STAFF REPORT
ACTION REQUIRED

Local Air Quality Study of Ward 30 and Ward 32

Date:	January 12, 2012
To:	Parks and Environment Committee
From:	Deputy City Manager, Cluster B
Wards:	Wards 5, 6, 30 and 32
Reference Number:	P:\2012\Cluster B\TEO\PE12001

SUMMARY

In 2005 the Toronto Board of Health requested that the City of Toronto examine the air quality impact of emissions from all sources of air pollution that affect Ward 30 and Ward 32 – encompassing the areas of South Riverdale, Leslieville and the Beaches. The Toronto Environment Office, with a history of assessing air quality using computer models, was tasked with the work, and retained Golder Associates to prepare a comprehensive analysis of air quality in Wards 30 and 32, known as the "Golder Report".

The Golder Report identified that the overall air quality issues in Wards 30 and 32 are principally caused by numerous small sources (such as vehicles, smaller industrial sources, commercial sources and residential furnaces), but there are still some localized poor air quality 'hot spots' that are caused by large industrial sources. In addition, air quality is impacted from pollution sources in the United Sates and Ontario (external to Toronto). Four of the air contaminant substances examined in this study exceed the Province of Ontario's air quality standards and are of concern.

To ensure that the emitters of large sources of air pollution comply with air emission standards it is essential to engage the Ministry of the Environment, who regulate air emissions in Ontario.

To better understand the impact of the numerous smaller emission sources, it is also essential that the Toronto Environment Office incorporate the ChemTRAC data generated through Toronto's Environmental Reporting and Disclosure Bylaw, and use the methods employed in the study of Wards 30 and 32 in additional wards to build up a fuller understanding of all city-wide air quality issues.

Transportation related emissions were identified as a major contributor to localized air quality issues in the Ward 30 and 32 study area, therefore, Wards 5 and 6 that are also located near major transportation corridors have been recommended as the next logical location for a local air quality study. The Toronto Environment Office has in-house resources to undertake additional air quality studies and, therefore, can carry out the associated recommendations of this report.

Toronto Public Health has undertaken cumulative health impact evaluations of carcinogenic and non-carcinogenic substances in the air based on the air contaminant concentration data created as part of this study. Toronto Environment Office has also mapped these cumulative impact maps.

RECOMMENDATIONS

The Deputy City Manager, Cluster B, recommends that:

1. City Council forward this staff report and the Golder Report to the Minister of the Environment for information purposes and request that additional resources be applied to verification and regulatory enforcement in connection with air quality certificates of approval.

2. City Council forward this staff report and the Golder Report to the Board of Health for information purposes and to identify that the original request made by the Board of Health has been addressed.

3. City Council direct the Director of the Toronto Environment Office to engage the Ministry of the Environment's Toronto and District Office to measure, assess, verify and address the findings of the Toronto Environment Office as to the four compounds identified in the Golder Report that potentially exceed the Ministry's Ambient Air Quality Criteria and request additional air monitors at industrial locations that may exceed Ambient Air Quality Criteria, at no cost to the City.

4. City Council direct the Director of the Toronto Environment Office to conduct a Local Air Quality study of Wards 5 and 6 using resources housed within the Toronto Environment Office, and report on the findings to the Parks and Environment Committee following completion of the study.

Financial Impact

The proposed air quality study of Wards 5 and 6, which includes collection of local emission data and local public engagement including meeting notices in local papers will cost approximately $20,000. This funding is included in the Toronto Environment

Office's 2012 Operating Budget submission and is conditional on Council approval of 2012 Operating Budget.

The Chief Financial Officer has reviewed this report and agrees with the financial impact information.

DECISION HISTORY

A Toronto Public Health staff report (April 12, 2005) to the Board of Health (http://www.toronto.ca/health/hphe/pdf/abtp_board_of_health.pdf), on the findings and conclusions of the Air Emissions and Health Status studies undertaken for South Riverdale and The Beaches communities, in fulfillment of the Ashbridges Bay Treatment Plant Environmental Assessment, recommended that the Executive Director of Technical Services Division, (subsequently identified as the Director of the Toronto Environment Office), examine the "air quality impact of emissions of sources" in the South Riverdale and The Beaches communities, including the Ashbridges Bay Treatment Plant.

ISSUE BACKGROUND

The Toronto Environment Office, with a history of assessing air quality in Toronto using advanced computer modelling, was tasked with leading the work and obtaining further technical expertise as required. Following budget approvals, the study was begun in November 2008 and was developed in close cooperation with staff of other City divisions, Toronto Public Health, and local concerned stakeholders. Through a competitive Request for Proposals process, Golder Associates was hired to assist the City undertake the local air quality study and record its work and recommendations in a report.

COMMENTS

The local air quality study of the Ward 30 and 32 air-shed is based on a simulated air quality model to produce data and maps of average and daily maximum concentrations of thirty air pollutants from all emission sources impacting the Ward 30 and 32 communities. Golder Associates undertook the detailed modelling and computer intensive component of the study. Their final report outlines the data collection and computer modeling work they undertook as well as their analysis and conclusions.

The modeling phase of the study was completed in early 2011. The results of the study were provided to Toronto Public Health for their cumulative health impact assessment of three groups of pollutants: carcinogens, non-carcinogens, and common air contaminants. The Public Health analysis is included in Appendix A.

Citizen Liaison Committee and Public Meetings

To ensure that the concerns of the residents of Wards 30 and 32 were addressed, the City engaged the public through a local study-specific Community Liaison Committee comprised of community residents, Councillor's representatives and staff of the Ministry of the Environment. A list of the participants is recorded in Appendix B.

The Community Liaison Committee identified a widely held local view and concern regarding air pollution emanating from the Ashbridges Bay Treatment Plant, the Portland Energy Centre and several other industrial sources. The study was organized so that these issues were addressed by asking two questions:

1. What is the air quality in the study area?
2. What are the sources that contribute to the air pollution levels in the study area?

A public meeting was held on October 18, 2011 at the Fire & Emergency Management Services Academy to provide the public with study findings and next steps. Members of the public emphasized their concern for health impacts related to local air quality and stressed the need for regulatory action to reduce pollution from industrial sources. The public were appreciative of the study, the presentations and the display materials. A commitment was given to the community that the forthcoming ChemTRAC data (linked to Toronto's Environmental Reporting and Disclosure Bylaw) would be incorporated into the local air quality model for Wards 30 and 32, and that the results would be communicated to the community.

Study's Main Findings

The Golder Report identifies three significant air quality issues that should be addressed further: transportation related emissions; site specific industrial emissions; and emissions from residences and commercial businesses. Key points are discussed below.

<u>Traffic Related Emissions</u>

Traffic related emissions include tailpipe emissions as well as the fine particles that come from the wearing down of vehicle tires and road surfaces. Such emissions are clearly an issue of concern on the western edge of the local study area where high traffic volumes occur along the Don Valley Parkway. Such high traffic-volume related air emissions, and their impacts also occur along the other 400 series highways, or their equivalents in Toronto (i.e. Hwy 401, Hwy 400, Hwy 427, the Gardiner and the Queen Elizabeth Way).

<u>Site Specific Industrial Emissions</u>

Site specific industrial emissions create some highly localized poor air quality 'hot spots'. All local industrial emissions data were obtained from the public information provided by local businesses and public works facilities to the federal and provincial governments, or based on that public information to derive below federal National Pollutant Release Inventory reporting threshold emissions data.

Area-Wide Multiple Small Source Emissions

Area-wide multiple small source emissions include emissions from natural gas burning furnaces and boilers as well as emissions associated with vehicles. These are significant contributors to the air quality in the study area. Traffic related emissions from vehicles using neighbourhood main roads and local roads are similar to the emissions associated with traffic on the Don Valley Parkway, but their significance for air quality is significantly less than the highway related emissions.

Overview of the Local Air Quality Modelling Approach

The Golder Report incorporated emissions from all different types of sources: industrial, commercial, residential, agricultural, natural, and transportation related emissions. Information about air pollutants emitted from sources in Ontario (aside from Toronto) and the United States were included with local sources within Toronto and dove-tailed with information about distant and local weather patterns to predict the total ground level concentrations of 30 selected contaminants comprised of seven air contaminants given high priority by the Ministry of the Environment and Environment Canada and an additional 23 toxic air contaminants identified by Toronto Public Health.

The study used air emissions inventory data that were obtained from all available sources across northeast North America and Ontario, advanced meteorological computer modelling, and air quality computer modelling techniques to assess annual average and worst case 24-hour ground level concentrations of each of the 30 selected contaminants.

The air quality model incorporated the weather patterns (meteorology) and air emissions that affect local air quality and calculates ground level pollutant concentrations at 550 identified receptor points (these can be considered virtual air monitoring stations). Receptor points were spaced equally throughout the study area. Additional receptor points were identified within Toronto but outside the local study area of Wards 30 and 32 in order to provide comparisons between the predicted model ground level concentrations with physical air monitoring station ground level concentrations. The comparisons made between predicted and actual concentrations indicate a good correlation in the contaminants of most concern from health and regulatory compliance perspectives and also indicates a confidence in the modeled results obtained.

Data Sources

The air quality model developed for the Ward 30 and 32 study area included sources from as far away as Indiana and Sudbury, to sources as local as vehicle tailpipes and small auto-body shops. The air emissions data used in the model consisted of three study specific sub-areas covering: (i) the Great Lakes States and Provinces (including in whole or in part – Michigan, Illinois, Indiana, Ohio, Kentucky, West Virginia, Virginia, North Carolina, Maryland, Pennsylvania, and New York - as well as northern Ontario and southern Quebec); (ii) southern Ontario; and (iii) Toronto.

The Great Lakes and Provinces were modeled using a 36 km x 36km grid size; southern Ontario was also modeled using a 36 km x 36km grid size; and Toronto was modeled using a 1 km x 1 km grid size. Additional grid cells were used within the local study area of Ward 30 and 32 to provide better analysis of local air pollution sources.

Standard detailed emission estimation techniques were used to quantify the emissions from all sources. In addition, the model varied the emissions from all three areas (United States, Ontario and Toronto) and from all sources (residential, commercial, industrial, transport, agricultural and biogenic) according to time of day, day of week and month of year to more closely resemble expected timing of when the emissions typically occur.

Substances Assessed

The 30 "Priority Air Contaminants" identified and modelled as part of the study include Toronto Public Health's top 25 contaminants of concern (which include two Criteria Air Contaminants) as well as a combination of the remaining five Criteria Air Contaminants of the Ministry of the Environment and Environment Canada's are listed in Table 1.

Table 1 – Contaminants of Concern Modelled in the Local Air Quality Study

Acetaldehyde	1,2-Dichloroethane	$PM_{2.5}$ * [2]
Acrolein	Dichloromethane	Tetrachloroethylene
Benzene	Ethylene dibromide	Toluene
1,3-Butadiene	Formaldehyde	Trichloroethylene
Cadmium	Lead	Vinyl Chloride
Carbon tetrachloride	Manganese	Carbon Monoxide *
Chloroform	Mercury	PM_{10} * [2]
Chloromethane	Nickel Compounds	Sulphur Dioxide *
Chromium	Nitrogen Oxides *	VOC (Anthropogenic & Biogenic) * [3]
1,4-Dichlorobenzene	PAHs (as B[a]Ps) [1]	Ozone *

* Criteria Air Contaminants (CACs)

Notes: 1. PAH (as B[a]Ps) refers to "Polycyclic-aromatic hydrocarbons as Benzo[a]pyrene"; B[a]P is used as a surrogate for the whole PAH family of compounds
2. PM_{10} and $PM_{2.5}$ are two separate components of PM (Particulate Matter) where PM_{10} is particulate matter less than 10 microns and $PM_{2.5}$ is particulate matter less than 2.5 microns
3. VOC are volatile organic compounds

Modelling System

Three key factors combine to influence air quality: air emissions, weather patterns, and the physical environment. The model used in this study works to mimic these three factors, using modelling systems to simulate local source of air pollution and pollutants from the United States. The modelling systems are known as CALPUFF and Penn State MM5. CALPUFF provides simulations of atmospheric pollution dispersion and is used by the United States Environmental Protection Agency. Penn State MM5 is used for creating weather forecasts and climate projections. It has been developed by Pennsylvania State University and the United States National Center for Atmospheric Research.

A full year (2006) of detailed hourly meteorological data were used to drive the model and to ensure better consistency across the three study areas and between the interacting weather systems within the model.

Validation of Results

Physical air quality monitoring stations remains the standard benchmark against which modelled concentrations are judged and compared. The air quality model employed in this study creates virtual air monitoring stations which produces the same data (plus additional data) as a physical monitoring station collects.

The modeled results of the thirty substances examined in the Ward 30 and 32 air quality study are provided as tables and distribution maps in the Golder Report. Examples of the mapped distributions of two substances that exceed the Ministry of the Environment's levels are also provided in Appendix C of this report.

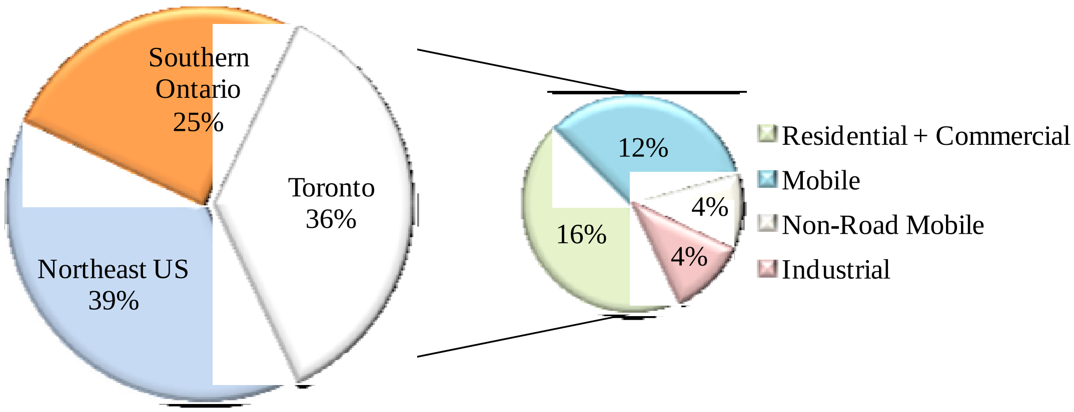
The comparison between predicted modelling results (virtual stations) and monitored data (physical stations) are very good for the air contaminants that are monitored (only 11 of the 30 substances modelled in this study are monitored by the Ministry of the Environment or Environment Canada). The results of the comparison give an average monitoring (physical stations) to modelling (virtual stations) ratio of 1.03, which identifies high validity in the conclusions drawn from the modelling results.

Sources of Air Pollution

The influence of upwind air emissions from the United States and Ontario on Toronto's air quality has long been recognized. However, the influence of such upwind sources is largely outweighed in the Ward 30 and 32 study area by local air pollution sources, as upwind sources are dispersed, and their contribution to the Ward 30 and 32 area concentrations are diminished as they cross over the north-east section of the continent.

Effectively, by the time those emissions cross over Toronto, the bulk of them pass too far overhead to significantly impact local air quality at ground level. The relative percentages of the sources of air pollution are shown in the following pie chart, which also shows the sources of air pollution generated within Toronto.

Pie Chart 1: Source Contributions to Downwind Concentrations by Three Areas plus Contributions by Categories for Toronto Only



This pie chart shows both the relative contributions from the three modelled source areas as northeast USA (39%), southern Ontario (25%) and Toronto (36%) as well as the contribution by category type for Toronto as residential and commercial (16%), mobile (i.e. cars and trucks – 12%), non road mobile (i.e. planes, trains, boats and off road – 4%) and industry (4%); the small amounts of biogenic and agricultural emissions that occur are too small to identify at this scale of comparison.

The residential and commercial sources of air pollution in Toronto directly cause about 16% of the total ground-level concentrations in the local area of Wards 30 and 32, while the transportation sector contributes about 12%. The 12% caused by local transportation is more significant in causing local air quality exceedances than the 16% caused by local residential and commercial releases, because of the immediate localized impact of emissions from cars and trucks on highways.

The emissions from vehicles are subject to federal regulations concerning initial manufacture (fuel efficiency and permitted emissions) and to provisions for ongoing maintenance in provincial regulations (known as "Drive Clean"). The amount of emissions varies with traffic volume and the mix of traffic types (cars, vans and trucks, etc., by size). Unlike industrial emissions, tail pipes are effectively at ground level, and though emissions rise with exhaust heat and vehicle created turbulence, the pollution concentrations in areas adjacent to roads, such as the Don Valley Parkway, can be significant.

Estimating "Below Threshold" Reporting at National Pollutant Release Inventory Sources

Canada's National Pollutant Release Inventory is Canada's legislated, publicly accessible inventory of pollutant releases (to air, water and land), disposals and transfers for recycling. However, it does not require all emissions to be reported to them, nor does it publish all the reports it receives. Data of non-reported and/or non-published data are referred to as "below threshold" emissions simply because such data are below the National Pollutant Release Inventory's reporting threshold requirements – where for example a facility releases less than "x" or has less than "y" workers.

Where emission releases are below the reporting threshold, emission estimates are developed based on the intensity level of an activity such as the amount of material consumed or product produced over a period of time (e.g. tonnes of raw product per hour). The activity level is multiplied by the appropriate emissions factor to estimate the rate of emissions released into the atmosphere by the activity.

Applicable emission factors were obtained using the United States' Environmental Protection Agency's (US EPA) web-based Factor Information Retrieval (web-FIRE) Data System for emission estimating, and applying them to the National Pollutant Release Inventory reporting facilities by linking the USA's Environment Protection Agency's Standard Classification Code to the National Pollutant Release Inventory industrial codes.

This approach will be augmented and superseded by the City's ChemTRAC initiative as that data become available.

Air Contaminant Concentration Issues

The Ministry of the Environment has developed Ambient Air Quality Criteria values as a component of their air quality standard setting and assessment process. Ambient Air Quality Criteria effectively define acceptable contaminant concentration levels; these concentration levels are “effect-based” and associated with specific averaging times (e.g., annual, 24 hour, 1 hour, or 10 minutes). Ambient Air Quality Criteria are set at levels below which adverse health and/or environmental effects are not expected. The Ambient Air Quality Criteria are used in the non-cumulative impacts part of this study as benchmarks to help identify substances at issue.
Using the standard Ambient Air Quality Criteria values as benchmarks, 1 of the 30 modelled substances reveals concentration values across the study area that exceeds its Ambient Air Quality Criteria benchmark; and 3 other substances reveal concentration values in the western parts of Wards 30 and 32 that exceed their respective Ambient Air Quality Criteria benchmarks.

The substances which demonstrate air quality compliance issues in Wards 30 and 32 in respect to the established Ambient Air Quality Criteria are shown in Table 2. Issues are apparent in respect to four substances: oxides of nitrogen (key source is vehicle emissions); benzene (key source is industrial processes), polycyclic-aromatic hydrocarbons (key source is vehicle emissions); and particulate matter (key source is vehicle emissions and road and tire wear). Particulate matter represented as "PM" is recorded as PM_{10} and a subset, $PM_{2.5}$, because it has health issues associated with it. The table indicates a maximum concentration and an average concentration for each substance. Concentration levels are measured against a 24-hour timeframe.

Table 2: Air Pollutants Determined to be at Concentration Levels of Concern

Individual Air Pollutant	ID	24-hr AAQC[1] ug/m^3	24-hr Maximum Concentration ug/m^3	24-hr Neighbourhood Average ug/m^3
Oxides of nitrogen (NOx)[2]	CAC[5]	200	292.3	223.6
PM_{10} [3]	CAC[5]	50	58.5	43
$PM_{2.5}$ [3]	CAC[5]	30	20.8	18.8
Benzene[2]	Mobile Toxic	2.3	3.4	2.3
PAHs (as B[a]P) [4]	Aromatics	.0011	.026	.024

Notes:
1. Ambient Air Quality Criteria (AAQC)
2. AAQC standard
3. Canada Wide Standard used in absence of AAQC standard
4. Interim Ontario Standard used in absence of AAQC standard
5. Criteria Air Contaminants

What the maximum and average values do not show and do not address are the locations of the air quality issues within the community. Where concentrations are seen to exceed accepted standards, analysis of concentration distribution maps can be used to determine where such concentrations come from.

The major issues revealed for Wards 30 and 32 relate to transportation and to local industry "hot spots". Table 4 provides the principal sources of air pollution in the local study area. The four substances seen to exceed either 24-hour or annual Ambient Air Quality Criteria C standards are (i) nitrogen oxides, (ii) fine particulate matter, (iii) PAHs (polycyclic-aromatic hydrocarbons) as typified by B[a]P (benzo[a]pyrene), and (iv) benzene. These four contaminant substances present cause for concern but the levels of confidence in the results, vary among them with the quality of model input data sources.

The sources of the air pollution as experienced in Wards 30 and 32 (rather than that which is simply inputted into the model or that passes overhead rather than at ground pollution level) by input category are identified in Table 3.

Table 3: Sources of Principal Air Pollution in Wards 30 and 32

Individual Air Pollutant	NE USA[1]	Southern Ontario	Toronto				
			Industrial	Residential & Commercial	On Road Vehicles	Non Road Vehicles	Biogenic & Agriculture
Oxides of nitrogen (NOx)	22%	21%	5.2%	11.30%	**32.6%**	7.9%	0%
$PM_{2.5}$ [2]	32%	20%	10.9%	16.00%	16.0%	5.1%	0%
PM_{10} [2]	30%	20%	5.1%	6.40%	**36.3%**	2.2%	0%
$PM_{2.5}$ [2]	32%	20%	10.9%	16.00%	16.0%	5.1%	0%
Benzene	26%	19%	**8.7%**	0%	**39%**	8.3%	0%
PAHs (as B[a]P) [3]	68%	8%	0.07%	0%	**23.9%**	0%	0%

Notes: 1. Northeastern United States source area, as identified here, includes, in whole or in part – Michigan, Illinois, Indiana, Ohio, Kentucky, West Virginia, Virginia, North Carolina, Maryland, Pennsylvania, and New York - as well as parts of northern Ontario and western Quebec.
2. PM_{10} and $PM_{2.5}$ are components of PM (Particulate Matter) where PM_{10} is particulate matter less than 10 microns and $PM_{2.5}$ is particulate matter less than 2.5 microns
3. PAH (as B[a]Ps) refers to "Polycyclic-aromatic hydrocarbons as Benzo[a]pyrene"; B[a]P is used as a surrogate for the whole PAH family of compounds

Background Concentrations and Locally Significant Concentrations

The data in Table 3 show that the predominant source of the pollution concentrations of concern in Wards 30 and 32, by emission sources, is from car and truck emissions. Though not included in this table, the greatest proportion of the emissions from the north-east USA and southern Ontario follow the same contribution pattern.

What these figures do not show, but which can be clearly seen on the associated maps of pollutant concentrations in Wards 30 and 32, is that whereas the contributions from the United States and southern Ontario provide a uniform "background" across the Ward 30 and Ward 32 study area, the Toronto emissions, and especially the emissions from the roads and highways within and adjacent to Wards 30 and 32 have a significantly pronounced localized and linear impact. The closer a location is to a high volume vehicle carrying road or major highway, the greater is the localized impact.

These maps also help identify an example of a local industry "hot spots" (see Appendix C, Map 5). This hot spot was identified as a National Pollutant Release Inventory listed source of $PM_{2.5}$ but the "benzene" hot spot was estimated using the United States' Environment Protection Agency's webFIRE (see above) as the facility in question (Canroof) does not report any benzene emissions to the National Pollutant Release Inventory.

The emissions data inputted into the air quality model are taken from the National Pollutant Release Inventory's 2006 database except in the case of a few facilities, including Canroof, whose emissions were updated by using National Pollutant Release Inventory data for 2008. This was done because staff of the Ministry of the Environment had been encouraged to investigate the facility having seen the City's early modelling results and this led to the Ministry of the Environment encouraging the facility to change its production processes and that Ministry of the Environment believed that the change was reflected in the improved 2008 National Pollutant Release Inventory emissions reporting. The contribution from Canroof to local model concentrations was remodelled and included with the other results.

More recent information, received from the Ministry of the Environment in November 2011, and as confirmed by Canroof, indicates that their production line process has been further improved and the hot spot may now be reduced to an insignificant status and indeed be no more significant than the background concentration levels produced by other sources. Their process update occurred as part of an amended Certificate of Approval as issued by the Ministry of the Environment at the end of October 2011. This also clearly demonstrates the value and importance of the Toronto Environment Office working with the Ministry of the Environment to assess and address "hot spot" issues in the future in a manner that leads to improved local air quality.

In order to address local air pollution problems, and in particular the pollutants that exceed acceptable levels, it is also important to verify such modelled estimates as referenced here, by encouraging the deployment of mobile air monitoring stations as are operated by the Ministry of the Environment, appropriately.

City of Toronto Facility Contributions

In 2009, three hundred and four "industrial" facilities in Toronto reported to the National Pollutant Report Inventory, managed by Environment Canada. Reports include combined reporting requirements Environment Canada (through their National Pollutant Release Inventory) and the Ontario Ministry of the Environment (Ontario Regulation, O.Reg.127/01). Of the 304 public and private facilities in Toronto that reported in 2009, 21 were City of Toronto corporate facilities.

The air emissions from all of Toronto's National Pollutant Release Inventory reporting facilities were included in the modeling undertaken for the Wards 30 and32 study (as for 2006). No City facility, including the Ashbridges Bay Treatment Plant, Commissioners Street Transfer Station and the Eastern and Booth Yards, are seen to have had any noticeable impact on air contaminant concentrations in the study area.

The local "hot spots" of benzene and fine particulate matter ($PM_{2.5}$) shown in Appendix C, Maps 3 and 4 are linked to private sector facility releases and not to City facilities.

Portland Energy Centre (PEC)

The development and operation of the Portland Energy Centre on Unwin Avenue has raised neighbourhood concerns about the impact of the Portland Energy Centre's emissions on local air quality. The impact of the Portland Energy Centre's operations on the air quality of Wards 30 and 32 was added as a component to the neighbourhood air quality study. Data of average emission rates and stack configurations were supplied by the Portland Energy Centre and included in the air quality modeling. But no data as to start-ups and shut-downs with respect to related emissions or event frequency were supplied by the Portland Energy Centre.

It could therefore only be assumed in the study that the Portland Energy Centre was operated for 24-hours per day for 5 days a week with only one start-up and one shut-down each week. Furthermore, as the purpose of the study was to identify the annual average situation and the maximum 24-hour situations in respect to existing provincial Ambient Air Quality Criteria standards, the model was configured to run on a time frame of 1-hour, which meant that emissions from such start-ups, which display considerable variability within an hour, had to be blended into a one hour average for the model.

The results of the modeling as conducted based on the limited data provided, showed the Portland Energy Centre to contribute only insignificantly to the background levels of nitrogen oxides (NO_x) as caused by all other contributing sources in Wards 30 and 32 and as identified and compared to annual and 24-hour averages. NO_x was selected to be modelled as it is both a significant emission and the most visible as it relates to the dark smoke observed at start ups. The modelling results, in the absence of start-up frequency data, show that the Portland energy Centre contributes very little to pre-existing background levels.

The Cumulative Health Impacts of the Air Pollutants

The health assessment looked at the cumulative impacts of modelled air concentrations of the 25 priority substances in Toronto's Environmental Reporting and Disclosure Bylaw (ChemTRAC program) and five other air pollutants in Wards 30 and 32. The summary of Toronto Public Health's Assessment for the Ward 30 and 32 Cumulative Air Modelling Study can be found in Appendix A.

The health assessment suggests that many of the thirty air contaminants selected for this study, mainly the non-carcinogenic ones, occur below levels of concern to health in Wards 30 and 32 even when the combined exposure is taken into account. However, there is an indication that some carcinogens are present at levels above the one in one million excess cancer risk benchmark. Other pollutants such as ozone, nitrogen dioxides, and particulate matter are also found at levels that are known to have an adverse impact on health. For many substances of greatest concern, such as benzene, 1,3-butadiene, and nitrogen dioxides, the locally generated emissions are mainly from transportation sources. Therefore, it is important to continue efforts to reduce air pollution from both on and off-road transportation sources.

This study is a novel way of assessing cumulative health risks from multiple pollutants for a specific neighbourhood within a large urban area. For the first time, the contribution of pollution from different geographic areas and sectors to health risks at the local level was assessed. The results aid in setting priorities and determining effective strategies for pollution prevention to reduce exposures and improve the health of Toronto residents. There is currently limited data available on the small commercial and industrial sources of air pollutants in the area of study. The data collected through the Environmental Reporting and Disclosure Bylaw (ChemTRAC program) will help improve future estimates of the cumulative exposure in these and other Toronto neighbourhoods and direct pollution prevention priorities in these communities.

Content and Availability of Consultant Report

The Golder Report includes a detailed overview of the modelling system, the methods used to calculate and estimate emissions, detailed analysis of the air emission sources, information about the emission sources, and maps displaying emissions by source and displaying concentrations for each of the 30 substances modelled.

Copies of the Golder Report can be obtained on DVD from the Toronto Environment Office or by using a link on the Toronto Environment Office's website. The complete Golder report can also be found on the Toronto Environment Office's website – http://www.toronto.ca/teo/reports-resources.htm.

CONCLUSIONS

The successful execution of the local air quality study in Wards 30 and 32 has incorporated a number of new and beneficial directions, including:

- the first local neighbourhood or community cumulative air quality study to be completed at high resolution (i.e. dense concentration of data collection points) within Toronto;
- the first time that thirty "Priority Air Contaminants" (seven federal/provincial criteria air contaminants together with 25 Toronto Health identified air toxics – two of which are also federal/provincial criteria air contaminants) have been modelled to show their predicted ground level concentrations within a Toronto neighbourhood;
- the first time that trans-boundary sources (from the northeast United States and Ontario) have been included and modelled together with local sources (from the entire City, including Wards 30 and 32) to reveal the ground level concentrations contaminants within a local neighbourhood or community air shed;
- the first time that the contribution from many different sources (including industrial, commercial, transportation, and residential sources in urban, sub-urban and rural areas) were identified and incorporated in the local air quality modelling; and
- the first time ward level air emission inventories were developed to address air quality issues within Toronto.

A key feature of the local air quality modelling study is the ability that Toronto Environment Office has to predict the cumulative concentration of multiple air contaminants in the neighbourhood arising from multiple sources, from multiple locations. Historically, human health impacts have only looked at the health effects of individual air contaminants from multiple sources. This approach acknowledged that exposure to air pollution, and any related health impacts, arises from a combination and the interaction of air contaminants from multiple sources.

Concentrations of 26 of the 30 substances studied in Wards 30 and 32 do meet provincial air quality standards. The other four contaminants may have average neighbourhood concentrations that exceed the Ministry of Environment's Ambient Air Quality Criteria standards: nitrogen oxides (NOx), benzene, polyaromatic hydrocarbons (PAHs) and fine particulate matter. It is recommended that the exceedances identified for these compounds should be verified by ground monitoring and the local exceedances addressed in co-operation with the Ministry.

Addressing the few air quality issue related "hot spots" that do exist requires a co-ordinated approach between city partners, other levels of government, and community stakeholders. One possibility is to engage the Ministry of the Environment to add additional air monitors in the area to verify the results identified by this study.

The Golder Report, produced by the project consultant (Golder Associates), points to the transportation sector as a key focus for further studies. Therefore, it is recommended that Toronto Environment Office continue to study air quality on a ward-by-ward basis focussing first on those wards that are dominated by transportation issues such as Wards 5 and 6 which are bounded by Highway 427, Queen Elizabeth Way, the Gardiner and the Lakeshore. It is anticipated that this study will be completed within approximately one year from project initiation.

Subsequent air quality studies should incorporate new sources of information such as the information that the City will obtain from Toronto Public Health's Environmental

Reporting and Disclosure Bylaw (ChemTRAC) to provide better estimates of local air emissions.

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SIGNATURE

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John Livey, Deputy City Manager, Cluster B

Appendix A

Cumulative Health Impact Assessment of Air Quality

Toronto Public Health, August 2011

The health assessment of Toronto Environment Office's modelling study looked at the cumulative impacts of modelled air concentrations of the 25 priority substances in Toronto's Environmental Reporting and Disclosure Bylaw (ChemTRAC program) and five other air pollutants in Wards 30 and 32, which include the South Riverdale and The Beaches neighbourhoods.

The cumulative assessment work was undertaken using the output from the air quality model based on emissions as reported for 2006 except in the case of a few facilities (including Canroof) that were updated based on 2008 National Pollutant Release Inventory reported data.

Toronto Public Health's Assessment for the South Riverdale and The Beaches Cumulative Air Modelling Study (found at http://www.toronto.ca/health/hphe/abtp_emissions.htm) covers:

- The background of this study
- The modelling approach used and substances chosen for the air quality assessment
- The health impacts, including the methods and findings, and
- A discussion of the results of the study.

Air modelling studies typically compare the estimated levels of pollutants against air standards or health benchmarks to identify if releases could result in levels of concern in a specific area. The predicted ambient concentrations of the individual pollutants considered in this study were below Ontario's Ambient Air Quality Criteria (AAQCs) for most of the substances. However, the model predicted that levels of benzene, nitrogen dioxides, polyaromatic hydrocarbons (PAH, measured as benzo[a]pyrene) and particulate matter (PM10) might exceed air quality objectives in some areas, some of the time. The modelling study showed that transportation is the largest local source of these pollutants.

As people are exposed to a mixture of pollutants it is useful to also consider the combined impacts of these pollutants, even when most are individually below levels of concern. The science for assessing the health impacts of mixtures of chemicals continues to evolve and there is no common approach to combined exposures from the complete range of substances considered in this study. Therefore pollutants in this study were grouped into three categories and the cumulative impact estimated for each group of substances separately. These categories were:

1) Substances associated with non-cancer effects, for which there is a health threshold;
2) Substances associated with cancer; and

3) Common air contaminants, which are mainly associated with premature death from cardiovascular and respiratory diseases.

The results of these separate cumulative assessments are described below.

1) Cumulative risk for non-cancer effects

In general, for non-cancer effects it is assumed that there is a threshold – a level below which exposure to the substance will have no adverse health impacts. The health benchmark is set at this level. Since substances have different levels of toxicity it is not possible to just add the modelled air concentrations to estimate the cumulative impacts; a common measure is needed. One such measure is the *hazard ratio*, which is obtained by dividing the exposure level with the health benchmark for each pollutant. For each substance this tells us what fraction of the health benchmark a person might be exposed to. If the hazard ratio is less than one, then a person or community is being exposed at a level which current knowledge suggests is not a concern. The hazard ratio was calculated for 22 substances with health benchmarks based on non-cancer effects

The hazard ratio values for the individual non-carcinogenic substances are all much less than one; acrolein had the largest hazard ratio at 0.1. This confirms that there is little or no risk of adverse health effects from exposures to these substances individually. When the hazard ratios for the 22 pollutants were added together, the cumulative hazard index is 0.31; this is still well below one. This suggests that the combined exposure to these air pollutants do not pose a health risk for non-cancer effects.[1]

2) Cumulative risk of cancer

For carcinogens is assumed that every amount of exposure has a risk of causing cancer. Toronto Public Health uses a concentration level in air that is associated with increasing cancer by one in one million as the health benchmark for a carcinogen. The risk of cancer for a single carcinogen is calculated by multiplying the level of the carcinogen in the air by its associated risk factor. Seven of the 19 carcinogens had modelled annual concentrations above the one in one million excess lifetime cancer risk benchmark in parts or the whole of the two wards, including: benzene; benzo[a]pyrene; 1,3-butadiene; chromium (VI); 1,4-dichlorobenzene; formaldehyde and tetrachloroethylene (perchloroethylene). With the exception of chromium and tetrachloroethylene, on and off-road transportation is the largest local source of these carcinogens.

The estimated risk for each substance was added to give a total estimate of the risk. If the average annual risk is summed across all 19 carcinogenic substances, the average cumulative cancer risk in these two wards is 83 in one million. Chromium (VI), benzene, 1,3-butadiene, and benzo[a]pyrene account for most of this risk. While the cumulative

[1] There are limitations to this approach. It assumes that the effect of the individual pollutants is in direct proportion to the level of exposure and the effect of each pollutant is additive. In some circumstances, this could overestimate the risk since it does not take into account that different pollutants affect different parts of the body and ignores the natural mechanism of the body to eliminate or detoxify these substances. At the same time, the approach could underestimate the risk since it does not take into account potential interactions between these pollutants that could increase the health impacts.

risk was somewhat above the one in a million cancer risk benchmark in all parts of the two wards, only two areas had more elevated risks – one next to the Don Valley Parkway (DVP) and the other around an industrial area close to the Port Lands (see Figure 1).

The largest part of the total cancer risk in these two wards comes from chromium (VI). The modelling shows that most of this chromium comes from sources outside Toronto and thus is a health risk that is likely common to other parts of the city. The elevated risk next to the Don Valley Parkway is mostly from 1,3-butadiene, benzene, and benzo[a]pyrene. As indicated above, these substances are mostly released from transportation sources. These are also the substances that contribute most to the overall cumulative cancer risk in the other parts of the study area. The Toronto Environment Office and the Ontario Ministry of the Environment have investigated the facility for which the modelling results indicate high exposure. The facility has taken steps to reduce its emissions. Therefore the impact this facility has on the neighbourhood is now less.

3) Cumulative risk from common air contaminants (CACs)

Our current knowledge of the health effects from the five common air pollutants (carbon monoxide, ozone, nitrogen dioxide, particulate matter (PM) and sulphur dioxide) shows that there is no threshold for these effects. Therefore, Toronto Public Health used an approach similar to the one used for carcinogens to estimate the cumulative risk from this group of pollutants. Instead of excess cancer risk we used the estimate of excess risk of premature death to calculate the cumulative impact.

Annual average values were used for estimating percent excess risk of premature death, as they are most representative of chronic, long-term exposures. The common air pollutants have a cumulative excess risk of 8.9 percent (that is, they increase the overall mortality by this amount). Fine particulate matter ($PM_{2.5}$) and nitrogen dioxide are the pollutants that contribute most to this risk.

Similar to the analysis for carcinogens, there is a higher risk in the area close to the Don Valley Parkway and industrial sources near the Port Lands. Nitrogen dioxide is the pollutant that accounts for most of the risk near the Don Valley Parkway, while fine particulate matter ($PM_{2.5}$) was the pollutant associated with the higher risk around the point source. The change in the processes in the facility that have taken place since suggest that the facility has reduced its emissions of particulate matter.

Conclusions

This health assessment suggests that many of the thirty air contaminants selected for this study, mainly the non-carcinogenic ones, occur below levels of concern to health in Wards 30 and 32 even when the combined exposure is taken into account. However, there is an indication that some carcinogens are present at levels above the one in one million excess cancer risk benchmark. Other pollutants such as ozone, nitrogen dioxides, and particulate matter are also found at levels that are known to have an adverse impact on health. For many substances of greatest concern, such as benzene, 1,3-butadiene, and nitrogen dioxides, the locally generated emissions are mainly from transportation sources.

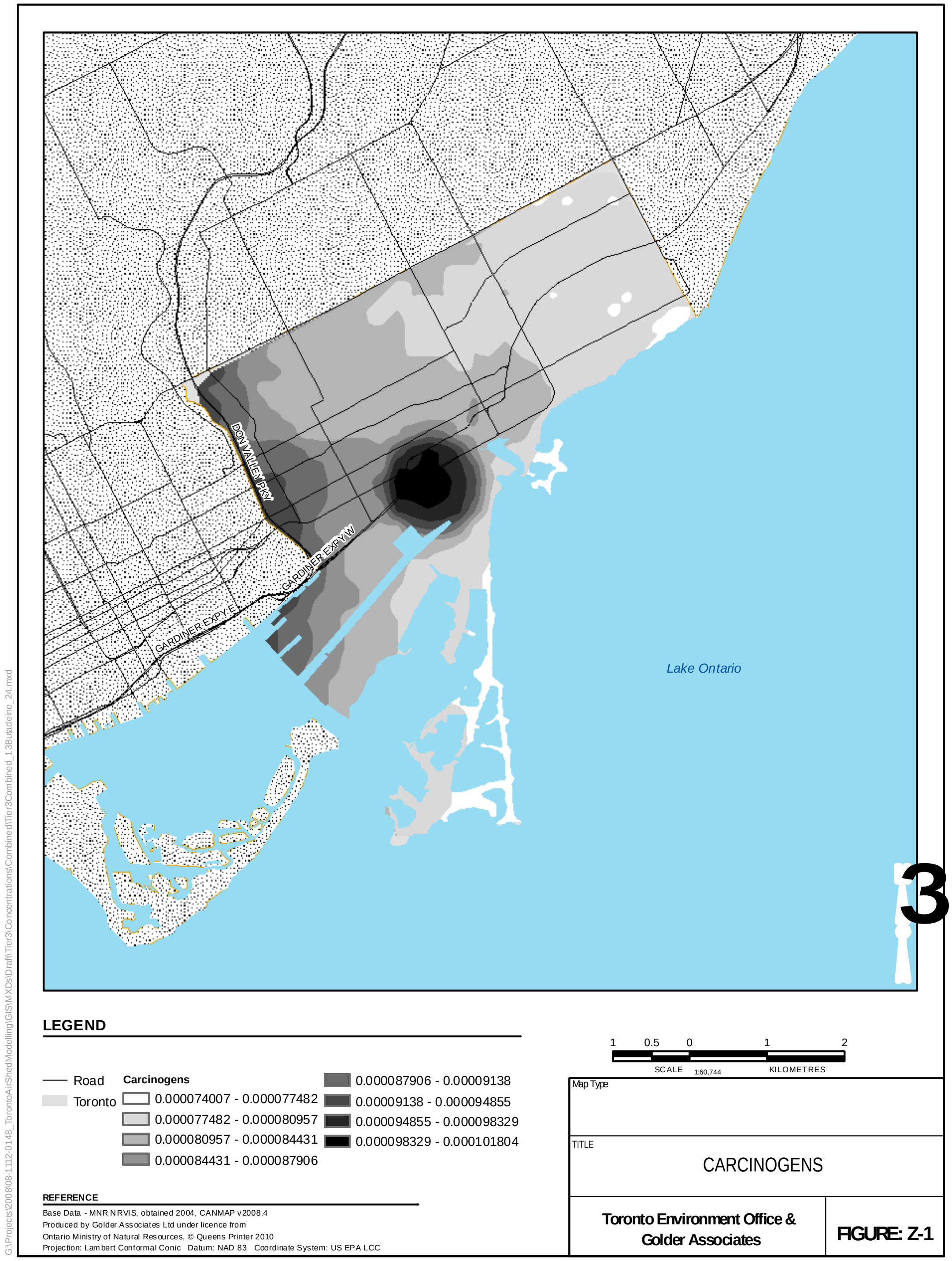
Therefore, it is important to continue efforts to reduce air pollution from both on and off-road transportation sources.

The study and modelling utilized for cumulative health effects has several limitations. It is difficult to compare the multiple health impacts into a single measure of health risk for the community. As the modelling is based on one year, 2006, the lifetime risk of diseases such as cancer are being estimated based on the air quality situation from one year. This assessment cannot account for past exposures from sources in the community that may contribute to current and future health problems.

This study is a novel way of assessing cumulative health risks from multiple pollutants for a specific neighbourhood within a large urban area. For the first time, the contribution of pollution from different geographic areas and sectors to health risks at the local level was assessed. The results aid in setting priorities and determining effective strategies for pollution prevention to reduce exposures and improve the health of Toronto residents. There is currently limited data available on the small commercial and industrial sources of air pollutants in the area of study. The data collected through the Environmental Reporting and Disclosure Bylaw (ChemTRAC program) will help improve future estimate of the cumulative exposure in these and other Toronto neighbourhoods and direct pollution prevention priorities in these communities.

[Figure 1: Estimated Cumulative Risk of 19 Carcinogens in Wards 30 and 32 follows on the next page.]

Figure 1: Estimated Cumulative Risk of 19 Carcinogens in Wards 30 and 32



Appendix B

Citizen Liaison Committee Members

Paul Young	South Riverdale Community Health Centre,
Peg Lahn	formerly with South Riverdale Community Health Centre,
Andy King	resident,
Colin Braithwaite	East End Community Health Centre,
Gayle Mount	resident,
Sarah McLaren	Portland Energy Centre Citizen Liaison Committee,
Karen Buck	Toronto Beach East Residents Association,
Julia McInerney	Toronto Beach East Residents Association,
Paul Complin	resident and air quality engineer,
Christopher Blythe	Beach Triangle Residents Association,
Ketan Shankardass	Centre for Research on Inner City Health,
Carol Goyette	observer, from Lakeshore Area Multi-Service Project "LAMP" Community Health Centre),
David McCully	former Executive Assistant and committee representative for former Councillor Sandra Bussin,
Estair Van Wagner	former Executive Assistant and committee representative for Councillor Fletcher,
Kathy Anderson	Ministry of the Environment, and
Rod Adams	Ministry of the Environment.

Appendix C

Air Quality Concentration Maps,
Examples: Nitrogen Oxides and Benzene

The first four maps included here pertain to concentrations of two substances, nitrogen oxides and benzene, and are shown as a relative percentage to the two standards, annual "average" concentrations (aka "Typical Daily" concentrations) and 24-hour "maximum" concentrations (aka "Worst Case" Daily Concentrations), in the Ward 30 and 32 area. The two "compliance maps" as a percentage of Ambient Air Quality Criteria ("AAQC") standards as shown below are not included in the Golder Report, however, the two "analysis maps" that are included here, can be found in the Golder Report.

Maps portraying nitrogen oxides and benzene were selected because they reveal clear source issues to be addressed. The majority of all other substances either reveal similar source issues or do not reveal such issues at all.

A fifth map is included to depict the influence of the activities and emissions that occur at the Billy Bishop Toronto City Airport source point. The compliance map for Acrolein is selected as representing the similar concentration patterns of sulphur dioxide, acetaldehyde and formaldehyde.

Of the 30 priority air contaminants modelled and compared with 24-hr AAQC standards, there are few contaminants that exceed their specific standard. There are only two contaminants that have been identified to exceed the AAQC at both the annual average and the maximum 24-hour reading at each virtual receptor, namely NOx and benzene (see Maps 1, 2, 3 and 4 - note that the maximum concentrations shown on the maps do not all occur on the same day; the maps show the maximum concentration that was predicted to occur at least once in the year).

PM_{10} AAQC is also exceeded at a maximum 24-hour AAQC but not as an annual average AAQC.

Ambient Air Quality Criteria ("AAQC")

The AAQCs were developed by the Ontario Ministry of the Environment as a component of their standard setting process. AAQCs are effect-based contaminant concentration levels in air, with variable averaging time (e.g., annual, 24 hour, 1 hour and 10 minutes) to be used as are appropriate for the effect that it is intended to protect against. The effects considered may be based on health, odour, vegetation, soiling, visibility, corrosion or other effects. If a contaminant has multiple AAQCs, all of them must be used for assessment purposes since each represents a different type of effect linked to a particular averaging period. The AAQCs are set at levels below which adverse health and/or environmental effects are not expected. The term “ambient” implies that these levels reflect general air quality independent of location.

The AAQCs are most commonly used in environmental assessments, special studies using ambient air monitoring data, and for the assessment of general air quality in a community. The AAQCs are used for assessing general air quality and the potential for causing an adverse effect. AAQCs effectively represent desirable levels in ambient air.

Annual Average Conditions and Worst Case Conditions

The smallest unit of time used in the local air quality modeling of Wards 30 and 32 has been one hour. Calculating hourly conditions makes it possible to also calculate average annual and average daily (i.e. 24-hour) conditions. An average annual assessment represents the typical daily conditions experienced throughout the year, based on the average conditions that occur at each receptor point over the year. The 24-hour "worst case" assessment represents the maximums average daily conditions (i.e. not a one hour maximum but a maximum averaged over a 24-hour period, which may or may not include the 1-hour maximum of the year's data, but will include the accumulated maximums of a 24-hour period) for each receptor point in the study.

Both the annual average assessment and the 24-hour (worst case) assessment when combined spatially across the local air quality study area represent a theoretical maximum concentration level as the data "producing" these maps are created from the average and worst case situations at the receptor points in the course of the year. As such, where the pollution from a smokestack, for example, will have a downwind plume on an hourly basis, by taking the worst case situations independent of time as in this study, shows on the map as a concentric or annular "hot spot" as if created by winds blowing "downwind" in all directions at the same time.

This has the benefit of showing the level of a substance's concentrations, and the area to which the concentration levels apply, during the course of a year as an average situation and as a "worst case" situation to better guide policy and improvement actions.

Annual average concentration maps represent a chronic background exposure level and the 24-hour AAQC exceedances represent an acute exposure level. Only the acute exceedances are regulated by the province.

The Substances and Maps

The four maps selected for inclusion here are taken from a basic set of approximately 120 maps (4 maps per each of 30 substances of interest) created by Toronto Environment Office (TEO) as part of the study project and provided to Golder Associates (the project consultant); 60 of these maps can be found in the in Appendix C and Appendix D of the Golder Report. For each substance modelled, TEO has produced two comparative maps and two analytical maps; comparative maps compare the "average" and the "maximum" concentration distribution against the appropriate regulatory standard – the AAQCs , and analytical maps are used to identify the actual distribution of the concentration across the local air quality study area. The analytical maps are used to identify source origins, and are especially useful where the comparative maps indicate a uniform concentration distribution at the lowest identifiable rank.

The two maps depicting nitrogen oxides are shown as "hypothetical" maps as the output from the model to hypothetically better present reality. The amount of nitrogen oxides modeled is overestimate due to the outdated and overestimated emissions provided by the USA national emissions database (the USA's Environment Protection Agency's Toxic Release Inventory - TRI) and the lack of adequate chemistry in the City's air quality model. As such, it was deemed more valid to reduce the model's resultant concentrations by a correction constant in keeping with informed estimates of recent emissions reductions in the US and informed estimates of the chemical conversions taking place within the air-shed modelled. The estimated likely reductions are in the range of 20% to 25%. The "hypothetical" maps of nitrogen oxides, as annual and maximum concentrations, have been prepared with a "hypothetical" 20% reduction – in order to address the overestimate but not to overcorrect it or risk losing sight of the real significance of NOx in the community.

<u>Nitrogen Oxides</u> (modelled as Nitrogen Dioxide)

What is it? Nitrogen oxides (NO_x) in the ambient air consist primarily of nitric oxide (NO) and nitrogen dioxide (NO_2). These two forms of gaseous nitrogen oxides are significant pollutants of the lower atmosphere. Another form, nitrous oxide (N_2O), is a greenhouse gas. At the point of discharge from man-made sources, nitric oxide, a colorless, tasteless gas, is the predominant form of nitrogen oxide. But nitric oxide is very readily and quickly converted to nitrogen dioxide by chemical reactions in air, and especially with ozone in the atmosphere. Typically, nitrogen oxides (NO_x) are modelled and monitored as nitrogen dioxide (NO_2).

Possible sources of release to air: Nitrogen oxides are found in vehicle exhaust. In the Toronto area, many manufacturing and other industrial facilities including power generation facilities report emissions of NO_2. Indoors, NO_2 is released from unvented gas stoves, other gas appliances, and kerosene heaters.

Main potential health effects: NO_2 is a common air pollutant that contributes to formation of smog and is an important contributor to the burden of illness from air pollution in the Toronto area. Both NO_2 and smog are linked to cardiovascular and respiratory illness and death. Exposure to NO_2 affects mainly the respiratory system, causing irritation and decreasing the lungs' ability to fight infection. People with asthma and bronchitis, young children, older adults, and adults with heart and respiratory disorders are especially sensitive to the adverse effects of NO_2 exposure.

Standards:

- Concentration at or below which the risk of mortality after short-term exposure is no more than 1 person in a million: 0.0134 $\mu g/m^3$ (Health Canada, 2006)

- Annual Ambient Air Quality Criterion (AAQC): None
- 24-hour Ambient Air Quality Criterion (AAQC): 200 µg/m^3 (0.10 ppm)

Map 1: Nitrogen Oxides, Hypothetical Compliance Map – Worst Case Daily Compared to AAQCs (aka Figure: C-20C)

This compliance map depicts a comparison of worst case daily concentrations to the 24-hour AAQC (200 µg/m^3) as a percentage of the AAQC standard. All locations in Wards 30 and 32 exhibit higher levels of NOx than the standard 24-hour AAQC level in a worst case situation.

Map 2: Nitrogen Oxides, Analysis Map – Annual Average Hypothetical Concentrations (aka Figure: C-50)

This analysis map clearly shows that the dominant source of NO_x (as NO_2) for Wards 30 and 32 is the Don Valley Parkway. This map shows predicted annual average concentrations (rather than percentages relative to the standard) and there is no standard established for annual averages in the case of NO_x. The maximum levels shown, as occur adjacent to the Don Valley Parkway, are less than 89 µg/m^3. The 24-hour AAQC for NO_x is 200 µg/m^3 (0.10 ppm) and the 1-hour is 400 µg/m^3 (0.20 ppm).

Acrolein

Possible sources of release to air: automobile, truck and airplane exhaust, pesticide use, heating of lubrication oils, combustion of animal and vegetable fats, wood, and plastics. Cigarette smoke is a source of acrolein indoors.

- No large facilities in the Toronto area report emissions of acrolein to air.

Main potential health effects: Exposure to high levels of acrolein in the air can irritate the respiratory tract eyes, nose and throat.

Standards:

- Annual Ambient Air Quality Criterion (AAQC): None
- 24-hour Ambient Air Quality Criterion (AAQC): 0.4 µg/m^3 (proposed)

Map 3: Analysis Map – Worst Case Daily Compared to AAQCs (aka Figure: C-2C)

The compliance map for this substance shows no part of Ward 30 or Ward 32 to have an AAQC execeedance. However, the analysis map as shown below is included to show a typical distribution from a source external to the boundaries of Wards 30 and 32 – the Billy Bishop Toronto City Airport.

Other contaminants considered to come from the same source include acetaldehyde, acrolein, formaldehyde, and sulphur dioxide and all show a similar concentric distribution with distance from the airport.

Fine Particulate Matter (PM_{10} and $PM_{2.5}$)

What is it?
Fine particulate matter smaller than 10 microns aerodynamic diameter (PM_{10}), and its subset, fine particulate matter small than 2.5 microns aerodynamic diameter ($PM_{2.5}$) are very small particles of varying chemistry but similar sized particles that only slowly settle through still air, and are readily suspended in moving air. The range of particle sizes between 10 microns and 2.5 microns are referred to as the "coarse fraction". The range of particles smaller than 2.5 microns are known as the "fine fraction". The chemistry of the particles varies with it sources.

Possible sources of release to air:
The coarse fraction is released as road dust and also as construction dust. Road dust PM comes from the wearing down of vehicle tyres, brakes and the road surface itself. Such PM is continually re-entrained by subsequent vehicles unless swept up by road sweepers or washed by rain into the sewers. Construction PM due to construction is very non-location specific and time dependent and is not included in this local air quality study. However, across Toronto, PM from construction equates approximately to the amount released by vehicles across the City.

The fine fraction of PM comes mostly from combustion related processes, including the emissions from combustion of fuels in vehicles via their tail pipes. $PM_{2.5}$ is also released in coal combustion, non-ferrous smelting, iron and steel production, and many other industrial processes. It is also released indoors and outdoors from furnaces, gas stoves, and wood stoves, and from cigarette smoke, cooking, and mould growth.

Main potential health effects:
Fine particulate matter is an important contributor to the burden of illness from air pollution in Toronto. The fine fraction of particulate matter is a component of smog, and both PM and smog are linked to cardiovascular and respiratory illness and death. PM can irritate the eyes, throat and lungs. People who are susceptible to the effects of particles include the elderly, people with existing respiratory disease such as asthma, chronic

obstructive pulmonary disease and bronchitis, people with cardiovascular disease, people with infections such as pneumonia, and children.

Standards:

- Annual Ambient Air Quality Criterion (AAQC): None
- Ministry of the Environment (MOE) Interim Guideline 24 hour standard for PM_{10}: 50 µg/m^3
- Canada Wide Standard (CWS) "proposed" 24 hour standard for $PM_{2.5}$: 30 µg/m^3

Map 4: PM_{10} Compliance Map - Worst Case Daily Compared to MOE Interim Guideline (in lieu of AAQC) (aka Figure: C-22C)

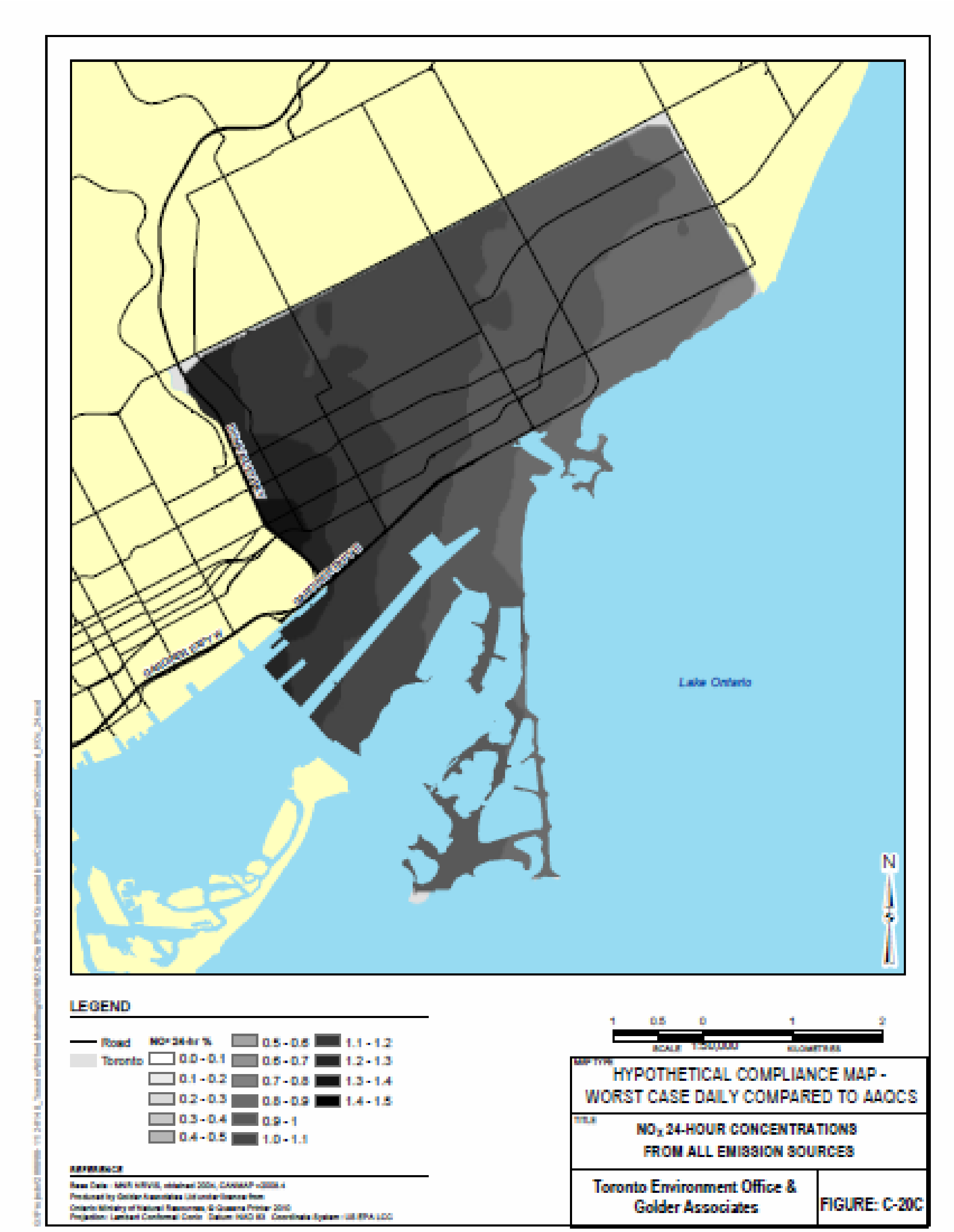
The compliance map for this substance shows approximately 66% of the area to be at or above the Ministry of the Environment's interim guideline for PM_{10}. The major area of exceedance clearly relates to the Don Valley Parkway and the adjacent downwind neighbourhood.

There is also a weak (i.e., just above the standard) concentration that extends along Commissioners Street that links the DVP related concentration with the Canroof facility. (The PM2.5 subset on Map 5 shows this contribution more clearly.)

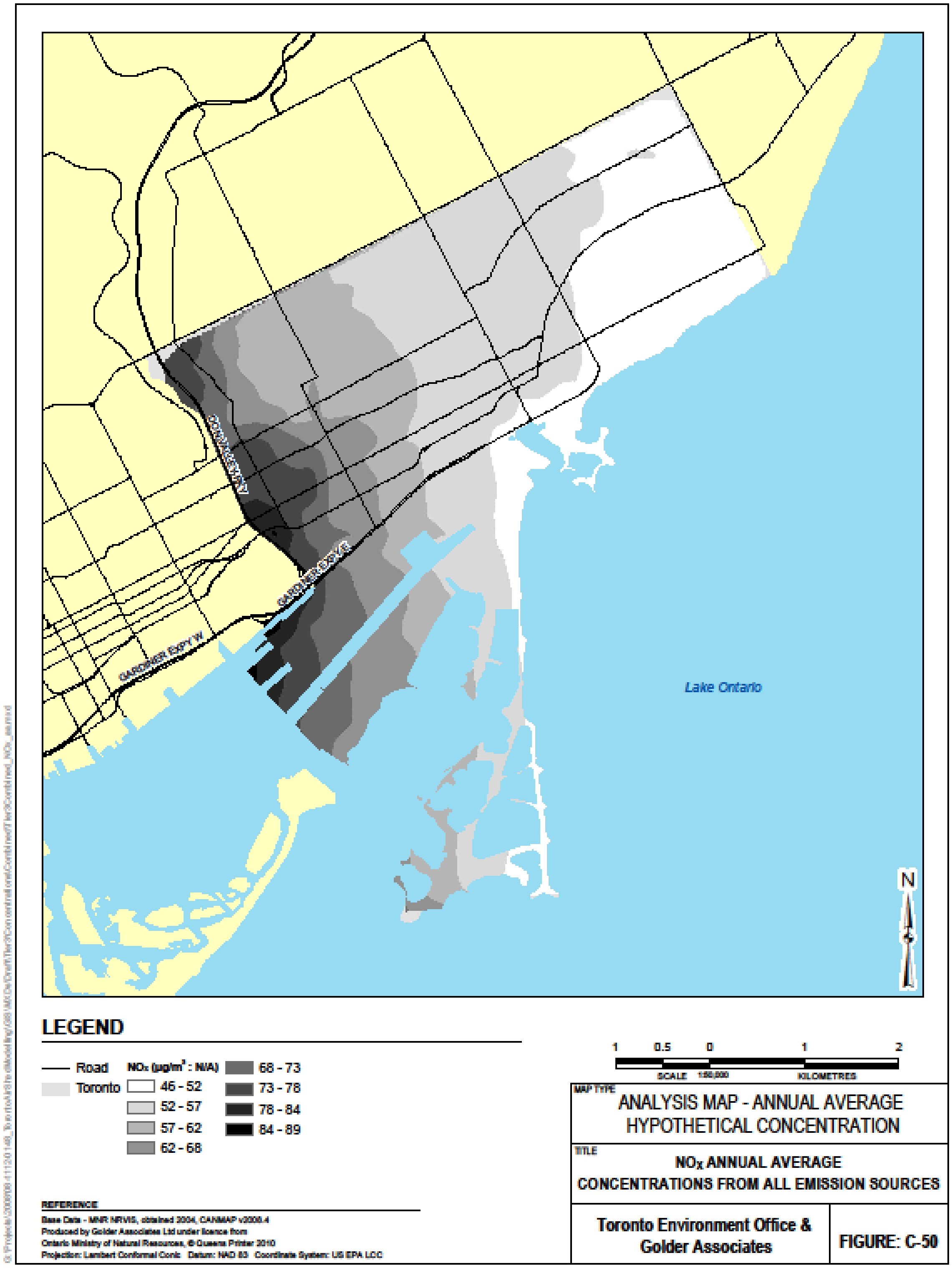
Map 5: PM Analysis Map – Worst Case Daily Compared to "proposed" Canada Wide Standard (in lieu of AAQC) (aka Figure: C-23C)

The compliance map for this substance shows a variety of source point related concentrations for $PM_{2.5}$ throughout the area, most notably as adjacent to the DVP, and in the area of the Canroof facility on Commissioners Street. The concentration along Gerard (east of Coxwell) is of mixed and uncertain origin and requires further evaluation in partnership with the MOE (see recommendation #3).

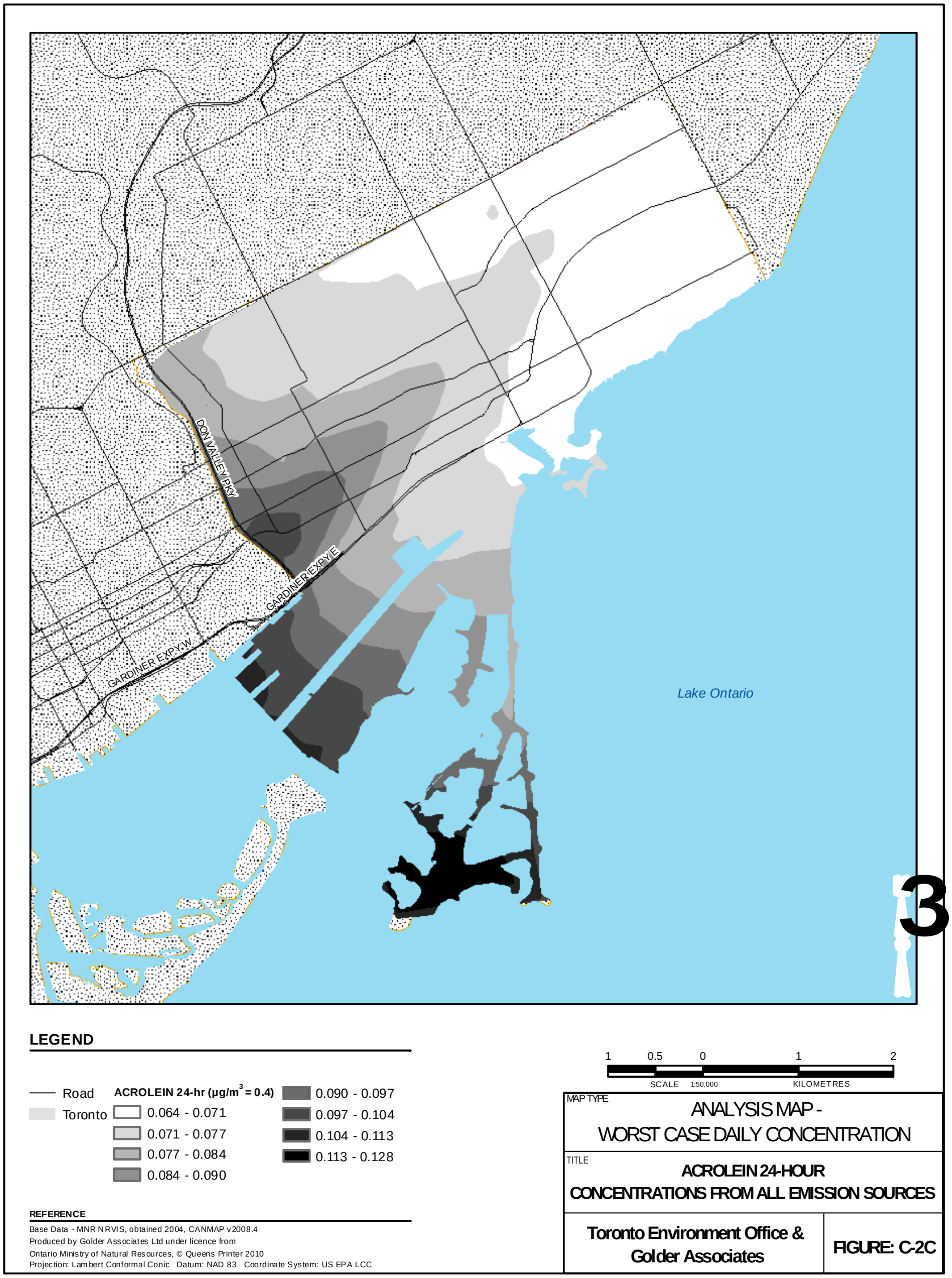
Map 1: Nitrogen Oxides, Hypothetical Compliance Map – Worst Case Daily Compared to AAQCs (aka Figure: C-20C)



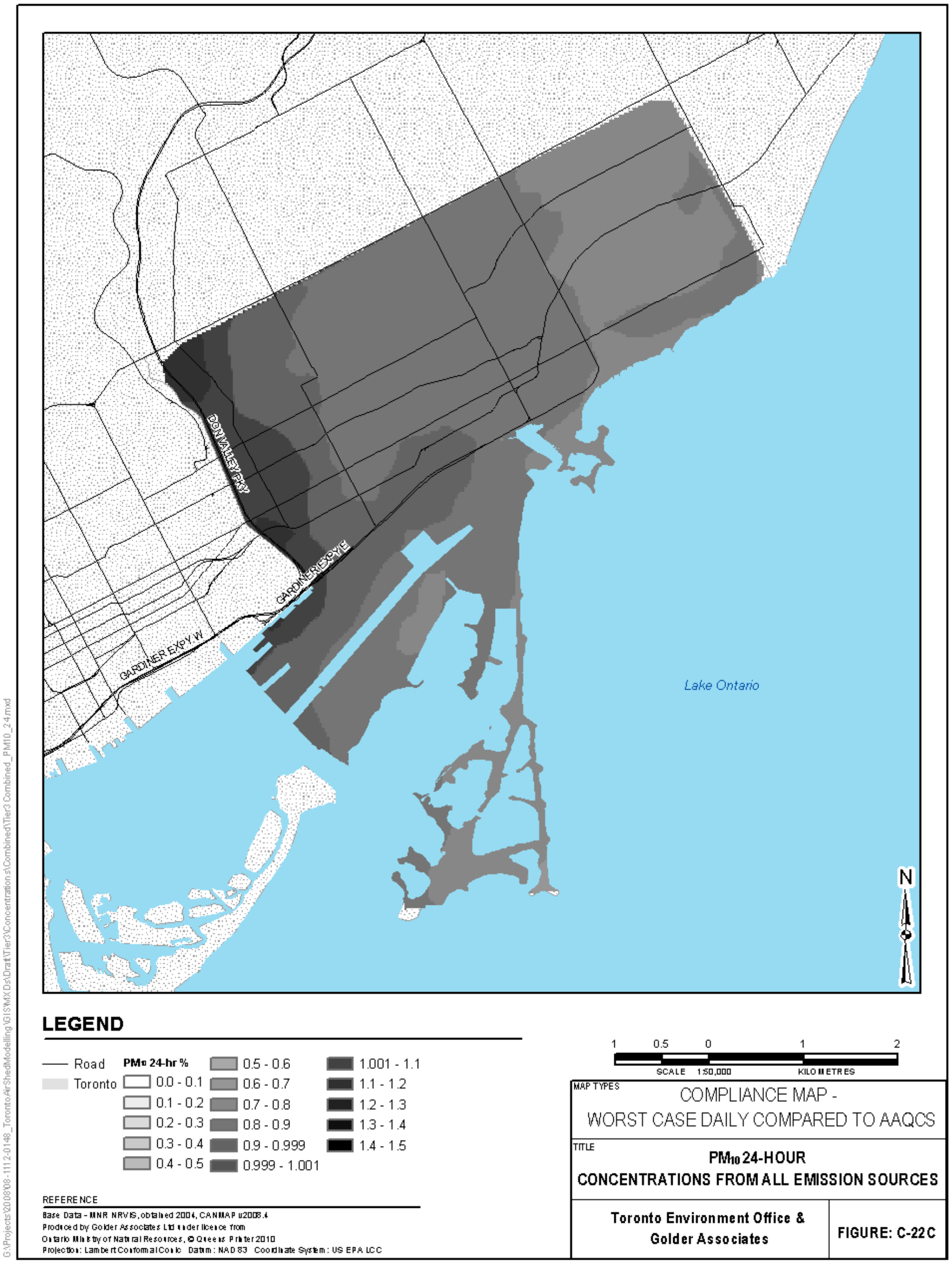
Map 2: Nitrogen Oxides, Analysis Map – Annual Average Hypothetical Concentrations (aka Figure: C-50)



Map 3: Acrolein Analysis Map – Worst Case Daily Compared to AAQCs (aka Figure: C-2C)



Map 4: PM_{10} Compliance Map - Worst Case Daily Compared to MOE Interim Guideline (in lieu of AAQC) (aka Figure: C-22C)



Map 5: PM Analysis Map – Worst Case Daily Compared to "proposed" Canada Wide Standard (in lieu of AAQC) (aka Figure: C-23C)