health concerns associated with SO_2 exposures are linked to the gas itself as well as to the particulate material derived from it. During the summer months, about 25% of the mass of $PM_{2.5}$ in the air in southern Ontario is SO_4.

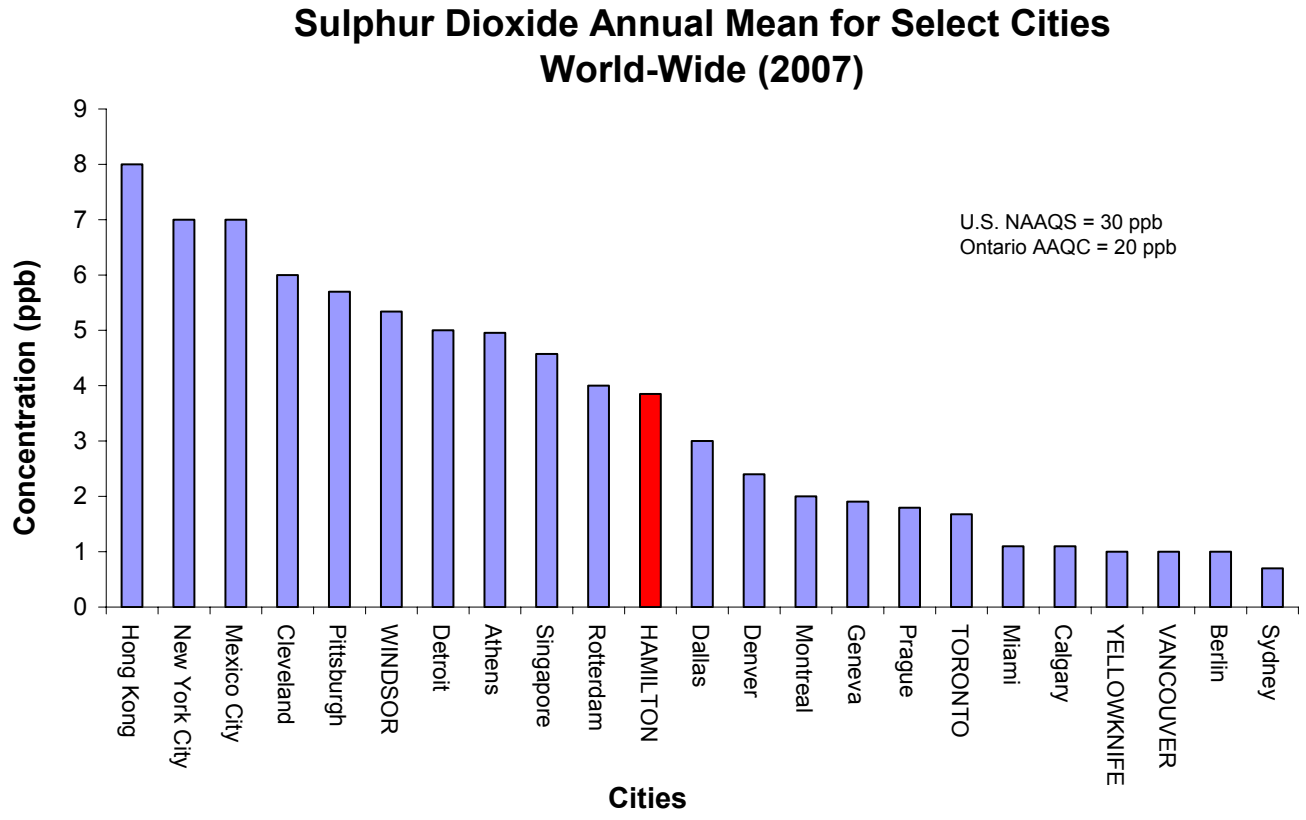


The graph below shows a comparison of the 19-year trends in SO_2 levels in seven southern Ontario cities. There have been dramatic decreases in SO_2 levels across southern Ontario over the past two decades. These reductions reflect the actions to reduce sulphur levels in diesel fuel (since 2007), the closure of local coal-fired power plants and the steady reduction of sulphur in combustion materials. The SO_2 levels in Hamilton are higher than the other southern Ontario cities due to the industrial sources that are unique to Hamilton.

When viewing the figure below, please note that some data points contain values based on a partial year. These data may not be as representative of annual SO_2 levels. Please view this figure as an approximate representation of SO_2 data from these cities.



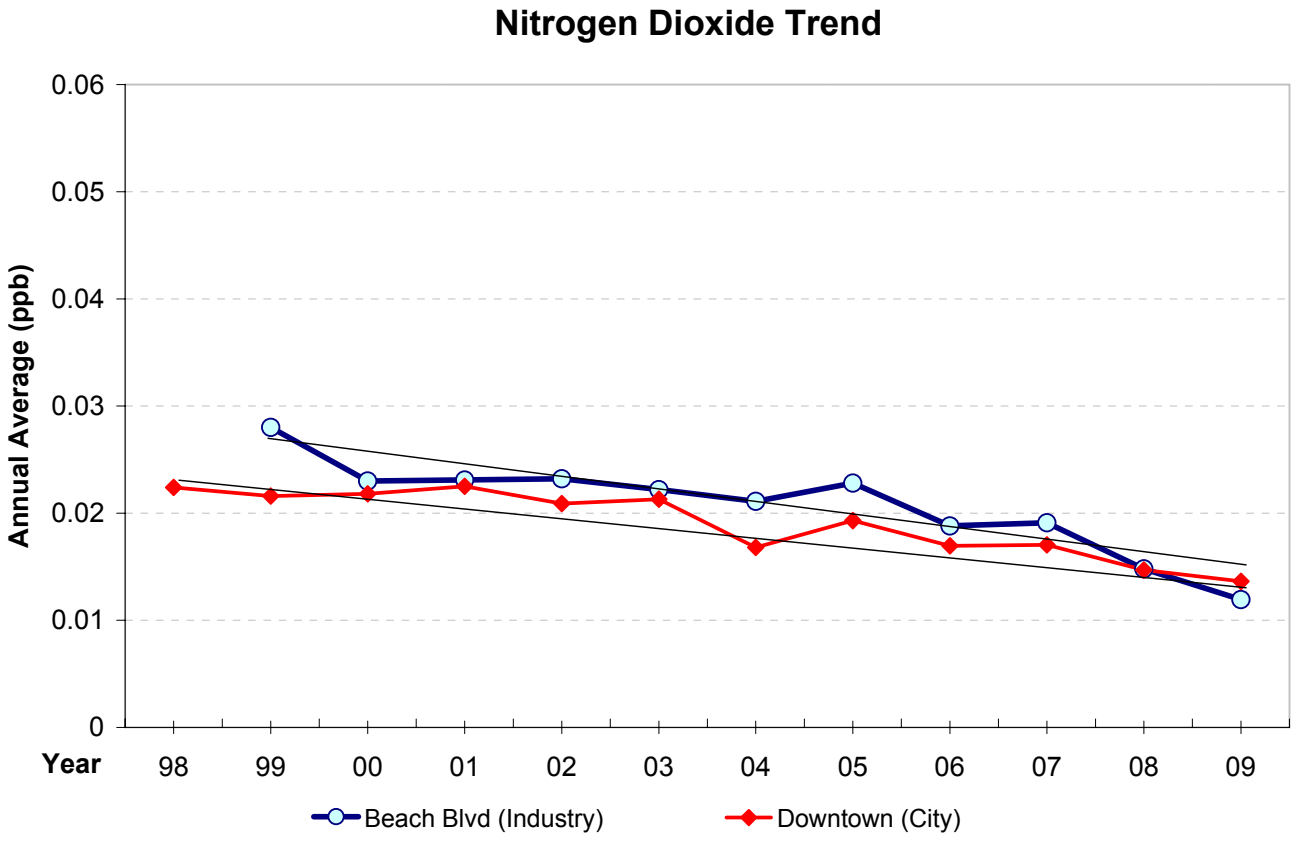
As discussed previously, Hamilton's industrial processes contributed to higher levels of SO_2 in the air. Hamilton recorded the second highest annual mean reading of SO_2 when compared to the other Canadian cities. Other cities, with a similar industrial base as Hamilton, such as Cleveland, Pittsburgh, Windsor and Detroit also recorded annual means values which were higher than most of the other cities. This demonstrates the significant effect industrial emissions have on air levels of SO_2. Despite having higher air levels of SO_2 in comparison with other cities, Hamilton's continual improvement in reducing SO_2 emissions have resulted in 2007 air levels of SO_2, which are well below Ontario Ambient Air Quality Criterion of 20 parts per billion (ppb) and even further below the U.S. National Ambient Air Quality Standard of 30 ppb. All 23 cities had 2007 annual means of SO_2 that were considerably below Ontario and U.S. SO_2 ambient air standards.



Nitrogen Dioxide (NO_2)

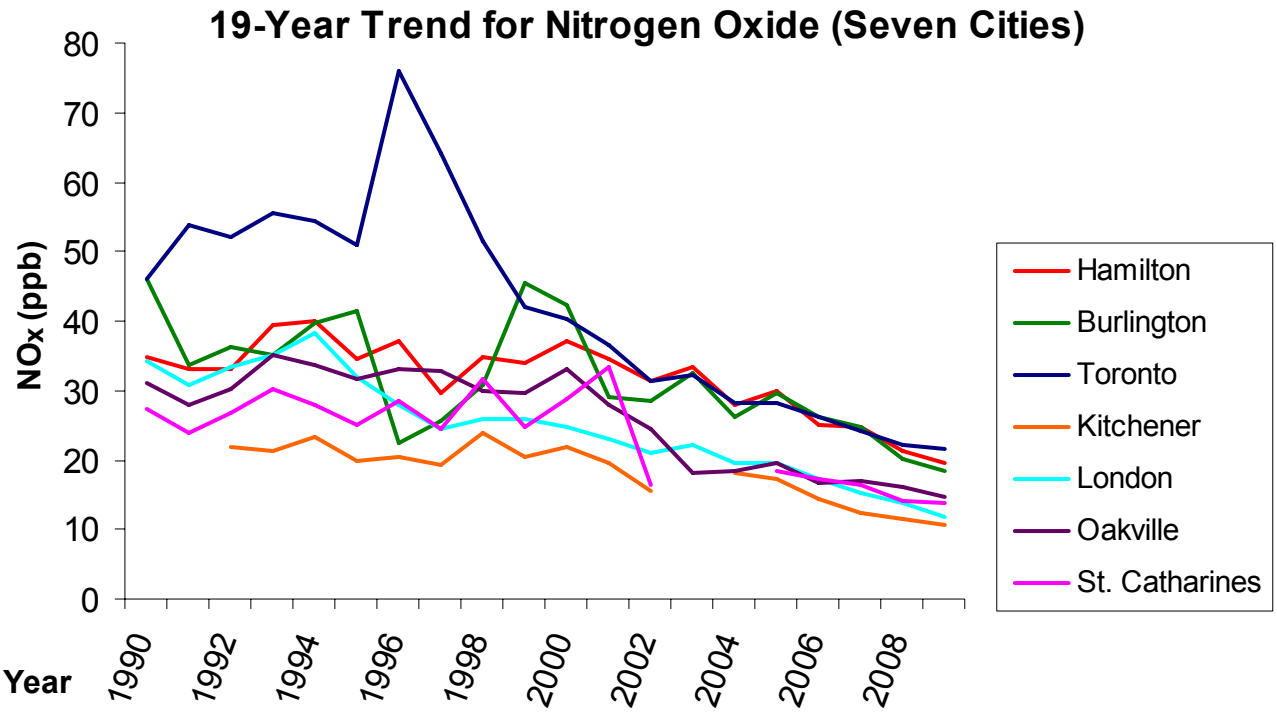
Nitrogen dioxide (NO_2) is responsible for a significant share of the air pollution-related health impacts in Hamilton. NO_2 is formed in the atmosphere from nitric oxide (NO) which is produced during the combustion of fuels such as gasoline, diesel, coal, wood, oil and natural gas. The leading sources of NO_2 in Hamilton are the transportation sector followed by the industrial sector. The level of vehicle use across Hamilton has increased slightly during the past decade, while the overall emissions of NO_2 from new vehicles has decreased.

There has been a steady decline in the annual average levels of NO_2 in Hamilton over the past decade, both at the downtown site and at a site downwind of the industries. Overall, improvements in vehicle emissions performance coupled with better industrial practices have resulted in an overall improvement in NO_2 levels of about 40%. For example, within the City the annual average NO_2 level was 23 parts per billion (ppb) a decade ago; today the annual average is 13 ppb. This corresponds to a steady annual reduction of about 1 ppb per year.

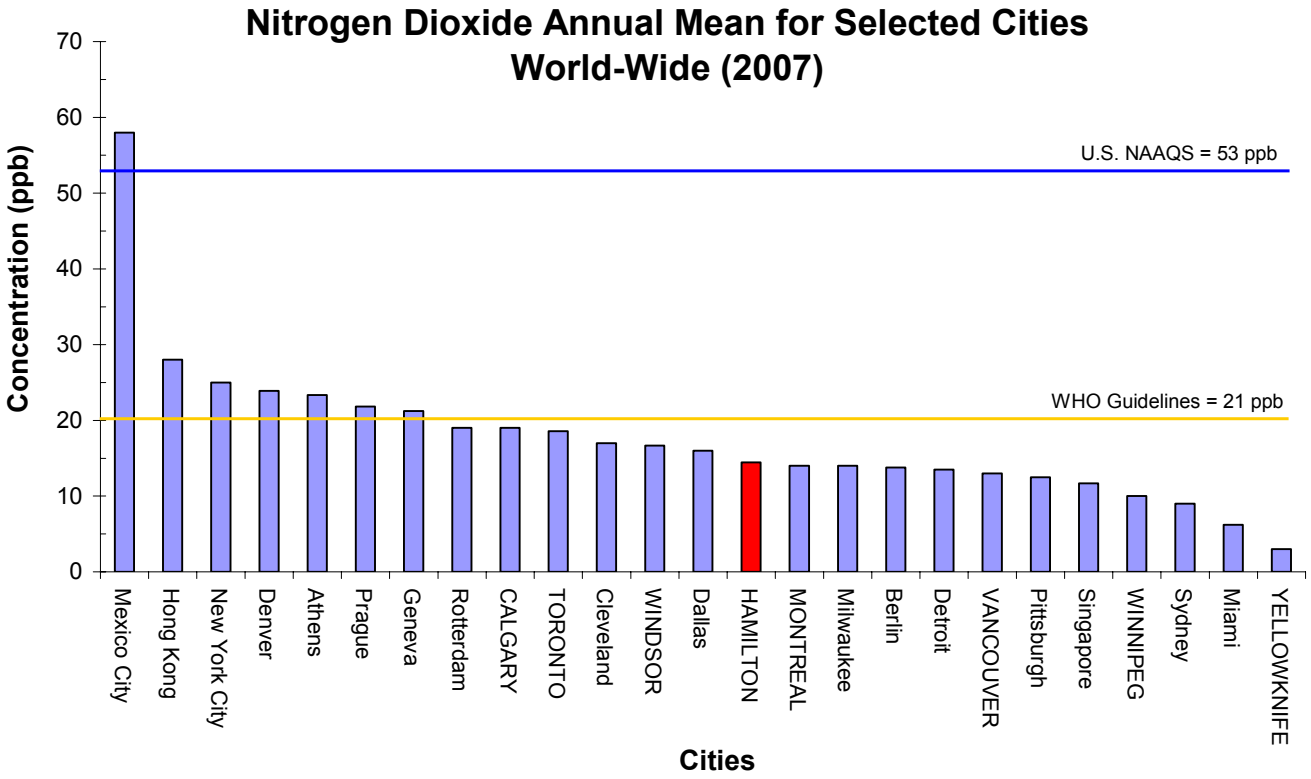


When we compare the 19-year trends in air levels of NO_x in Hamilton to NO_x levels in other Ontario cities we note that all cities have seen a steadily decreasing trend over the past decade. Toronto, which has no significant industrial NO_x contributors but significant vehicular NO_x emissions, has shown the largest decrease. Since the 1990's both Toronto and London have seen reductions in NO_x levels of approximately 60%. Hamilton's NO_x levels have decreased by approximately 46% since 1990. The NO_x levels in Hamilton have decreased more slowly than in cities such as London and Toronto during this period, due presumably to contributions from sources other than vehicles. The NO_x level is the sum of the levels of NO and NO_2. The decrease in the average NO_x levels is a reflection of improvements in emissions performance of the vehicle fleet in Ontario over the past decade.

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



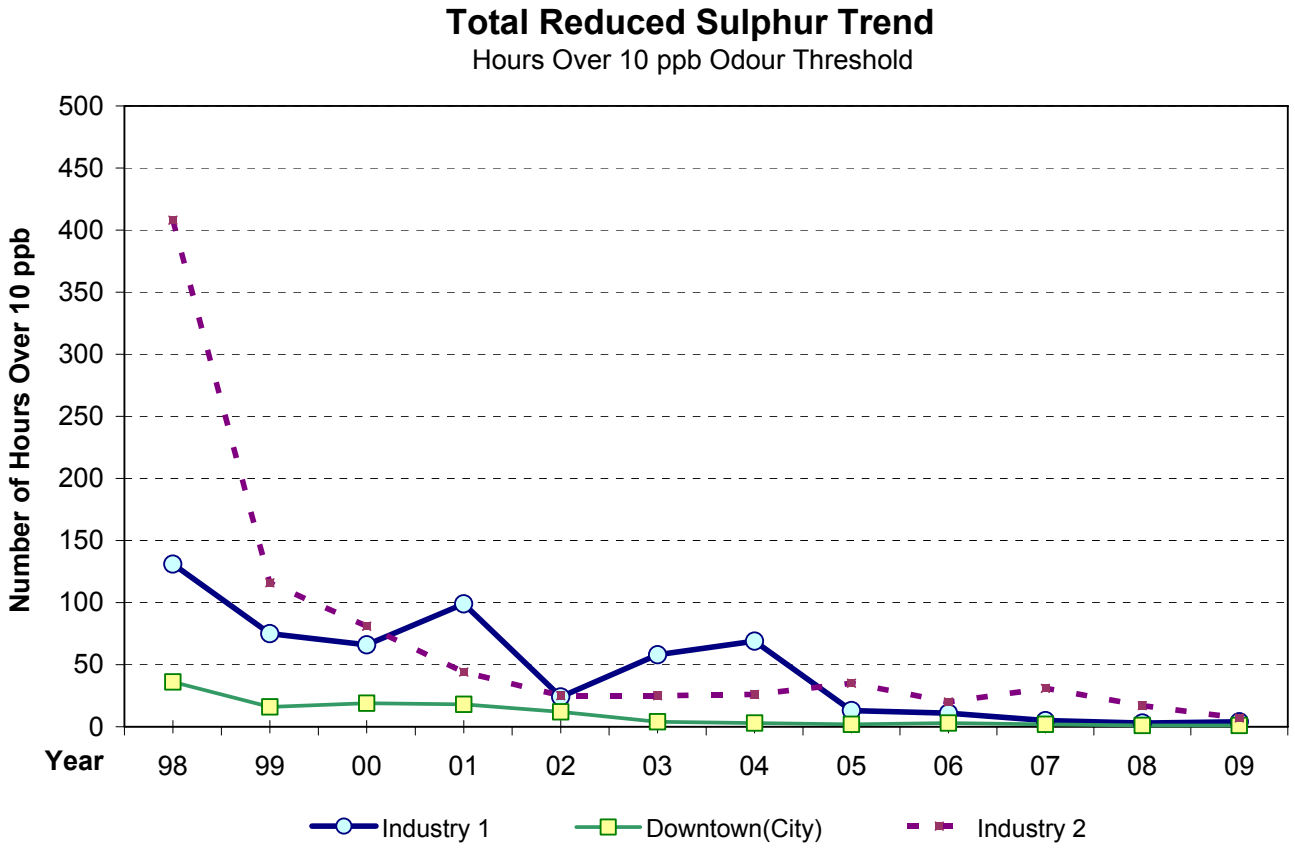
The figure below compares the annual mean levels of NO_2 levels in Hamilton with 24 Canadian and other cities around the world. Hamilton had the fourth highest NO_2 annual mean reading compared with other Canadian cities. Calgary, Toronto and Windsor were the three Canadian cities with higher NO_2 annual mean values. Hamilton's annual mean levels of NO_2 remain below the World Health Organization air quality guidelines and the U.S. National Ambient Air Quality Standards. Despite being below these guidelines, Hamilton has recorded higher NO_2 annual means in comparison with cities with a similar industrial base, such as Milwaukee, Detroit and Pittsburgh.


Nitrogen Dioxide Annual Mean for Selected Cities
World-Wide (2007)
Concentration (ppb)
70
60
50
40
30
20
10
0
U.S. NAAQS = 53 ppb
WHO Guidelines = 21 ppb
Mexico City
Hong Kong
New York City
Denver
Athens
Prague
Geneva
Rotterdam
CALGARY
TORONTO
Cleveland
WINDSOR
Dallas
HAMILTON
MONTREAL
Milwaukee
Berlin
Detroit
VANCOUVER
Pittsburgh
Singapore
WINNIPEG
Sydney
Miami
YELLOWKNIFE
Cities

Total Reduced Sulphur (TRS)

Total Reduced Sulphur (TRS) is a measure of the volatile, 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. An odour threshold has been set at 10 parts per billion (ppb) TRS because at this level about one-half of any group of people can detect an odour similar to the smell of rotten eggs. There is a wide range of sensitivities to odours among the population. A common measure of odour impact on the population is the number of hours per year that TRS levels exceed the 10 ppb threshold level.

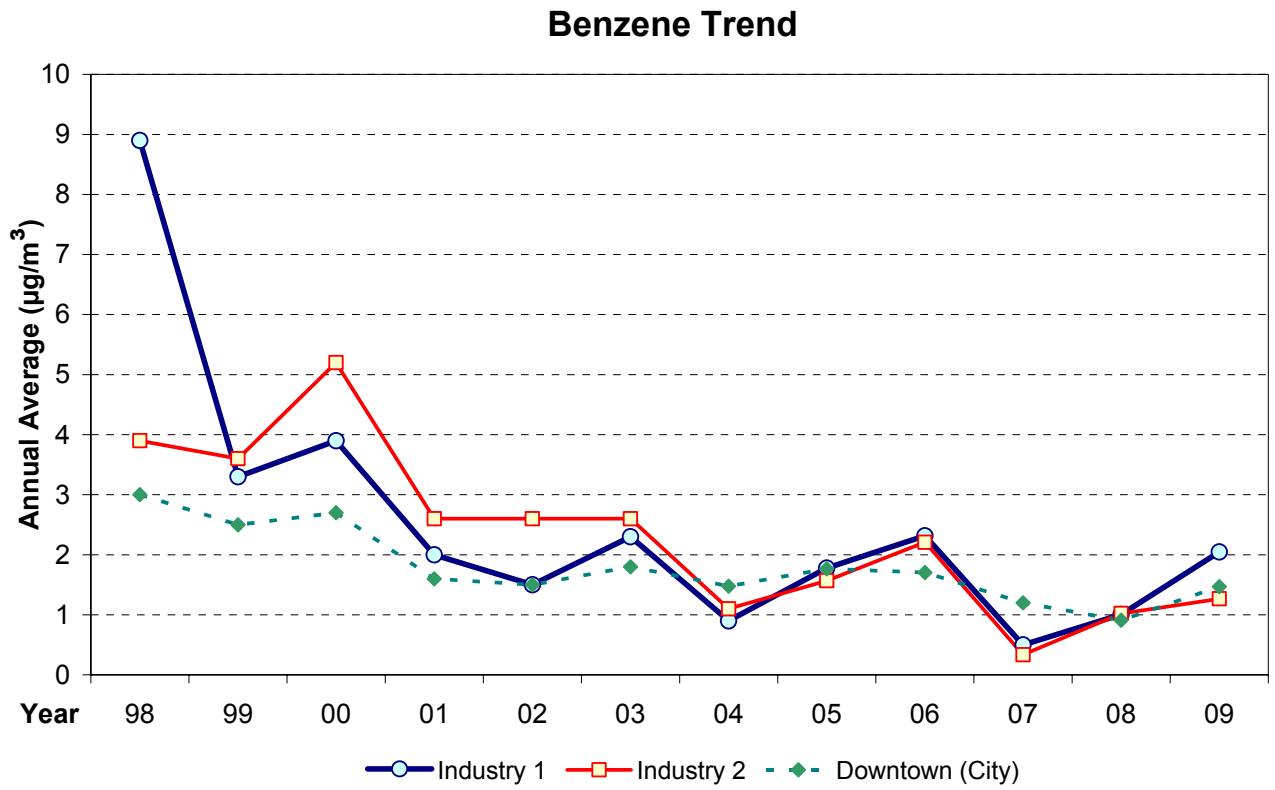
Hourly exceedances of the 10 ppb odour threshold have been reduced by over 90% since the mid-1990s due to significant changes in the management and operation of the coke ovens and blast furnaces. In particular, changes to slag procedures from quenching (using water) to pelletizing (using air cooling) have had a dramatic effect on reducing odour-causing emissions from slag handling operations. Odour threshold exceedances have been below 10 hours per year in the downtown area, and under 20 hours per year in the industrial areas over the past four years.



Benzene

Benzene is a volatile pollutant that is capable of producing cancer in humans. Benzene is emitted from some operations within the steel industry, specifically from the releases of 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 operating procedures at the coke plants, and improved control of release of benzene vapour from the coke by-products plants.

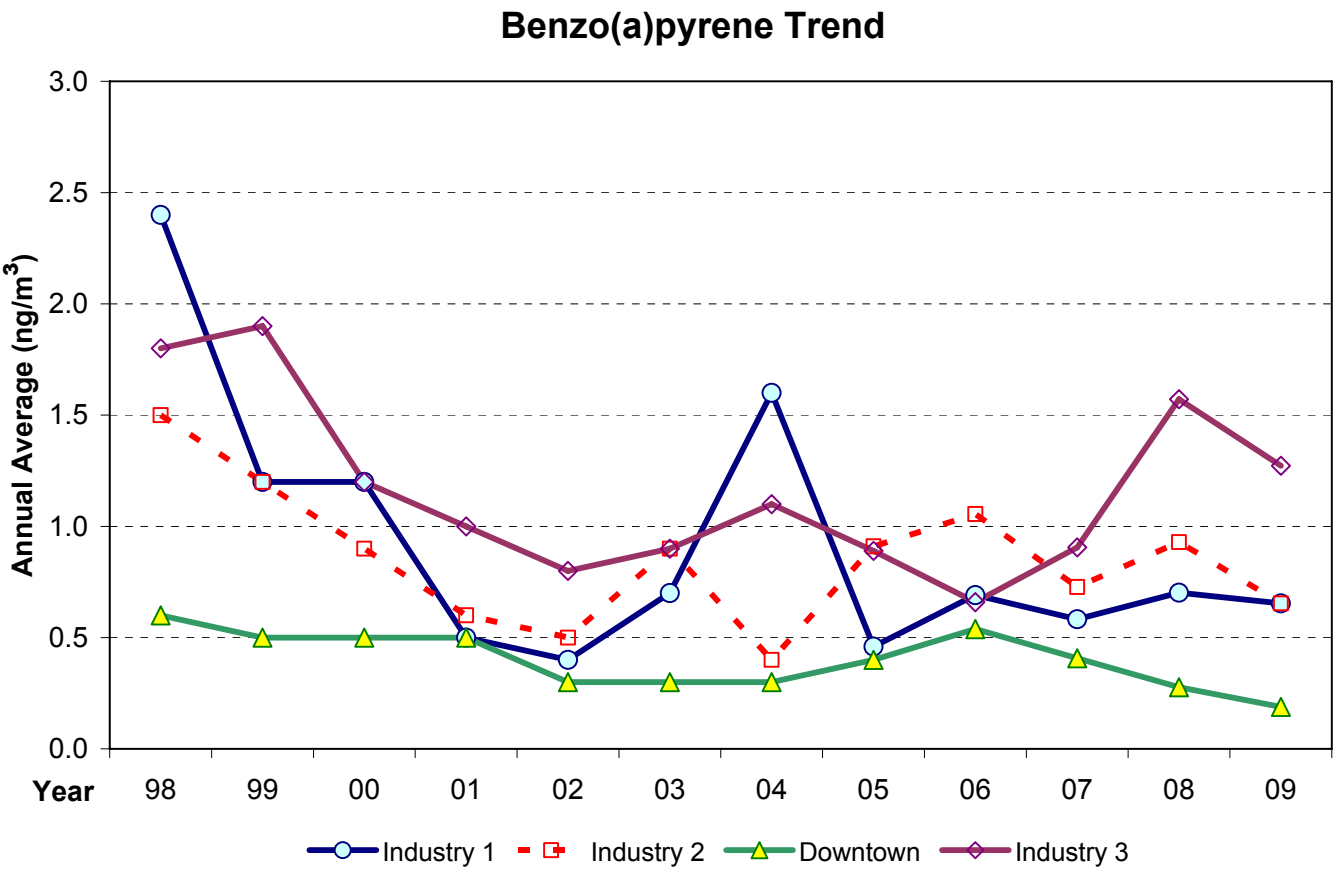
Benzene is also a component of gasoline; benzene concentrations in this fuel can up to 5%. In other words, since benzene is volatile, benzene vapours can be detected in the air in areas where gasoline is pumped and distributed. Thus, all cities in Canada have low but measurable levels of benzene in the air primarily due to the pumping of gasoline; whenever a person fills a gasoline tank, the gasoline vapours in the tank (which contain benzene) are displaced out of the tank into the atmosphere, potentially exposing anyone near the filled tank. The levels of benzene in downtown Hamilton have now dropped to levels comparable to those in other Canadian and Ontario cities of similar size, which do not have coking operations but do pump gasoline.



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 (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 BaP levels since the late 1990s 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.

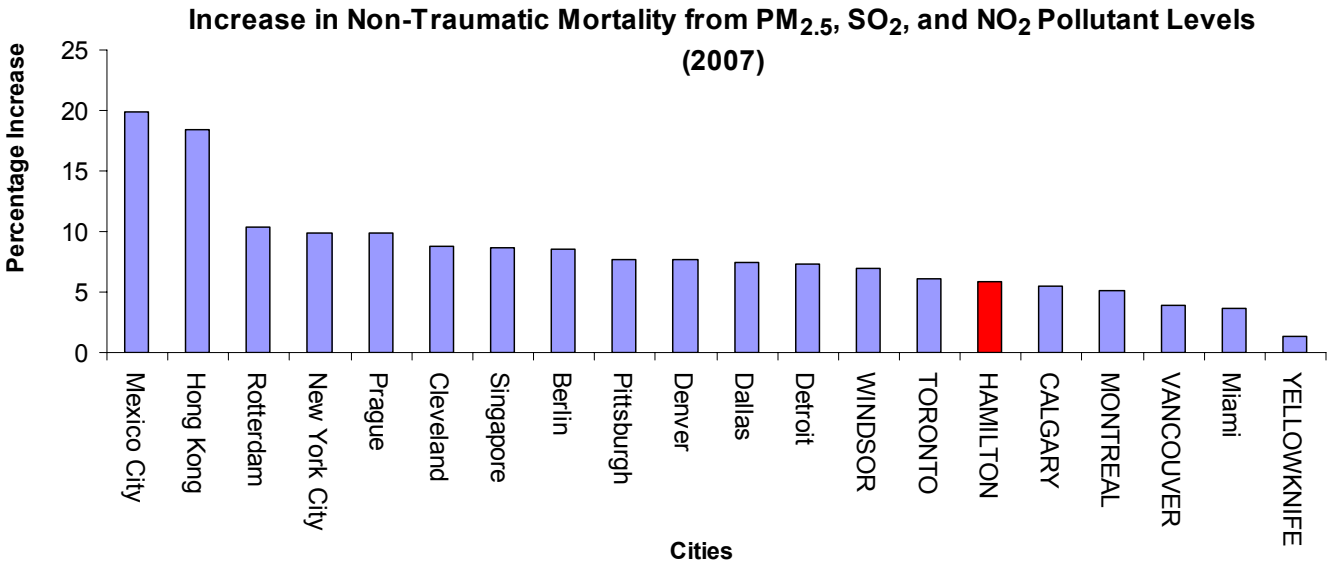
While BaP is only one of many PAH released from coking operations, BaP is undoubtedly the most potent and most studied of all PAH carcinogens (cancer-causing agents) in the scientific literature. As a result of the extensive amount of chemical and toxicological research work and occupational exposure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



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

Poor air quality is associated with a range of health impacts, with increased mortality rates being one of them. The Ontario Medical Association report (OMA, 2005) on health impacts of poor air quality in Ontario estimated 5,800 premature deaths in 2005 were associated with poor air quality. Also included in this report, OMA estimated that there were 290 premature deaths associated with air pollution in the Hamilton-Wentworth region in 2005; this number is projected to increase to 500 premature deaths in 2026. Three years later, in 2008, the OMA's updated Illness Costs of Air Pollution (ICAP) model concluded that air pollution (specifically smog) is responsible for 9,500 premature deaths in Ontario each year, and 445 premature deaths in the Hamilton-Wentworth Region are associated with increased air pollution (OMA, 2008). Alarmingly, OMA's initial projection of 445 premature deaths from air pollution in 2026 was already reached in 2008.

In the *Clean Air Hamilton*'s 2003 Air Quality Health Assessment Study, a metric to calculate the percent increase of non-traumatic mortality associated with air pollutants was developed. This metric calculated the percent change in non-traumatic mortality per 10-unit of air pollutants and was applied to the following five air pollutants: respirable particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), ozone (O_3), and carbon monoxide (CO) (Jerrett & Sahsuvaroglu, 2003). Using this metric, the figure below presents the cumulative percentage increase in non-traumatic mortality resulting from air levels of $PM_{2.5}$, SO_2, and NO_2 in several cities world-wide. Please take in consideration, that these values were calculated using simple arithmetic addition and should be considered a rough indicator of the effects air pollutants have on rates of non-traumatic mortality. This figure also does not account for the health impacts resulting from synergistic effects of air pollutants (e.g. SO_2 and $PM_{2.5}$).



Appendix D: Upwind Downwind 2010 Conference Report

Executive Summary

The 2010 Upwind Downwind Conference was held in Hamilton, Ontario on Monday, February 22nd 2010 at the Hamilton Convention Centre. The Conference brings recognition to Hamilton as a leader in air quality, transboundary and climate initiatives. This year's Conference and a free two-day public event, Hamilton Green Solutions Marketplace, were reported in all forms of local media (i.e. print, radio, television, and Internet). The Conference is hosted every two years by the City of Hamilton and Clean Air Hamilton. The Conference generates many ideas and is an excellent opportunity for Hamilton and other communities to share practical solutions for addressing air quality, transboundary and climate problems in the fields of health, planning, municipal action and partnerships. Approximately 243 planners, health promoters, high school and university/college students, environmental consultants, and citizens participated in the one-day 2010 Conference.

Hamilton Green Solutions Marketplace was held on Sunday, February 21st and Monday, February 22nd, 2010 at the Hamilton Convention Centre. The Marketplace was free for the public to attend and featured 53 exhibitors who offered information, products and solutions to issues of air quality and climate change. The Marketplace attracted 745 individuals.

Introduction

The 2010 Upwind Downwind Conference: *Air Knows No Boundaries* was the sixth biennial conference focusing on practical solutions to the air quality, transboundary air and climate change issues and impacts facing urban regions. The one-day Conference aimed to provide a forum to enable an improved understanding of these issues in relation to transboundary air movements, land use planning and transportation. Secondly, the Conference highlighted the roles that industry, community groups and government can play in achieving air quality improvements and climate action.

The Hamilton Green Solutions Marketplace was introduced as a two-day venue as part of the Conference to provide information, products and solutions to the general public and Conference attendees on issues of air quality and climate change.

Background

The Upwind Downwind Conference is an important activity in *Clean Air Hamilton*'s overall strategy to bring the best science in the air quality and climate change field to the attention of planning and health practioners, decision-makers, politicians and the public. The Conference is designed to develop continued awareness of air quality issues and to address new matters that relate to transboundary air pollution and climate change. The first Upwind Downwind Conference was hosted in September 1999 by the former Region of Hamilton-Wentworth and the Hamilton – Wentworth Air Quality Initiative.

Conference Goals

The goal of this year's biennial conference was to build upon the momentum and strong networks initiated by previous conferences, in order to facilitate continued discussion and improvements on clean air issues. The 2010 Upwind Downwind Conference aimed to provide an information-sharing forum to enable an improved understanding of air quality and climate change issues, the direct linkage between air quality and climate change and the impacts to cities, human health and the economy, that result from having better air quality.

To achieve these goals, the themes of the one-day 2010 Conference were "Transboundary Air Issues" and "Innovative and Practical Solutions" with adjoining themes of "Innovative Energy Future" and "The Carbon Neutral Future."

2010 Upwind Downwind Conference Speakers

Transboundary Air Issues
• **Gord Miller**, Environmental Commissioner of Ontario • **Rachel Kampus**, Ontario Climate Change Secretariat • **Adam Redish** and **Karen Clark** (Air Policy and Climate Change Branch), and **Craig Golding** (Air Policy Instruments and Program Design Branch) of the Ontario Ministry of the Environment • **Paul Miller**, Northeast States for Coordinated Air Use Management (NESCAUM) • **Dr. Jeff Brook**, Environment Canada
Innovative and Practical Solutions
• **Dr. Robert Shaw**, National Aeronautics and Space Administration (NASA)
Innovative Energy Future
• **Mike Elwood**, Electric Mobility Canada • **John Taylor**, Bionx EBikes • **Brent Gilmour**, Canadian Urban Institute
Carbon Neutral Future
• **Libby Little**, Town of Eden Mills • **Ian Graham** and **Dave Carson**, Dundas in Transition • **Rodney Wilts**, One Planet Communities

In addition to the 2010 Conference, a two-day Hamilton Green Solutions Marketplace was featured with 53 exhibitors who offered information, products and solutions to issues of air quality and climate change. A feature of the Hamilton Green Solutions Marketplace was the Green Solutions Stage, a free venue on Sunday, February 21, 2010 that featured the following:

- Revolutionizing the Eco Build – **Dave Braden** (Braden Homes)
- Smart Meters & Time Shifting – **Horizon Utilities**
- Raw Food Demo – **Chef Marg-Ann Rourda** (Bread & Roses Café) and **Karen Burson**
- Food and the Farm – **Chris Krucker** (Manorun Farm)
- Earth to Table – **Chef Jeff Crump** (Ancaster Old Mill)
- Cool Climate Science – J**ay Ingram** of the Discovery Channel's "Daily Planet"
- RevWear Fashion Show – **Sapphire Singh**

Attendance at the Sunday event was 446 people.

Hamilton Green Solutions Marketplace

A total of 53 exhibitors were in attendance for the Hamilton Green Solutions Marketplace. The Marketplace was an addition to the 2010 Conference in order to attract the public to the event and to showcase partners, solutions and products that address air quality and climate change. The exhibitors ranged from businesses selling products that help reduce greenhouse gas emissions and improve air quality to government agencies and environmental organizations dealing with Climate Change and Air Quality. Approximately 745 individuals from the public attended the Hamilton Green Solutions Marketplace on both days.

The 53 exhibitors were:

- Alota Electro-Wheels
- Avani Creations
- Axis gears
- Bhumi Products
- Bionx eBikes
- Braden Homes
- Bread and Roses Café
- Bullfrog Power
- Citizens Opposed to Paving the Escarpment (COPE)
- City of Hamilton- Public Works
- Clean Air Hamilton
- Dads Against Dirty Air (DADA)
- Desjardins Ethical Funds
- Earth Day Hamilton
- Earth to Table
- Eat Local
- EnergySmarts
- Energy Systems Planning
- Hamilton ECO Film & Art Festival
- Easy Green Roof Systems
- Environmental Hamilton
- Future Watch
- Garden Motorcar
- Goelectric Inc.
- Green Venture
- Halton Environmental Network (HEN)
- Hamilton 350
- Hamilton CarShare
- Hamilton Industrial Environmental Association (HIEA)
- Hamilton Mountain Green party
- Health Canada
- Horizon Utilities
- Iroquoia Bruce Trail Club
- Katimavik
- Kynk Naturals
- Martin K Ince and Associates Ltd.
- Manorun Farm
- McMaster Solar Car
- Medi-Air Inc./TiBBiTS
- Mountsberg Conservation
- Ministry of the Environment
- Plan B Organics
- Hamilton Public Health Services
- Rainbarrel.ca
- Smart Car Centre Burlington
- Smart Commuter
- Hamilton Rapid Transit
- Toyota Ancaster
- Union Gas
- Waste Watchers
- Whole Village

Conference Coordination

Conference planning for the 2010 event began in the spring of 2009 with a team of 12 representatives from Clean Air Hamilton, City of Hamilton, Ontario Ministry of the Environment, McMaster Institute of Environment and Health, Rotek Environmental Inc., McKibbon Wakefield Inc., and Green Venture. The City of Hamilton's Air Quality Co-ordinator within the Planning and Economic Development Department executed the planning activities. The inaugural meeting of the planning committee occurred on June 29, 2009.

2010 Upwind Downwind Conference Planning Committee

Organization	Representative	Work Title
Clean Air Hamilton McMaster University	Brian McCarry	Department Chair
McMaster Institute of Environment and Health	Bruce Newbold	Director, MIEH
City of Hamilton	Brian Montgomery	Clean Air & Climate Coordinator
	Katherine Kung	Assistant Environmental Planner (May – Aug. 2009)
	Leah Marshall	Assistant Environmental Planner (Sept. – Dec. 2009)
	Alice Bao	Assistant Environmental Planner (Jan. – April 2010)
	Steve Walsh	Public Health Services
	Lindsay King	Planner
	Chris Hill	Manager- Central Fleets- Public Works
Ministry of the Environment	Carl Slater	Manager, Technical Support Section, West Central Region
Rotek Environmental Inc.	Denis Corr	Consultant
McKibbon Wakefield Inc.	George McKibbon	Consultant
Green Venture	Paul Barrett	Air & Transportation Coordinator
	Laurel Harrison	Green Solutions Marketplace Manager

Advertising and Promotions

The objectives for the promotion and advertising campaign of the 2010 Upwind Downwind Conference and the Hamilton Green Solutions Marketplace were to expand the number of attendees, and raise awareness of the event as an opportunity for the public and professionals to share best practices, network, learn from others and increase international presence.

In order to catch the attention of potential delegates internationally, nationally and locally, advertising of the Conference and the Marketplace began six months in advance of the Conference in September 2009. The advertising campaign included:

In order to catch the attention of potential delegates internationally, nationally and locally, advertising of the Conference and the Marketplace began six months in advance of the Conference in September 2009. The advertising campaign included:

- E-mail notifications and flyers were sent to previous Conference attendees and potential new attendees, which included members of the Ministry of the Environment, City of Hamilton, Green Drinks, GTA Clean Air Partnership, Southwestern Ontario Clean Air Partnership, the Federation of Canadian Municipalities, Hamilton Chamber of Commerce, the Association of Municipalities of Ontario, members of the Hamilton Community Energy Collaborative, youth groups and potential exhibitors (large corporations with green initiatives), other non-government organizations, industry and government
- Conference event listings submitted online at: Environment Canada, Green pages.ca, Hamilton Eco-Network, Urbancity, People & Planet Friendly, Green Ontario, Ontario Professional Planners Institute, Green Party of Canada, MyHamilton.ca, Yahoo, Go for Green, Facebook, Google, McMaster University, Canada Events, H Calender, Halton Environmental Network, Activist Managazine, Craigs List, Partners in Nutrition, Kijiji, and a range of other online sites
- Colleges and University students in Southern Ontario and neighbouring U.S. Universities were notified by email through University Departments, professors, and Green NGO campus groups
- Online notifications were posted on the McMaster University MIEH website and the University of Waterloo Sustainability Project website
- High school students were notified though contacts at the Hamilton-Wentworth Public School Board, the Hamilton-Wentworth Catholic School Board, the Hamilton Independent School Board, through a table at the Living for the Environment High School Conference at Mohawk College in April 2009, and some other schools in Ontario were contacted from the Ontario Eco Schools; invitations were sent through school's courier systems
- City Staff Employee Bulletin at the City of Hamilton
- 3 banners advertising the Hamilton Green Solutions Marketplace were hung at the Sheraton hotel, in Room 250 A of the City Centre and at the Hamilton Convention Centre
- Media notifications to H magazine, View Magazine, Hamilton Spectator, the Hamilton Community Newspapers, Cable 14, CHCH News, and the Canadian Newswire
- Advertisements were purchased: 6 ads in the Hamilton Community Newspapers (Stoney Creek News, Ancaster News, Dundas Star News, Flamborough Review, Hamilton Mountain News, and Glanbrook Gazette) and ads in H Magazine and View Magazine

- 250 posters were distributed to various locations by Conference Planning Committee, such as churches, Hamilton Art Guild, Children's Museum, Westdale, Farmer's Market, Hamilton Central Library, Locke Street, Food Security Council, community and recreation centres
- Interviews were given on Talk820, CHML and Cable14
- The Hamilton Spectator wrote two articles on the Conference and speakers

Funding

The total cost of the 2010 Upwind Downwind Conference and Green Solutions Marketplace was $57,950. The total revenue was $45,075, which included $10,840 from registration fees, $3,735 from exhibitors and $30,500 from funding. City of Hamilton provided staff resources to procure sponsorship, coordinate logistics, facilitate meetings, process registrations and promote the Conference agenda ($50,000). Also, the Ontario Professional Planners Institute assisted in distributing notices about the Conference ($3,000). Planning Committee members helped confirm speakers and facilitate Conference sessions. Volunteers helped on the registration desk during the Conference.

2010 Upwind Downwind Conference Funds/Grants

Organizations	Donation
Hamilton Planning Department	$50,000 **in-kind**
Hamilton Public Health Services	$10,000
Environment Canada	$8,000
Ontario Ministry of the Environment	$5,000
Ontario Professional Planners Institute	$3,000 **in-kind**
Health Canada	$2,500
Hamilton Industrial Environmental Association (HIEA)	$1,000
Rotek Environmental Inc.	$1,000
Horizon Utilities	$1,000
ArcelorMittal Dofasco	$1,000
McKibbon Wakefield Inc.	$500
McMaster Institute of Environment and Health	$500
TOTAL – CASH	$30,500
TOTAL – IN-KIND*	$53,000*
Total	**$83,500**

Responses from Conference Attendees

The 2010 Upwind Downwind Conference received very positive feedback (refer to Appendix 1). A total of 43 evaluations were submitted. When asked to rate their overall satisfaction with the Conference, 17 individuals chose 'somewhat satisfied" while 26 picked "very satisfied". Not one individual indicated they were "not at all satisfied". For 35 respondents, the Conference "met their expectations"; 6 delegates did not feel that the Conference met their expectations.

The Hamilton Green Solutions Marketplace received very positive feedback (refer to Appendix 2). A total of 45 evaluations were submitted. When asked to rate their overall satisfaction with the Marketplace, 18 individuals chose 'somewhat satisfied" while 25 picked "very satisfied", while 2 individuals indicated they were "not at all satisfied". For 14 respondents, the Marketplace "met their expectations"; 5 attendees did not feel that the Marketplace met their expectations.

Appendix E: 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. More information can be found at **www.HAMNair.ca**

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**

The Southwestern Ontario Clean Air Council (SWO-CAC)

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

Hamilton Area Eco-Network (Eco-Net)

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

Appendix F: Glossary of Terms

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

Air Quality Health Index (AQHI) – a national health protection tool designed to help you make decisions to protect your health by limiting short-term exposure to air pollution and adjusting activity levels during episodes of increased air pollution. The AQHI is presented on a 10-point scale to indicate the level of health risk associated with air quality. It is calculated based on the relative health risk presented by a mixture of three air contaminants, ground-level ozone, particulate matter, and nitrogen dioxide. The AQHI provides specific advice for at-risk populations as well as the general public. For more information visit: www.ec.gc.ca/cas-aqhi/default.asp?lang=En&n=065BE995-1

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

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

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

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

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

Carbonaceous Fuels – fuels that are rich in carbon.

Cardiovascular – refers to the heart and associated blood vessels.

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

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

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

CO_2e – carbon dioxide equivalent; a unit of measurement used to compare the relative climate impact of the different greenhouse gases. The CO_2e quantity of any greenhouse gas is the amount of carbon dioxide that would produce the equivalent global warming potential.

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

Contaminant – refer to "What is a Contaminant" on page 17.

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

Cumulative Air Impacts and Effects – refer to Section 3.8.

Environmental Registry (EBR) – an electronic filing cabinet (www.ebr.gov.on.ca) containing "public notices" about environmental matters being proposed by all government ministries covered by the Environmental Bill of Rights (i.e. new laws, regulations, programs, proposals, etc.). Each notice allows users to comment. When final decisions are made, the EBR will tell users what kind of comments were made, as well as the impact, if any, the comments had on the decision. The user will also be told whether and how they can appeal and challenge the decision.

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

Geographic Information System – a collection of computer hardware, software, geographic data, methods, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information.

Global Positioning System – a navigational system involving satellites and computers that can determine the latitude and longitude of a receiver on Earth by computing the time difference for signals from different satellites to reach the receiver.

Global Warming Potential (GWP) – an index for estimating relative global warming contribution due to atmospheric emission of a kilogram (kg) of a particular greenhouse gas compared to the emission of a kg of carbon dioxide (refer to CO_2e). GWP is calculated for different time horizons and shows the effects of atmospheric lifetimes of the different gases.

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

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

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

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

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

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

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

National Ambient Air Quality Standards (NAAQS) – established by the United States Environmental Protection Agency under authority of the 1970 Clean Air Act that address outdoor air; for more information visit: www.epa.gov/air/criteria.html

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

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

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

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

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

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

$PM_{0.1}$ – ultra-fine particulate; airborne particles with mean aerodynamic diameters of 0.1 µm or less. $PM_{0.1}$ is currently being studied for links to health impacts.

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

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

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

ppm – parts per million; one part per million is one weight unit of chemical in one million (10^6) weight units of water, soil, etc. This is equivalent to one drop of water diluted into 50 liters (roughly the fuel tank capacity of a compact car).

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

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

Smog Advisory – see 'What is a Smog Advisory?' on page 19.

Stratospheric Ozone – also known as the ozone layer; see the Ground Level Ozone analysis of Appendix C on page 74.

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

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

Temperature Inversion – state in which cooler, denser air underlies warmer, lighter air and is thus prevented by gravity from vertical mixing and dispersion. Such a condition acts to trap air pollutants near the ground.

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

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

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

Transportation Demand Management (TDM) – see Section 5.2.1

Urban Heat Island - a metropolitan area which is significantly warmer than its surrounding rural areas. Heat islands form as vegetation is replaced by asphalt and concrete for roads, buildings,

and other structures necessary to accommodate growing populations. These surfaces absorb - rather than reflect - the sun's heat, causing surface temperatures and overall ambient temperatures to rise.

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

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

World Health Organization (WHO) – a United Nations agency to coordinate international health activities and to help governments improve health services. For more information visit: www.who.int/en/

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