# CITY OF HAMILTON
***PUBLIC HEALTH SERVICES***
**Healthy Environments Division**

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| **TO:** | Mayor and Members<br>Board of Health |
| **COMMITTEE DATE:** | April 16, 2018 |
| **SUBJECT/REPORT NO:** | Hamilton Airshed Modelling System (BOH18016) (City Wide) (Outstanding Business List Item) |
| **WARD(S) AFFECTED:** | City Wide |
| **PREPARED BY:** | Sally Radisic<br>(905) 546-2424, Ext. 5549<br>Matt Lawson<br>(905) 546-2424, Ext. 5823 |
| **SUBMITTED BY & SIGNATURE:** | Kevin McDonald<br>Director, Public Health Services - Healthy Environments Division<br>Healthy and Safe Communities Department |

## RECOMMENDATIONS

(a) That staff work with Golder Associates to undertake sub-region analyses using the Hamilton Airshed Modelling System, and in consultation with key stakeholders and affected residents;

(b) That staff examine the feasibility of using Hamilton Airshed Modelling System to estimate morbidity and mortality outcomes associated with air pollution and report back to Board of Health, if necessary;

(c) That the Board of Health direct Public Health Services' staff to work with City of Hamilton Planning staff to review the Hamilton Airshed Modelling System analysis and determine appropriate applications for planning directions and decisions and report back to Planning Committee in Q1 2019;

(d) That the Board of Health request the Ministry of Environment and Climate Change to work with the City of Hamilton, other Ontario municipalities and levels of government regarding traffic-related air pollutants to address transboundary transportation contributions impacting the City of Hamilton;

(e) That the Board of Health advocate that the province of Ontario adopt the 24-hour Canadian Ambient Air Quality Standard for fine particulate matter (PM 2.5) of 28 micrograms per cubic metre of air (28 µg/m3) as air quality benchmarks for the maximum desirable concentration of particulate matter in the City of Hamilton; and

(f) Support the Ministry of the Environment and Climate Change in their proposal for a new policy focusing on Cumulative Effects Assessment in air approvals: "to more effectively consider cumulative impacts from multiple air pollution sources - both industrial and non-industrial" to address air quality issues in the City of Hamilton.

## EXECUTIVE SUMMARY

In early 2015, Golder Associates was contracted to develop a comprehensive airshed model of the City of Hamilton (BOH13029(a)) through a partnership between the City and the Hamilton Industrial Environmental Association (HIEA). The development of the model is a primary milestone identified within the City of Hamilton's Air Quality Task Force Action Plan (BOH13029).

The Hamilton Airshed Modelling System (HAMS) was developed using emissions and meteorology data via the Community Multi-scale Air Quality (CMAQ). CMAQ is a state of the science, sophisticated model developed by the U.S. EPA capable of addressing regional air pollution problems such as those found in Hamilton.

HAMS helped us to understand both the types and place of origin of emissions contributing to Hamilton's airshed. The model distinguished between emissions generated locally, and those coming from outside Hamilton, be they from neighbouring regions, or further away.

The Hamilton emission profile was developed and showed the following in terms of the type of emissions:

Industrial ..... 21.0%
Commercial ..... 1.0%
Residential ..... 0.5%
Agricultural ..... 3.0%
Transportation ..... 75.0%
- On-Road (e.g. trucks, cars) ..... 41.0%
- Non-Road (e.g. rail) ..... 34.0%

Transportation represents 75% of the total Hamilton emission profile. Further, local transportation represents over 74% of the local NOx and 37% of $PM_{2.5}$ emissions into the Hamilton airshed.

Industrial emissions represent 21% of the total Hamilton emission profile. Industrial activities generate products of combustion (such as CO, NOx, $SO_2$, and $PM_{2.5}$) as well as metals and benzo(a)pyrene (B(a)P).

Industrial activities are the largest local emitters of $PM_{2.5}$, $SO_2$, B(a)P and metals in the local airshed.

The model distinguished local emission sources from those that come from outside Hamilton. These are termed “transboundary emissions”. The model shows that, of emissions that come from outside the Hamilton region, transportation activities represent over 62% of NOx emissions and over 75% of $PM_{2.5}$ emissions respectively. Further, industrial sources represent about 97% of transboundary $SO_2$ emissions and 61% of metal emissions that come from outside the Hamilton region.

The model weighs out the contributions of specific source sectors and activities for each of the contaminants of concern that we have measurements for. These “source apportionment” model simulations look at the place of origin of the contaminants to assess the relative importance of specific source sectors (i.e. Industrial, On-Road, Non-Road, Transboundary and other such as commercial, residential and biogenic/agriculture activities) with respect to $PM_{2.5}$, $PM_{10}$, $O_3$, $SO_2$, $NO_2$, benzene and B(a)P concentrations in Hamilton.

Local industrial activities contribute less than 20% by compound ($PM_{2.5}$, $PM_{10}$, $SO_2$, $NO_2$ and benzene) to air quality in Hamilton except for B(a)P where industry is the main source of that compound(~45%). Local on-road sources are a major contributor to $NO_2$ levels in the city. Transportation related emissions are the major contributor to transboundary emission for all compounds except $SO_2$ which is dominated by industrial sources. Ozone was shown to be constant across the city but reduces near the major highways where it reacts with NOx to create higher $NO_2$ levels near the roads. There is definite geographical variation in the profile of contributors to air quality within the city.

Overall the HAMS model provides better understanding of the sources of emissions into Hamilton’s airshed, and relates these to the health and environmental impacts the contaminants have on our residents and our community. The model results suggest that air quality in Hamilton is hugely influenced by transboundary emissions with the exception of a few compounds including $PM_{2.5}$, $SO_2$, B(a)P and metals which are emitted by local industry. Therefore, emissions reductions in Hamilton will be dependent on local policies and programs but to a greater extent on advocacy for change at provincial and other levels of government.

***Alternatives for Consideration – See Page 8***

## FINANCIAL – STAFFING – LEGAL IMPLICATIONS

**Financial:** Additional funding will be needed to perform any additional future analysis using the HAMS. If additional funding beyond existing and/or approved departmental budget is required, staff will report back to BOH before initiating any projects.

**Staffing:** Not Applicable.

**Legal:** Not Applicable.

## HISTORICAL BACKGROUND (Chronology of events)

- **December 2013**: Board of Health members approve recommendations put forward from the Hamilton Air Quality Task Force Action Plan (BOH13029), which included the development of an airshed model for the City of Hamilton;

- **July 2014:** Board of Health approves the Medical Officer of Health be authorized and directed to negotiate and execute a funding agreement for the development of an airshed model with the Hamilton Industrial Environmental Association Inc. (HIEA) (BOH13029(a));

- **December 2014**: Funding agreement between City of Hamilton and HIEA signed;

- **January 2015:** Golder Associates procured to develop the Hamilton Airshed Modelling System;

- **January 2018:** Golder Associates announces that the HAMS data has been successfully validated and model results can be reported in near future, and;

- **March 2018:** Golder Associates present the HAMS at the 5th biennial 'Upwind/ Downwind' conference.

## POLICY IMPLICATIONS AND LEGISLATED REQUIREMENTS

Not Applicable.

## RELEVANT CONSULTATION

Public Health Services staff consulted with members of Clean Air Hamilton (CAH) about developing an airshed model for Hamilton. An advisory committee for the project was formed to monitor the progress of the development of the HAMS and to provide feedback requested from the contracted developer of the model (Golder Associates).

Members of CAH representing the following organizations participated on the HAMS advisory committee: Ontario Ministry of Environment & Climate Change (MOECC); the Hamilton Industrial Environmental Association (HIEA); Environment Hamilton; and Hamilton Public Health Services. In addition to the advisory committee, Golder Associates obtained an expert review of the analysis methodology and the modelling results to ensure the quality of data provided by the HAMS is of the highest quality.

## ANALYSIS AND RATIONALE FOR RECOMMENDATION

### Hamilton Airshed Modelling System (HAMS)

Air quality in an urban airshed like Hamilton's is influenced by local, regional and transboundary sources, as well as the prevailing geographical and meteorological conditions that transport, disperse and deposit air pollutants. The Hamilton Airshed Modelling System (HAMS) relies on the development of two key data sets including: meteorology and emissions. These data sets were combined via the application of the Community Multi-scale Air Quality (CMAQ) model which predicts spatially and temporally resolved concentrations of priority air contaminants including: particulate matter ($PM_{2.5}$, $PM_{10}$), ozone ($O_3$), sulphur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), benzene and benzo(a)pyrene (B(a)P) concentrations in Hamilton. CMAQ brings together three kinds of models including: a meteorological model (representing of atmospheric and weather conditions), an emissions model (representing of human-made and naturally occurring contributions in the atmosphere), and an air chemistry-transport model (predicting the atmospheric fate of air pollutants under varying conditions).

For HAMS, CMAQ was used to model four nested grid resolutions referred to as the following Tiers:

| | |
|---|---|
| Tier I | 36 km x 36 km comprising of Canada and US |
| Tier II | 12 km x 12 km comprising of Ontario |
| Tier III | 4 km x 4 km comprising of Hamilton Region |
| Tier IV | 1.33 km x 1.33 km comprising of the Community Level |

The capture of both local and regional emissions and chemistry is achieved via increasing grid resolution that becomes more detailed with proximity to the Hamilton study area.

### Emissions Inventory

Data from provincial air regulatory and transportation planning agencies was used to develop a comprehensive emission dataset which includes parts of the US and Canada. Emissions for the compounds of interest were built up from activity data and integrated together for a composite of emissions from the various tiers.

Emission classifications included industrial, transportation (on-road and non-road such as airport, railway and marine activities), commercial, residential and agricultural for all four tiers. The Tier IV or Hamilton emission profile was developed and the distribution by total mass emission is as follows:

- Industrial ..... 21.0%
- Commercial ..... 1.0%
- Residential ..... 0.5%
- Agricultural ..... 3.0%
- Transportation ..... 75.0%
  - On-Road (i.e. trucks, cars) ..... 41.0%
  - Non-Road (i.e. rail) ..... 34.0%

Transportation represents 75% of the total Hamilton emission profile. Further local transportation represents over 74% of the local NOx and 37% of $PM_{2.5}$ emissions into the Hamilton airshed.

Industrial emissions represent 21% of the total Hamilton emission profile. Industrial activities generate products of combustion (CO, NOx, $SO_2$, and $PM_{2.5}$) as well as metals and B(a)P and are the largest local emitters of $PM_{2.5}$, $SO_2$, B(a)P and metals in the local airshed.

Transboundary emissions are from sources outside the Hamilton region (i.e. the sum of Tier I, II and III). Therefore, from outside the Hamilton region, transportation activities represent over 62% of NOx emissions and over 75% of $PM_{2.5}$ emissions respectively. Further, from outside the Hamilton region, industrial sources represent about 97% of transboundary $SO_2$ emissions and 61% of metal emissions.

**Hamilton Airshed Model Performance Evaluation**

Model Performance Evaluation (MPE) is the process of testing a model's ability to accurately predict observations. Hamilton model results were compared with observations from the air quality monitoring network which includes regulatory stations (i.e. MOECC, Environment Canada) as well as the Hamilton Air Monitoring Network (HAMN). MPE was carried out for $PM_{2.5}$, $PM_{10}$, $O_3$, $SO_2$, $NO_2$, benzene and B(a)P.

Overall, the modelling system provides good results given the complexity of the model and inputs. CMAQ tends to over-predict concentrations with the exception of $PM_{10}$ where the model under-predicts which is attributed to unaccounted local fugitive dust sources such as construction activities.

## Source Apportionment Results

Source apportionment (i.e. place of contaminant origin) model simulations were used to assess the relative importance of specific source sectors (i.e. Industrial, On-Road, Non-Road, Transboundary and other such as commercial, residential and biogenic/agriculture activities) with respect to $PM_{2.5}$, $PM_{10}$, $O_3$, $SO_2$, $NO_2$, benzene and B(a)P concentrations in Tier IV Hamilton as shown in the table below.

**Table 7-1: Tier IV Domain Annual Averaged Source Contribution (%)**

| Source | $PM_{2.5}$ | $PM_{10}$ | $SO_2$ | $NO_2$ | Benzene | B(a)P |
|---|---|---|---|---|---|---|
| Industrial | 6% | 6% | 18% | 4% | 13% | 48% |
| On-Road | 1% | 2% | 1% | 34% | 6% | 23% |
| Non-Road | 1% | 1% | 17% | 7% | 12% | 0% |
| Transboundary | 91% | 90% | 64% | 43% | 68% | 28% |
| Other | 0.5% | 0.5% | 0.2% | 12% | 0.6% | 0.3% |

Averaged over the City local industrial emissions contribute less than 20% by compound ($PM_{2.5}$, $PM_{10}$, $SO_2$, $NO_2$ and benzene) to air quality in Hamilton except for B(a)P where industry is the main source of that compound.

It is important to point out that although B(a)P is hazardous to human health, in Hamilton, B(a)P is localized and concentrated around the industrial area with limited reach and impact on population health; whereas, $PM_{2.5}$ which is also hazardous to human health, is dispersed all over the City of Hamilton and has broader reach and higher impact on population health such that all residents are exposed on a continuous basis.

Local on-road sources are a major contributor to $NO_2$ levels in the city. Transportation related emissions are the major contributor to transboundary emission for all compounds except $SO_2$ which is dominated by industrial sources.

There is variation of the contribution profile depended on the area/ward within the City. For example, the contribution along Burlington Street would be greatly influenced by industrial sources than elsewhere. Similarly for near major roadways which flow through the City.

## Conclusion

The results of the HAMS identify the contribution and nature of various local and transboundary sources of contaminants including: particulate matter ($PM_{2.5}$, $PM_{10}$), ozone ($O_3$), sulphur dioxide ($SO_2$), nitrogen dioxide ($NO_2$), benzene and benzo(a)pyrene (B(a)P) concentrations in the Hamilton study area. Based on the findings, transboundary sources dominated the total emissions released into Hamilton with the

exception of a few compounds including $PM_{2.5}$, $SO_2$, B(a)P and metals which are emitted by local industrial activities. Therefore, emissions reductions in Hamilton will be dependent on local policies and programs but to a greater extent on advocacy for change at provincial and other levels of government.

## ALTERNATIVES FOR CONSIDERATION

Do nothing and allow the province to lead in the area of air quality management.

## ALIGNMENT TO THE 2016 – 2025 STRATEGIC PLAN

**Healthy and Safe Communities**
*Hamilton is* a safe and supportive city where people are active, healthy, and have a high quality of life.

**Clean and Green**
*Hamilton is* environmentally sustainable with a healthy balance of natural and urban spaces.

## APPENDICES AND SCHEDULES ATTACHED

Appendix A to Report BOH18016 - Golder's Results Report on Hamilton Airshed Modelling System (HAMS)