CEAA ENVIRONMENTAL

ENVIRONMENTAL IMPACT ASSESSMENT

AMBASSADOR BRIDGE ENHANCEMENT PROJECT

Replacement Span and Plaza Expansion

APPENDIX D

AIR QUALITY ASSESSMENT

Final Report

ORTECH Environmental
a division of ORTECH Consulting Inc.

Air Quality Assessment for the Ambassador Bridge Enhancement Project

A Report to: The Canadian Transit Company
780 Huron Church Road, Suite 202
Windsor, Ontario
N9C 2K2

Attention: Mr. Dan Stamper
Tel: (313) 849-5244
Fax: (313) 849-1063

Submitted by: Scott Manser, P.Eng.
Senior Project Manager, Compliance and Permitting
Tel: (519) 966-8798
Fax: (519) 966-8014
E-mail: smanser@ortech.ca
and
Paul Complin, M.Sc., P.Eng
Principal, Compliance and Permitting
Tel: (905) 822-4120, Ext 266
Fax: (905) 855-0406
E-mail: pcomplin@ortech.ca

Project No.: 90868
56 pages, 16 Appendices

Date: April 20, 2012

TABLE OF CONTENTS

Page

EXECUTIVE SUMMARY 1
1. INTRODUCTION 5
2. SCOPE OF THE AIR QUALITY ASSESSMENT 7
2.1 The Study Area 7
2.1.1 The Site Study Area 7
2.1.2 The Local Study Area 7
2.1.3 The Regional Study Area 10
2.2 Receptors 11
2.2.1 Virtual Receptors 11
2.2.2 Special Receptors 11
2.3 Pollutants of Interest 11
2.4 The Emission Scenarios 13
2.5 Air Quality Criteria and Background Concentrations 13
2.6 Tiered Approach 13
3. DATA COLLECTION AND ANALYSIS 15
3.1 Ambient Air Quality Data 15
3.2 Fleet Data 18
3.3 Ambassador Bridge Enhancement Project Data 18
3.4 Receptor Data 19
3.5 Dispersion Models and Output Data 20
4. EMISSION INVENTORY 21
4.1 Vehicle Emissions 21
4.1.1 Vehicle Emission Factors from MOBILE 6.2C 22
4.1.2 Vehicle Emission Factors for Other Pollutants of Interest 24
4.2 Road Dust 26
4.3 Construction Activities 27
4.4 Summary of Annual Emissions (Burden) 29
4.4.1 Bridge Annual Vehicle and Road Dust Emissions 29
4.4.2 Regional Annual Emissions 30

TABLE OF CONTENTS

Page

5. DISPERSION MODELLING....33
5.1 CAL3QHCR Dispersion Modelling (Roadways)....33
5.2 AERMOD Dispersion Modelling (Construction Activities)....34
5.3 Ozone Predictions....36
6. ASSESSMENT OF RESULTS....37
6.1 Cumulative Effects....38
6.1.1 Maximum Modelling Concentrations....38
6.1.2 Cumulative Concentrations....40
6.2 Mitigation Measures for Areas....43
6.2.1 Vehicle and Road Dust Emissions....43
6.2.2 Construction Activity Emissions....45
6.3 Significance of Environmental Effects....47
6.3.1 Environmental Effects of Project (ABEP)....47
6.3.2 Environmental Effects of Other Projects....50
6.4 Monitoring and Adaptive Management Planning....53

7. SUMMARY OF KEY FINDINGS....54

Figure 1 Air Quality Assessment Flow Diagram....8
Figure 2 Site Study Area and Local Study Area....9

Table 1 Pollutants of Interest....12
Table 2 Emission Scenarios for Air Quality Assessment....13
Table 3 Summary of Air Quality Criteria and Background Concentration....17
Table 4 Summary of Traffic Profile and Peak Hourly Traffic Flow-Tier 1....23
Table 5 Comparison of PAH Emission Factors to Air Quality Criteria....25
Table 6 Summary of Bridge Annual Emissions....30
Table 7 Summary of Annual Regional Emissions....31
Table 8 Comparison of Annual Emissions....32
Table 9 Summary of Tier 2 Assessments....37
Table 10 Summary of Maximum Modelling Concentration Results....39
Table 11 Summary of Maximum Air Quality Concentration Results....42
Table 12 Summary of Scenarios Above Air Quality Criterion....43
Table 13 Summary of Cumulative Environmental Effects Relative to Present (Baseline)....52

TABLE OF CONTENTS

Appendix 1 Revised Federal Environmental Assessment Guidelines
Appendix 2 Ambient Air Quality Data Collection and Analysis
Appendix 3 Fleet Data Collection and Analysis
Appendix 4 Construction Activities Data Collection and Analysis
Appendix 5 Receptor Data Collection and Analysis
Appendix 6 Meteorological Data Collection and Analysis
Appendix 7 Vehicle Emission Calculations
Appendix 8 Road Dust Emission Calculations
Appendix 9 Construction Emission Calculations
Appendix 10 Annual Bridge and Regional Emissions
Appendix 11 Dispersion Modelling
Appendix 12 Ozone Isopleth Method
Appendix 13 Concentration Contours
Appendix 14 Mitigation Measures for Construction Activities
Appendix 15 Frequency Plots
Appendix 16 Air Quality Monitoring Plan

EXECUTIVE SUMMARY

The Ambassador Bridge Enhancement Project (ABEP) involves the construction and operation of a new international bridge across the Detroit River parallel to the existing Ambassador Bridge (interim improvements) and expansion of the Windsor Plaza (ultimate improvements). The proposed bridge is a new six-lane cable-stayed bridge, located approximately 30.5 metres (100 feet) from the centre line of the existing Ambassador Bridge to the centre line of the proposed bridge which is referred to as the replacement span. The replacement span will have six-lanes and new safety shoulders and will be able to accommodate modern vehicles. The central median barrier will offer more safety, and the proposed six-lane design will facilitate better traffic flow back and forth across the border. Two of the six lanes will be dedicated to the low-risk FAST/NEXUS traffic, allowing for faster clearance of that traffic and leaving four lanes for general and non-FAST commercial traffic. The construction of the replacement span is considered the interim improvement and will occur in Phase I of the Project. The proposed bridge will connect to the existing plazas in Canada and the United States. Plaza improvements are considered the ultimate improvement of the Project and will occur in Phase 2.

The overall purpose of the air quality assessment is to determine if the construction and operation of the ABEP will result in any environmental effects and consider any mitigation measures to avoid significant environmental effects.

The study scope was carefully planned to provide insight into a variety of substances, locations and future scenarios. The study scope was based on the factors for air quality and climate change outlined in the Environmental Assessment Guidelines: August 2007 (EA Guidelines) provided by the federal EA review team. Prior to commencing the air quality assessment, ORTECH documented the intended study scope in an Air Quality Work Plan (AQWP) and submitted to Environment Canada for review and comment. An initial air quality assessment study was conducted in 2007. This report provides an updated assessment based upon the current project timelines and developments.

In conducting the assessment, the current air quality conditions were compared to air quality conditions that are expected to occur in the future. The areas surrounding the bridge, the customs plaza, and the stretch of public roadway leading from the bridge known as Huron Church Road were included in the assessment. The air quality impacts related to construction activities were also taken into account.

Traffic data from publicly available sources such as The City of Windsor, Canadian Transit Company and Detroit River International Crossing Project as described in detail in Section 3.2, was used for estimating vehicle flow and profile for existing and future scenarios. The roadway fleet data, combined with

MOBILE6.2C (a model developed by the United States Environmental Protection Agency (USEPA) and enhanced by Environment Canada to reflect Canadian standards) was used to develop emission factors for vehicle emissions. A USEPA Compilation of Emission factors (AP-42: Chapter 13.2) was used to develop emission factors for roadway emissions (road dust).

State-of-science air dispersion modeling tools were utilized based on the Air Dispersion Modelling Guide for Ontario (ADMGO), specifically the USEPA CAL3QHCR was used to evaluate vehicle emissions and road dust and the USEPA AERMOD was used to evaluate construction activities. Cumulative effects were considered by adding the background concentration to the concentrations predicted using the dispersion models.

The key findings of the assessment were:

1. The **existing conditions** indicate that the greatest air quality impacts do not occur at the bridge or the customs plaza, but occur around key intersection locations along Huron Church Road. The impacts generally occur in close proximity (within $\underset{\sim}{}$ <150 m) to Huron Church Road and decrease significantly with distance. Air quality modeling indicates that concentrations above the air quality criteria may occur at these locations for certain pollutants of interest (NO_X, PM_{10} and $PM_{2.5}$). Idling and acceleration of vehicles related to traffic control lights appear to be a significant contributor to the air quality impacts. Air quality impacts could be reduced by measures that would allow thru-traffic to flow more freely such as enhanced signal timing and/or the removal of lights at key intersections.

2. The **existing conditions** indicate that the greatest impact, aside from Huron Church Road intersections, occurs at the customs plaza. Air quality modeling indicates that concentrations above the air quality criteria could occur in close proximity to this location for certain pollutants of interest. Idling and acceleration of vehicles in the customs queue seem to be the primary contributor.

3. Under the future scenario, in **2015**, that considers impacts from **construction activities** related to the replacement span, air quality in close proximity (within 300m) to the bridge will be impacted due to emissions from construction equipment. The potential exists for concentrations of PM_{10} to be above the air quality criteria. The project proponent plans a number of practical measures that will mitigate the construction impacts, including when, how and where the construction equipment will be deployed. Specific mitigation measures are discussed in detail in Section 6.2 of this report.

4. Under the future scenario, in **2025** with the **Ambassador Bridge** referred to as "Future Do Nothing" or 2025 (FDN), the greatest air quality impacts are still predicted to occur along Huron Church Road, but are reduced in magnitude and aerial extent relative to the present (baseline) as more stringent fuel and vehicle emission standards take effect. For most pollutants of interest, the model suggests that the effect of more stringent standards outweighs the increase in traffic volumes. The improvement is most apparent for substances that are closely tied to the standards, such as NO_X. Under this scenario, NO_X concentrations are predicted to be below the air quality criteria. The policy assumptions considered by Environment Canada in the development of the model (MOBILE 6.2C) used to estimate current and future vehicle emissions are detailed in the model documentation. Policies impacting future vehicle emissions include but are not limited to a reduction in the gasoline and diesel sulphur content to 30 ppm and 15 ppm, respectively; 5% ethanol replacement; emission standards for passenger vehicles and light duty trucks phased in according to the schedules specified in Tier 1, NLEV and Tier 2 regulations; Canadian motorcycle emission regulations phased in during the period 2006 to 2010 as well as regular incremental reductions in volatile organic compound emissions under the United States 1990 Clean Air Act Requirements for ozone non-attainments areas. It should be noted that the new emission standards for heavy duty vehicles implemented in the United States in 2007 are not accounted for in MOBILE6.2C.

5. Under the future scenario, in **2025**, 10 years after construction and operation of the **replacement span** referred to as 2025 (A), the greatest air quality impacts are still predicted to occur along Huron Church Road, but are reduced in magnitude and aerial extent relative to the present (baseline) as more stringent fuel and vehicle emission standards take effect as described above. In addition, the air quality in the area near the customs plaza and on the bridge is predicted to benefit from improved traffic flow due to the higher capacity of the expanded customs plaza and the new bridge. The reduced vehicle emissions appear to outweigh the increase in traffic volumes for most pollutants of interest. The reduced magnitude and aerial extent is most apparent for substances that are closely tied to the standards, such as NO_X. Under this scenario, NO_X concentrations are predicted to be below the air quality criteria.

6. Under the future scenario, in **2025**, 10 years after construction and operation of the **replacement span plus Ambassador Bridge** referred to as 2025 (B), the greatest air quality impacts are still predicted to occur along Huron Church Road, but are reduced in magnitude and aerial extent relative to the present (baseline) as more stringent fuel and vehicle emission standards take effect as described above. In addition, the air quality in the area near the customs plaza and on the bridge is predicted to benefit from improved traffic flow due to the higher capacity of the expanded customs plaza and the new bridge. The reduced vehicle emissions appear to outweigh the increase in traffic volumes for most pollutants of interest. The reduced magnitude and aerial extent is most apparent for substances that are closely tied to the standards, such as NO_X. Under this scenario, NO_X concentrations are predicted to be below the air quality criteria.

7. A comparison of the future **2025 "do nothing" and replacement span** only scenarios, indicate that the **replacement span and customs plaza will result in an improvement** in air quality, notably in the area close to the bridge and the customs plaza.

8. The future **2025** replacement span plus existing Ambassador Bridge scenario results in an increase in air quality concentrations of some contaminants in the vicinity of the customs plaza relative to the other 2025 scenarios. This is due to the "worst case" nature of this "two bridge scenario" which assumes all heavy duty vehicle traffic occurs on the replacement span with all light duty vehicle traffic on the Ambassador Bridge. The increased concentration of higher emitting heavy duty vehicles along the replacement span (particularly in the southbound direction) is predicted to result in slightly higher concentrations of some pollutants of interest, particularly PM_{10} and $PM_{2.5}$ associated with road dust, in the vicinity of the customs plaza. Operation of the replacement span plus the Ambassador Bridge is not considered a practical scenario by the proponent but has been assessed at the request of the federal EA review team.

9. The greatest potential for improving air quality exists where air quality is impacted the most, along Huron Church Road. Comparing areas along Huron Church Road where traffic flows freely to areas with major arterial intersections suggests that air quality impacts could be reduced significantly by measures that would allow thru-traffic to flow more freely such as enhanced signal timing and/or the removal lights at key intersections. Such measures fall outside the jurisdiction of the project proponent and as such strategies for mitigation in this area were not considered in the context of this air quality assessment.

1. INTRODUCTION

ORTECH Environmental (ORTECH) was contracted by the Canadian Transit Company (CTC) to carry out an air quality assessment as part of the Environmental Impact Statement (EIS) related to the Ambassador Bridge Enhancement Project.

For over 50 years, industry and government have turned to ORTECH for independent technology-based environmental science and air quality services. As a recognized leader, ORTECH provides the highest quality services in technical consulting, problem solving, testing and evaluation with emphasis on air quality assessment and advanced computational techniques.

The Ambassador Bridge Enhancement Project (ABEP) involves the construction and operation of a new international bridge across the Detroit River parallel to the existing Ambassador Bridge (interim improvements) and expansion of the Windsor Plaza (ultimate improvements). The proposed bridge is a new six-lane cable-stayed bridge, located approximately 30.5 metres (100 feet) from the centre line of the existing Ambassador Bridge to the centre line of the proposed bridge which is referred to as the replacement span. The replacement span will have six-lanes and new safety shoulders and will be able to accommodate modern vehicles. The central median barrier will offer more safety, and the proposed six-lane design will facilitate better traffic flow back and forth across the border. Two of the six lanes will be dedicated to the low-risk FAST/NEXUS traffic, allowing for faster clearance of that traffic and leaving four lanes for general and non-FAST commercial traffic. The construction of the replacement span is considered the interim improvement and will occur in Phase I of the Project. The proposed bridge will connect to the existing plazas in Canada and the United States. Plaza improvements are considered the ultimate improvement of the Project and will occur in Phase 2.

The overall purpose of the air quality assessment is to determine if the construction and operation of the Enhancement Project will result in any significant adverse impacts on the environment.

The scope of the air quality assessment was originally developed to address requirements set forth by the federal Environmental Assessment review team in the document titled “Draft Federal Environmental Assessment Guidelines under the Canadian Environmental Assessment Act for the Ambassador Bridge Environmental Assessment (2006)” dated March 2007. The guidelines were revised in August 2007 (“EA Guidelines”). The EA Guidelines include a summary of the air quality and climate requirements provided in the Appendix 1.

As recommended in the draft EA Guidelines, prior to commencing the air quality assessment, ORTECH documented the intended study scope in a document titled "draft Air Quality Work Plan" dated June 8, 2007. Incorporating comments and suggestions provided by Environment Canada (July 13, 2007), a revised Air Quality Work Plan (AQWP) dated August 10, 2007 was submitted and reviewed by Environment Canada. Further information for clarification purposes was provided to Environment Canada on October 23, 2007. An initial air quality assessment study was conducted in 2007. This report provides an updated assessment based upon the current project timelines and developments.

The scope of the air quality assessment involved:

- preparation of a AQWP including defining the study area, receptors and pollutants of interest;
- relevant data collection and analysis;
- assessment of current and projected fleet profile and traffic flow;
- preparation of an air emission inventory (air pollutant burden);
- setup and completion of dispersion modeling; and
- assessment of results including assessing cumulative effects and mitigation measures where necessary.

The scope of the air quality assessment is described in detail in Section 2.

The emission estimation tools and air quality models used were those identified by Transport Canada in the revised EA Guidelines dated August 2007 and are widely used and state-of-the-art tools for such analysis. Ambient air quality background data from government sources was relied upon for the purposes of this analysis. The results related to concentrations of substances were based on model predictions and are sophisticated estimates only; actual measured at physical locations by analytical methods may give different results.

2. SCOPE OF THE AIR QUALITY ASSESSMENT

The scope of the air quality assessment, based on the AQWP is summarized in the following sections and is shown graphically in the flow chart presented in Figure 1.

The air quality assessment considered maximum (worst case) impacts for specific scenarios through the use of conservative model inputs and selection of maximum model outputs to develop the maximum credible air pollution emission scenarios for comparison with air quality criteria.

2.1 The Study Area

Since the replacement span is situated predominantly within the Windsor urban area, the impacts on residences and other potentially sensitive receptors were addressed. Impacts on other nearby potentially sensitive environmental areas such as First Nations lands and transboundary receptors were also considered.

The study area was defined in three zones (site, local and regional) as described below.

2.1.1 The Site Study Area

Consistent with the EA Guidelines, the Site Study Area will consist of the project footprint, identified as the area where new construction takes place. The Site Study Area is shown in Figure 2.

2.1.2 The Local Study Area

The Local Study Area is defined as the area existing outside the Site Study Area boundary, where there may be the possibility for potential environmental effects of the project on air quality.

For the purpose of air quality impacts, the Local Study Area has been defined as areas within 300 m of Huron Church Road extending two kilometers from the Site Study Area to the intersection of Huron Church Road and Industrial Drive. An ambient air quality study conducted by the Ontario Ministry of the Environment (2004) concluded *"Increases in particulate matter above ambient conditions were measured at distances from a few metres to 300 metres from the roadway"*. The extent of the Local Study Area was established based upon a review of the build / no build emission scenarios.

The Local Study Area is described below and shown in detail in Figure 2.

Figure 1: Air Quality Assessment Flow Diagram

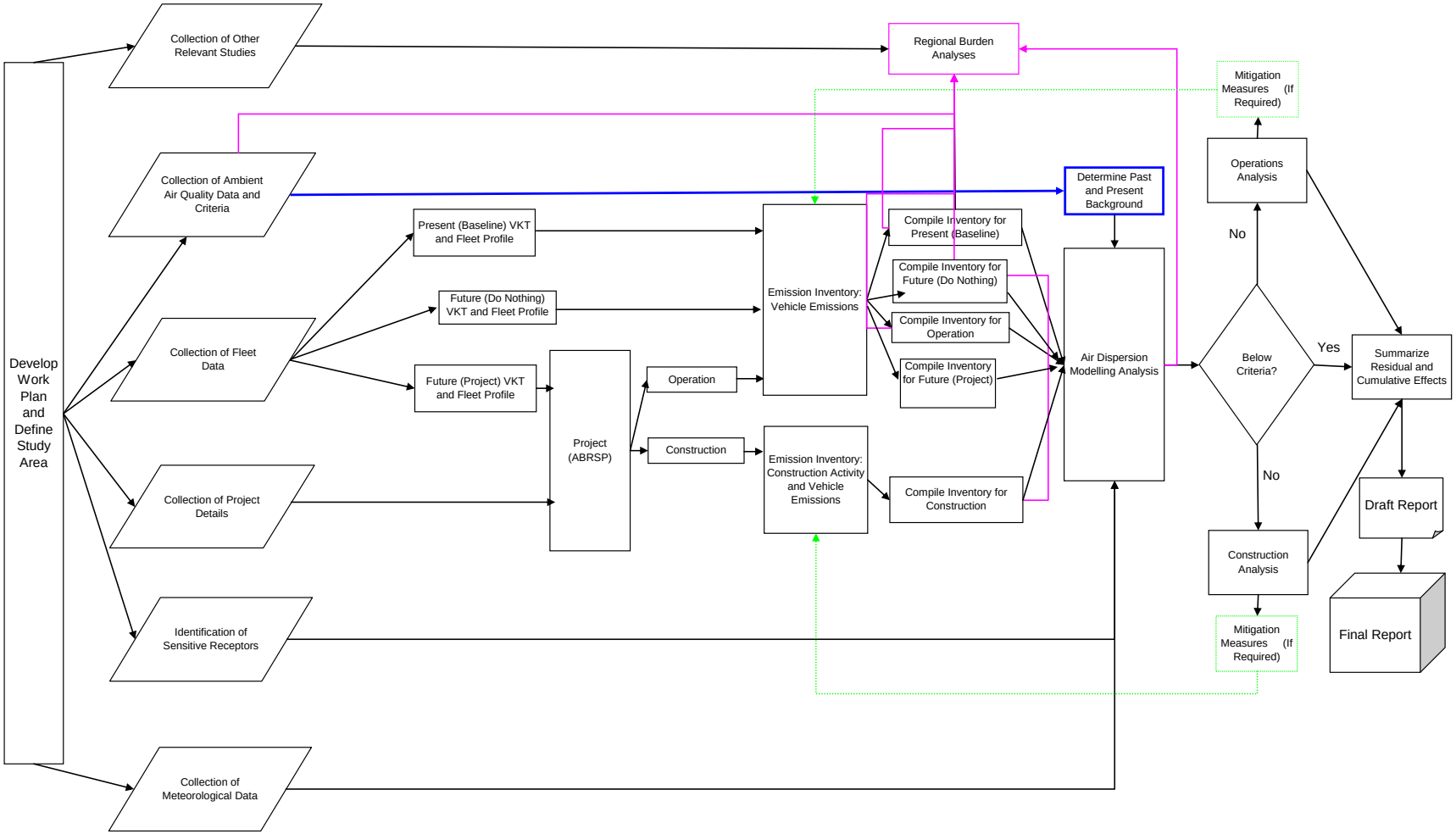
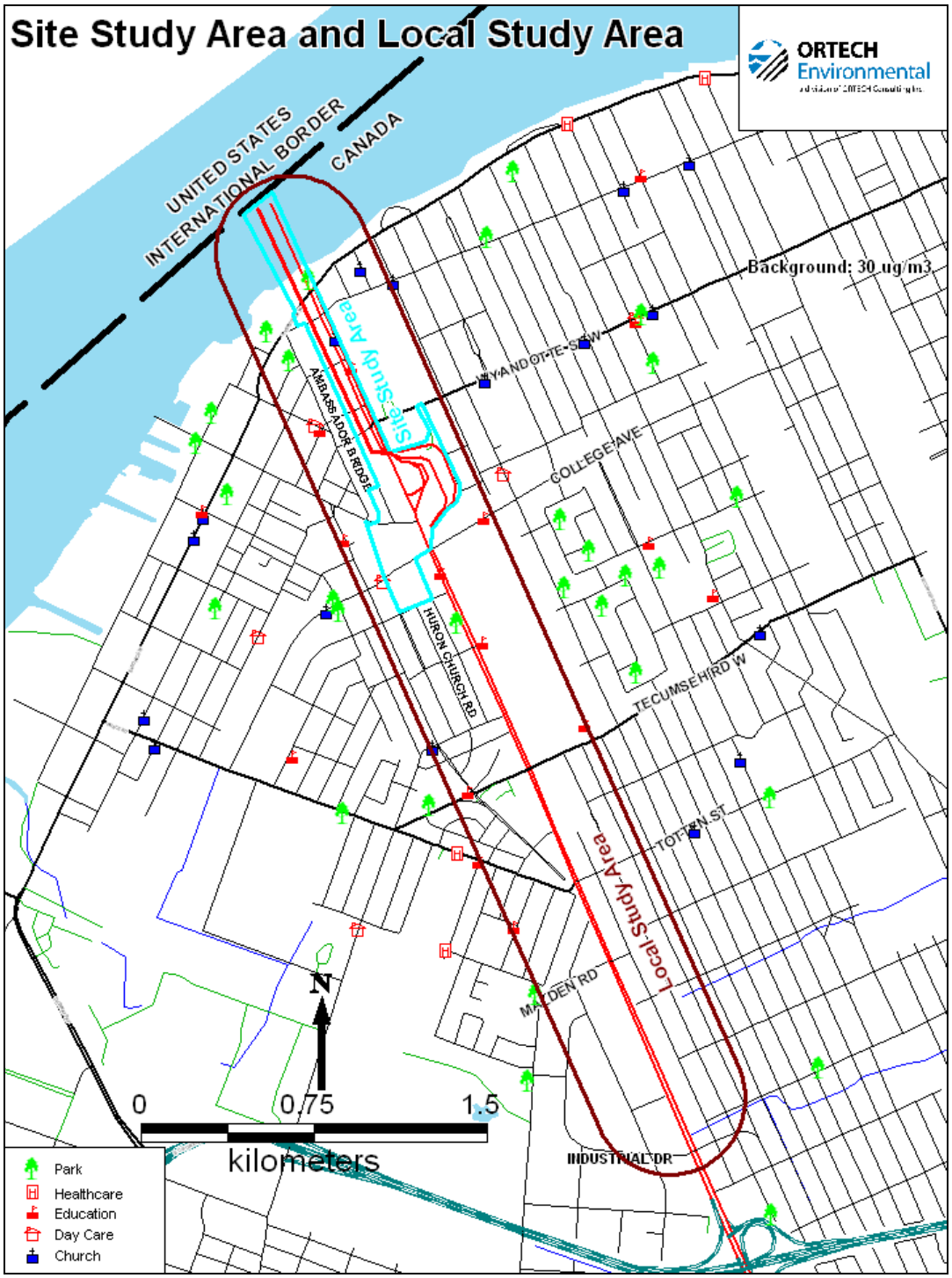


Figure 2: Site Study Area and Local Study Area



Local Study Area:

This section of the Local Study Area closest to the site, commences from the international boundary line near the middle of the Detroit River and includes the section of Huron Church Road extending from the edge of the Site Study Area (i.e. edge of the customs plaza) to a distance of approximately two kilometers to include the current turn for secondary inspection at Industrial Drive;

The following approach was used to perform the air quality assessment for the Local Study Area:

- due to the complex activities in the vicinity of the Site Study Area, the assessment of air emissions warranted a detailed analysis including quantification of emission rates from vehicle exhaust and roadway emissions (road dust) (using USEPA MOBILE 6.2/6.2C and USEPA emission factors that have been adjusted to reflect Canadian standards, where appropriate as recommended by EA Guidelines) associated with traffic along Huron Church Road using site specific fleet data and peak traffic flow obtained from the Canadian Transit Company, City of Windsor and the Detroit River International Crossing (DRIC) reports that is representative of this section of Huron Church Road;
- the results were used as input for detailed dispersion modeling (using CALQ3HCR and based on the Air Dispersion Modelling Guide for Ontario) to generate concentration profiles; the predicted concentrations were added to suitable background concentrations for comparison with relevant criteria; and
- impacts, if any, were assessed on special receptors described in detail in Section 2.2.2.

2.1.3 The Regional Study Area

The Regional Study Area is defined as the area within which there is the potential for cumulative effects (with other projects). The level of detail provided in the assessment of cumulative effects is more conceptual and less detailed as these effects become more remote in distance and time to the project. The assessment examined the annual emissions associated with the project relative to annual regional emissions for Essex County (Ontario) and Wayne County (Michigan).

2.2 Receptors

Receptors included in the air quality assessment are categorized in two groups: Virtual Receptors and Special Receptors, as summarized below.

2.2.1 Virtual Receptors

Virtual receptors are defined points in space used in air dispersion modeling to define locations at which pollutant concentrations are predicted and subsequently used to generate concentration contour plots. A grid system is used to define the location of the virtual receptors.

2.2.2 Special Receptors

Additional special receptors considered in the air quality assessment include potentially sensitive receptors such as residences, education facilities, healthcare facilities, day care facilities, places of worship and municipal parks. These special receptors represent those that are likely to be most sensitive to impacts from all phases of the project. Impacts on other potentially sensitive environmental areas such as First Nations Lands, federal and provincial parks and transboundary receptors were also considered as special receptors.

2.3 Pollutants of Interest

Consistent with the EA Guidelines, the air quality assessment addressed the pollutants of interest summarized in Table 1.

As described in Section 4, for polycyclic aromatic hydrocarbons (PAHs), emphasis was placed on benzo (a) pyrene as this contaminant has air quality criteria at least 100 times lower than the other PAH compounds commonly associated with vehicle emissions.

Table 1: Pollutants of Interest

Group	Pollutants of Interest
Pollutants and Precursors	Carbon monoxide (CO) Nitrogen oxides (NO_X) (include nitric oxide (NO) and nitrogen dioxide (NO_2) expressed and NO_2) Sulphur dioxide (SO_2) Particulate matter ≤ 10 microns (10^{-6} meters) in diameter (PM_{10}) Particulate matter ≤ 2.5 microns (10^{-6} meters) in diameter ($PM_{2.5}$) volatile organic compounds expressed as non-methane hydrocarbons (NMHC)
Air Toxics	Benzene (C_6H_6) Acetaldehyde (CH_3CHO) Formaldehyde (H_2CO) 1,3-butadiene (C_2H_4) acrolein (C_3H_4O) benzo(a) pyrene plus other polycyclic aromatic hydrocarbons (PAHs) compounds listed below
Greenhouse Gases	Carbon dioxide (CO_2) Nitrous oxide (N_2O) Methane (CH_4)
Other	ground level ozone (O_3)
Other PAH Compounds	acenaphthylene acenaphthene anthracene benzo (a) anthracene benzo (b) fluoranthene benzo (g,h,i) pyrene benzo (k) fluorene chrysene dibenzo (ah) anthracene fluoranthene fluorene ideno (1,2,3-cd) pyrene naphthalene phenanthrene pyrene

2.4 The Emission Scenarios

In accordance with the EA Guidelines, the scenarios listed in Table 2 were assessed.

Table 2: Emission Scenarios for Air Quality Assessment

Identification	Code	Description
Past	Past	Operation of Ambassador Bridge only (recent 5-year period)
Present (Baseline)	Present (Baseline)	Operation of Ambassador Bridge only (recent 1-year period)
Construction	2015 (Construction)	Construction of replacement span and operation of Ambassador Bridge only (2013-2015). Plaza construction follows completion of replacement span.
Operation	2015 (Operation)	Operation of replacement span only on expected date of completion (2015)
Future (Do Nothing)	2025 (FDN)	Operation of Ambassador Bridge only (2025)
Future (A)	2025 (A)	Operation of replacement span only (10 Years Post Construction) (2025)
Future (B)	2025 (B)	Operation of replacement span (heavy duty vehicles only) and Ambassador Bridge (light duty vehicles only) (10 Years Post Construction) (2025)

2.5 Air Quality Criteria and Background Concentrations

The air quality criteria and ambient air quality monitoring data utilized for this study were obtained primarily from Ontario provincial and federal regulatory jurisdictions. Relevant air quality monitoring data was reviewed. The 90th percentile concentrations were selected to represent the background ambient air concentrations within the study areas as per the EA Guidelines.

The assessment of ambient air quality criteria and background concentrations are described in detail in Section 3.

2.6 Tiered Approach

The air quality assessment was performed using a 3-tier approach as summarized below. Details on the approach related to the air emission inventory and dispersion modelling assessment are provided in Section 4 and Section 5, respectively.

Tier 1: Very Conservative Screening Basis

Initially, the air quality assessment was performed on a very conservative screening basis. Traffic flow recorded during the peak morning or afternoon rush hours periods was applied to all hours of the day. Where maximum air quality

concentrations predicted for Tier 1 were below ambient air quality criteria, further refinements were not required. If the maximum air quality concentrations for Tier 1 indicate that concentrations above the criteria may occur, further refinements were warranted as described in Tier 2.

Tier 2: Refined Basis

For Tier 2, the very conservative basis (Tier 1) assumptions were refined to a more realistic yet still conservative basis. The peak traffic flow recorded during the higher of the morning or afternoon peak hour was used as the basis to develop an hourly traffic flow distribution. Non peak hours were proportioned according to the hourly traffic flow distribution for Huron Church Road. Where the maximum air quality concentrations predicted for Tier 2 were below ambient air quality criteria, assessment of further action was not required. If the maximum air quality concentrations predicted for Tier 2 indicate that concentrations above the criteria may occur, further analysis is warranted as summarized below.

Tier 3: Further Study Required

Tier 3 includes an assessment of further action that may be required in cases where the maximum air quality concentrations predicted for Tier 2 indicate that concentrations above the criteria may occur. Such further actions include mitigation measures used to reduce short-term impacts during the construction activities to ensure no significant environmental effects. Areas requiring mitigation measures are described in Section 6.

3. DATA COLLECTION AND ANALYSIS

3.1 Ambient Air Quality Data

Air quality criteria (National Ambient Air Quality Criteria, Canada Wide Standards (CWS) and Ontario Ministry of Environment Ambient Air Quality Criteria) and averaging periods for the pollutants of interest were researched and summarized.

For pollutants of interest without Canadian or Ontario air quality criteria, available criteria from other jurisdictions were used including the State of Michigan and the State of New Hampshire. The hierarchy of selection of air quality criteria was the Ontario Ministry of Environment ambient air quality criteria and point of impingements standards and guidelines and Environment Canada (CWS) followed by the State of Michigan and then other jurisdictions, as needed.

In instances where a pollutant of interest has more than one averaging period (e.g., CO, NO_X, SO_2, PM_{10}, $PM_{2.5}$), the most commonly used averaging period was selected as the relevant averaging period (RAP) used in the subsequent air quality assessment. In the case of NO_X, the air quality was assessed against both the 1-hour and 24-hour standard for completeness since for some emission scenarios the predicted concentration is significant relative to the criteria. The pollutants of interest, criteria and selected RAP are summarized in Table 3.

Air quality monitoring data for the specified pollutants of interest, used to identify background ambient air concentrations within the study area, were examined from a variety of information sources and published network monitoring results. The data sources examined with an indication of the monitoring period used and the most recent publication date includes:

- the Ontario Ministry of the Environment (MOE) Air Quality in Ontario annual reports (2000 – 2009) dated 2009;
- the Environment Canada National Air Pollutant Surveillance Program (NAPS) reports (2006 – 2009) dated 2007;
- the Michigan Department of Environmental Quality (DEQ) annual air quality report (2005) dated 2006;
- MOE air quality assessment related to traffic congestion at Windsor's Ambassador Bridge (2002 – 2003) dated 2004;
- the Detroit River International Crossing (DRIC) initial report of monitoring adjacent to Huron Church Road (2006) dated 2007;

- Environment Canada Integrated Atmospheric Deposition Network (IADN) monitoring (1996 – 2000) dated 2007;
- Sarnia Lambton Environmental Association (SLEA) monitoring data (2002 – 2003) dated 2007; and
- other published data such as Environment Canada Detroit Incinerator Monitoring reports (1987 – 1990) dated 1992 and recognized air pollution publications (Seinfeld and Pandis) dated 1998.

Ambient air quality data spanning a recent five-year period for stations located in the study area for the pollutants of interest were gathered. This included local monitoring data from within the City of Windsor and other identified air quality studies pertinent to the study area. Data were used to the extent possible from the MOE Windsor West and Downtown monitoring sites which were considered to conservatively represent the urban area-specific background levels.

Details related to the collection and analysis of ambient air quality data including the location of the ambient monitoring stations considered in the analysis and past ambient air quality data are provided in Appendix 2. Where available, the mean, 90th percentile, maximum, and frequency of exceedences were summarized. The 90th percentile value was selected to represent a suitable background concentration as per the EA Guidelines. The background concentration data are also summarized in Table 3.

Utilizing this approach the background concentration for PM_{10} and $PM_{2.5}$ represent 84% and 67% of the ambient air quality criterion.

Table 3: Summary of Air Quality Criteria and Background Concentration

Pollutant of Interest	Averaging Period	Air Quality Criteria µg/m^3	Reference	Selected Relevant Averaging Period	Background Concentration[(1)] µg/m^3
Pollutants and Precursors					
CO	1 hr	36,200	MOE (Reg 419/05: Standard)	1 hr	737
	8 hr	15,700	MOE (Reg 419/05: Standard)		
NOx	1 hr	400	MOE (Reg 419/05: Standard)	1 hr	60
	24 hr	200	MOE (Reg 419/05: Standard)	24 hr	50
SO_2	1 hr	690	MOE (Reg 419/05: Standard)	1 hr	14.1
	24 hr	275	MOE (Reg 419/05: Standard)	24 hr	11.2
PM_{10}	24 hr	50	MOE (Interim AAQC)	24 hr	42
$PM_{2.5}$	24 hr	30	Environment Canada (Canada Wide Standard)	24 hr	20
VOC (NMHC)	1 hr	NA		1 hr	0.29
Air Toxics					
benzene	24 hr	30	Michigan (Department of Environmental Quality)	24 hr	2.5
acetaldehyde	24 hr	500	MOE (Reg 419/05: Standard)	24 hr	2.2
	24 hr	5,000	MOE (Reg 419/05: Upper Risk Threshold)		
formaldehyde	24 hr	65	MOE (Reg 419/05: Standard)	24 hr	3.7
1,3-butadiene	24 hr	2	Michigan (Department of Environmental Quality)	24 hr	0.18
acrolein	1hr	4.5	MOE (Reg 419/05: Standard)	24 hr	0.14
	24hr	0.4	MOE (Reg 419/05: Standard) - applicable starting 2020		
	24 hr	4.0	MOE (Reg 419/05: Upper Risk Threshold)		
benzo (a) pyrene	24 hr	0.0011	MOE (Reg 419/05: AAQC)	24 hr	0.00054
	annual	0.0003	MOE (Reg 419/05: AAQC)		
Greenhouse Gases					
CO_2	annual	NA		annual	650,000
N_2O	24 hr	9,000	MOE (Reg 419/05: AAQC)	24 hr	560
CH_4	annual	NA		annual	1,130
Other					
ozone	1 hr	165	MOE (Reg 419/05: Standard)	1 hr	< 50
	8 hr	130	Environment Canada (Canada Wide Standard)		
Other PAH Compounds					
acenaphthylene	24 hr	35	Michigan (Department of Environmental Quality)	24 hr	0.0028
acenaphthene	24 hr	210	Michigan (Department of Environmental Quality)	24 hr	0.0025
anthracene	24 hr	1000	Michigan (Department of Environmental Quality)	24 hr	0.0018
benzo (a) anthracene	24 hr	0.36	New Hampshire (Code of Administration Rules)	24 hr	0.0008
benzo (b) fluoranthene	24 hr	0.36	New Hampshire (Code of Administration Rules)	24 hr	0.0018
benzo (g,h,i) perylene	24 hr	12	Michigan (Department of Environmental Quality)	24 hr	-
benzo (k) fluoranthene	-	NA		-	-
chrysene	24 hr	0.36	New Hampshire (Code of Administration Rules)	24 hr	0.0012
dibenzo (ah) anthracene	-	NA		-	0.00014
fluoranthene	24 hr	140	Michigan (Department of Environmental Quality)	24 hr	0.0064
fluorene	24 hr	140	Michigan (Department of Environmental Quality)	24 hr	0.0057
indeno (1,2,3-cd) pyrene	-	NA		-	0.00066
naphthalene	24 hr	22.5	MOE (Reg 419/05: AAQC)	24 hr	0.50
phenanthrene	24 hr	0.71	New Hampshire (Code of Administration Rules)	24 hr	0.020
pyrene	24 hr	100	Michigan (Department of Environmental Quality)	24 hr	0.0038

Note: (1) selected as 90th percentile value of ambient air quality data, where available. For benzo (a) pyrene and other PAH species (excluding naphthalene) the average concentration plus one standard deviation was used.

3.2 Fleet Data

Information on fleet profile and traffic flow from the following sources (described in detail in Appendix 3) were collected and analyzed:

- Transport Canada;
- The City of Windsor;
- Canadian Transit Company (CTC);
- Detroit River International Crossing (DRIC);
- Statistics Canada; and
- Environment Canada

Fleet data (fleet profile and traffic flow) was identified for present and future scenarios for the bridge, Huron Church Road and other Arterial Routes within the study area. Details related to the collection and analysis of fleet data is provided in Appendix 3 and summarized in Section 4.

Information on traffic signaling was obtained from The City of Windsor. This information combined with traffic flow and the CAL3QHCR model described in Section 3.5 provided information on vehicle queuing and idling (including spatial, frequency and duration considerations) at intersections, customs plazas and approaches were incorporated into the analysis.

The fleet data, combined with MOBILE6.2C, were used to develop emission factors for vehicle emissions including exhaust plus evaporative emissions, tire wear and brake wear as described in detail in Section 4.1.

The fleet data, combined with USEPA AP-42 (Chapter 13.2: Fugitive Dust Sources – Paved Roads), were used to develop emission factors for roadway emissions (road dust). The road dust estimation method is described in detail in Section 4.2.

3.3 Ambassador Bridge Enhancement Project Data

The fleet data associated with future emissions scenarios which include the replacement span were collected and analyzed as described above. This includes projected future improvements in the flow of traffic associated with the replacement span including the reduction in queuing and idling associated with improvements in the customs plaza and the two additional bridge lanes, dedicated to the low risk FAST / NEXUS traffic.

Data related to activities during construction of the replacement span and Canadian plaza were collected and analyzed. This data included information on the approximate schedule, location, type of machinery and other details necessary to calculate and assess emissions from the type of construction activities identified in the revised EA Guidelines including:

- movement and storage of materials;
- demolition activities;
- heavy equipment exhaust; and
- roadway emissions (road dust) from movement of heavy equipment.

Information on further action potentially required to minimize short-term impacts during construction activities were collected and assessed where appropriate.

Details related to the collection and analysis of construction activity data is provided in Appendix 4 and summarized in Section 4.3.

3.4 Receptor Data

The EA Guidelines state "*the identification of residences and sensitive receptors should include those that are likely to be most-heavily impacted by air emissions and fugitive dust emissions from all project phases, including construction, operation and decommissioning. This should include the closest residences to the customs plaza and the closest residences along the most frequently congested section(s) of Huron Church Road approaching the customs plaza".*

Data on the identification and location of special receptors described in Section 2.2 was obtained from the following sources:

- City of Windsor;
- City of Windsor and Essex County School Boards – Public and Catholic;
- Listings of education, healthcare and day care facilities, places of worship and municipal parks; and
- supplemented by local knowledge

Details were confirmed by field observations where appropriate. Details related to the collection and analysis of receptor data, including the location of specified receptors, is provided in Appendix 5.

3.5 Dispersion Models and Input Data

Meteorological data available through federal, provincial or state agencies was assessed. The surface data from the Windsor Airport in combination with upper air data from Detroit was selected.

Dispersion modelling was performed based on the Air Dispersion Modelling Guide for Ontario (ADMGO), version 2.0, March 2009 and guidance provided with the selected air quality dispersion models, USEPA CAL3QHCR and USEPA AERMOD. The selection of these models is described in more detail in Section 5.

The CAL3QHCR model, one of the alternative models described in the ADMGO, requires at least one year of preprocessed meteorological data. A 5-year surface meteorological data set (2002 - 2006) was provided by the Ontario Ministry of Environment (Air Modelling and Emissions Unit). Upper air meteorological data for the same 5-year period was obtained from the National Oceanic Atmospheric Administration. The CAL3QHCR was run separately for each year with the present (baseline) inventory and the year that predicted the highest concentrations (2005) selected for subsequent model runs.

The USEPA AERMOD model was used for assessing the impact from the construction phase of the project. The 5-year meteorological data set (2002 - 2006) described above was used with AERMOD.

Details related to the collection and analysis of meteorological and other dispersion modeling data including a wind rose for the selected data is provided in Appendix 6 and summarized in Section 5.

4. EMISSION INVENTORY

The air quality assessment included the development of emission factors and quantification of emission rates related to vehicle emissions (exhaust, evaporative losses, tire wear and brake wear), dust generated from vehicles traveling over the surface of roads (road dust) and emissions from construction activities.

Emission factors and emission rates were developed for each emission scenario as summarized in the following sections.

4.1 Vehicle Emissions

The techniques used to estimate emissions associated with vehicles including exhaust, evaporative loses, tire wear and brake wear are provided in detail in Appendix 7 and summarized below.

MOBILE 6.2C, a Canadian mobile emission factor model, was developed by Environment Canada based on the USEPA MOBILE6.2 model. This model was used to generate composite emission factors (i.e., grams of pollutant emitted per vehicle mile traveled, g/VmT). Emission factors were developed for the months of January and July for each of the following emission scenarios:

- present (baseline);
- construction / operation – 2015 (Construction / Operation);
- future (do nothing) – 2025 (FDN);
- future (A: replacement span only) – 2025 (A); and
- future (B: replacement span and Ambassador Bridge) – 2025 (B)

The MOBILE6.2C model was used for emission calculations for most of the pollutants of interest. Emission calculations for benzo (a) pyrene, nitrous oxide (N_2O) and methane (CH_4) were developed using the techniques as described in Section 4.1.2.

It should be noted that the new emission standards for heavy duty vehicles implemented in the United States in 2007 are not considered in MOBILE6.2C.

4.1.1 Vehicle Emission Factors from MOBILE 6.2C

Tier 1: Very Conservative Screening Basis

As a first-level screening air quality assessment, very conservative assumptions were made to assist in identifying areas of interest as described below.

The peak present (baseline) and future traffic flow for the bridge and in the Local Study Area generally occurs during morning (7:00 to 10:00) and afternoon (15:00 to 19:00) periods. The fleet profile and traffic flow data during these peak periods are described in detail in Appendix 3 and summarized in Table 4.

The data provided below, based on the annual fleet profile, were entered into MOBILE 6.2C to generate emission factors for January and July. Peak hourly traffic flow is primarily attributed to passenger cars as truck traffic levels remain relatively constant throughout the day. On an annual basis, the Huron Church Road fleet profile consists of approximately 75% passenger cars and 25% heavy duty trucks. However, during peak hours, the fleet profile consists of approximately 80% passenger cars and 20% heavy duty trucks. As a consequence, use of the annual fleet profile will over predict contributions from heavy duty truck traffic during peak hours.

The maximum of the two seasonal emission factors (January or July) were used in subsequent assessment of vehicle emissions and are summarized in Appendix 7.

For simplicity, the vehicle $PM_{2.5}$ emission factors were considered equal to the PM_{10} emission factors (i.e., all particulate emissions from vehicle emissions are considered to be <2.5 µm in diameter). This simplification represents a conservative approach, especially for gasoline vehicles. The contribution of $PM_{2.5}$ from vehicle emissions is small relative to the background concentration, especially in future emission scenarios as discussed in Section 6.

Initial Tier 1 air quality assessments for the baseline and future years 2011 and 2021 demonstrate compliance with the air quality criterion for all pollutants with the exception of NO_X, PM_{10}, $PM_{2.5}$ and Acrolein. The highly conservative nature of the Tier 1 assessment allows for these conclusions to be applied to alternate emission scenarios where minor variances in quantity or quality of the vehicle fleet occur. For these reasons Tier 1 pollutants assessed for the years 2011 and 2021 were not re-assessed for the current emission scenarios presented in this report of 2015 (operation of replacement span) and 2025 (operation plus 10 years). The remaining pollutants (NO_X, PM_{10}, $PM_{2.5}$, and Acrolein) were further assessed using a Tier 2 approach.

Table 4: Summary of Traffic Profile and Peak Hourly Traffic Flow – Tier 1

Parameter	Units	Bridge (Existing)			Bridge (Replacement Span)			Huron Church Road (Local Study Area)			Arterial Roads (Local Study Area)		
		Baseline	2025 (FDN)	2025 (B)	2015	2025 (A)	2025 (B)	Baseline	2015	2025 (FDN), (A) & (B)	Baseline	2015	2025 (FDN), (A) & (B)
Annual Fleet Profile - Light Duty Vehicles	%	62.8	49.6	100.0	49.6	54	0	75.0	74.7	71.3	91.7	91.7	91.7
Annual Fleet Profile - Buses	%	0.2	0.2	0.0	0.2	0.2	0.2	0.3	default	default	0.3	default	default
Annual Fleet Profile - Heavy Duty Vehicles	%	37.0	50.2	0.0	50.2	45.8	99.8	24.7	25.3	28.7	8.0	8.3	8.3
Hourly Peak Traffic Flow (Tier 1)	Vehicles / hr	2,725	4,125	2,982	3,652	4,125	1,143	3,367	3,714	4,175	highly variable	highly variable	highly variable

Note: light duty vehicles includes light duty cars and trucks and motorcycles (this group consists of vehicle classes 1 to 5 and 16 as specified in MOBILE 6.2C)
Note: buses considerd to include school buses and transit/urban buses (this group consists of vehicle classes 14 and 15 specified in MOBILE 6.2C)
Note: heavy duty vehicles includes heavy duty trucks (this group consists of vehicle classes 2b to 8b specified in MOBILE 6.2C)
Note: 2025 (FDN) refers to future operation of existing bridge only, 2025 (A) refers to future operation of replacement span only and 2025 (B) refers to future operation of replacement span plus existing bridge.

Tier 2: Refined Basis

Where concentrations above the air quality criteria may occur, the approach was refined as described below.

The peak hourly traffic flow used in Tier 1 was refined using the hourly traffic flow distribution to provide a more realistic traffic flow distribution throughout the day. This refinement was applied to all areas (i.e. bridge, Huron Church Road and Arterial Roads) as described in detail in Appendix 3. The refined traffic flow and the Tier 1 emission factors presented in Appendix 7 were used.

This Tier 2 approach is more realistic but still conservative. As with Tier 1, the use of the annual fleet profile will over predict contributions from heavy duty truck traffic during peak hours since peak hourly traffic flow is primarily attributed to passenger cars and truck traffic levels remain relatively constant throughout the day.

4.1.2 Vehicle Emission Factors for Other Pollutants of Interest

Tier 1: Very Conservative Screening Basis

As described in detail in Appendix 7, emission calculations for polycyclic aromatic hydrocarbons (PAHs) were developed based on the MOBILE6.2C emission factors for PM_{10} and $PM_{2.5}$. Many PAH compounds, including benzo (a) pyrene, are associated with the particulate emissions in vehicle exhaust. Naphthalene, although sometimes considered a PAH, is generally more volatile and may partition in the gas phase rather than the particulate phase.

The emission factors for common PAH compounds for the present (baseline) scenario for vehicles traveling on the bridge at low speed (2.5 mph), which generally results in the highest emission factors, are summarized in Table 5.

A list of common PAH compounds and the respective air quality criteria were provided previously in Table 3. A comparison of PAH emission factors to air quality criteria is also provided in Table 5.

Except for naphthalene, the emission factors for the list of common PAHs were similar or lower than benzo (a) pyrene and the air quality criteria for these other PAHs are 2 or more orders of magnitude higher than benzo (a) pyrene. Naphthalene has an emission factor that is 2 to 3 orders of magnitude higher than benzo (a) pyrene but has air quality criteria that is more than 4 orders of magnitude higher than benzo (a) pyrene. Therefore, the emphasis of the detailed air quality assessment, including dispersion modeling as described in Section 5, was placed on benzo (a) pyrene on the basis that when benzo (a) pyrene is predicted to be below the air quality criteria, it is reasonable to conclude that the other common PAH compounds are also below the air quality criteria.

Benzo (a) pyrene emission factors are provided in Appendix 7.

Table 5: Comparison of PAH Emission Factors to Air Quality Criteria

Pollutant of Interest	Units	Emission Factor	Air Quality Criteria (24-hour) µg/m^3	Ratio of Emission Factor to Criteria
Air Toxics				
benzo (a) pyrene	mg / VmT	0.0028	0.0011	2.5
Other PAH Compounds				
acenaphthylene	mg / VmT	0.0641	35	<0.01
acenaphthene	mg / VmT	0.0129	210	<0.01
anthracene	mg / VmT	0.0161	1000	<0.01
benzo (a) anthracene	mg / VmT	0.0042	0.36	0.01
benzo (b) fluoranthene	mg / VmT	0.0030	0.36	<0.01
benzo (g,h,i) perylene	mg / VmT	0.0047	12	<0.01
benzo (k) fluoranthene	mg / VmT	0.0030	NA	-
chrysene	mg / VmT	0.0023	0.36	<0.01
dibenzo (ah) anthracene	mg / VmT	5.5E-06	NA	-
fluoranthene	mg / VmT	0.0164	140	<0.01
fluorene	mg / VmT	0.0271	140	<0.01
indeno (1,2,3-cd) pyrene	mg / VmT	0.0013	NA	-
naphthalene	mg / VmT	1.421	22.5	0.06
phenanthrene	mg / VmT	0.0441	0.71	0.06
pyrene	mg / VmT	0.0232	100	<0.01

Note: for presemt (baseline) scenario for vehicles travelling on the bridge at low speed (2.5 mph)

The MOBILE6.2C model does not include predictions for nitrous oxide (N_2O) and methane (CH_4). Emission calculations for these pollutants of interest were developed using the published data described below.

Published vehicle exhaust emission factors for N_2O and CH_4 for light duty (LD) gasoline vehicles and heavy duty (HD) diesel vehicles were obtained from the USEPA (Office of Transportation and Air Quality). Similar to the MOBILE6 models, the vehicle exhaust composite emission factor (EF) was estimated for the fleet profile. The methodology and composite N_2O and CH_4 emission factors are summarized in Appendix 7.

4.2 Road Dust

Roadway emissions (road dust) calculation procedures are summarized below with detailed calculations provided in Appendix 8.

Road dust emissions were calculated using USEPA AP-42 Chapter 13 – Miscellaneous Sources, Section 13.2.1 (Fugitive Dust Sources – Paved Roads). Consistent with the pollutants of interest identified in the EA Guideline, road dust emissions were quantified for PM_{10} and $PM_{2.5}$.

Data on silt loading, vehicle weight profile and number of precipitation days were used in conjunction with the equation shown in Appendix 8 to calculate the road dust emission factor for the bridge along Huron Church Road and the Arterial Roads. The emission factors were developed for present (baseline), 2015 (construction/operation), 2025 (FDN), 2025 (A) and 2025 (B) emission scenarios.

The road dust emission factor calculation methodology and composite emission factor results for each road segment and emission scenario is summarized in Appendix 8.

Tier 1: Very Conservative Screening Basis

The initial air quality assessment was based on very conservative assumptions as described below.

The input for the air dispersion modeling (CAL3QHCR described in detail in Section 5) requires an emission factor expressed in terms of mass of road dust emitted per hour per unit distance (i.e. g / hr / mile). Each 24-hour period includes peak traffic flow northbound (approximately 8:00 – 9:00 am) and southbound (approximately 4:00 – 5:00 pm). The fleet profile shown previously in Table 4 was used to estimate the maximum traffic flow for each hour. The peak morning and afternoon traffic flow applied to all hours were considered separately and the maximum emission factor was selected.

Maximum traffic flows in conjunction with the road dust emission factors summarized in Appendix 8 were used as input to the air dispersion model. Theses road dust emission factors are conservative and do not account for potential reductions due to precipitation. Also, the emission factors are conservatively based on the average gross vehicle weight rating (GVWR) as discussed in Appendix 8.

Tier 2: Refined Basis

As identified in the dispersion modeling and results section, Section 5 and Section 6, PM_{10} and/or $PM_{2.5}$ are predicted to exceed the air quality criteria when background is considered for some emission scenarios. Use of the very conservative Tier 1 emission factors generated from USEPA AP-42 was refined as described below.

The selected USEPA emissions factors are applicable for free flowing and slow moving or "stop and go" traffic. Emission rates associated with idling will be much lower. Therefore, it is not appropriate for the Tier 1 emission factors to be applied to queue links at signalized intersections (the factors were set to zero in these areas).

4.3 Construction Activities

Emissions associated with construction activities are described in detail in Appendix 9 and summarized below.

PM_{10} and $PM_{2.5}$ were calculated for the main construction activities such as land clearing, ground excavation, cut and fill operations, demolition activities, structure and facility construction and road dust from movement of heavy equipment and heavy equipment exhaust.

In addition diesel engine combustion emissions of nitrogen oxides, carbon monoxide and sulphur dioxide were calculated for the non-road equipment engines and licensed vehicle engines.

The inventory was based on construction activities being carried out over a period of 10 hours per day, 5 days a week during the period 2013 to 2015 and in compliance with municipal by-laws. Should greater or lesser inventory of equipment be used, the work hours may need to be adjusted accordingly.

Tier 1: Very Conservative Screening Basis

A Midwest Research Institute (MRI) generic emission factor for PM_{10} and $PM_{2.5}$ dust generated from construction activities was used. The emission factor is expressed in terms of tonnes of particulate matter emitted per hectare per month of construction (tonnes/hectare/month of activity): a PM_{10} emission factor of 0.25 tonnes/hectare/month of activity and a $PM_{2.5}$ emission factor of 0.05 tonnes/hectare/month of activity.

The construction particulate emission factor is assumed to include the effects of typical control measures, such as routine watering which reflect the intended implementation of a Best Management Plan (BMP) to control dust emissions.

The mitigation measures during construction, including the BMP, are discussed in more detail in Section 6.

The total Site Study Area where construction activities could take place for the replacement span is 125 hectares (includes Canadian side of the construction activities). At any give time, it is estimated that construction activities will be occurring on up to 10% of the Site Study Area or 12.5 hectares. It is proposed that after completion of the replacement span construction improvements to the Canadian Plaza may be initiated pending increased vehicle volumes. Improvements to the Canadian Plaza are neither necessary nor required to accommodate the replacement span. The total Site Study Area where plaza construction activities could take place is 0.96 hectares.

The PM_{10} and $PM_{2.5}$ emission rate calculation results are provided in Appendix 9.

Diesel engines of the construction equipment on-site will emit combustion products such as nitrogen oxides, carbon monoxide and sulphur dioxide. These engines also emit particulate; however, the particulate emissions are included in the total heavy construction activities particulate emissions (MRI generic emission factors).

For licensed road equipment such as the haul trucks and concrete trucks, published emission factors for idling emissions of NO_X and CO from heavy duty diesel equipment were used together with the maximum number of these vehicles operating simultaneously on-site.

For other on-site diesel powered equipment, such as cranes, the US EPA Non-road Diesel Engine Level 3 Emission Standards for NO_X and CO were used. The Level 3 emission standards were used together with the maximum number of each type of equipment operating simultaneously on-site, the kW rating of the equipment engines and the anticipated load factors to calculate the diesel engine NO_X and CO emissions for the different construction activities.

Since the river barges will not be operating on the land based construction site, particulate emissions were calculated separately for the marine diesel engines of these barges. Emissions were calculated using a marine engine emission and load factors.

For the all on-site diesel powered equipment, including the licensed road equipment, the US EPA AP-42 Section 3.3 (Table 3.3-1) sulphur dioxide emission factor was used. This emission factor was used together with the maximum number of each type of equipment operating simultaneously on-site, the kW rating of the equipment engines and the anticipated load factors to calculate the diesel engine sulphur dioxide emissions for the different construction activities.

Nitrogen oxides, carbon monoxide and sulphur dioxide emission rate calculation results are provided in Appendix 9.

The above emission rates were used with the USEPA AERMOD air dispersion model to assess emissions from construction activities as described in Section 5.2.

4.4 Summary of Annual Emissions (Burden)

Annual mass emissions (burden) calculations from vehicle and road dust associated with traffic on the bridge as well as regional annual emissions are described in detail in Appendix 10 and summarized below.

4.4.1 Bridge Annual Vehicle and Road Dust Emissions

Annual releases associated with vehicle emissions and road dust emissions were estimated for the existing bridge (baseline and 2025) and the future enhanced bridge (2015 and 2025). These annual emission calculations include traffic flow for the bridge and in the customs plaza.

Vehicle emission factors generated using MOBILE6.2C for free flow and queuing traffic and road dust emission factors generated using USEPA AP-42 (Section 13.2.1) for the Ambassador Bridge and customs plaza area as described previously were utilized. Annual road dust emission factors employ the precipitation correction factor to account for the number of ‘wet” days experienced in the Windsor area.

These emission factors were used in combination with the distance traveled on the Canadian side of the bridge and the customs plaza to calculate annual emissions. The annual emission calculations are described in detail in Appendix 10 and summarized in Table 6.

Table 6: Summary of Bridge Annual Emissions

Parameter	Units	Bridge (Existing)		Bridge (Replacement Span)	
		Baseline	2025 (FDN)	2015	2025 (A)
Pollutants and Precursors					
CO	tonnes / year	231	126	128	126
NOx	tonnes / year	82	14	40	14
SO_2	tonnes / year	1.5	0.29	0.28	0.29
PM_{10}	tonnes / year	8	10	11	10
$PM_{2.5}$	tonnes / year	5.1	4.1	5.0	4.1
VOC	tonnes / year	27	11	14	11
Air Toxics					
benzene	tonnes / year	0.55	0.21	0.25	0.21
acetaldehyde	tonnes / year	0.16	0.09	0.11	0.09
formaldehyde	tonnes / year	0.44	0.24	0.28	0.24
1,3-butadiene	tonnes / year	0.09	0.03	0.04	0.03
acrolein	tonnes / year	0.02	0.01	0.01	0.01
benzo (a) pyrene	tonnes / year	5.1.E-05	1.1.E-06	2.3.E-06	1.1.E-06
Greenhouse Gases					
CO_2	tonnes / year	13,808	24,122	21,702	24,122
N_2O	tonnes / year	0.58	0.94	0.81	0.94
CH_4	tonnes / year	1.7	2.5	2.1	2.5
Other					
ozone	tonnes / year	-	-	-	-

Notes:
FDN refers to future do nothing option. 2025 (A) refers to operation of replacement span.
Emissions for 2025 (B) operation of Ambassador Bridge plus replacement span are represented by 2025 (A)

4.4.2 Regional Annual Emissions

Annual bridge emissions were compared with regional annual emission inventory data where available. For the purpose of this comparison, regional emissions were defined by the Essex County (Ontario) and Wayne County (Michigan). Regional emissions inventory information was developed from the following sources:

- Environment Canada (2005 Reporting Year) Criteria Air Contaminants Emission Inventory from Environment Canada National Pollutant Release Inventory (NPRI)
- Environment Canada National Pollutant Release Inventory (NPRI)
- Great Lakes Commission (2002 Revised) Benzo (a) Pyrene Air Emissions Inventory (March 2007)
- MOBILE6.2C emission factors generated for this study
- US Environmental Protection Agency National Emission Inventory Database for Criteria Air Pollutants (2001) and Hazardous Air Pollutants (1999)
- Michigan Department of Environmental Quality Report "Michigan Greenhouse Gas Inventory 1990 and 2002, April 2005"
- Great Lakes Commission Report "Assessment of Benzo(a)pyrene Air Emissions In the Great Lakes Region", March 2007

The regional annual emissions are described in detail in Appendix 10 and summarized in Table 7.

A comparison of the annual bridge and regional emissions is provided in Table 8. The total annual bridge emissions of the pollutants of interest are less than 1% and in many cases less than 0.1% of the total annual regional emissions for Essex County (Ontario) and Wayne County (Michigan).

Table 7: Summary of Annual Regional Emissions

Parameter	Units	Essex County (Ontario)					Wayne County (Michigan)				
		Area	Industrial	Transport & Road Dust	Non Road	Total	Area	Point	Mobile	Non Road	Total
Pollutants and Precursors											
CO	tonnes / year	-	9,221	28,662	-	37,883	-	-	-	-	720,519
NOx	tonnes / year	-	2,477	10,549	-	13,026	-	-	-	-	109,331
SO_2	tonnes / year	-	1,208	488	-	1,696	-	-	-	-	60,845
PM_{10}	tonnes / year	-	2,626	55,931	-	58,557	-	-	-	-	17,811
$PM_{2.5}$	tonnes / year	-	1,439	12,791	-	14,230	-	-	-	-	9,330
VOC	tonnes / year	-	9,582	3,367	-	12,949	-	-	-	-	100,217
Air Toxics											
benzene	tonnes / year	-	-	1,762	-	1,762	117	9.0	1,506	212	1,844
acetaldehyde	tonnes / year	-	-	373	-	373	2.1	0.55	203	88	293
formaldehyde	tonnes / year	-	-	1,001	-	1,001	15	1.7	522	230	768
1,3-butadiene	tonnes / year	-	-	262	-	262	0.22	1.4	173	41	216
acrolein	tonnes / year	-	-	9.6	-	9.6	6.9	0.25	28	18	53
benzo (a) pyrene	tonnes / year	-	-	0.09	-	0.09	0.22	0.49	0.027	0.027	0.76
Greenhouse Gases											
CO_2	tonnes / year	-	3,654,788	-	-	3,654,788	-	-	-	-	8,122,500
N_2O	tonnes / year	-	540	-	-	540	-	-	-	-	1,031
CH_4	tonnes / year	-	4,379	-	-	4,379	-	-	-	-	37,000
Other											
ozone	tonnes / year	-	-	-	-	-	-	-	-	-	-

Table 8: Comparison of Annual Emissions

Parameter	Units	Essex County (Ontario)	Wayne County (Michigan)	Bridge (Existing)						Bridge (Replacement Span)					
				Baseline			2025 (FDN)			2015			2025 (A)		
				Total	Percent of Essex County (Ontario) %	Percent of Wayne County (Michigan) %	Total	Percent of Essex County (Ontario) %	Percent of Wayne County (Michigan) %	Total	Percent of Essex County (Ontario) %	Percent of Wayne County (Michigan) %	Total	Percent of Essex County (Ontario) %	Percent of Wayne County (Michigan) %
Pollutants and Precursors															
CO	tonnes / year	37,883	720,519	231	0.61	0.03	126	0.33	0.02	128	0.34	0.02	126	0.33	0.02
NOx	tonnes / year	13,026	109,331	82	0.63	0.07	14	0.11	0.01	40	0.31	0.04	14	0.11	0.01
SO_2	tonnes / year	1,696	60,845	1.5	0.09	0.003	0.29	0.02	0.0005	0.28	0.02	0.0005	0.29	0.02	0.0005
PM_{10}	tonnes / year	58,557	17,811	8	0.01	0.05	10	0.02	0.06	11	0.02	0.06	10	0.02	0.06
$PM_{2.5}$	tonnes / year	14,230	9,330	5.1	0.04	0.05	4.1	0.03	0.04	5.0	0.04	0.05	4.1	0.03	0.04
VOC	tonnes / year	12,949	100,217	27	0.21	0.03	11	0.09	0.01	14	0.11	0.01	11	0.09	0.01
Air Toxics															
benzene	tonnes / year	1,762	1,844	0.55	0.03	0.03	0.21	0.01	0.01	0.25	0.01	0.01	0.21	0.01	0.01
acetaldehyde	tonnes / year	373	293	0.16	0.04	0.05	0.095	0.03	0.03	0.11	0.03	0.04	0.095	0.03	0.03
formaldehyde	tonnes / year	1,001	768	0.44	0.04	0.06	0.24	0.02	0.03	0.28	0.03	0.04	0.24	0.02	0.03
1,3-butadiene	tonnes / year	262	216	0.089	0.03	0.04	0.032	0.01	0.01	0.037	0.01	0.02	0.032	0.01	0.01
acrolein	tonnes / year	10	53	0.023	0.24	0.04	0.011	0.12	0.02	0.013	0.14	0.02	0.011	0.12	0.02
benzo (a) pyrene	tonnes / year	0.09	0.76	5.1E-05	0.05	0.01	1.1E-06	0.00	0.000	2.3E-06	0.00	0.000	1.1E-06	0.00	0.000
Greenhouse Gases															
CO_2	tonnes / year	3,654,788	8,122,500	13,808	0.38	0.17	24,122	0.66	0.30	21,702	0.59	0.27	24,122	0.66	0.30
N_2O	tonnes / year	540	1,031	0.58	0.11	0.06	0.94	0.17	0.09	0.81	0.15	0.08	0.94	0.17	0.09
CH_4	tonnes / year	4,379	37,000	1.7	0.04	0.005	2.5	0.06	0.01	2.1	0.05	0.01	2.5	0.06	0.01
Other															
ozone	tonnes / year	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: 2025 (FDN) refers to future operation of existing bridge only, 2025 (A) refers to future operation of ABEP. 2025 (B) is represented by 2025 (A) emissions (no change in vehicle volume).

5. DISPERSION MODELLING

Two air dispersion models, CAL3QHCR and AERMOD, were used to predict concentrations of the pollutants of interest at receptors based on the emission factors (Tier 1 and Tier 2) described in Section 4. CAL3QHCR was used to evaluate roadways and AERMOD was used to evaluate construction activities. The application of these dispersion models are described in detail in Appendix 11 and summarized below.

5.1 CAL3QHCR Dispersion Modelling (Roadways)

The CAL3QHCR air dispersion model is a recognized tool developed by the USEPA for assessing emissions from linear sources such as roadways. The main inputs to the model are described in detail in Appendix 11 and summarized below:

- vehicle exhaust emission factors (i.e., g/VmT) for the road segments in each area (bridge, Huron Church Road and Arterial Roads) and each emission scenario as described in Section 4.1;
- road dust emission factors (i.e., g/hr/mile) for the road segments in each area and each emission scenario as described in Section 4.2;
- the location and length of each road segment;
- the location of receptors;
- for Tier 1, the overall peak hourly traffic flow in each area for all hours of the day (i.e., the overall peak flow is assumed for all hours of the day);
- for Tier 2, the peak hourly traffic flow in each area for each hour (i.e., the peak hourly flow changes throughout the day);
- traffic signal timing used to calculate idle times and length of traffic queuing; and
- one-year (2005) meteorological data set (hourly projections). Note: 2005 data was selected on the basis that it predicted the highest concentrations for the 5-year data set (2002 – 2006).

Tier 1: Very Conservative Screening Basis

The CAL3QHCR model predicts concentrations for each hour of the representative 1-year meteorological data set (i.e., up to 8,760 individual hourly predictions) as a function of location relative to the emission sources. For the Tier 1 (very conservative) assessment, the above input data was input to the CAL3QHCR model to predict the maximum concentration for each pollutant of interest for present (baseline) and emission scenarios for the years 2011 and 2021. The highly conservative nature of the Tier 1 assessment allows for these conclusions to be applied to alternate emission scenarios where minor variances in quantity or quality of the vehicle fleet occur. For these reasons Tier 1 pollutants assessed for the years 2011 and 2021 were not re-assessed for the current emission scenarios presented in this report of 2015 (operation of replacement span) and 2025 (operation plus 10 years).

As discussed previously, this maximum concentration is considered very conservative as the maximum emission factors and peak traffic flow are used for all hours of the one-year modeling period when in reality the actual emission factors and traffic flow are less at times. Provided the predicted maximum concentrations resulting from this Tier 1 assessment are below the air quality criteria, further refinement of the input data, was not considered warranted (i.e., even considering these very conservative assumptions, compliance is predicted).

Tier 2: Refined Basis

In instances where these very conservative assumptions predict that concentrations above the air quality criteria may occur for any of the defined emission scenarios, the more realistic Tier 2 assessment was performed.

5.2 AERMOD Dispersion Modelling (Construction Activities)

The AERMOD air dispersion model is a recognized tool developed by the USEPA for assessing emissions from a variety of sources including many of the construction activities expected for the replacement span. It is more suitable than CAL3QHCR for assessing emissions from these types of sources.

The main inputs to the AERMOD model are discussed in detail in Appendix 11 and summarized below:

- maximum emission rate associated with the main construction activities including dust emissions from material movement and storage piles, heavy equipment movement on paved and unpaved roads, demolition activities and heavy equipment exhaust as described in Section 4.3;
- information related to the expected schedule (daily, seasonal and year) of these construction activities;

- information related to the expected location of these construction activities; and
- a one-year (2005) meteorological data set (hourly projections) to be consistent with CAL3QHCR modelling.

Tier 1: Very Conservative Screening Basis

The AERMOD model predicts concentrations for each hour of the representative 1-year meteorological data set (i.e. up to 8,760 individual hourly predictions) as a function of location relative to the emission sources. For the Tier 1 assessment, the above input data was used with the AERMOD model to predict the maximum concentration for each pollutant of interest on the basis that all replacement span construction activities are occurring simultaneously and continuously. This maximum concentration is considered very conservative as not all construction activities will result in maximum emissions and these maximum emissions may not occur simultaneously and continuously for the entire construction period (estimated to be 2013 to 2015). Construction on the Canadian plaza would occur after construction of the replacement span and was modeled separately.

Provided the predicted maximum concentrations resulting from this Tier 1 assessment are below the air quality criteria (when cumulative effects are considered as discussed in Section 6), further refinement of the input data was not considered warranted (i.e., even considering these conservative assumptions, compliance is predicted). Construction of the Canadian Plaza satisfied the Tier 1 assessment criteria whereas construction of the bridge proceeded to a Tier 2 assessment.

Tier 2: Refined Basis

In instances where these very conservative assumptions predict that concentrations above the air quality criteria may occur, the more realistic Tier 2 assessment was performed. The adjustment to the AERMOD inputs used in the Tier 2 assessment is to use the actual daily schedule of main construction activities were considered and set to zero during the period nighttime periods (5:00 pm to 7:00 am). Acceptable alternate emission scenarios may also include extending the construction hours accompanied with a reduced activity factor for operating equipment.

The assessment of dispersion modeling results, including cumulative effects and mitigation measures are discussed in Section 6.

5.3 Ozone Predictions

The potential impacts due to O_3 for each emission scenario were assessed using the NO_X and VOC output from the CAL3QHCR model combined with the Ozone Isopleth Method. The method is described in detail in Appendix 12.

6. ASSESSMENT OF RESULTS

The maximum air quality concentration within the study area was simulated by adding the maximum concentrations predicted by dispersion modelling (Tier 1 or Tier 2) at a given receptor to the 90th percentile background concentration. The cumulative concentrations (cumulative effects) are discussed in detail in Section 6.1.

In instances where the Tier 2 results indicate that cumulative concentrations greater than the air quality criteria may occur, mitigation measures were considered as discussed in detail in Section 6.2.

A Tier 2 assessment was performed only for the specific pollutants of interest and emission scenarios as listed in Table 9. The Tier 2 assessment was not necessary for other pollutants of interest since compliance was predicted even when the very conservative Tier 1 assumptions were used.

Table 9: Summary of Tier 2 Assessments

Pollutant of Interest	Relevant Averaging Period	Emission Scenario (s)
NO_X	1-hr	Baseline, 2015, 2025 (FDN), 2025 (A), 2025 (B)
NO_X	24-hr	Baseline, 2015, 2025 (FDN), 2025 (A), 2025 (B)
PM_{10}	24-hr	Baseline, 2015, 2025 (FDN), 2025 (A), 2025 (B)
$PM_{2.5}$	24-hr	Baseline, 2015, 2025 (FDN), 2025 (A), 2025 (B)
acrolein	24-hr	Baseline, 2015, 2025 (FDN), 2025 (A), 2025 (B)

The assessment of dispersion modeling results, including cumulative effects and further action that may be required following the Tier 2 assessment, are discussed below.

6.1 Cumulative Effects

6.1.1 Maximum Modelling Concentrations

The maximum concentrations predicted from vehicle emissions and roadway emissions (road dust) using the CAL3QHCR model are described in Section 5.1 and the maximum concentrations predicted from emissions from construction activities using the AERMOD model are described in Section 5.2.

For the construction emission scenario, the maximum concentrations consider the maximum concentrations predicted from both CAL3QHCR for roadways plus AERMOD for specific construction activities at a given receptor. For all other emissions scenarios, the maximum modeling concentrations are equivalent to the maximum concentrations from vehicle emissions and road dust as predicted using CAL3QHCR.

The maximum modeling concentrations (Tier 1 or Tier 2) are summarized in Table 10.

Table 10: Summary of Maximum Modelling Concentration Results

Pollutant of Interest	Units	Tier	Baseline Maximum Modelled Concentration	2015 (Construction) Maximum Modelled Concentration	2015 (Operation) Maximum Modelled Concentration	2025 (FDN) Maximum Modelled Concentration	2025 (A) Maximum Modelled Concentration	2025 (B) Maximum Modelled Concentration
Pollutants and Precursors (1)								
CO	µg/m^3	1	5039	*2.6*	*2.5*	*2.6*	*2.0*	*2.4*
NOx (1 hr)	µg/m^3	2	652	233	218	106	106	106
NOx (24 hr)	µg/m^3	2	248	85	84	38	38	38
SO_2 (1 hr)	µg/m^3	1	18	*165*	*1.9*	*2.2*	*2.2*	*2.2*
SO_2 (24 hr)	µg/m^3	1	6.9	*21*	*0.99*	*1.3*	*1.3*	*1.3*
PM_{10}	µg/m^3	2	20	45	18	21	21	21
$PM_{2.5}$	µg/m^3	2	11.7	6.7	6.6	7.3	7.3	7.3
VOC	ppm	1	0.50	-	*0.20*	*0.40*	*0.23*	*0.23*
Air Toxics								
benzene	µg/m^3	1	6.8	-	*3.4*	*2.9*	*2.9*	*2.9*
acetaldehyde	µg/m^3	1	1.4	-	*0.66*	*0.72*	*1.3*	*1.3*
formaldehyde	µg/m^3	1	3.6	-	*2.1*	*2.2*	*3.6*	*3.6*
1,3-butadiene	µg/m^3	1	0.94	-	*0.38*	*0.21*	*0.21*	*0.21*
acrolein	µg/m^3	2	0.11	-	*0.054*	*0.044*	*0.034*	*0.034*
benzo (a) pyrene	µg/m^3	2	0.00010	-	*< 0.00001*	*< 0.00001*	*< 0.00001*	*< 0.00001*
Greenhouse Gases								
CO_2	µg/m^3	-	-	-	-	-	-	-
N_2O	µg/m^3	1	2.6	-	*3.2*	*4.2*	*4.3*	*4.3*
CH_4	µg/m^3	-	-	-	-	-	-	-
Other								
ozone	µg/m^3	-	< 80	-	*< 80*	*< 130*	*< 130*	*< 130*

Note: (1) Tier 1 assessed pollutants (shown in *italics)* for years 2015 and 2025 are representative of the initial study years 2011 and 2021 respectfully.
Note: 2025 (FDN) refers to future operation of existing bridge only, 2025 (A) refers to future operation of ABEP only and 2025 (B) refers to future operation of ABEP plus existing bridge.
Note: ozone estimate includes background ozone.

6.1.2 Cumulative Concentrations

The selection of the background concentration as described in the EA Guidelines is summarized in Section 3.1.

The cumulative effect was assessed by adding the maximum concentration predicted by dispersion modeling (Tier 1 or Tier 2) to the 90th percentile background to establish the maximum air quality concentration. This approach provides a very conservative assessment of the maximum air quality concentration. The selected background for urban areas may already include impacts from roadways. The maximum air quality concentration results are summarized in Table 11.

The maximum air quality concentration results and comparison to air quality standards and guidelines were used to evaluate impacts to human health and sensitive ecosystems. These results will be provided to the federal EA review team for further guidance on potential human health effects and impact on sensitive ecosystems.

In general, the contribution of vehicle emissions is minor relative to the current background for PM_{10}, $PM_{2.5}$ and benzo (a) pyrene especially for future emission scenarios. Vehicle emissions for these and other pollutants of interest are predicted to decline due to future improvements to fuel standards and emission controls. The policy assumptions considered by Environment Canada and USEPA in the development of the model (MOBILE6.2C and MOBILE6.2, respectively) used to estimate current and future vehicle emissions are detailed in the model documentation. Policies impacting future vehicle emissions include:

- a reduction in the gasoline sulphur content to 30 ppm from current level of 42 ppm;
- a reduction in the diesel sulphur content to 15 ppm from current level of 320 ppm;
- 5% ethanol replacement;
- emission standards for passenger vehicles and light duty trucks phased in according to the schedules specified in United States Tier 1, Tier 2 and Low Emission Vehicle regulations;
- Canadian motorcycle emission regulations phased in during the period 2006 to 2010;
- regular incremental reductions in volatile organic compound emissions under the United States 1990 Clean Air Act Requirements for ozone non-attainments areas.

As noted in Section 4.1, the new emission standards for heavy duty vehicles implemented in the United States in 2007 are not considered in MOBILE6.2C.

For illustrative purposes, concentration contours were generated for NO_X, PM_{10} and $PM_{2.5}$ for select emissions scenarios. The concentration contours are provided in Appendix 13.

The potential for transboundary air quality impacts as well as any impacts on First Nations' lands (Walpole Island) from the replacement span are deemed insignificant. A comparison of the annual bridge and regional emissions concludes that less than 1% and in many cases, less than 0.1% of the total annual regional emissions for Essex County (Ontario) and Wayne County (Michigan) emissions originate from the Ambassador Bridge.

Although transboundary air pollutants from the United States may account for up to 50 per cent of smog in Southwestern Ontario and may be as high as 90 per cent for Windsor, *(Preliminary Air Quality Assessment Related to Traffic Congestion at Windsor's Ambassador Bridge, MOE, 2004)* the contribution from the project area, consisting of approximately 3 kilometers of plaza, customs inspection and bridge roadway is not a significant source of regional air pollution in itself. The main purpose of the project is to improve the flow of traffic across the international border through the construction of a replacement span including dedicated lanes for low risk traffic and improved functionality of the plaza. This improvement in traffic flow will reduce emissions originating from the project area compared to the "do-nothing" scenario. Additional details regarding regional emissions from the project are discussed in Section 4.4.2.

Impacts from the US side of the project are generally localized and within 300 meters from the project area. Construction impacts will be mitigated on both sides of the bridge, with the greatest potential for transboundary impacts resulting from the operation of tug boats and barges operating close to international waters. Impacts associated with construction activities are discussed in Section 4.3 and 6.2.2.

Table 11: Summary of Maximum Air Quality Concentration Results

Pollutant of Interest	Relevant Averaging Period	Air Quality Criteria	Units	Baseline			2015 (Construction)			2015 (Operation)			2025 (FDN)			2025 (A)			2025 (B)		
				Maximum Modelling Concentration	Background Concentration	Maximum Air Quality Concentration	Maximum Modelling Concentration	Background Concentration	Maximum Air Quality Concentration	Maximum Modelling Concentration	Background Concentration	Maximum Air Quality Concentration	Maximum Modelling Concentration	Background Concentration	Maximum Air Quality Concentration	Maximum Modelling Concentration	Background Concentration	Maximum Air Quality Concentration	Maximum Modelling Concentration	Background Concentration	Maximum Air Quality Concentration
Pollutants and Precursors [1]																					
CO	1 hr	36,200	µg/m^3	5039	737	5776.0	*2.6*	*737*	*739.6*	*2.5*	*737*	*739.5*	*2.6*	*737*	*739.6*	*2.0*	*737*	*739.0*	*2.4*	*737*	*739.4*
NOx	1 hr	400	µg/m^3	652	60	712	233	60	293	218	60	278	106	60	166	106	60	166	106	60	166
NOx	24 hr	200	µg/m^3	248	50	298	85	50	135	84	50	134	38	50	88	38	50	88	38	50	88
SO_2	1 hr	690	µg/m^3	18	14.1	32	*165*	*14.1*	*180*	*1.9*	*14.1*	*16*	*2.2*	*14.1*	*16.3*	*2.2*	*14.1*	*16*	*2.2*	*14.1*	*16*
SO_2	24 hr	275	µg/m^3	6.9	11.2	18	*21*	*11.2*	*33*	*0.99*	*11.2*	*12*	*1.3*	*11.2*	*12*	*1.3*	*11.2*	*12*	*1.3*	*11.2*	*12*
PM_{10}	24 hr	50	µg/m^3	20	42	62	45	42	87	18	42	60	21	42	63	21	42	63	21	42	63
$PM_{2.5}$	24 hr	30	µg/m^3	11.7	20	32	6.7	20	27	6.6	20	27	7.3	20	27	7.3	20	27	7.3	20	27
VOC	1 hr	NA	ppm	0.50	0.29	0.79	-	*0.29*	*0.29*	*0.20*	*0.29*	*0.49*	*0.4*	*0.29*	*0.69*	*0.23*	*0.29*	*0.52*	*0.23*	*0.29*	*0.52*
Air Toxics																					
benzene	24 hr	30	µg/m^3	6.8	2.5	9	-	*2.5*	*2.5*	*3.4*	*2.5*	*5.94*	*2.9*	*2.5*	*5.4*	*2.9*	*2.5*	*5.4*	*2.9*	*2.5*	*5.4*
acetaldehyde	24 hr	500	µg/m^3	1.4	2.2	3.6	-	*2.2*	*2.2*	*0.66*	*2.2*	*2.9*	*0.72*	*2.2*	*2.9*	*1.3*	*2.2*	*3.5*	*1.3*	*2.2*	*3.5*
formaldehyde	24 hr	65	µg/m^3	3.6	3.7	7.3	-	*3.7*	*3.7*	*2.1*	*3.7*	*5.8*	*2.2*	*3.7*	*5.9*	*3.6*	*3.7*	*7.3*	*3.6*	*3.7*	*7.3*
1,3-butadiene	24 hr	2	µg/m^3	0.94	0.18	1.1	-	*0.18*	*0.18*	*0.38*	*0.18*	*0.56*	*0.21*	*0.18*	*0.39*	*0.21*	*0.18*	*0.39*	*0.21*	*0.18*	*0.39*
acrolein[2]	24 hr	4.0	µg/m^3	0.11	0.140	0.25	-	*0.14*	*0.14*	*0.054*	*0.14*	*0.19*	*0.044*	*0.14*	*0.18*	*0.034*	*0.14*	*0.17*	*0.034*	*0.14*	*0.17*
benzo (a) pyrene	24 hr	0.0011	µg/m^3	0.00010	0.00054	0.00064	-	*0.00054*	*0.00054*	*< 0.00001*	*0.00054*	*0.00055*	*< 0.00001*	*0.00054*	*0.00055*	*< 0.00001*	*0.00054*	*0.00055*	*< 0.00001*	*0.00054*	*0.00055*
Greenhouse Gases																					
CO_2	annual	NA	µg/m^3	-	650,000	-	-	*650,000*	-	-	*650,000*	-	-	*650,000*	-	-	*650,000*	-	-	*650,000*	-
N_2O	24 hr	9,000	µg/m^3	2.6	560	563	-	*560*	*560*	*3.2*	*560*	*563*	*4.2*	*560*	*564*	*4.3*	*560*	*564*	*4.3*	*560*	*564*
CH_4	annual	NA	µg/m^3	-	1,130	-	-	*1,130*	-	-	*1,130*	-	-	*1,130*	-	-	*1,130*	-	-	*1,130*	-
Other																					
ozone[3]	1 hr	165	µg/m^3	< 80			-			*< 80*			*< 130*			*< 130*			*< 130*		

Note: (1) Tier 1 assessed pollutants (shown in *italics)* for years 2015 and 2025 are representative of the initial study years 2011 and 2021 respectfully.
Note: (2) the current acrolein air quality criteria is represented by the Upper Risk Threshold (URT) value of 4.0 µg/m3 under Ontario Regulation 419/05. The future (2020) air quality standard under Ontario Regulation 419/05 is 0.4 µg/m3.
Note: (3) estimate based on the VOC / NOx ratio and ispoleth method includes background ozone.

Note: 2025 (FDN) refers to future operation of existing bridge only, 2025 (A) refers to future operation of ABEP only and 2025 (B) refers to future operation of ABEP plus existing bridge.

6.2 Mitigation Measures for Areas

This air quality assessment identified areas which may require mitigation where the predicted maximum air quality concentrations (following Tier 2 and including background) above the air quality criteria may occur. Predicted maximum air quality concentrations (following Tier 2) above the air quality criteria may occur for the pollutants of interest and emission scenarios listed in Table 12.

Proposed mitigation measures are outlined below and are both technically and economically feasible.

Table 12: Summary of Scenarios Above Air Quality Criterion

Pollutant of Interest	Relevant Averaging Period	Emission Scenario (s)
NO_X	1 hr	Baseline
NO_X	24 hr	Baseline
PM_{10}	24 hr	Baseline, 2015(Construction), 2015 (Operation), 2025(FDN), 2025(A), 2025(B)
$PM_{2.5}$	24 hr	Baseline

6.2.1 Vehicle and Road Dust Emissions

The greatest potential for improving air quality exists where air quality is impacted the most, along Huron Church Road. Comparing areas along Huron Church Road where traffic flows freely to areas with major arterial intersections suggests that air quality impacts could be reduced significantly by measures that would allow thru-traffic to flow more freely such as enhanced signal timing and/or the removal lights at key intersections. Such measures fall outside the jurisdiction of the project proponent.

Further details related to pollutants of interest for which predicted maximum air quality concentrations (following Tier 2) above the air quality criteria may occur, are discussed below. Pollutants of interest related to construction activities are discussed in Section 6.2.2.

Nitrogen Oxides

Maximum 1-hour and 24-hour NO_X air quality concentrations (following Tier 2 and including background) above the air quality criteria may occur for the baseline scenario.

The areas of highest NO_X concentrations are predicted to occur near many of the intersections along Huron Church Road. The future reductions in NO_X air quality concentrations (1-hour and 24-hour) adjacent to the Site Study Area are related to improved traffic flow with the replacement span and expanded customs processing resulting in less queuing and idling. Projected future reductions in vehicle emissions due to improved fuel standards and emission controls also contribute to future reductions in NO_X air quality concentrations. The policy assumptions considered by Environment Canada in the development of the model (MOBILE 6.2C) used to estimate current and future vehicle emissions are discussed in Section 6.1.2.

PM_{10} and $PM_{2.5}$

Maximum 24-hour PM_{10} air quality concentrations (following Tier 2 and including background) above the air quality criteria may occur for the baseline, 2015 (Operation), 2025 (FDN), 2025(A) and 2025(B) scenarios. Also, maximum 24-hour $PM_{2.5}$ air quality concentrations (following Tier 2 and including background) above the air quality criteria may occur for the baseline scenario.

It should be noted that for both PM_{10} and $PM_{2.5}$, the selected background is a significant fraction of the maximum air quality concentration for all scenarios. The PM_{10} background accounts for approximately 84% of the maximum 24-hour PM_{10} air quality concentrations whereas the $PM_{2.5}$ background accounts for approximately 67% of the maximum 24-hour $PM_{2.5}$ air quality concentrations. The approach of adding the background to the maximum modeled concentration provides a very conservative assessment of the maximum air quality concentration as the selected background for urban areas would already include impacts from roadways.

Vehicle emissions (exhaust, evaporative loses, tire wear and brake wear) and roadway emissions (road dust) contribute to the maximum PM_{10} and $PM_{2.5}$ air quality concentrations. As with NO_X, vehicle emissions of PM_{10} and $PM_{2.5}$ are predicted to reduce due to improved traffic flow with the replacement span resulting in less queuing and idling. Vehicle emissions of PM_{10} and $PM_{2.5}$ are also predicted to decline in the future due to improved fuel standards and emission controls. The policy assumptions considered by Environment Canada in the development of the model (MOBILE6.2C) used to estimate current and future vehicle emissions are discussed in Section 6.1.2.

Predicted future reductions in PM_{10} and $PM_{2.5}$ vehicle emissions are partially offset by roadway emissions (road dust) due to future increases in traffic flow resulting in a marginal increase in the maximum PM_{10} and $PM_{2.5}$ air quality concentrations for future scenarios.

The areas of highest PM_{10} and $PM_{2.5}$ concentrations are predicted to occur along Huron Church Road. Mitigation measures to address silt loading and municipal actions (e.g., road cleaning) to further reduce material on the surface of the road represent some of the proposed measures.

Other Pollutants of Interest

The cumulative concentrations of all other pollutants of interest are predicted to be below the air quality criteria at all locations for all emission scenarios.

6.2.2 Construction Activity Emissions

Project planning during the construction phase demonstrates compliance with the maximum 1-hour and 24-hour NO_X air quality criterion.

During the construction phase, the maximum 24-hour PM_{10} and $PM_{2.5}$ air quality concentration is predicted to be higher than the operational emission scenario for the same period (2015). The maximum concentrations during construction consider the combined impacts of construction activities and vehicle emissions and roadway emissions associated with traffic on the bridge, customs plaza, Huron Church Road and Arterial Roads in Local Study Area.

Measures to be used to manage NO_X and reduce PM_{10} and $PM_{2.5}$ air quality concentrations during construction activities include:

- review of the construction emission inventory prior to start. The construction emission modeling was based on a conservative inventory of equipment with construction activities being carried out over a period of 10 hours per day, 5 days a week during the period 2013 to 2015 and

in compliance with municipal by-laws. Should greater or lesser inventory of equipment be used, the work hours may need to be adjusted accordingly;

- implementation of a Best Management Plan (BMP) described in detail in Appendix 14, utilizing established measures outlined in reference materials such as "Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities" (2005);
- adhere to, where applicable, the "Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities" developed by Environment Canada (2005);
- contract documents requiring that the BMP be used to minimize short-term impacts;
- Dust suppression measures including periodic watering of unpaved (non-vegetated) areas; periodic watering of stockpiles; limiting speed of vehicular travel; use of water sprays during the loading; unloading of materials; use of calcium chloride; sweeping and/or water flushing of the entrance to the construction zones; and road sweeping practices in accordance with maintenance standards will be employed t reduce silt loading;
- contract documents will stipulate that heavy equipment must meet design specifications for emission controls and that licensed vehicles conform to provincial Drive Clean standards, where appropriate;
- idling of heavy equipment will be monitored and limited consistent with the municipal by-law to the extent possible;
- the contractors most polluting heavy equipment will be identified and use limited during smog advisories;
- the number and/or size of heavy equipment that will be operating simultaneously will be reviewed prior to construction. The river barges are predicted to be a significant contributor to the maximum NO_X concentrations during construction and as such the number and/or size of these will be limited; and
- since the NO_X concentrations are predicted to be highest at the virtual receptors located on the water versus virtual and special receptors located on land, restrictions will be imposed to limit the distance between operating barges and water based receptors such as pleasure boats.

With the application of these mitigation measures, no significant impacts are anticipated. Further, a mitigation compliance monitoring plan has been created for this project with respect to air quality. Details on this plan are provided in Appendix 16.

6.3 Significance of Environmental Effects

6.3.1 Environmental Effects of Project (ABEP)

As presented in the EA Guidelines, the definitions of "environment" and "environmental effect" are as follows:

"Environment" means the components of the Earth, and includes:

a) Land, water and air, including all layers of the atmosphere;
b) All organic and inorganic matter and living organisms; and
c) The interacting natural systems that include components referred to in paragraphs (a) and (b).

"Environmental effect" means, with respect to a project:

a) Any change that the project may cause in the environment, including any change it may cause to a listed wildlife species, it's critical habitat or the residences of individuals of that species, as those terms are defined in subsection (2(1) of the Species at Risk Act,
b) Any effect of any such change referred to in paragraph (a) on:
  i) Health and socio-economic conditions,
  ii) Physical and cultural heritage,
  iii) The current use of lands and resources for traditional purposes by aboriginal persons, or
  iv) Any structure, site or thing that is of historical, archaeological, paleontological or architectural significance, or
c) Any change to the project that may be caused by the environment,

Whether any such change or effect occurs within or outside Canada.

The significance of the environmental effects is summarized in this air quality assessment in qualitative terms including magnitude, geographic extent, frequency, duration, degree of reversibility and ecological context. As described in the EA Guidelines, the Responsible Authority (Transport Canada) will make the final decision on the significance of environmental effects including air quality.

The air quality assessment includes an assessment of the cumulative effects of the project plus background concentrations.

The results show a positive environmental change as the future air quality is predicted to improve with the replacement span. These improvements are both direct, due to predicted improvements in traffic flow resulting in less queuing and idling and indirect due to improved fuel standards and vehicle emission controls.

The policy assumptions considered by Environment Canada in the development of the model (MOBILE6.2C) used to estimate current and future vehicle emissions as discussed in Section 6.1.2.

The impacts that occur along Huron Church Road are localized and immediately adjacent to the roadway. The air quality assessment does not consider possible future improvements to Huron Church Road that will further reduce queuing and idling and improve air quality.

The total annual bridge emissions of the pollutants of interest are less than 1% and in many cases less than 0.1% of the total annual regional emissions for Essex County (Ontario) and Wayne County (Michigan).

Measures to further reduce the environmental effect of the project, including mitigation of short-term nuisance during all phases of construction, are discussed in Section 6.2.

Nitrogen Oxides

A detailed assessment of the predicted frequency of air quality concentrations (including background) above the air quality criteria was performed for NO_X for the present (baseline) emission scenario for illustrative purposes. At virtual and special receptors located close to Huron Church Road, the frequency was established as the number of days during which the 24-hour average air quality concentration is predicted to be above the air quality criteria expressed as a percentage of the number of days in the modeling period (2005), in this case 365 days.

For the present (baseline) scenario, of the more than 900 virtual receptors included in the dispersion modeling analysis, only 28 (or 3%) predict that 24-hour NO_X concentrations above the air quality criteria may occur. The virtual receptor with the single highest maximum 24-hour NO_X air quality concentration (298 $\mu g/m^3$ of which 50 $\mu g/m^3$ (17% attributed to background) located near Huron Church and Tecumseh Road West is predicted to have concentrations that may be above the air quality criteria of 200 $\mu g/m^3$ for 21 days per year (i.e., frequency of approximately 6%). For the remaining 27 affected virtual receptors with predicted 24-hour NO_X concentrations above the air quality criteria the frequency exceedence is less than 5%, with most below 1%. A histogram plot of the predicted 24-hour NO_X air quality concentrations (including background) for the virtual receptor with the highest concentration, for the present (baseline) scenario, versus days per year are shown in Appendix 15. Implementation of the additional mitigation measures proposed such as enhanced signaling and removal of traffic lights to improve traffic flow along Huron Church Road can reduce concentrations below the air quality criteria.

One of the special receptors defined in this analysis is predicted to have a 24-hour NO_X air quality concentration marginally above the air quality criteria. This special receptor (University of Windsor School of Visual Arts) has a maximum 24-hour NO_X air quality concentration of 203 µg/m^3 (of which 50 µg/m^3 is attributed to background) with a predicted frequency of exceedence of 1 days per year (0.3%). This maximum concentration is predicted on the property near Huron Church Road and will be lower at the buildings set back from the road.

The 24-hour NO_X air quality concentration (including background) was predicted to be below the air quality criteria for all receptors for all other emission scenarios.

PM_{10}

The study predicts that the 24-hour PM_{10} concentrations above the air quality criteria may occur at both virtual receptors and special receptors. For the present (baseline) scenario the special receptor with the highest maximum 24-hour PM_{10} air quality concentration is Assumption High School (62 µg/m^3 of which 42 µg/m^3 are attributed to background) compared to the air quality criteria of 50 µg/m^3. This maximum concentration is predicted on the school property near Huron Church Road and will be lower at the buildings set back from the road. The model predicts 24-hour PM_{10} air quality concentrations (including background) at this special receptor may be above the ambient air quality criteria for 85 days per year (i.e., frequency of approximately 23%).

It should be noted that the road dust component accounts for over 90% of the overall PM_{10} emission factor with vehicle emissions being a minor contributor (<10%).

A histogram plot of the predicted 24-hour PM_{10} air quality concentrations (including background) for the virtual receptor with the highest concentration, for the present (baseline) scenario, versus days per year are shown in Appendix 15.

Considering the conservatism of the 90th percentile background (42 µg/m^3) when compared to the more realistic average background (≈ 25 µg/m^3) and the fact that over 90% of the PM_{10} air quality concentrations are attributed to road dust and not vehicle emissions and that the primary particulate component of concern related to vehicle emissions is the very fine fraction (i.e. $PM_{2.5}$ and less), a more detailed analysis of the frequency of exceedances of PM_{10} is not warranted.

Also, air quality impacts associated with the project are based upon the extent, frequency and duration of queuing and idling representative of the $PM_{2.5}$ fraction. Road dust emissions are influenced by vehicle volumes and weights. Implementation of this project is not predicted to change these impacts along Huron Church Road.

6.3.2 Environmental Effects of Other Projects

A screening level assessment of cumulative effects that are likely to result from the project (replacement span) in conjunction with other projects or activities that are reasonably foreseeable was performed.

Identified projects and activities with the potential for cumulative impacts with this project that are of interest from an air quality perspective include:

- the Ambassador Bridge;
- the US side of the replacement span; and
- the Detroit River International Crossing (DRIC).

The cumulative effects of the replacement span with the existing Ambassador Bridge are described in detail in Section 6.1 (Table 11) and summarized in Table 13. In summary the environmental effects associated with vehicle emissions are predicted to improve relative to the present (baseline) scenario. Although PM_{10} and $PM_{2.5}$ vehicle emissions are predicted to decline relative to the present (baseline) due to predicted improvements in traffic flow resulting in less queuing and idling and improved fuel standards and vehicle emission controls, emissions associated with road dust are predicted to marginally increase due to increased traffic flow.

The cumulative effects of the replacement span with the US side of the replacement span were discussed in Section 6.1.2. The potential for transboundary air quality impacts is deemed insignificant since impacts from these activities are generally localized (within 300 metres). The proposed mitigation measures for construction impacts will be applied on both sides of the bridge.

The DRIC project is considered remote (>2 km) from the replacement span and as such the effects are not likely to overlap with the effects of the replacement span and do not produce a cumulative effect. It is expected that Transport Canada (TC), through a separate EA process, will require DRIC to assess environmental impacts from the proposal (including build and no-build scenarios).

The cumulative concentrations (including 90th percentile background) discussed in Section 6.2 included, but are not limited to, the following maximum credible emission scenarios:

- 2025 (FDN): operation of the existing Ambassador Bridge only (4 lanes; future do nothing)
- 2025 (A): operation of replacement span only (6 lanes)
- 2025 (B): operation of replacement span (6 lanes) plus Ambassador Bridge (4 lanes)

For the purpose of this cumulative effects assessment, if it is assumed that the DRIC project is implemented and that no increase in the predicted traffic volumes across the Ambassador Bridge and/or replacement span occurs, the cumulative effects including the DRIC will be less than presented in this report (Table 11).

Table 13: Summary of Cumulative Environmental Effects Relative to Present (Baseline)

Emission Scenario	Air Quality Effects, Including Cumulative Effects	Potential Mitigation	Significance of Environmental Effects in Local Study Area A					Residual Air Quality Effects After Mitigation
			Pollutant of Interest (POI)	Magnitude	Geographic Extent	Degree of Reversibility	Ecological Context	
Present (Baseline)	vehicle emissions, road dust emissions	Not Applicable - Baseline Condition	NOx (24-hour, 1-hour)	-	-	R	EAE	Not Applicable - Baseline Condition
		Not Applicable - Baseline Condition	PM_{10} (24-hour)	-	-	R	EAE	
		Not Applicable - Baseline Condition	$PM_{2.5}$ (24-hour)	-	-	R	EAE	
		Not Applicable - Baseline Condition	All Other POI	-	-	R	EAE	
Construction: 2015	vehicle emissions, road dust emissions, dust generation from construction activities, vehicle emissions from construction equipment	- enhance traffic flow with additional customs processing - government policies (improved fuel standards, ethanol replacement, more stringent emission controls) - government infrastructure improvements to enhance traffic flow along HC Road - for construction activities, develop Best Management Plan, limit to daytime hours, use low emission equipment, enforce idling by-law, monitor and limt the number and size of equipment operating simultaneously	PM_{10} (24-hour)	++	NIL	R	EAE	+++ (short term duration)
			$PM_{2.5}$ (24-hour)	+	+++	R	EAE	NIL
		-use of low emission equipment, monitor and limit size of equipment operating.	NOx (1-hour)	NIL	NIL	R	EAE	NIL
		no mitigation required	All Other POI	NIL	NIL	R	EAE	NIL
Operation: 2015	vehicle emissions, road dust emissions	- enhance traffic flow with additional customs processing - government policies (improved fuel standards, ethanol replacement, more stringent emission controls) - government infrastructure improvements to enhance traffic flow along HC Road	PM_{10} (24-hour)	++	++	R	EAE	NIL
			$PM_{2.5}$ (24-hour)	NIL	+++	R	EAE	NIL
		no mitigation required	NOx (24-hour)	NIL	NIL	R	EAE	NIL
			All Other POI	NIL	NIL	R	EAE	NIL
Future (Do Nothing): 2025 (FDN)	vehicle emissions, road dust emissions	- enhance traffic flow with additional customs processing - government policies (improved fuel standards, ethanol replacement, more stringent emission controls) - government infrastructure improvements to enhance traffic flow along HC Road	PM_{10} (24-hour)	+++	++	R	EAE	NIL
			$PM_{2.5}$ (24-hour)	NIL	NIL	R	EAE	NIL
		no mitigation required	NOx (24-hour)	NIL	NIL	R	EAE	NIL
			All Other POI	NIL	NIL	R	EAE	NIL
Future (ABEP): 2025 (A)	vehicle emissions, road dust emissions	- enhance traffic flow with additional customs processing - government policies (improved fuel standards, ethanol replacement, more stringent emission controls) - government infrastructure improvements to enhance traffic flow along HC Road	PM_{10} (24-hour)	+++	+++	R	EAE	NIL
			$PM_{2.5}$ (24-hour)	NIL	NIL	R	EAE	NIL
		no mitigation required	NOx (24-hour)	NIL	NIL	R	EAE	NIL
			All Other POI	NIL	NIL	R	EAE	NIL
Future (ABEP plus Existing Bridge): 2025 (B)	vehicle emissions, road dust emissions	- enhance traffic flow with additional customs processing - government policies (improved fuel standards, ethanol replacement, more stringent emission controls) - government infrastructure improvements to enhance traffic flow along HC Road	PM_{10} (24-hour)	+++	+++	R	EAE	NIL
			$PM_{2.5}$ (24-hour)	NIL	NIL	R	EAE	NIL
		no mitigation required	NOx (24-hour)	NIL	NIL	R	EAE	NIL
			All Other POI	NIL	NIL	R	EAE	NIL

Environmental Effect	**Description**
All	"NIL" indicates **negligible increase** (≤ 5%) or **no increase** in environmental effect relative to present (baseline) condition
Magnitude	+ = > 5% and ≤ 10% increase in the maximum air quality concentration relative to present (baseline) condition ++ = > 10% and ≤ 20% increase in the maximum air quality concentration relative to present (baseline) condition +++ = > 20% increase in the maximum air quality concentration relative to present (baseline) condition
Geographic Extent	+ = > 5% and ≤ 10% increase in the geographic area where there are predicted exceedances of the air quality criteria relative to the present (baseline) condition ++ = > 10% and ≤ 20% increase in the geographic area where there are predicted exceedances of the air quality criteria relative to the present (baseline) condition +++ = > 20% increase in the geographic area where there are predicted exceedances of the air quality criteria relative to the present (baseline) condition
Degree of Reversibility	R = reversible I = irreversible
Ecological Context	NAE = area not adversely effected by human activity (pristine area) EAE = evidence of adverse effects due to human activity
Residual Air Quality Effects	"NIL" indicates **negligible increase** (≤ 5%) or **no increase** in environmental effect relative to present (baseline) condition + = > 5% and ≤ 10% increase in the maximum air quality concentration relative to present (baseline) condition ++ = > 10% and ≤ 20% increase in the maximum air quality concentration relative to present (baseline) condition +++ = > 20% increase in the maximum air quality concentration relative to present (baseline) condition

6.4 Monitoring and Adaptive Management Planning

Based upon Ontario ambient air monitoring results, exceedences of the PM10 ambient air quality criterion frequently occur throughout the province, including Windsor. Construction of the project incorporating a construction best management plan (BMP) has the potential to mitigate impacts during the construction phase of the project. The effectiveness of these measures, the need to incorporate additional measures and the adherence of construction practices to the proposed mitigation measures may be determined through a monitoring and an adaptive management plan.

A proposed monitoring plan covering pre-construction, construction and operation project phases is provided in Attachment 16. The plan describes the methods and equipment which could be used to provide real-time air monitoring data to the project proponent.

Information obtained from the monitoring program would be used as input into an adaptive management plan whereby actions would be initiated to identify and control sources of emissions contributing to exceedences of the ambient air quality criterion. Examples of adaptive management may include:

- reducing the extent of active work areas to reduce fugitive dust emissions;
- scheduling of material deliveries and handling activities to avoid meteorological events attributed to high ambient levels;
- identify the need for additional operator training and awareness of mitigation measures to be used, and
- increased understanding of traffic flow patterns and local air quality.

7. SUMMARY OF KEY FINDINGS

The air quality assessment documented in this report has been carried out as part of the Environmental Impact Statement related to the federal environmental assessment for the Ambassador Bridge Enhancement Project (replacement span), located in Windsor, Ontario.

The purpose of the air quality assessment is to determine if the construction and operation of the proposed new bridge will result in any significant adverse impacts to the environment.

The study scope was carefully planned to provide insight into a variety of substances, locations and future scenarios and is based on the EA Guidelines provided by the federal Environmental Assessment review team. In conducting the assessment, the current air quality conditions were compared to air quality conditions that are anticipated to occur in the future. Specifically assessed were the areas surrounding the bridge, the customs plaza, and two kilometers of public roadway leading from the bridge to the Huron Church Road/Industrial Drive intersection, currently being used as the turning point for secondary truck inspections leaving the Canadian Plaza. Traffic data from publicly available sources was used for estimating vehicle flow and profile for existing and future scenarios. Publicly available ambient air quality data were assessed and used to establish background concentrations which were added to the predicted air quality impacts of the project to assess cumulative effects.

The key findings of the assessment were:

1. The **existing conditions** indicate that the greatest air quality impacts do not occur at the bridge or the customs plaza, but occur around key intersection locations along Huron Church Road. The impacts generally occur in close proximity (within $\underset{\sim}{}$ <150 m) to Huron Church Road and decrease significantly with distance. Air quality modeling indicates that concentrations above the air quality criteria may occur at these locations for certain pollutants of interest (NO_X and PM_{10} and $PM_{2.5}$). Idling and acceleration of vehicles related to traffic control lights appear to be a significant contributor to the air quality impacts. Air quality impacts could be reduced by measures that would allow thru-traffic to flow more freely such as enhanced signal timing and/or the removal of lights at key intersections.

2. The **existing conditions** indicate that the greatest impact, aside from Huron Church Road intersections, occurs at the customs plaza. Air quality modeling indicates that concentrations above the air quality criteria could occur in close proximity to this location for certain pollutants of interest. Idling and acceleration of vehicles in the customs queue seem to be the primary contributor.

3. Under the future scenario, in **2015**, that considers impacts from **construction activities** related to the **replacement span**, air quality in close proximity (within 300m) to the bridge will be impacted due to emissions from construction equipment. The potential exists for concentrations of PM_{10} to be above the air quality criteria. The project proponent plans a number of practical measures that will mitigate the construction impacts, including when, how and where the construction equipment will be deployed. Specific mitigation measures are discussed in detail in Section 6.2 of this report. These same mitigation measures are applicable to the construction of an improved Canadian Plaza.

4. Under the future scenario, in **2025,** with the **Ambassador Bridge** referred to as "future do nothing" or 2025 (FDN), the greatest air quality impacts are still predicted to occur along Huron Church Road, but are reduced in magnitude and aerial extent relative to the present (baseline) as more stringent fuel and vehicle emission standards take effect. For most pollutants of interest, the model suggests that the effect of more stringent standards outweighs the increase in traffic volumes. The improvement is most apparent for substances that are closely tied to the standards, such as NO_X. Under this scenario, NO_X concentrations are predicted to be below the air quality criteria. The policy assumptions considered by Environment Canada in the development of the model (MOBILE 6.2C) used to estimate current and future vehicle emissions are detailed in the model documentation. Policies impacting future vehicle emissions include but are not limited to a reduction in the gasoline and diesel sulphur content to 30 ppm and 15 ppm, respectively; 5% ethanol replacement; emission standards for passenger vehicles and light duty trucks phased in according to the schedules specified in Tier 1, NLEV and Tier 2 regulations; Canadian motorcycle emission regulations phased in during the period 2006 to 2010 as well as regular incremental reductions in volatile organic compound emissions under the United States 1990 Clean Air Act Requirements for ozone non-attainments areas. It should be is noted that the new emission standards for heavy duty vehicles implemented in the United States in 2007 are not accounted for in MOBILE6.2C.

5. Under the future scenario, in **2025**, 10 years after construction and operation of the **replacement span** referred to as 2025 (A), the greatest air quality impacts are still predicted to occur along Huron Church Road, but are reduced in magnitude and aerial extent relative to the present (baseline) as more stringent fuel and vehicle emission standards take effect as described above. In addition, the air quality in the area near the customs plaza and on the bridge is predicted to benefit from improved traffic flow due to the higher capacity of the new bridge. The reduced vehicle emissions appear to outweigh the increase in traffic volumes for most pollutants of interest. The reduced magnitude and aerial extent is most apparent for substances that are closely

tied to the standards, such as NO_X. Under this scenario, NO_X concentrations are predicted to be below the air quality criteria.

6. Under the future scenario, in **2025**, 10 years after construction and operation of the **replacement span plus Ambassador Bridge** referred to as 2025 (B), the greatest air quality impacts are still predicted to occur along Huron Church Road, but are reduced in magnitude and aerial extent relative to the present (baseline) as more stringent fuel and vehicle emission standards take effect as described above. In addition, the air quality in the area near the customs plaza and on the bridge is predicted to benefit from improved traffic flow due to the higher capacity of the new bridge. The reduced vehicle emissions appear to outweigh the increase in traffic volumes for most pollutants of interest. The reduced magnitude and aerial extent is most apparent for substances that are closely tied to the standards, such as NO_X. Under this scenario, NO_X concentrations are predicted to be below the air quality criteria.

7. A comparison of the future **2025** "do nothing" and replacement span only scenarios, indicate that the **replacement span and customs plaza will result in an improvement in air quality**, notably in the area close to the bridge and the customs plaza.

8. The future **2025** replacement span plus Ambassador Bridge scenario results in an increase in air quality concentrations of some contaminants in the vicinity of the customs plaza relative to the other 2025 scenarios. This is due to the "worst case" nature of this "two bridge scenario" which assumes all heavy duty vehicle traffic occurs on the replacement span with all light duty vehicle traffic on the Ambassador Bridge. The increased concentration of higher emitting heavy duty vehicles along the replacement span (particularly in the southbound direction) is predicted to result in slightly higher concentrations of some pollutants of interest, particularly PM_{10} and $PM_{2.5}$ associated with road dust, in the vicinity of the customs plaza. Operation of the replacement span plus the Ambassador Bridge is not considered a practical scenario by the proponent but has been assessed at the request of the federal EA review team.

9. The greatest potential for improving air quality exists where air quality is impacted the most, along Huron Church Road. Comparing areas along Huron Church Road where traffic flows freely to areas with major arterial intersections suggests that air quality impacts could be reduced significantly by measures that would allow thru-traffic to flow more freely such as enhanced signal timing and/or the removal lights at key intersections. Such measures fall outside the jurisdiction of the project proponent and as such strategies for mitigation in this area were not considered in the context of this air quality assessment.

APPENDIX 1

Revised Federal Environmental Assessment Guidelines Ambassador Bridge Enhancement Project (2006): August 2007 – Scope of Factors for Air Quality and Climate (5 pages)

Table 1: Scope of Factors for Air Quality and Climate

Factor	Issues to be Examined
Air Quality[2] and Climate	• Description of ambient air quality (including mean, 90th percentile, maximum observed values as well as the number and frequency of exceedances of criteria and standards) in the study area over a recent 5-year period, drawing from provincial, federal and any other monitoring programs, with reported results from monitoring locations in the City of Windsor. Include key results of localized studies focused within or near the study area • Identification of residences and sensitive receptors potentially impacted by air emissions and fugitive dust from all project phases, including construction, operation, and decommissioning. This should include the residences and receptors closest to the most heavily congested roadways in the study area such as the approaches to the customs plaza. • The analysis should take into account the potential alternatives for the existing structure, in order to reasonably predict potential effects that may result from the implementation of the proposed project. • Identification of potential effects associated with construction, and any required demolition activity, such as exhaust emissions from operation of heavy equipment and dust generation • Identification of the measures that will be used to reduce dust and particle emissions from construction activities and construction vehicle movements • Identification of potential air quality effects associated with the operations phase of the project, including emissions associated with increased traffic in the proposed study area, using recognized air quality modeling techniques; • Development of emissions scenarios for past (baseline) present and future (project completion and 10 years later) milestone dates. The future operating scenarios should include all credible options including continued operation of the existing bridge. • Use of an appropriate transportation model to estimate current and projected vehicle kilometres travelled and use of an recognized approach to project fleet composition • Estimation of vehicle exhaust and roadway emissions using recognized tools such as MOBILE6/6.2C and United States EPA emission factors. Include information on current and future vehicle queuing and idling (including spatial extent, frequency and duration) • Assessment of air quality effects for key pollutants and precursors

2 Annex A provides additional guidance on air quality. The proponent may wish to submit a draft Air Quality work plan to federal authorities for review to ensure that all relevant parameters are addressed.

Factor	Issues to be Examined
	(CO, NO_x, SO_2, $PM_{2.5}$, PM_{10} and VOCs), air toxics (benzene, acetaldehyde, formaldehyde, 1-3 butadiene, acrolein and PAHs) and greenhouse gases (CO_2, N_2O and CH_4) • Evaluation of regional impacts through pollutant burden analyses for the pollutants listed above. • Use of a 5-year meteorological data set representative of conditions in the study area to support dispersion modeling. • Use of a recognized dispersion model (such as the US EPA's CALQ3HCR) for the pollutants listed above for the baseline, do nothing and future operating scenarios. The application of the models(s) should be consistent with published guidelines and recommendations. • Consideration of the additional impact of other local and regional emissions through addition of a suitably conservative background concentration (i.e. 90th percentile) or through use of another approach such as combined effects assessment • Comparison of the predicted effects on residences and sensitive receptors with the National Ambient Air Quality Objectives and Canada Wide Standards. • Identification of related impacts to human health and sensitive ecosystems. • Discussion of the potential for transboundary air quality impacts as well as any potential for impacts on First Nations' lands. • Description of any proposed mitigation measures as well as their anticipated impact on the magnitude and frequency of the predicted effects of the project. • Opinion on the significance of residual effects

2 Annex A provides additional guidance on air quality. The proponent may wish to submit a draft Air Quality work plan to federal authorities for review to ensure that all relevant parameters are addressed.

Annex A
Ambassador Bridge Enhancement Project – Air Quality Requirements

Air quality was identified as an environmental component of specific concern to the federal EA review team. This annex provides additional information on how the federal review team expects the air quality assessment to be conducted. It is recommended that the proponent consider providing a draft Air Quality work plan to federal reviewers before carrying out the air quality study, in order to ensure that all requirements will be met.

It should be noted that the environmental assessment will also need to address potential human health effects associated with project-related effects on air quality. Additional guidance on how to carry out this assessment this can be provided by the federal review team later in the process, once preliminary air quality results are available.

The ambient air quality concentrations in the study area should be described for key pollutants based on local monitoring data within the City of Windsor from provincial, federal and any other available stations. Pollutants of interest include NO_X, SO_2, CO, particulate matter (PM_{10} and $PM_{2.5}$) and transportation-related volatile organic compounds (see later in this section) and PAHs. The analysis should span a recent five-year period and include mean and 90th percentile values, as well as maximum observed values and the number and frequency of exceedences of provincial and national criteria and standards. Local air quality studies focused within or near the study area would also assist in the description of the existing air quality conditions.

The identification of residences and sensitive receptors should include those that are likely to be most-heavily impacted by air emissions and fugitive dust emissions from all project phases, including construction, operation and any decommissioning activities. This should include the closest residences to the customs plaza and the closest residences along the most frequently congested section(s) of Huron Church Road approaching the customs plaza.

Emission scenarios should be developed for past, present and future milestone dates, to illustrate changes in emissions that are likely to result from the project. The assessment should include appropriate milestone years to reflect the existing conditions, the expected date of project completion, and10 years post-construction. The future operating scenarios should include both the continued operation and the decommissioning of the existing bridge. The analysis should also include a "do nothing" case for the future dates. Particular attention should be paid to the fleet mix as well as particulate and VOC emissions from heavy trucks.

An appropriate transportation model should be used to estimate current and projected future Vehicle Kilometres Traveled (VKT) for the project area. The projected vehicle fleet composition for the project area should also be evaluated. Emissions from vehicle exhaust and roadway surfaces should be generated using recognized tools such as United States Environmental Protection Agency (EPA) emission factors that have been adjusted

2 Annex A provides additional guidance on air quality. The proponent may wish to submit a draft Air Quality work plan to federal authorities for review to ensure that all relevant parameters are addressed.

to reflect Canadian standards where appropriate. MOBILE6 and the Canadian version MOBILE6.2C are the standard tools used to generate vehicle exhaust emissions estimates. Information on current and projected vehicle queuing and idling (including spatial extent, frequency and duration) at intersections, customs plazas and approaches should also be collected and incorporated into the analysis. These methodologies should be used to determine the pollutant emission rates and quantities for the pollutant burden analysis.

Pollutant burdens for each operational scenario should be calculated for the following pollutants and precursors: carbon monoxide (CO), nitrogen oxides (NOx), SO2, CO2, CH4, particulate matter less than 10 microns (PM10), particulate matter less than 2.5 microns (PM2.5) (which includes Diesel Particulate Matter (DPM)), and volatile organic compounds (VOC), and for the following air toxics: benzene, acetaldehyde, formaldehyde, 1,3-butadiene, acrolein, and polycyclic aromatic hydrocarbons (PAH). Potential impacts due to ground level ozone (GLO) should be considered through an assessment of emissions changes in ozone precursors and their ratios, in relation to ambient ozone concentrations.

Maximum emission scenarios should be developed for all relevant averaging time frames. The highest predicted traffic flow scenario for each project corridor and each operating scenario should be used to develop the maximum credible air pollutant emission scenarios. The emission rates shall be input to the dispersion model to predict the maximum concentrations at ground level and elevated receptors.

A 5-year meteorological data set, representative of conditions in the study area should be used in conjunction with an approved air dispersion model, to assess the maximum concentrations of the contaminants emitted from the project. Meteorological data from readily available sources, such as federal, provincial and state agencies is recommended. Dispersion modeling should be undertaken using a recognized model (such as the US EPA's CALQ3HCR) for each of the pollutants identified earlier in this section, for the baseline, do-nothing and future operational scenarios. The application of the model(s) should be consistent with published guidelines and recommendations for that model. In order to obtain an accurate representation of the predicted worst-case air quality conditions at any point, the impact of roadway operating emissions should be combined with the contributions from other local, regional and distant air pollution sources. This may be done by adding the worst-case modeled concentration at a given receptor to a suitably conservative background concentration (such as the 90th percentile of hourly observations) to arrive at the worst-case concentration at the receptor. Another acceptable approach to incorporate ambient influences would be to undertake what is referred to as a combined effects analysis. Under this approach, modeled concentrations for each hour of the 5-year data set are added to the representative background concentration of that pollutant for the exact same time to determine the worst-case concentrations.

The predicted worst-case concentrations should be compared to provincial (MOE Ambient Air Quality Criteria (AAQC)) and federal (Canada-wide Standards and National Ambient Air Quality Objectives) guidelines, as available. For receptors where an air

2 Annex A provides additional guidance on air quality. The proponent may wish to submit a draft Air Quality work plan to federal authorities for review to ensure that all relevant parameters are addressed.

quality standard or criterion is predicted to be exceeded, an analysis of the frequency of exceedances should be completed. If any criterion or objective is expected to be exceeded, then suitable mitigation measures should be evaluated. Additional dispersion modeling could be undertaken to estimate the frequency and magnitude of the residual impacts after the application of the mitigation measures.

The modeling results and their comparison to air quality standards and guidelines should then be used to evaluate the related impacts to human health and sensitive ecosystems. It is recommended that interim air quality modeling results be provided to the review team when available so that additional guidance on potential human health effects can be provided.

The potential for transboundary air quality impacts should be discussed as well as any potential impacts on First Nations lands.

An assessment of the construction-phase emissions (including dust, exhaust from the operation of heavy equipment and any demolition-related emissions) would help to identify and minimize any short-term nuisance effects. In addition, where possible, effects due to traffic disruption (i.e. increased idle times and queuing) should also be assessed. These analyses should take into account the plans for the existing structure, in order to reasonably predict potential effects that may result from the implementation of this proposed project.

The assessment should also discuss the measures that will be used to reduce dust and particle emissions from construction activities and construction vehicle movements. It should also outline how contract documents will stipulate that motorized equipment must meet design specifications for emission controls and conform to provincial Drive Clean standards, where appropriate, and that idling of any equipment should be limited to an absolute minimum and be strictly monitored. Provisions should also be made for contractors to avoid, or at least limit, the use of their most polluting motorized equipment during smog advisories.

The assessment should include an opinion concerning the significance of residual effects.

2 Annex A provides additional guidance on air quality. The proponent may wish to submit a draft Air Quality work plan to federal authorities for review to ensure that all relevant parameters are addressed.

APPENDIX 2

Ambient Air Quality Data Collection and Analysis
(19 pages)

A2-1: Data Sources and Availability

Air quality monitoring data for the specified pollutants of interest, to denote background ambient air concentrations within the study area, were examined from a variety of information sources and published network monitoring results as described in the main body of the report (Section 3.1).

Most of the relevant data were acquired from MOE network monitoring reports and all Windsor monitoring station concentrations were summarized from the year 2000 to the most recent year for which data were available (i.e., usually 2009 for some pollutants of interest). For pollutants of interest which were monitored at more than one Windsor site, average concentrations for pertinent statistics (e.g., arithmetic mean level, 90th percentile, maximum concentration, number of exceedences) were determined for each of the sites within the available years in order to deduce both year-specific and between-site differences.

The summarized concentrations for each of the relevant parameters are provided in the series of Tables A2-1 to A2-15. It can be seen that some pollutants of interest were monitored at several Windsor sites (i.e., SO_2, NO_X, PM_{10}, $PM_{2.5}$), others at only one Windsor site (i.e., CO, VOC species, PAH) whereas greenhouse gases are not routinely monitored in urban air quality networks. Other reported data were acquired for both the greenhouse gas components (CO_2, CH_4, N_2O) and total non-methane hydrocarbons (NMHC). Similarly, some pollutants of interest have not been recently monitored in Ontario networks (i.e., PM_{10}) and/ or data have not been recently published (i.e., PAH).

Environment Canada data is available for PAH constituents reported for the 2006 - 2009 calendar years at the College / South Street Environment Canada location.

A2-2: Background Concentrations

The air quality monitoring stations selected for Windsor background level data were:

- MOE Station #12008, 467 University, Downtown Windsor, and
- MOE Station #12016, College/South St., West Windsor.

For parameters that were monitored at both stations, the associated statistical data were combined (i.e., averaged for the two stations). Alternatively, the specific levels for either of the above-noted stations were used for pollutants of interest that were monitored at only site.

The average and 90th percentile concentrations by pollutant of interest, along with the average member of regulatory level exceedences for these stations, are summarized in Table A2-16 for two time periods. The annual period designated as 'current' represented the levels for the most recent available year (typically 2004 or 2005) and the period designated as 'past' included the average levels for the entire data period (typically 2000 to the most recent year). The current 90th concentrations for these sites were selected as the background levels for this assessment and were considered conservative as noted below.

The background total PAH, and associated constituent PAH concentrations, comprised the average of 90th percentile levels covering calendar year 2006 – 2009 at the College / South Street ambient monitoring location. Average annual levels of the greenhouse gases, that have been reported (Seinfeld and Pandis, 1998) and might be regarded as global-averaged atmospheric levels, were used as background levels for the area. In the absence of total VOC measurements in most locales, the maximum NMHC level measured in Sarnia (Lasalle Road) by ORTECH Environmental for the SLEA program over a two-year period (2002-2003) was used as the background level after conversion to applicable reporting units (ppm-carbon). The average methane level measured at this same SLEA site was of similar magnitude to that measured in other global areas. It is also relevant to note that ambient levels in exceedance of specific regulatory limits (e.g., existing or future Ontario air quality standards) occurred in both the current and past periods for some pollutants of interest (i.e., O_3, PM_{10}, $PM_{2.5}$, and benzo (a) pyrene).

A2-3: Data Conservatism

The data selected to represent background ambient air concentrations in Windsor was considered to be conservative for the following reasons:

- the Windsor air quality monitoring stations, selected to obtain background levels, were located in generally populated/busy areas of the City which typically have elevated levels of most pollutants of interest as opposed to stations more remote from urban emission sources,
- the associated monitoring data from these sites could be expected to encompass parameter contributions from sources under all wind directions, including existing bridge and road traffic components, since data for complete years were applied rather than selected directionally-dependent data,
- assignment of 90th percentile concentrations to represent background levels for most pollutants of interest, with the exception of applied mean levels for the greenhouse gases, provided a significant degree of conservatism,

- selection of the most recent year of available data for the background levels was considered to be more applicable than the average of several years since the more recent data should more closely represent current conditions with respect to emission sources. For some key pollutants of interest (e.g., O_3, NO_X, PM_{10}, $PM_{2.5}$, certain VOC species), the 90th percentile data for the most recent year (i.e., current levels) were either higher or nearly the same as the average 90th percentile data for the previous years (i.e., past levels). Similarly, generally poorer air quality occurred in Southern Ontario during 2005 than in the other previous years (e.g., a greater member of elevated air quality indices and smog advisories in 2005),
- the selected $PM_{2.5}$ background level (20 $\mu g/m^3$ for 24-hour averaging time) was higher than the overall mean concentrations that are currently being monitored at two sites along Huron Church Road for the period October-December 2006 (i.e., 19 and 21 $\mu g/m^3$) and also higher than most of the short-term (3-hour) $PM_{2.5}$ concentrations that were measured upwind near Huron Church Road during the MOE 2002-2003 Windsor bridge traffic studies,
- the selected NMHC background level was particularly conservative (i.e., significantly higher than the sum of measured individual VOC species at the Windsor site on the basis of species conversion to ppm-carbon),
- the predicted traffic-related NO_X concentrations, which may contain both nitric oxide (NO) and nitrogen dioxide (NO_2) components, have been compared with the Ontario AAQC that is relevant to NO_2 only.

Table A2-1: Ambient Carbon Monoxide Data

Windsor Air Quality Monitoring
Parameter: Carbon Monoxide — Standard, Criterion, Guideline: 30 ppm (1 hour)
Units: ppm — 13 ppm (8 hour)

Monitoring Location	Year	Valid Hours	1 hour Concentrations		24 hour Concentrations	
			Mean	90th %	Mean	90th %
MOE # 12008	2009	8547	0.21	0.36	0.21	0.33
Downtown	2008	8637	0.19	0.35	0.19	0.33
467 University Ave.	2007	8593	0.23	0.43	0.23	0.40
	2006	8557	0.29	0.49	0.29	0.44
	2005	7867	0.19	0.38	0.19	0.32
	2004	8573	0.48	0.72	0.48	0.68
	2003	5035a	INSa	1.20	NDb	NDb
	2002	7303	0.46	1.10	0.46	1.03
	2001	8487	0.26	0.57	0.26	0.48
	2000	8586	0.27	0.6	0.27	0.55
	Avg.		0.3	0.65		

a INS - flagged as insufficient measurements for statistically valid mean
b ND - No Data Available

Table A2-2: Ambient Sulphur Dioxide Data

Windsor Air Quality Monitoring
Parameter: Sulphur Dioxide
Units: ppb

Standard, Criterion, Guideline: 250 ppb (1 hour)
100 ppb (24 hour)
20 ppb (1 year)

Monitoring Location	Year	Valid Hours	1 hour Concentrations		24 hour Concentrations	
			Mean	90th %	Mean	90th %
MOE # 12008	2009	8744	3.5	10	3.5	7
Downtown	2008	8703	4.5	11	4.5	9
467 University Ave.	2007	8739	5.5	14	5.5	11
	2006	8699	5.0	12	5.0	11
	2005	8387	4.9	13	4.9	11
	2004	8750	4.8	13	4.8	10
	2003	8564	5.9	14	5.9	11
	2002	7295	5.7	15	5.7	11
	2001	8680	6.1	15	6.1	12
	2000	8671	6.1	15	6.2	12
	Avg.		5.2	13	5.2	10
MOE # 12016	2009	8698	3.6	10	3.6	8
West	2008	8718	4.7	13	4.7	10
College/South St.	2007	8700	5.2	14	5.2	11
	2006	8680	4.9	12	5.0	10
	2005	8584	5.1	14	5.2	11
	2004	8766	4.6	12	4.5	10
	2003	6656[a]	INS[a]	15	6.3	12
	2002	7272	7.9	19	7.9	15
	2001	8410	9.3	20	9.3	17
	2000	8776	8.8	20	8.8	17
	Avg.		6.0	15	6.1	12
All Sites (2000-2009)			5.6	14.1	5.6	11.2

[a] INS - flagged as insufficient measurements for statistically valid mean

Table A2-3: Ambient Ozone Data

Windsor Air Quality Monitoring
Parameter: Ozone Standard, Criterion, Guideline: 80 ppb (1 hour)
Units: ppb

Monitoring Location	Year	Valid Hours	1 hour Concentrations		24 hour Concentrations	
			Mean	90th %	Mean	90th %
MOE # 12008	2009	8711	24.8	44	25	37
Downtown	2008	8711	26.9	49	27	43
467 University Ave.	2007	8705	27	50	27	44
	2006	8722	24.6	47	25	41
	2005	8723	26.0	53	25	44
	2004	8745	20.2	40	20	34
	2003	8524	22.9	46	23	38
	2002	7299	21.9	49	22	43
	2001	8688	20.5	45	21	39
	2000	8663	18.6	41	19	33
	Avg.		23.3	46	23	39.6
MOE # 12016	2009	8670	24.9	44	25	37
West	2008	8767	25.9	48	26	41
College/South St.	2007	8710	25.3	48	25	42
	2006	8698	24.3	48	24	41
	2005	8633	25.6	54	26	45
	2004	8765	22.6	44	23	38
	2003	8618	22.80	47	23	39
	2002	7275	20.2	50	20	42
	2001	8316	19.0	43	19	37
	2000	8773	17.0	40	17	32
	Avg.		22.8	47	23	39.2
All Sites (2000-2009)			23.1	47	23	39.4

Note: 10 yr trend at both stations - fairly flat concentration behaviour between 1996-2004, 2005 higher

[a] INS - flagged as insufficient measurements for statistically valid mean

Table A2-4: Ambient Nitrogen Oxides Data

Windsor Air Quality Monitoring
Parameter: Oxides of Nitrogen — Standard, Criterion, Guideline: see NO_2
Units: ppb — (no MOE standard for NO_X)

Monitoring Location	Year	Valid Hours	1 hour Concentrations		24 hour Concentrations	
			Mean	90th %	Mean	90th %
MOE # 12008	2009	8443	20	39	20.0	36
Downtown	2008	8703	21.1	39	21.1	35
467 University Ave.	2007	8742	23.6	46	23.6	41
	2006	8730	24.4	46	24.4	41
	2005	8541	24.9	52	25.0	46
	2004	8563	29.3	58	29.4	58
	2003	3415[a]	INS[a]	72	40.6	70
	2002	7285	29.2	53	29.2	51
	2001	8589	30.5	57	30.5	49
	2000	8552	36.0	64	35.9	55
	Avg.		26.6	53	28.0	48
MOE # 12016	2009	8113	18.6	33	19	33
West	2008	7947	21.3	38	21	34
College/South St.	2007	8715	22.6	42	23	37
	2006	8485	22.8	42	23	38
	2005	8561	25.6	52	26	46
	2004	8766	29.1	56	29	55
	2003	6218[a]	INS[a]	69	38	59
	2002	7274	32.5	56	32	53
	2001	8434	31.1	58	31	51
	2000	4395[a]	INS[a]	71	36	62
	Avg.		25.5	52	27.8	47
All Sites (2000-2009)			26.0	52.2	27.9	47.6

[a] INS - flagged as insufficient measurements for statistically valid mean

Table A2-5: Ambient Nitrogen Dioxide Data

Windsor Air Quality Monitoring
Parameter: NO2 Standard, Criterion, Guideline:
Units: ppb

Monitoring Location	Year	Valid Hours	1 hour Concentrations		24 hour Concentrations	
			Mean	90th %	Mean	90th %
MOE # 12008	2009	8443	14.4	28	14.4	23
Downtown	2008	8703	15.2	28	15.2	24
467 University Ave.	2007	8742	17.2	32	17.2	28
	2006	8730	17.2	31	17.2	26
	2005	8541	16.9	33	17.0	27
	2004	8563	18.3	36	18.3	31
	2003	3415[a]	24.4	39	24.2	34
	2002	7285	19.1	32	19.1	27
	2001	8589	19.4	33	19.4	29
	2000	8552	21.6	37	21.6	32
	Avg. 00-09		18.4	32.9	18.4	28.0
	Avg 05-09		16.2	30.4	16.2	25.5
MOE # 12016	2009	8113	13.2	25	13	21
West	2008	7947	16.2	28	16	23
College/South St.	2007	8715	16.1	30	16	24
	2006	8485	15.7	29	16	23
	2005	8561	17.1	33	17	27
	2004	8766	17.6	33	18	27
	2003	6218[a]	22.1	37	22	32
	2002	7274	19.6	33	20	28
	2001	8434	20.8	35	21	29
	2000	4395[a]	20.7	35	21	30
	Avg. 00-09		17.9	31.8	17.9	26.4
	Avg 05-09		15.6	29.0	15.7	s
All Sites (2000-2009) in ppb			18.1	32.4	18.1	27.2
All Sites (2000-2009) in ug/m3			34.1	60.9	34.1	51.2
All Sites (2005-2009) in ppb			15.9	29.7	15.9	25.5
All Sites (2000-2009) in ug/m3			29.9	55.9	30.0	47.9

[a] INS - flagged as insufficient measurements for statistically valid mean

Table A2-6: Ambient Nitric Oxide Data

Windsor Air Quality Monitoring
Parameter: Nitric Oxide Standard, Criterion, Guideline: N/A (see NO_2)
Units: ppb

Monitoring Location	Year	Avg. Period (hours)	Valid Hours	Concentrations		Maximum		Number of Exceedances	
				Mean	90th %	1 h	24 h	1 h	24 h
	2009	1	8442	5.6	13	194	40	—	—
	2008	1	8703	5.9	13	173	50	—	—
	2007	1	8742	6.4	15	321	55	—	—
	2006	1	8730	7.2	17	272	86	—	—
MOE # 12008	2005	1	8541	7.8	20	184	74	—	—
Downtown	2004	1	8563	10.5	25	403	122	—	—
467 University Ave.	2003	1	3415[a]	INS[a]	35	544	114	—	—
	2002	1	7285	10.9	24	250	144	—	—
	2001	1	8589	11.0	26	202	71	—	—
	2000	1	8552	13.9	30	444	115	—	—
	Avg.			8.8	22	299	87		
	2009	1	8113	5.4	9	278	51	—	—
	2008	1	7947	5.1	10	195	51	—	—
	2007	1	8715	6.5	14	307	76	—	—
	2006	1	8485	7.2	15	350	153	—	—
MOE # 12016	2005	1	8561	8.3	20	356	73	—	—
West	2004	1	8766	11.3	25	439	112	—	—
College/South St.	2003	1	6218[a]	INS[a]	34	572	175	—	—
	2002	1	7274	13.0	25	624	257	—	—
	2001	1	8434	10.4	25	292	91	—	—
	2000	1	4395[a]	INS[a]	38	366	108	—	—
	Avg.			8.4	22	378	115		
MOE # 12009	2001	1	4841[a]	INS[a]	17	203	60	—	—
Little River	2000	1	7286	8.4	17	277	78	—	—
9725 Riverside Drive	Avg.			8.4	17	240	69		
Tecumseth Water Treatment Plant									
All Sites (2000-2009)				8.5	20.1	305.5	90.3		

[a] INS - flagged as insufficient measurements for statistically valid mean

Table A2-7: Ambient PM_{10} Data

Windsor Air Quality Monitoring
Parameter: Particulate Matter, diameter 10 micron or less
Units: $\mu g/m^3$ Standard, Criterion, Guideline: 50 $\mu g/m^3$ (24 hour)

Monitoring Location	Year	Avg. Period (hours)	Valid Hours	Concentrations		Maximum		Number of Exceedances
				Mean[b]	90th %	1 h	24 h	24 h
MOE # 12016	2001	1	8365	23.0	43	180	73	17
West	2000	1	8607	24.2	45	307	78	9
College/South St.	Avg.			23.6	44	244	76	13
MOE # 12507	2002	24	—	27.6	51	—	88	5
	2001	24	—	22.0	31	—	61	2
Wright/Water St.	2000	24	—	29.5	48	—	146	5
	Avg.			26.4	43		98	4
MOE # 12508	2002	24	—	24.7	42	—	76	4
Downtown	2001	24	—	29.4	51	—	79	6
467 University	2000	24	—	29.5	50	—	82	5
	Avg.			27.9	48		79	5
MOE # 12513	2002	24	—	26.9	51	—	82	5
3665 Wyandette St.	2001	24	—	32.8	58	—	95	8
Filtration Plant	2000	24	—	31.1	52	—	91	6
	Avg.			30.3	54		89	6
MOE # 12556	2002	24	—	18.9	32	—	55	1
1400 Roselawn Dr.	2001	24	—	19.6	29	—	46	0
St. Gabriel SS	2000	24	—	21.7	37	—	57	1
	Avg.			20.1	33		53	1
MOE # 12559	2002	24	—	24.0	48	—	70	5
5305 Adstol Ave.	2001	24	—	25.2	36	—	64	2
St. Alexander SS	2000	24	—	23.4	40	—	60	1
	Avg.			24.2	41		65	3
MOE # 12583	2002	24	—	17.3	29	—	55	1
13765 St. Gregory's	2001	24	—	16.9	27	—	48	0
St. Gregory SS	2000	24	—	23.0	35	—	71	2
	Avg.			19.1	30		58	1
All Sites (2000-2002)				24.5	42	244	74	5

[a] INS - flagged as insufficient measurements for statistically valid mean

[b] Arithmetic Mean

Table A2-8: Ambient $PM_{2.5}$ Data

Windsor Air Quality Monitoring
Parameter: Particulate Matter, diameter 2.5 micron or less
Units: $\mu g/m^3$ Standard, Criterion, Guideline: 30 $\mu g/m^3$ (24 hour)

Monitoring Location	Year	Valid Hours	1 hour Concentrations		24 hour Concentrations	
			Mean	90th %	Mean	90th %
MOE # 12008	2009	8620	7.2	15	7.1	13
Downtown	2008	8583	8.3	17	8.3	16
467 University Ave.	2007	8659	9.5	22	9.4	21
	2006	8632	8.2	18	8.2	17
	2005	8665	10.4	24	10	22
	2004	8597	8.6	19	8.6	17
	2003	8480	8.5	19	8.5	16
	2002	6697	9.8	21		
	2001	8303	9.4	20		
	Avg.		8.9	19		
MOE # 12016	2009	8658	7.4	15	7.4	13
West	2008	8668	8.9	18	8.9	16
College/South St.	2007	8676	9.8	21	10	20
	2006	8693	8.9	19	9.2	19
	2005	8643	10.5	24	11	24
	2004	8757	9.5	21	10	19
	2003	8605	9.6	20	10	17
	2002	7045	11.8	26		
	Avg.		9.6	21	9.3	18
All Sites (2000-2009)			9.2	20.0		

[a] INS - flagged as insufficient measurements for statistically valid mean

Table A2-9: Ambient Butadiene Data

Windsor Air Quality Monitoring
Parameter: 1,3-Butadiene
Units: µg/m^3 Standard, Criterion, Guideline: ?

Monitoring Location	Year	Avg. Period (hours)	Valid Hours	Concentrations		Maximum		Number of Exceedances
				Mean	90th %	1 h	24 h	1 h
MOE # 12016	2009	24	—	0.060	0.100	—	—	—
West	2008	24	—	0.060	0.100	—	—	—
College/South St.	2007	24	—	0.070	0.110	—	—	—
	2006	24	—	0.080	0.130	—	—	—
	2005	24	—	—	—	—	—	—
	2004	24	—	0.109	0.211	—	0.461	—
	2003	24	—	0.109	0.218	—	0.459	—
	2002	24	—	0.130	0.210	—	0.619	—
	2001	24	—	0.143	0.227	—	0.440	—
	2000	24	—	0.187	0.300	—	0.430	—
	Avg.			0.105	0.178		0.482	
Michigan DEQ Detroit								
Allen Park	2005	24	—	0.17	—	—	0.974	
W. Fort	2009	24	—	0	—	—	0	
	2008	24	—	0.0079	—	—	0.23	
	2007	24	—	0.28	—	—	0.139	
	2006	24	—	0.0696	—	—	0.79	
	2005	24	—	0.035	—	—	0.280	
W. Jefferson	2005	24	—	0.098	—	—	0.354	

[a] INS - flagged as insufficient measurements for statistically valid mean

Table A2-10: Ambient Acetaldehyde Data

Windsor Air Quality Monitoring
Parameter: Acetaldehyde
Units: µg/m^3 Standard, Criterion, Guideline: 500 µg/m^3 (24 hour)

Monitoring Location	Year	Avg. Period (hours)	Valid Hours	Concentrations		Maximum		Number of Exceedances	
				Mean	90th %	1 h	24 h	1 h	24 h
MOE # 12016	2009	24	—	0.65	1.04	—	—	—	
West	2008	24	—	1.27	2.26	—	—	—	
College/South St.	2007	24	—	1.04	1.81	—	—	—	
	2006	24	—	1.04	1.76	—	—	—	
	2005	24	—	—	—	—	—	—	
	2004	24	—	1.199	2.022	—	2.298	—	0
	2003	24	—	1.711	2.738	—	4.569	—	0
	2002	24	—	1.731	3.040	—	6.040	—	0
	2001	24	—	1.856	2.620	—	5.606	—	0
	2000	24	—	1.841	2.685	—	3.417	—	0
	Avg.			1.371	2.219		4.386		0
Michigan DEQ Detroit Sites									
Allen Park	2005	24	—	1.56	—	—	4.63	—	—
W. Fort	2009	24	—	1.58	—	—	3.28	—	—
	2008	24	—	1.52	—	—	4.48	—	—
	2007	24	—	3.92	—	—	1.89	—	—
	2006	24	—	1.71	—	—	3.46	—	—
	2005	24	—	1.72	—	—	4.37	—	—

[a] INS - flagged as insufficient measurements for statistically valid mean

Table A2-11: Ambient Acrolein Data

Windsor Air Quality Monitoring
Parameter: Acrolein
Units: µg/m^3

Standard, Criterion, Guideline: 0.08 µg/m^3 (24 hour)
9.6 µg/m^3 (24 hour)
SENES Report ?

Monitoring Location	Year	Avg. Period (hours)	Valid Hours	Concentrations		Maximum		Number of Exceedances	
				Mean	90th %	1 h	24 h	1 h	24 h
MOE # 12016	2009	24	—	0.03	0.07	—	—	—	
West	2008	24	—	0.04	0.07	—	—	—	
College/South St.	2007	24	—	0.05	0.1	—	—	—	
	2006	24	—	0.03	0.08	—	—	—	
	2005	24	—	—	—	—	—	—	
	2004	24	—	0.064	0.081	—	0.133	—	~1
	2003	24	—	0.134	0.284	—	0.315	—	~13
	2002	24	—	0.108	0.156	—	0.694	—	~14
	2001	24	—	0.109	0.207	—	0.398	—	~20
	2000	24	—	0.120	0.219	—	0.349	—	~14
	Avg.			0.076	0.141		0.378		

[a] INS - flagged as insufficient measurements for statistically valid mean

Table A2-12: Ambient Benzene Data

Windsor Air Quality Monitoring
Parameter: Benzene
Units: µg/m^3

Standard, Criterion, Guideline: 60 µg/m^3 (24 hour)
SENES Report ?

Monitoring Location	Year	Avg. Period (hours)	Valid Hours	Concentrations		Maximum		Number of Exceedances	
				Mean	90th %	1 h	24 h	1 h	24 h
MOE # 12016	2009	24	—	0.75	1.38	—	—	—	
West	2008	24	—	0.76	1.16	—	—	—	
College/South St.	2007	24	—	0.93	1.34	—	—	—	
	2006	24	—	1.07	1.48	—	—	—	
	2005	24	—	—	—	—	—	—	
	2004	24	—	1.754	3.360	—	6.257	—	0
	2003	24	—	1.746	2.833	—	6.287	—	0
	2002	24	—	1.497	3.321	—	4.090	—	0
	2001	24	—	1.692	3.352	—	4.470	—	0
	2000	24	—	2.161	4.000	—	5.170	—	0
	Avg.			1.373	2.470		5.255		0
Michigan DEQ Detroit Sites									
Allan Park	2005	24	—	2.21	—	—	8.5	—	—
W. Fort	2009	24	—	0.971	—	—	3.4	—	—
	2008	24	—	1.47	—	—	7.3	—	—
	2007	24	—	3.3	—	—	1.28	—	—
	2006	24	—	1.22	—	—	4.89	—	—
	2005	24	—	1.77	—	—	7.0	—	—
W. Jefferson	2005	24	—	8.18	—	—	47.9	—	—

[a] INS - flagged as insufficient measurements for statistically valid mean

Table A2-13: Ambient Formaldehyde Data

Windsor Air Quality Monitoring
Parameter: Formaldehyde
Units: µg/m^3 Standard, Criterion, Guideline: 65 µg/m^3 (24 hour)

Monitoring Location	Year	Avg. Period (hours)	Valid Hours	Concentrations		Maximum		Number of Exceedances	
				Mean	90th %	1 h	24 h	1 h	24 h
MOE # 12016	2009	24	—	0.86	1.33	—	—	—	
West	2008	24	—	2.06	4.1	—	—	—	
College/South St.	2007	24	—	1.45	2.57	—	—	—	
	2006	24	—	1.66	3.38	—	—	—	
	2005	24	—	—	—	—	—	—	
	2004	24	—	2.076	4.543	—	4.548	—	0
	2003	24	—	3.141	4.957	—	11.347	—	0
	2002	24	—	2.672	5.044	—	15.021	—	0
	2001	24	—	2.605	3.569	—	9.595	—	0
	2000	24	—	2.555	4.157	—	4.157	—	0
	Avg.			2.120	3.739		8.934		0
Michigan DEQ Detroit Sites									
Allan Park	2005	24	—	2.08	—	—	5.37	—	—
Fort Street	2009		—	1.76	—	—		—	—
	2008			1.84					
North Delray	2007			2.27					
W. Fort	2006			2.5					
	2005	24	—	1.62	—	—	3.90	—	—

[a] INS - flagged as insufficient measurements for statistically valid mean

Table A2-14: Ambient PAH Data

Windsor - College/South Street
EC # 60211

24-hr samples

	2009 µg/m³		2008 µg/m³		2007 µg/m³		2006 µg/m³		Average µg/m³	
Compound	**mean**	**90th %**	**mean**	**90th %**	**mean**	**90th %**	**mean**	**90th %**	**mean**	**90th %**
napthalene*	**0.16**	**0.27**	**0.17**	**0.33**	**0.30**	**0.52**	**0.38**	**0.86**	**0.25**	**0.50**
number of samples*	***56***		***39***		***62***		***42***			
	Jan-Dec		***Jan-Dec***		***Jan-Dec***		***Jan-Dec***			
number of samples	***26***		***21***		***44***		***42***			
	Jan-May		***Jun-Dec***		***Jan-Dec***		***Jan-Dec***			

	2009 ng/m³		2008 ng/m³		2007 ng/m³		2006 ng/m³		Average ng/m³	
Compound	**mean**	**90th %**	**mean**	**90th %**	**mean**	**90th %**	**mean**	**90th %**	**mean**	**90th %**
benzo (a) pyrene	**0.53**	**1.20**	**0.28**	**0.44**	**0.17**	**0.27**	**0.28**	**0.23**	**0.32**	**0.54**
acenaphthylene	**2.01**	**4.74**	**1.20**	**2.30**	**0.88**	**1.94**	**1.34**	**2.41**	**1.36**	**2.85**
acenaphthene	**1.02**	**1.73**	**0.91**	**1.82**	**0.89**	**1.76**	**1.81**	**4.82**	**1.16**	**2.53**
anthracene	**1.11**	**2.13**	**0.80**	**1.72**	**0.50**	**0.96**	**0.97**	**2.24**	**0.85**	**1.76**
benzo (a) anthracene	**0.82**	**1.80**	**0.38**	**0.62**	**0.24**	**0.43**	**0.42**	**0.42**	**0.47**	**0.82**
benzo (b) fluoranthene	**1.72**	**3.61**	**0.89**	**1.56**	**0.54**	**1.10**	**0.95**	**1.01**	**1.03**	**1.82**
chrysene	**1.17**	**2.48**	**0.54**	**0.97**	**0.36**	**0.61**	**0.59**	**0.61**	**0.67**	**1.17**
dibenzo (ah) anthracene	**0.13**	**0.29**	**0.07**	**0.12**	**0.05**	**0.08**	**0.07**	**0.06**	**0.08**	**0.14**
fluoranthene	**4.84**	**8.73**	**3.39**	**5.10**	**2.90**	**4.67**	**3.57**	**7.19**	**3.68**	**6.42**
fluorene	**3.84**	**5.93**	**2.87**	**4.58**	**2.26**	**4.28**	**4.27**	**7.84**	**3.31**	**5.66**
ideno (1,2,3-cd) pyrene	**0.57**	**1.15**	**0.36**	**0.56**	**0.23**	**0.47**	**0.38**	**0.47**	**0.39**	**0.66**
phenanthrene	**9.82**	**15.67**	**10.09**	**20.58**	**8.81**	**13.10**	**13.64**	**29.27**	**10.59**	**19.66**
pyrene	**3.05**	**5.39**	**2.04**	**3.23**	**1.68**	**2.77**	**2.20**	**3.94**	**2.24**	**3.83**
number of samples	***8***		***12***		***23***		***14***			
	Jan - Apr		Jan - Dec		Jan - Dec		Aug - Dec			

Table A2-15: Ambient Greenhouse Gas Data

Windsor Air Quality Monitoring
Parameter: Greenhouse Gases / Other
Units: ppb Standard, Criterion, Guideline: N/A

Parameter & Location	Monitoring	Year	Avg. Period (hours)	Concentration		Maximum		Number of Exceedances	
				Mean	90th %	1 h	24 h	1 h	24 h
NMHC (as CH_4) Sarnia Lasalle Road		2003	Grab Samples	15	—	392	—	—	—
Methane (CH_4) Sarnia Lasalle Road		late 1990's	Grab Samples	1,800	—	—	—	—	—
Methane (CH_4) Global Background ref: Seinfeld & Pardis (1998)		late 1990's	Grab Samples	1,720	—	—	—	—	—
Nitrous Oxide (N_2O) Global Background ref: Seinfeld & Pardis (1998)		late 1990's	Grab Samples	311	—	—	—	—	—
Carbon Dioxide (CO_4) Global Background ref: Seinfeld & Pardis (1998)		late 1990's	Grab Samples	360,000	—	—	—	—	—

Table A2-16: Windsor Air Quality Mean and 90 Percentile Parameter Concentrations

Parameter	Designated Annual Period	Averaging Period	Average Concentrations		90%ile Concentrations		Number of Exceedances	Type of Limit	Data Year	Location
		(hours)	($\mu g/m^3$)	ppb	($\mu g/m^3$)	ppb				
CO	Current	1	220	190	433	380	0	1 h Std	2005	Windsor
	Past	1	380	330	870	760	0	1 h Std	2000-05	
SO_2	Current	1	13	5.0	37	14	0	1 h Std	2005	Windsor
	Past	1	17	6.4	42	16	0	1 h Std	2000-05	
O_3	Current	1	51	26	106	54	138	1 h Std	2005	Windsor
	Past	1	41	21	90	46	77	1 h Std	2000-05	
NO_X (as NO_2)	Current	1	47	25	98	52	—	—	2005	Windsor
	Past	1	56	30	113	60	—	—	2000-05	
NO_2	Current	1	32	17	62	33	0	1 h Std	2005	Windsor
	Past	1	36	19	66	35	0	1 h Std	2000-05	
NO	Current	1	10	8	25	20	—	—	2005	Windsor
	Past	1	13	11	34	28	—	—	2000-05	
PM_{10}	Current	24	24	—	46	—	10	24 h Int Guide	2002	Windsor
	Past	24	26	—	46	—	9		2000-02	
$PM_{2,5}$	Current	24	10	—	24	—	11	24 h CWS	2005	Windsor
	Past	24	10	—	22	—	10	24 h CWS	2001-05	
1,3-Butadiene	Current	24	0.11	—	0.21	—	—	—	2004	Windsor
	Past	24	0.14	—	0.23	—	—	—	2000-04	
Acetaldehyde	Current	24	1.1	—	2.0	—	0	24 h AAQC	2004	Windsor
	Past	24	1.7	—	2.6	—	0	24 h AAQC	2000-04	
Acrolein	Current	24	0.064	—	0.08	—	1	24 h AAQC	2004	Windsor
	Past	24	0.11	—	0.19	—	20	24 h AAQC	2000-04	
Benzene	Current	24	1.8	—	3.4	—	—	—	2004	Windsor
	Past	24	1.8	—	3.4	—	—	—	2000-04	
Formaldehyde	Current	24	2.1	—	4.5	—	0	24 h AAQC	2004	Windsor
	Past	24	2.6	—	4	—	0	24 h AAQC	2000-04	
PAH (Total)	Current	24	0.078	—	0.14	—	—	—	2005	Detroit
	Past	24	0.082	—	0.15	—	—	—	1987-90	Windsor
B(a)P	Current	24	0.00051	—	0.0008	—	✓	24 h AAQC	2005	Detroit
	Past	24	0.0006	—	0.0014	—	✓	24 h AAQC	1987-90	Windsor
NMHC (as C)	Current	—	—	—	—	—	—	—		
	Past	1	—	11	—	294	—	—	2003-04	Sarnia
CO_2	Current	—	—	—	—	—	—	—		
	Past	annual	650,000	360,000	—	—	—	—	~1995	N. Amer.
CH_4	Current	—	—	—	—	—	—	—		
	Past	annual	1,130	1,720	—	—	—	—	~1995	N. Amer.
N_2O	Current	—	—	—	—	—	—	—		
	Past	annual	560	311	—	—	—	—	~1990	N. Amer.

APPENDIX 3

Fleet Data Collection and Analysis
(12 pages)

A3-1: Fleet Profiles

MOBILE6.2C categorizes the on road vehicle fleet into 16 vehicle categories through the use of vehicle registration data. Vehicle fleet distributions specific for the province of Ontario were obtained from Environment Canada. An analysis of the Ontario fleet profile contained within MOBILE6.2C was conducted and compared against site specific fleet profile information for vehicles operating along the Ambassador Bridge, Huron Church Road and the local cross streets (Arterial Roads) intersecting Huron Church Road.

Fleet data obtained from the Ambassador Bridge and the City of Windsor provides two vehicle categories "Cars" and "Trucks". For the Ambassador Bridge "Trucks" refers to commercial vehicles passing through the "Truck" inspection lanes and will contain minor quantities of commercial vehicles such as cargo vans and light duty trucks. Conservatively, these vehicles were all considered to be represented by the MOBILE 6.2C vehicle classes 6 through 13 "Heavy Duty Vehicles". Buses are recorded separately by Ambassador Bridge and are assumed to represent vehicle class 15 "Transit and Urban Buses". Table A3-1 provides a summary of the annual fleet profile for the Ambassador Bridge.

Table A3-1: Present (Baseline) Annual Fleet Profile for Ambassador Bridge (Vehicles/year)

	CAR	TRUCK	BUS	TOTAL
Northbound (CTC)	2,909,353	1,709,828	8,207	4,627,388
Southbound (DIBC)	2,983,787	1,777,293	8,800	4,769,880
Total:	5,893,140	3,487,121	17,007	9,397,268
Fleet Composition	**62.7%**	**37.1%**	**0.2%**	

The "Truck" category contained within the turning movement count data (total vehicle count) from the City of Windsor for intersections along Huron Church Road covers vehicle classes 6 through 15. This information is representative of conditions during calendar years 2004 through 2006. A summary of the fleet profile for Huron Church Road and cross streets is provided in Tables A3-2 and A3-3.

Table A3-2: Present (Baseline) Fleet Profile for Huron Church

	Light Duty (Cars)		Heavy Duty (Trucks)		Total
One Hour Morning Peak	**Vehicles**	**%**	**Vehicles**	**%**	**Vehicles:**
Huron Church/College (NB)	1281	81.7%	286	18.3%	1567
Huron Church/College (SB)	474	73.8%	168	26.2%	642
Huron Church/Tecumseh (NB)	1158	80.2%	286	19.8%	1444
Huron Church/Tecumseh (SB)	429	71.3%	173	28.7%	602
Huron Chruch/Malden (NB)	1531	83.8%	295	16.2%	1826
Huron Chruch/Malden (SB)	692	74.6%	235	25.4%	927
Huron Church/Industrial (NB)	1691	83.8%	327	16.2%	2018
Huron Church/Industrial (SB)	811	82.2%	176	17.8%	987
One Hour Mid-day Peak					
Huron Church/College (NB)	587	62.7%	349	37.3%	936
Huron Church/College (SB)	702	73.0%	259	27.0%	961
Huron Church/Tecumseh (NB)	1646	85.3%	284	14.7%	1930
Huron Church/Tecumseh (SB)	717	76.4%	221	23.6%	938
Huron Chruch/Malden (NB)	923	77.3%	271	22.7%	1194
Huron Chruch/Malden (SB)	853	69.7%	371	30.3%	1224
Huron Church/Industrial (NB)	788	69.1%	353	30.9%	1141
Huron Church/Industrial (SB)	897	69.3%	398	30.7%	1295
One Hour Afternoon Peak					
Huron Church/College (NB)	512	60.4%	335	39.6%	847
Huron Church/College (SB)	1345	80.7%	321	19.3%	1666
Huron Chruch/Malden (NB)	882	79.5%	228	20.5%	1110
Huron Chruch/Malden (SB)	1546	82.2%	334	17.8%	1880
Huron Church/Tecumseh (NB)	747	68.8%	338	31.2%	1085
Huron Church/Tecumseh (SB)	762	67.2%	372	32.8%	1134
Huron Church/Industrial (NB)	995	74.3%	345	25.7%	1340
Huron Church/Industrial (SB)	1241	76.3%	386	23.7%	1627
Average AM Values		78.9%		21.1%	
Average MDay Values		72.9%		27.1%	
Average PM Values		73.7%		26.3%	
Average Peak Values:		**75.2%**		**24.8%**	

Note: values refer to number of vehicles per hour for northbound (NB) and southbound (SB) traffic

Table A3-3: Present (Baseline) Fleet Profile for Cross Streets

	Light Duty (Cars)		Heavy Duty (Trucks)		Total
Total Count 07:00 - 18:00	**Vehicles**	**%**	**Vehicles**	**%**	**Vehicles:**
Huron Church/College (WB)	1,844	96.5%	67	3.5%	1,911
Huron Church/College (EB)	1,980	93.0%	149	7.0%	2,129
Huron Church/Tecumseh (WB)	165	94.3%	10	5.7%	175
Huron Church/Tecumseh (EB)	371	91.8%	33	8.2%	404
Huron Chruch/Malden (WB)	2,193	91.1%	214	8.9%	2,407
Huron Chruch/Malden (EB)	1,120	93.5%	78	6.5%	1,198
Huron Church/Industrial (WB)	259	82.2%	56	17.8%	315
Huron Church/Industrial (EB)	186	91.2%	18	8.8%	204
Average		**91.7%**		**8.3%**	

Note: values refer to number of vehicles per hour for westbound (WB) and eastbound (EB) traffic

Table A3-4 provides a comparison of the default vehicle profiles contained within MOBILE 6.2C and the Ambassador Bridge, Huron Church Road and the local cross streets for the present (baseline) scenario. Limited information is available for Motorcycles and Buses. Motorcycles are combined with the light duty vehicle category 'Cars" whereas Buses were assigned default values when specific information was not available.

Table A3-4: Fleet Profile (Baseline)

Category #	Vehicle Class Code	MOBILE6.2C DESCRIPTION	MOBILE6.2C DEFAULT	MOBILE 6.2C DEFAULT GROUPED	Ambassador Bridge	Huron Church	Local Study Area Cross Roads
1	LDV	Light-Duty Vehicles (Passenger Cars)	35.4%	*87.8%*	*62.7%*	*75.0%*	*91.7%*
2	LDT1	Light-Duty Trucks 1	8.9%				
3	LDT2	Light Duty Trucks 2	29.7%				
4	LDT3	Light Duty Trucks 3	9.2%				
5	LDT4	Light Duty Trucks 4	4.1%				
16	MC	Motorcycles (All)	0.5%				
14	HDBS	School Busses	0.2%	*0.3%*	*0.2%*	*6.2C Default*	*6.2C Default*
15	HDBT	Transit and Urban Busses	0.1%				
6	HDV2B	Class 2b Heavy Duty Vehicles	4.0%	*11.9%*	*37.1%*	*25.0%*	*8.3%*
7	HDV3	Class 3 Heavy Duty Vehicles	0.4%				
8	HDV4	Class 4 Heavy Duty Vehicles	0.3%				
9	HDV5	Class 5 Heavy Duty Vehicles	0.2%				
10	HDV6	Class 6 Heavy Duty Vehicles	0.8%				
11	HDV7	Class 7 Heavy Duty Vehicles	1.0%				
12	HDV8A	Class 8a Heavy Duty Vehicles	1.2%				
13	HDV8B	Class 8b Heavy Duty Vehicles	4.0%				
		Total:	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Note: Bus contributions in local study area are subtracted from the Truck category

Adjustments to the default MOBILE 6.2C vehicle profile were made to reflect the distribution of vehicles operating along the Ambassador Bridge, Huron Church and the local cross streets. These adjustments were made through use of the following equation:

$$\text{MOBILE 6.2C (adjusted)} = \frac{\text{MOBILE 6.2C}}{\text{MOBILE 6.2C Default Grouped \%}} * \text{Ambassador Bridge \%}$$

For Light duty Vehicles (LDV) (passenger cars)

$$\text{MOBILE 6.2C (adjusted)} = \frac{35.4\%}{87.8\%} * 62.7\%$$

$$\text{LDV (adjusted)} = 25.3\%$$

Table A3-5 provides a detailed summary of the adjusted MOBILE 6.2C fleet profile for the baseline scenario.

Table A3-5: Adjusted MOBILE 6.2C Fleet Profile (Baseline)

Category #	Vehicle Class Code	MOBILE6.2C DESCRIPTION	MOBILE6.2C DEFAULT	Ambassador Bridge MOBILE6.2C	Huron Church MOBILE 6.2C	Local Study Area Cross Roads MOBILE6.2C
1	LDV	Light-Duty Vehicles (Passenger Cars)	35.4%	25.3%	30.2%	37.0%
2	LDT1	Light-Duty Trucks 1	8.9%	6.4%	7.6%	9.3%
3	LDT2	Light Duty Trucks 2	29.7%	21.2%	25.4%	31.0%
4	LDT3	Light Duty Trucks 3	9.2%	6.6%	7.9%	9.6%
5	LDT4	Light Duty Trucks 4	4.1%	2.9%	3.5%	4.3%
16	MC	Motorcycles (All)	0.5%	0.4%	0.4%	0.5%
14	HDBS	School Busses	0.2%	0.1%	***0.2%***	***0.2%***
15	HDBT	Transit and Urban Busses	0.1%	0.1%	***0.1%***	***0.1%***
6	HDV2B	Class 2b Heavy Duty Vehicles	4.0%	12.5%	8.3%	2.7%
7	HDV3	Class 3 Heavy Duty Vehicles	0.4%	1.2%	0.8%	0.3%
8	HDV4	Class 4 Heavy Duty Vehicles	0.3%	0.9%	0.6%	0.2%
9	HDV5	Class 5 Heavy Duty Vehicles	0.2%	0.6%	0.4%	0.1%
10	HDV6	Class 6 Heavy Duty Vehicles	0.8%	2.5%	1.7%	0.5%
11	HDV7	Class 7 Heavy Duty Vehicles	1.0%	3.1%	2.1%	0.7%
12	HDV8A	Class 8a Heavy Duty Vehicles	1.2%	3.7%	2.5%	0.8%
13	HDV8B	Class 8b Heavy Duty Vehicles	4.0%	12.5%	8.3%	2.7%
		Total:	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Similar adjustments were required for future study years 2015 and 2025 scenarios. The fleet profile for local cross streets was assumed to remain unchanged in future years.

Traffic forecasts contained within the Detroit River International Crossing (DRIC) Travel Demands Forecasts (September 2005) provide future projections for passenger and commercial vehicles for the Ambassador Bridge. Presently the influence of Ambassador Bridge traffic along Huron Church Road represents 55% of the total Huron Church Road annual volume. This influence was applied to future year fleet profile projections for Huron Church Road.

Tables A3-6 through A3-10 provide a summary of the future fleet profiles for 2015, 2025(FDN), 2025(A) and 2025(B).

Table A3-6: Adjusted MOBILE 6.2C Fleet Profile (2015)

Category #	Vehicle Class Code	MOBILE6.2C DESCRIPTION	MOBILE6.2C DEFAULT	MOBILE 6.2C DEFAULT GROUPED	Ambassador Bridge	Huron Church	Local Study Area Cross Roads
1	LDV	Light-Duty Vehicles (Passenger Cars)	35.4%	*87.8%*	*49.6%*	*74.7%*	*91.7%*
2	LDT1	Light-Duty Trucks 1	8.9%				
3	LDT2	Light Duty Trucks 2	29.7%				
4	LDT3	Light Duty Trucks 3	9.2%				
5	LDT4	Light Duty Trucks 4	4.1%				
16	MC	Motorcycles (All)	0.5%				
14	HDBS	School Busses	0.2%	*0.3%*	*0.2%*	*6.2C Default*	*6.2C Default*
15	HDBT	Transit and Urban Busses	0.1%				
6	HDV2B	Class 2b Heavy Duty Vehicles	4.0%	*11.9%*	*50.2%*	*25.3%*	*8.3%*
7	HDV3	Class 3 Heavy Duty Vehicles	0.4%				
8	HDV4	Class 4 Heavy Duty Vehicles	0.3%				
9	HDV5	Class 5 Heavy Duty Vehicles	0.2%				
10	HDV6	Class 6 Heavy Duty Vehicles	0.8%				
11	HDV7	Class 7 Heavy Duty Vehicles	1.0%				
12	HDV8A	Class 8a Heavy Duty Vehicles	1.2%				
13	HDV8B	Class 8b Heavy Duty Vehicles	4.0%				
		Total:	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table A3-7: Adjusted MOBILE 6.2C Fleet Profile (2025 (FDN))

Category #	Vehicle Class Code	MOBILE6.2C DESCRIPTION	MOBILE6.2C DEFAULT	MOBILE 6.2C DEFAULT GROUPED	Ambassador Bridge	Huron Church	Local Study Area Cross Roads
1	LDV	Light-Duty Vehicles (Passenger Cars)	35.4%	*87.8%*	*54.0%*	*71.3%*	*91.7%*
2	LDT1	Light-Duty Trucks 1	8.9%				
3	LDT2	Light Duty Trucks 2	29.7%				
4	LDT3	Light Duty Trucks 3	9.2%				
5	LDT4	Light Duty Trucks 4	4.1%				
16	MC	Motorcycles (All)	0.5%				
14	HDBS	School Busses	0.2%	*0.3%*	*0.2%*	*6.2C Default*	*6.2C Default*
15	HDBT	Transit and Urban Busses	0.1%				
6	HDV2B	Class 2b Heavy Duty Vehicles	4.0%	*11.9%*	*45.8%*	*28.7%*	*8.3%*
7	HDV3	Class 3 Heavy Duty Vehicles	0.4%				
8	HDV4	Class 4 Heavy Duty Vehicles	0.3%				
9	HDV5	Class 5 Heavy Duty Vehicles	0.2%				
10	HDV6	Class 6 Heavy Duty Vehicles	0.8%				
11	HDV7	Class 7 Heavy Duty Vehicles	1.0%				
12	HDV8A	Class 8a Heavy Duty Vehicles	1.2%				
13	HDV8B	Class 8b Heavy Duty Vehicles	4.0%				
		Total:	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table A3-8: Adjusted MOBILE 6.2C Fleet Profile (2025 (A))

Category #	Vehicle Class Code	MOBILE6.2C DESCRIPTION	MOBILE6.2C DEFAULT	MOBILE 6.2C DEFAULT GROUPED	Ambassador Bridge	Huron Church	Local Study Area Cross Roads
1	LDV	Light-Duty Vehicles (Passenger Cars)	35.4%	*87.8%*	*54.0%*	*71.3%*	*91.7%*
2	LDT1	Light-Duty Trucks 1	8.9%				
3	LDT2	Light Duty Trucks 2	29.7%				
4	LDT3	Light Duty Trucks 3	9.2%				
5	LDT4	Light Duty Trucks 4	4.1%				
16	MC	Motorcycles (All)	0.5%				
14	HDBS	School Busses	0.2%	*0.3%*	*0.2%*	*6.2C Default*	*6.2C Default*
15	HDBT	Transit and Urban Busses	0.1%				
6	HDV2B	Class 2b Heavy Duty Vehicles	4.0%	*11.9%*	*45.8%*	*28.7%*	*8.3%*
7	HDV3	Class 3 Heavy Duty Vehicles	0.4%				
8	HDV4	Class 4 Heavy Duty Vehicles	0.3%				
9	HDV5	Class 5 Heavy Duty Vehicles	0.2%				
10	HDV6	Class 6 Heavy Duty Vehicles	0.8%				
11	HDV7	Class 7 Heavy Duty Vehicles	1.0%				
12	HDV8A	Class 8a Heavy Duty Vehicles	1.2%				
13	HDV8B	Class 8b Heavy Duty Vehicles	4.0%				
		Total:	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table A3-9: Adjusted MOBILE 6.2C Fleet Profile (2025 (B) – New Bridge)

Category #	Vehicle Class Code	MOBILE6.2C DESCRIPTION	MOBILE6.2C DEFAULT	MOBILE 6.2C DEFAULT GROUPED	Ambassador Bridge	Huron Church	Local Study Area Cross Roads
1	LDV	Light-Duty Vehicles (Passenger Cars)	35.4%	*87.8%*	*0.0%*	*71.3%*	*91.7%*
2	LDT1	Light-Duty Trucks 1	8.9%				
3	LDT2	Light Duty Trucks 2	29.7%				
4	LDT3	Light Duty Trucks 3	9.2%				
5	LDT4	Light Duty Trucks 4	4.1%				
16	MC	Motorcycles (All)	0.5%				
14	HDBS	School Busses	0.2%	*0.3%*	*0.2%*	*6.2C Default*	*6.2C Default*
15	HDBT	Transit and Urban Busses	0.1%				
6	HDV2B	Class 2b Heavy Duty Vehicles	4.0%	*11.9%*	*99.8%*	*28.7%*	*8.3%*
7	HDV3	Class 3 Heavy Duty Vehicles	0.4%				
8	HDV4	Class 4 Heavy Duty Vehicles	0.3%				
9	HDV5	Class 5 Heavy Duty Vehicles	0.2%				
10	HDV6	Class 6 Heavy Duty Vehicles	0.8%				
11	HDV7	Class 7 Heavy Duty Vehicles	1.0%				
12	HDV8A	Class 8a Heavy Duty Vehicles	1.2%				
13	HDV8B	Class 8b Heavy Duty Vehicles	4.0%				
		Total:	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table A3-10: Adjusted MOBILE6.2C Fleet Profile (2021 (B) – Existing Bridge)

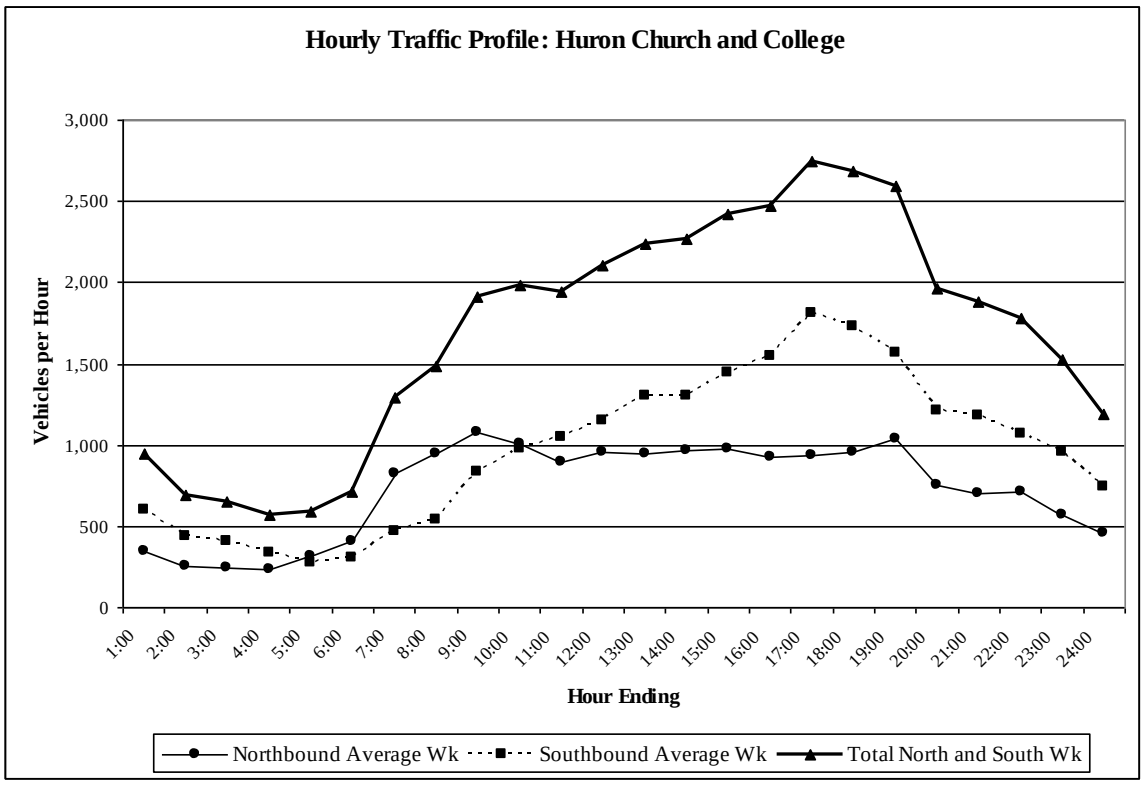
Category #	Vehicle Class Code	MOBILE6.2C DESCRIPTION	MOBILE6.2C DEFAULT	MOBILE 6.2C DEFAULT GROUPED	Ambassador Bridge	Huron Church	Local Study Area Cross Roads
1	LDV	Light-Duty Vehicles (Passenger Cars)	35.4%	*87.8%*	*100.0%*	*71.3%*	*91.7%*
2	LDT1	Light-Duty Trucks 1	8.9%				
3	LDT2	Light Duty Trucks 2	29.7%				
4	LDT3	Light Duty Trucks 3	9.2%				
5	LDT4	Light Duty Trucks 4	4.1%				
16	MC	Motorcycles (All)	0.5%				
14	HDBS	School Busses	0.2%	*0.3%*	*0.0%*	*6.2C Default*	*6.2C Default*
15	HDBT	Transit and Urban Busses	0.1%				
6	HDV2B	Class 2b Heavy Duty Vehicles	4.0%	*11.9%*	*0.0%*	*28.7%*	*8.3%*
7	HDV3	Class 3 Heavy Duty Vehicles	0.4%				
8	HDV4	Class 4 Heavy Duty Vehicles	0.3%				
9	HDV5	Class 5 Heavy Duty Vehicles	0.2%				
10	HDV6	Class 6 Heavy Duty Vehicles	0.8%				
11	HDV7	Class 7 Heavy Duty Vehicles	1.0%				
12	HDV8A	Class 8a Heavy Duty Vehicles	1.2%				
13	HDV8B	Class 8b Heavy Duty Vehicles	4.0%				
		Total:	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

A3-2: Traffic Flow Pattern

Available information related to current traffic flow patterns and volume along the Ambassador Bridge and Huron Church Road were collected from the City of Windsor, Ambassador Bridge and other relevant sources such as DRIC.

On an hourly basis, peak traffic flow in the northbound direction is encountered in the morning periods between the hours of 7:00 and 10:00 whereas southbound traffic peaks during the afternoon hours of 15:00 to 19:00. The maximum total peak traffic flow (northbound and southbound) along the Ambassador Bridge and Huron Church Road is encountered during the afternoon peak hours. Figure A3-1 provides an hourly distribution of the traffic flow for the Huron Church Road and College Avenue intersection based upon City of Windsor hourly traffic counts taken during April 10th – 16th, 2006.

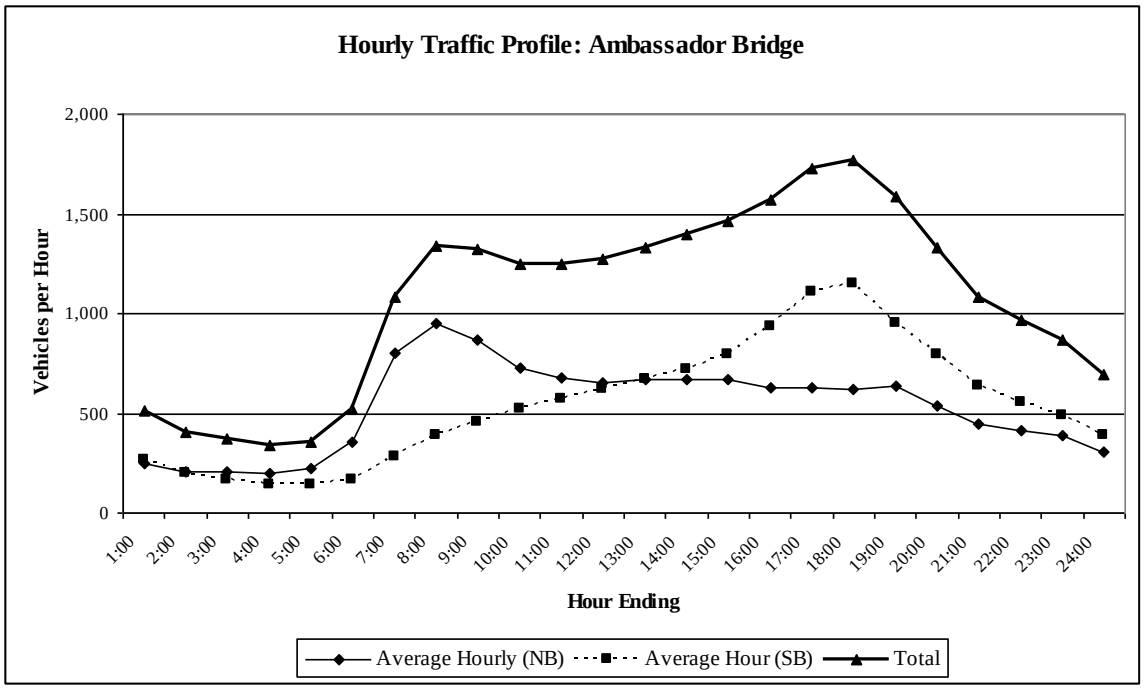
Figure A3-1: Hourly Traffic Flow Distribution: Huron Church Road and College Avenue (April 10-16, 2006 Average)



A similar analysis for the Huron Church Road and Industrial Road intersection (May 8th – 14th, 2006) was conducted and compared to the distribution above. Based upon this analysis it was determined that the Huron Church Road and College Avenue intersection would yield a more conservative hourly traffic flow distribution than the Huron Church Road and Industrial Road intersection due to the sustained peak afternoon hours shown in Figure A3-1.

Hourly traffic flow data from the Ambassador Bridge was analyzed for the 2006 calendar year for both northbound and southbound directions to arrive at a similar distribution as shown in Figure A3-2.

Figure A3-2: Hourly Traffic Flow Distribution: Ambassador Bridge (2006 Average)



The hourly traffic flow distributions shown in Figure A3-1 and A3-2 were used to arrive at an hourly traffic flow distribution for the remaining segments of Huron Church Road in Local Study Area. Peak traffic flows in the northbound direction are experienced during morning periods. The morning peak hourly traffic flow distribution was applied to north; west and east bound traffic to represent the peak traffic flow entering the study area and queuing at intersections. The afternoon peak hourly traffic flow distribution was applied to southbound traffic representing the peak traffic flow in this direction.

A3-3: Peak Hourly Traffic Flow Conditions

Hourly traffic flows for calendar year 2006 were analyzed to identify the peak hourly traffic flow across the bridge for both northbound and southbound vehicles. The peak hourly traffic flow for northbound vehicles of 1,544 occurred on September 19th during the hours 7:00-8:00. The peak hourly traffic flow for southbound vehicles of 1,754 occurred on June 28th during 16:00-17:00. Annual average peak hourly traffic flow for northbound and southbound traffic across the bridge, shown in Figure A3-2, are 954 and 1,149 corresponding to the peak hourly traffic flow for the morning and afternoon conditions. This analysis served as a comparative tool for other sources of data.

City of Windsor information pertaining to peak hourly traffic flow along Huron Church Road is based upon one week of samples taken at College (April 2006), shown in Figure A3-1, and Industrial Drive (May 2006). Similarly, DRIC conducted a coordinated traffic survey along Huron Church Road covering several major intersections during to collect, among other data, peak hourly traffic flow data. The findings of this survey are presented in the document entitled *"DRIC Level 2 Traffic Operations Analysis of Practical Alternatives, December 2008"* ("DRIC Traffic Study"). An assessment of the available City of Windsor and DRIC data was conducted. For the purpose of this study it was determined that information contained within the DRIC study was applicable to the scope and requirements of this assessment.

Peak hourly traffic flow along Huron Church Road and cross street intersections for both morning and afternoon peak hours were used for all hours of the day for Tier 1 CAL3QHCR model input. For Tier 2 CAL3QHCR modeling, hourly traffic flows were utilized to provide a more realistic emission scenario for the road segments.

Detailed peak hourly traffic flow for the various road segments is available from the DRIC Traffic Study covering years 2006 and 2015 and to a lesser extent 2025.

The DRIC Traffic Study projects a growth rate of 3.6 vehicles per hour per year for the period 2006 to 2015 for the west and east road segments. This growth factor was used to calculate the peak hourly traffic flow for cross streets for future study years (2025) where calculated values were absent.

Table A3-11 provides a summary of the peak hourly traffic flow for the Huron Church Road, Industrial Drive and Northwood Street intersections.

Table A3-11: Summary of Peak Hourly Traffic Flow (Vehicles/hour)

Huron Church Intersection	2006 DRIC	2011 Est	2015 DRIC	2017 (1) Est	2021 (1) Est	2025 DRIC
Huron Church Northbound @ Industrial Drive	2,018	2,144	2,244	2,277	2,344	**2,410**
Huron Church Southbound @ Industrial Drive	2,027	2,220	2,374	2,437	2,564	**2,690**
Industrial Drive Westbound	315	346	370	377	391	
Industrial DriveEastbound	116	128	137	144	158	
Northwood Street Westbound	229	251	269	276	290	
Northwood Street Eastbound	204	223	239	246	260	

Notes: (1) Average growth per year 2006 - 2015 = 3.6 vehicles per year, for all west and east road segments.

Annual Vehicle Volumes:

Annual vehicle volumes representing calendar year 2006 for the Ambassador Bridge were obtained from the DIBC and are summarized in Table A3-12. Annual vehicle volumes along the Ambassador Bridge serve as the basis for the calculation of annual emissions (burden analysis) associated with the project.

Table A3-12: 2006 Ambassador Bridge Annual Vehicle Volumes (Vehicles/year)

	2006 Ambassador Bridge Annual Volumes			
	CAR	**TRK**	**BUS**	**Total**
Jan	473,019	276,259	1,730	751,008
Feb	425,855	280,641	1,786	708,282
Mar	503,948	319,643	1,717	825,308
Apr	481,974	286,090	1,539	769,603
May	467,949	306,721	1,289	775,959
Jun	498,417	318,165	1,487	818,069
July	544,292	231,860	1,422	777,574
Aug	543,301	313,504	1,291	858,096
Sept	502,337	297,872	1,220	801,429
Oct	502,689	301,384	1,162	805,235
Nov	470,589	300,105	1,230	771,924
Dec	478,770	254,877	1,134	734,781
Total:	**5,893,140**	**3,487,121**	**17,007**	**9,397,268**

Note: total for northbound and southbound traffic

A comprehensive analysis conducted by Detroit River International Crossing (DRIC) 'Travel Demands Forecast" (September 2005) indicates commercial vehicle volumes will grow at substantially higher rates than passenger car traffic. Table A3-13 provides estimates of annual traffic volumes for study years 2015 and 2025 based upon the DRIC forecasts with the addition of additional 265,000 vehicles captured from the Blue Water Bridge by the year 2030.

Table A3-13: Ambassador Bridge Future Annual Vehicle Volumes

Year	DRIC Study Predicted Annual Truck Volume	DRIC Study Predicted Annual Car Volume	DRIC Study Predicted Annual Total Volumes
2030	7,318,796	9,109,005	16,427,801
2029	7,172,420	9,052,759	16,225,179
2028	7,028,972	8,996,860	16,025,832
2027	6,888,392	8,941,307	15,829,699
2026	6,750,625	8,886,096	15,636,721
2025	**6,615,612**	**8,831,227**	**15,446,839**
2024	6,450,222	8,764,450	15,214,672
2023	6,288,966	8,698,178	14,987,145
2022	6,131,742	8,632,408	14,764,150
2021	5,978,448	8,567,135	14,545,583
2020	5,828,987	8,502,355	14,331,342
2019	5,683,263	8,438,065	14,121,328
2018	5,541,181	8,374,261	13,915,442
2017	5,402,652	8,310,940	13,713,592
2016	5,267,585	8,248,098	13,515,683
2015	**5,135,896**	**8,185,730**	**13,321,626**

	% Trucks	% Cars
2025	42.8%	57.2%
2015	38.6%	61.4%

2025-2035 truck growth rate	2.00%
2015-2025 truck growth rate	2.50%
2025-2035 car growth rate	0.62%
2015-2025 car growth rate	0.76%
Cars captured from Blue Water Bridge in 2030	13,314
Trucks captured from Blue Water Bridge in 2030	252,679
Total captured from Blue Water Bridge in 2030	265,993

Source: DRIC Travel Demand Forecast, September 2005; Exhibit 5-23.

APPENDIX 4

Construction Activities Data Collection and Analysis
(3 pages)

A4-1: Background

The Ambassador Bridge Enhancement Project involves the construction and operation of a new international bridge across the Detroit River parallel to the existing Ambassador Bridge (interim improvements) and expansion of the Windsor Plaza (ultimate improvements). The proposed bridge is a new six-lane cable-stayed bridge, located approximately 30.5 metres (100 feet) from the centre line of the existing The construction of the replacement span is considered the interim improvement and will occur in Phase I of the Project. The proposed bridge will connect to the existing plazas in Canada and the United States. Plaza improvements are considered the ultimate improvement of the Project and will occur in Phase 2.

Construction of the cable stayed bridge will occur over approximately a 30 month time period, simultaneously on both the Canadian and American sides of the Detroit River. Activities related to construction will occur 5 days per week, 10 hours per day weather permitting.

Construction impacts occurring within Canadian boundaries have been considered in the assessment of emissions related to construction.

Traffic flow along the existing bridge will be maintained during construction. Access to sections of local roads passing through the construction site will be rerouted with minimal impact to local residents. The section of Indian Road adjacent to the construction site may experience localized traffic restrictions related to equipment staging and movement of large equipment. In general these localized impacts will occur over short time periods as construction progresses to the next construction area.

Improvements to the Canadian plaza are neither necessary nor required to accommodate the replacement span. However, in response to requests made by Transport Canada as the Responsible Authority, the Canadian Transit Company (CTC) has included, in this report an assessment of the environmental impacts related to expanding the current Canadian Plaza. Construction of an expanded plaza would occur after completion of the replacement span pending increased vehicle volumes.

A4-2: Construction Sequence

Initially, construction activities will consist of site preparation including the removal of structures and materials from the site to accommodate equipment and the bridge supports. The total site area for development is 125 hectares and includes the DIBC owned properties along the east side of Indian Road adjacent to the existing bridge and properties along the Detroit River. The active work area(s) at a given point in time will vary according to construction requirements and is estimated to account for 10%, or 12.5 hectares, of the total site area. Active and inactive construction areas will be controlled through the development and implementation of a best management plan to control dust emissions, further discussed in Appendix 9.

The general sequence of constructing the cable stayed bridge consists of the following activities:

- Tower Pier Foundation Construction
- Pylon Construction
- Pier Table Construction
- Balanced Cantilever Construction
- Back Span and Main Span Continuity

Upon completion of the back span and main span final grading and landscaping of the site will occur, although this activity may be conducted on an ongoing basis as the project progresses as part of an overall fugitive dust management plan.

Table A4-1 provides a preliminary summary of the equipment requirements and the general construction sequence for the purpose of identifying impacts and potential mitigation controls which may be employed during construction. The sequence of construction and estimate of equipment activity was provided by American Consulting Engineers, acting as the lead designer on the replacement span. This information was based upon the level of information available from construction drawings at the time of this report and historical knowledge from similar projects. The actual number, size and type of equipment will be determined by the constructor and subject to the development of the construction best management plan (BMP) to mitigate impacts to within the scope outlined in this section as well as that of Appendix 9. The constructor may thus be permitted to increase the number of and type of equipment active on-site above those quantities shown in Table A4-1 provided that the constructor can demonstrate mitigation measures will control emissions to within those specified in this document.

Activities listed in Table A4-1 may occur in parallel or in series to other activities listed for a given time period. The general approach to the development of the construction equipment timing chart was based on the following logic;

- to present the best case construction scenario for the bridge;
- quantification of potential off property impacts;
- assessment of predicted impacts with applicable air quality standards;
- development of mitigation strategies;
- quantification of potential off property impacts with mitigation measures in place, and
- assessment of off property impacts with mitigation measures in place.

Appendix 9 provides a detailed discussion regarding the various emission scenarios and emission estimation sources considered.

Table A4-1: Construction Activities and Associated Equipment

				Project Timing											
				2013				2014				2015			
Activity/ Source ID	Construction Activity	Equipment	Max Qty on Site	1	2	3	4	1	2	3	4	1	2	3	4
1	Site Preparation	Excavators	3	x											
		Haul trucks	6	x											
		Compactors	3	x											
		Diesel gen set	2	x											
2	Tower Pier Foundation	Auger	1	x	x										
		Haul trucks	3	x	x										
		Excavator	1	x	x										
		Crane	1	x	x										
		Concrete trucks	3	x	x										
		Diesel Gensets	2	x	x										
3	Pylon Construction	Crane	1			x	x	x							
		Concrete trucks	3			x	x	x							
		Diesel Gensets	2			x	x	x							
		Haul trucks	3			x	x	x							
4	Pier Table Construction	Crane	1					x	x						
		Concrete trucks	3					x	x						
		Diesel Gensets	2					x	x						
		Haul trucks	5					x	x						
5	Balanced Cantilever Construction	Crane	2						x	x	x				
		Barges	1						x	x	x				
		Diesel Gensets	2						x	x	x				
		Haul trucks	5						x	x	x				
6	Back Span & Main Span Continuity	Crane	2								x				
		Barges	1								x				
		Diesel Gensets	2								x				
		Haul trucks	2								x				
7	Cdn Bridge - Tens Spans Excavation / Drilling of Footings	Pile Driver	1	x	x										
		Haul Trucks	5	x	x										
		Gen Sets	2	x	x										
8	Forming / Pouring of Footings	Haul Trucks	4	x	x	x									
		Concrete trucks	4	x	x	x									
		Gen Sets	2	x	x	x									
9	Forming / Pouring of Pier Columns & Caps	Haul Trucks	4		x	x	x								
		Concrete Trucks	4		x	x	x								
		Gen Sets	2		x	x	x								
10	Erection of Beams	Haul Trucks	6				x	x							
		Gen Sets	2				x	x							
		Cranes	2				x	x							
11	Bridge Deck Construction	Concrete Truck	6						x	x					
		Gen Sets	2						x	x					
		Haul trucks	4						x	x					
		Concrete Finishing	1						x	x					
12	Final Site Grading	Haul trucks	4								x	x			
		Compactor	2								x	x			
		Gen Sets	2								x	x			
		Paver	1								x	x			
13	Canadian Plaza Modifications (occurs after Final Site Grading)	Excavators	2										x		
		Haul trucks	3										x		
		Compactors	1										x		
		Diesel gen set	2										x		
		Paver	1										x		

APPENDIX 5

Receptor Data Collection and Analysis
(1 page)

In addition to the virtual receptors which define points where the dispersion models predict concentrations, other special receptors were identified. These special receptors include education facilities, healthcare facilities, daycare facilities, places of worship and municipal parks. First Nations and transboundary receptors were also considered.

The procedures used to identify and locate special receptors are described below.

The Forward Sorting Area (FSA) identifying the first three letters of the postal code were used as a first level screen to determine if special receptors were close to the study area. The FSAs near the study area were N8X, N9A, N9B, N9C, N9E, N9G, N9H and N9J. Special receptors were then located with Google Earth to determine WGS UTM co-ordinates and the closest distance to a point along Huron Church Road / Talbot Road.

The location of the special receptor building and the property boundaries were considered. The point chosen to represent the special receptor was the point on the property closest to Huron Church Road / Talbot Road. For special receptors located on Huron Church Road / Talbot Road, a point on the special receptor property located 3 m away from the road was selected. Special receptors within 1 km of the study area were identified and plotted.

The initial list of receptors was sourced as follows:

- Public Schools - Public School Directory
- Catholic Schools - Windsor-Essex Catholic District School Board Directory (http://www.wecdsb.on.ca/ourschools.asp)
- Day Care Centres - list of Windsor/Essex County Licensed Child Care Services Providers (http://www.citywindsor.ca/DisplayAttach.asp?AttachID=7878)
- Colleges and Universities - University of Windsor and St. Clair College (Windsor Campus), checked against list of colleges from Ontario Ministry of Training, Colleges and Universities (http://www.edu.gov.on.ca/eng/general/list/college.html)
- Hospitals - Windsor Regional Hospital and Hotel Dieu Grace Hospital
- Health Care & Recreation Facilities – search in Windsor area (www.canada411.ca), City of Windsor Online (http://www.citywindsor.ca/000267.asp)
- Places of Worship – search in Windsor area (www.canada411.ca)
- Municipal Parks - City of Windsor Park Index Map (http://www.citywindsor.ca/000350.asp) and Town of LaSalle Road Map (http://www.town.lasalle.on.ca/planning/pdf/LA_2006_Street_Map.pdf)
- Provincial Park - Ojibway Prairie Provincial Park
- National Park - Fort Malden National Historic Park
- First Nations - Bkejwanong Territory (Walpole Island)
- Transboundary - Canada / US International Border

APPENDIX 6

Meteorological Data Collection and Analysis
(8 pages)

The CAL3QHCR and AERMOD models require actual hourly meteorological conditions as inputs. These models require pre-processed surface and upper air meteorological data. These data are typically provided in a raw or partially processed format that requires processing through a meteorological pre-processor. The CAL3QHCR model makes use of a pre-processor called PCRAMMET, while AERMOD uses a pre-processor known as AERMET. These two preprocessors are discussed below.

Hourly Surface Meteorological Data and Upper Air Sounding

The Air Dispersion Modelling Guideline for Ontario (ADMGO), version 2.0, March 2009 requires a 5-year meteorological data set for air dispersion modeling analysis using AERMOD, and at least 1-year meteorological data set using CAL3QHCR. The nearest surface meteorological observation station for this study with long-term observational records is at the Windsor Airport, operated by Environment Canada. There is currently no routine upper air measurement in Ontario. The nearest routine upper air station is in Detroit, Michigan, US.

The most recent readily available consecutive 5-year meteorological data from these two stations was obtained from 2002 to 2006.

The hourly surface values of wind speed, wind direction, temperature, opaque cloud cover and ceiling height were quality controlled and formatted by the MOE (Air Modelling and Emissions Unit) and provided to ORTECH.

The upper air sounding data were downloaded from National Oceanic Atmospheric Administration (NOAA) Radiosonde Database.

PCRAMMET and the CAL3QHCR Model

The PCRAMMET is a meteorological pre-processor used to prepare meteorological data for input CAL3QHCR as well as other common models such as ISC3 and CALPUFF when used in screening mode.

The input data requirements for PCRAMMET depend on the dispersion model and the model options for which the data is being processed. The minimum input data requirements are:

- the hourly surface observations of wind speed, wind direction, temperature, cloud cover and ceiling height; and
- the twice-daily mixing heights (upper are sounding).

Although not considered in the air quality assessment, an analysis of the rate of deposition of particulate matter also requires hourly values of station pressure, precipitation type and amount.

The PCRAMMET takes the above mentioned input data to:

- Calculate hourly values for atmospheric stability classes (unstable: A-C; neutral: D; stable: E-F);
- Interpolate the twice daily mixing heights to hourly values; and
- Optionally calculate the parameters for deposition processes.

The final CAL3QHCR model ready meteorological data set was provided by the MOE (Air Modelling and Emissions Unit).

In consideration of the number of model runs, the CAL3QHCR model was initially run for the present (baseline) scenario for carbon monoxide (CO) following the Tier 1 approach with the 5-year meteorological data set (2002 – 2006). The highest CO concentration was predicted with the 2005 meteorological data. All subsequent model runs were based on the meteorological data set in 2005.

Figures A6-1 and A6-2 show the wind roses for the 5-year period (2002 – 2006) and 1-year period (2005), respectively.

Figures A6-3 and A6-4 show the stability roses for the 5-year period (2002 – 2006) and 1-year period (2005), respectively.

From these figures it is concluded that the 2005 meteorological data set is reasonably representative of the 5-year meteorological data set.

AERMET and AERMOD Model

AERMET is a meteorological pre-processor which prepares hourly meteorological data set for use in the AERMOD.

AERMET is designed to be run as a three-stage process, as described below, and operate on three types of data – routine hourly surface observations, twice-daily upper air soundings, and meteorological data collected from an on-site measurement program such as from an instrumented tower.

The first stage extracts data and assesses data quality. The second stage merges all data available for 24-hour periods and stores them in a single file. The third stage reads the merged meteorological data along with land use data to estimate the necessary boundary layer parameters for use by AERMOD.

AERMET produces two files for AERMOD including a surface file of boundary layer parameters and a profile file of multiple-level observations of wind speed, wind direction, temperature, and standard deviation of the fluctuating wind components.

For this project, the input data includes:

- The 5-year surface hourly values of wind speed, wind direction, temperature and opaque cloud cover, at Windsor Airport, Ontario (2002 – 2006);
- The 5-year twice-daily upper air soundings at Detroit, Michigan (2002 – 2006), and
- The sector-wise land use data as summarized in Table A6-1 and shown in Figure A6-5.

The AERMOD was run with the 5-year meteorological data set.

Table A6-1: Sector-Wise Surface Characters as Input to AERMET

Sector	Land Use Make-up	Season	Albedo	Bowen Ratio	Roughness Height
0 - 54 (1)	38.7% Urban 2% Forest 59.3% Water	Winter	0.26	1.50	0.41
		Spring	0.13	0.46	0.41
		Summer	0.12	0.84	0.41
		Autumn	0.16	0.85	0.41
54 - 225 (2)	98.0% Urban 2.0% Forest	Winter	0.35	1.50	1.00
		Spring	0.14	0.99	1.00
		Summer	0.16	1.97	1.01
		Autumn	0.18	1.98	1.00
225 - 270 (3)	28.0% Urban 2% Forest 70.0% Water	Winter	0.25	1.50	0.30
		Spring	0.13	0.36	0.30
		Summer	0.12	0.64	0.31
		Autumn	0.15	0.65	0.30
270 - 360 (4)	57.8% Urban 2% Forest 40.2% Water	Winter	0.29	1.50	0.60
		Spring	0.13	0.63	0.60
		Summer	0.14	1.20	0.60
		Autumn	0.16	1.21	0.60

Surface Met Station:	Windsor Airport
Location of Surface Met Station:	43.27°N (lat.), 82.95°W (lon.)
Base Elevation of Surface Met Station (m):	189.6
Upper Air Station:	Detroit
Location of Upper Air Station:	42.70°N (lat.), 83.47° (lon.)
Application Site:	Ambassador Bridge
Location of Application Site:	42.30°N (lat.), 83.07°W (lon.)

Forest was assumed to consist of 50% deciduous and 50% coniferous

Note: see Figure A6-5 for description of sectors.

Figure A6-1: Wind Rose at Windsor Airport (2002 – 2006)

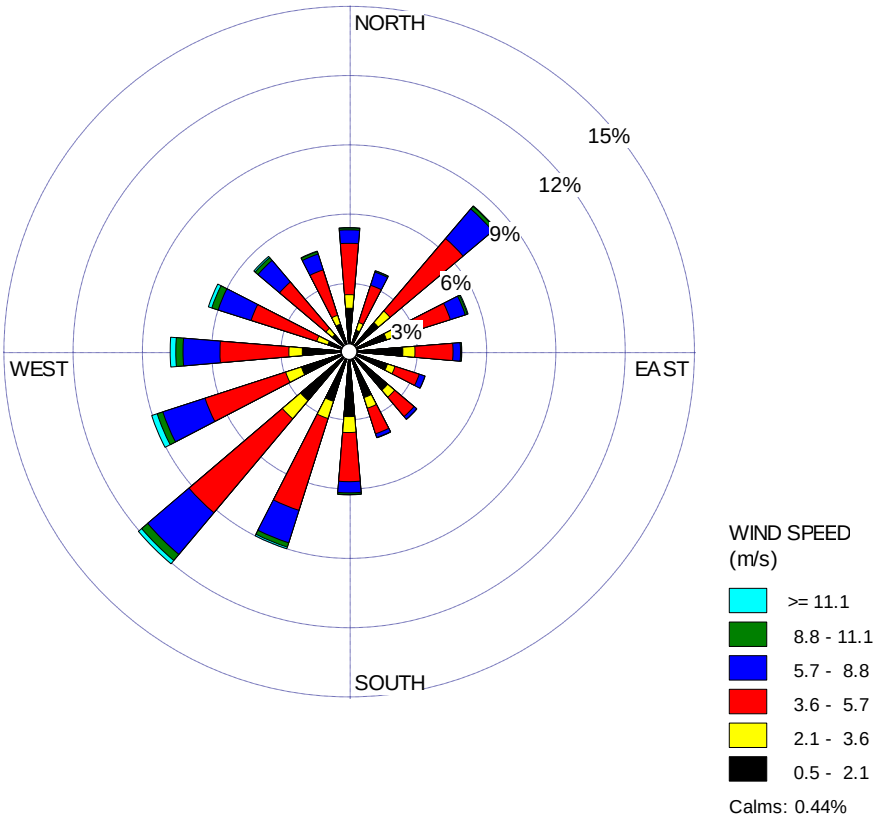


Figure A6-2: Wind Rose at Windsor Airport (2005)

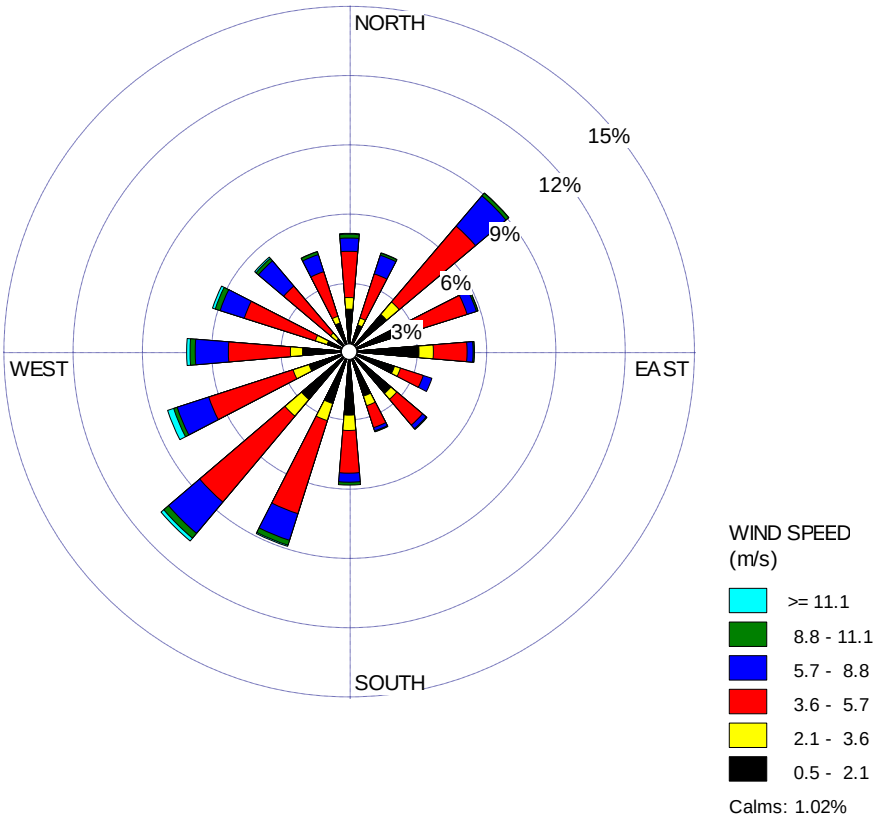


Figure A6-3: Stability Rose at Windsor Airport (2002 - 2006)

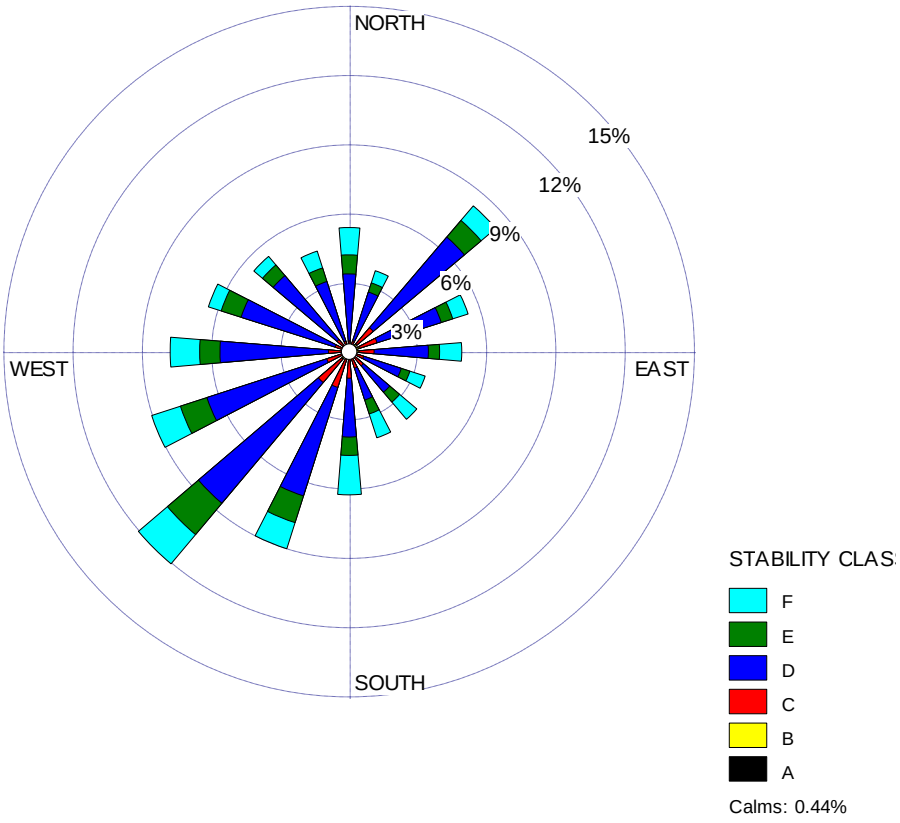


Figure A6-4: Stability Rose at Windsor Airport (2005)

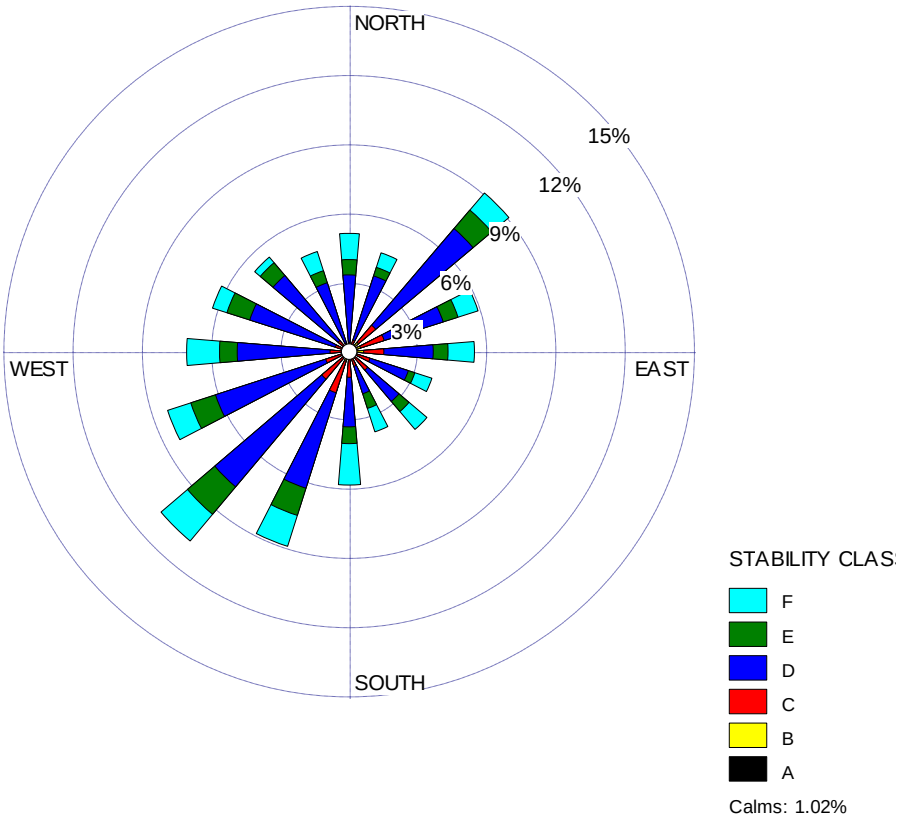
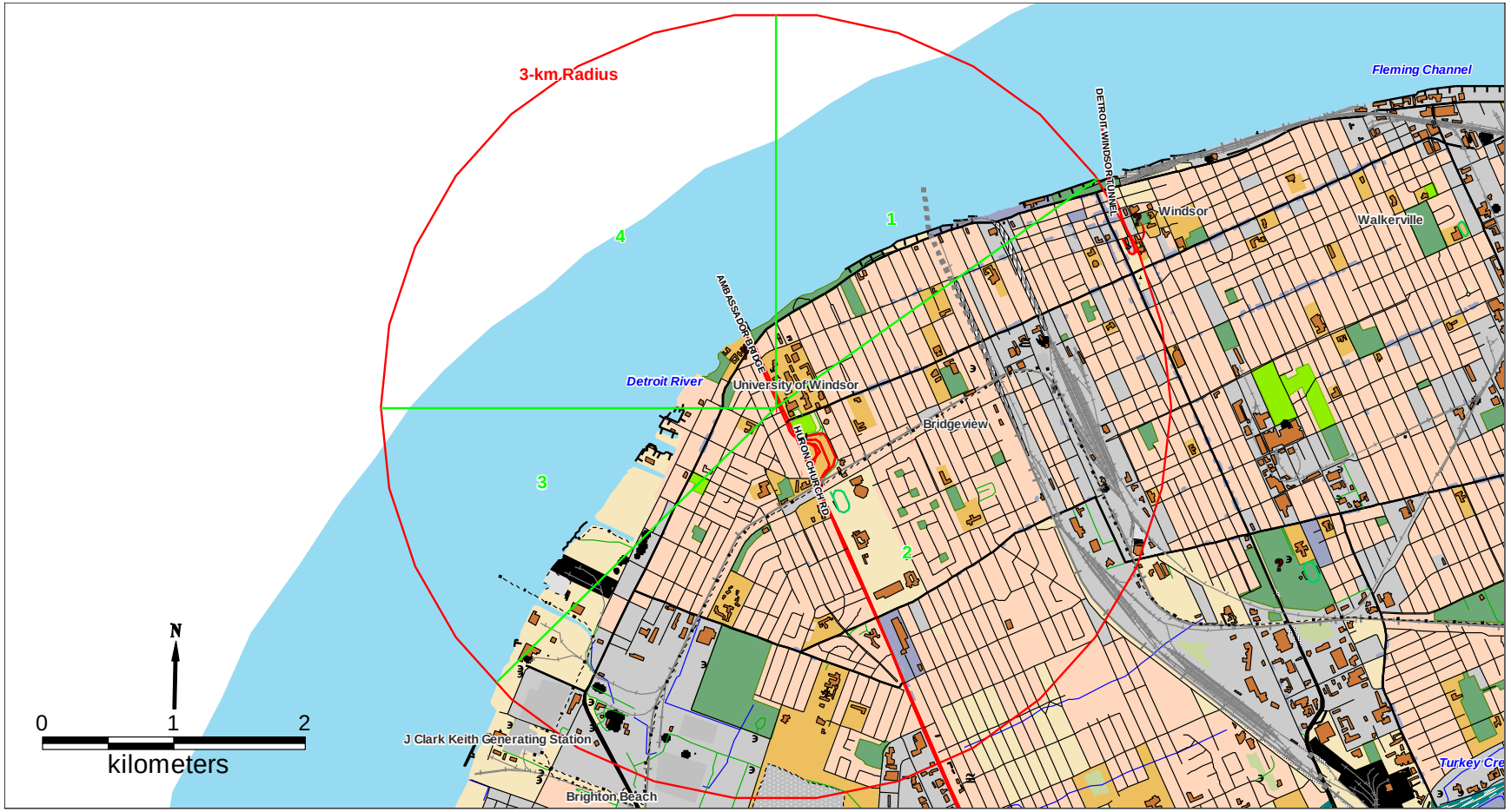


Figure A6-5: Land Use Near Ambassador Bridge



APPENDIX 7

Vehicle Emission Calculations
(14 pages)

A7-1: Mobile Vehicle Emission Factor Estimates

Mobile vehicle emissions are categorized as: (i) exhaust emissions that are the products of fuel combustion, (ii) evaporative emissions and (iii) particulate emissions associated with break wear and tire wear.

Evaporative emissions are divided into five emission sub-categories (hot soak, diurnal, running, resting and refueling losses) that describe the different phases of a vehicle operating cycle that include a standing hot or cold engine, a running engine, fuel tank vapour losses due to the diurnal air temperature cycle and vapour displacement losses due to refueling.

The USEPA has developed an emission factor model (MOBILE) for estimating both exhaust and evaporative emissions from a defined fleet of vehicles operating with a defined driving cycle. The most recent available version of the model is MOBILE6.2 (Version 6.2.03 dated 24 Sept 2003, particulate matter emission factor file was updated on 17 March 2006) was downloaded from http://www.epa.gov/otaq/m6.htm#m60. Besides the algorithms that are used to estimate the exhaust and evaporative emissions, the MOBILE model includes a suit of default model input files that can be used to run the MOBILE model. The default files provided with MOBILE6.2 are typical of the vehicle fleet, vehicle operating patterns and emission regulations in the United States. Recognizing the difference between Canada and the U.S. regarding the default information in the MOBILE files as well as some differences in the algorithms used for estimating mobile source emissions, Environment Canada developed a Canadian version of the EPA emission model known as MOBILE6.2C (Environment Canada, 27-05-2005). The default information provided with MOBILE6.2C is applicable for estimating Canadian mobile source emission. The MOBILE model allows the user to override the default data with site specific data in order to estimated site specific emissions; this capability has been used in the air quality assessment to estimate mobile source emissions specifically for Windsor and the present and proposed bridges.

Table A7-1 summarizes the input data required to run MOBILE6.2C and data sources. For each input in the first column, the source of data used for the Windsor area is noted in the second column. Where default data included in MOBILE6.2C are deemed appropriate for Windsor and bridge mobile sources, these default data have been used. In some instances, as noted in the third column of Table A7-1, the default data have been used for urban traffic in Windsor, but for the bridge and Huron Church Road, specific data are used (see also Appendix 3).

Table A7-1: Summary of MOBILE6.2C Inputs

	Input	Reference
External Conditions		
Calender year of evaluation	2004, 2015, 2025	(1)
Month	Janaury / July	(2)
Altitude	Low	(2)
Temperature	Hourly temperature at Windsor Airport	Temperature recorded at Windsor Airport during 1996 - 2006
Humidity	Hourly relative humidity, Pressure	Relative Humidity recorded at Windsor Airport during 1996 - 2007
Fuel Options		
RVP (PSI)	8.9 psi (summer) / 14.7 psi (winter)	(3)
Diesel sulphur content	320 ppm (2004) / 15 ppm (2011, 2021)	(4)
Gasoline sulphur content	42 ppm (2004) / 25 ppm (2011, 2021)	(3)
Air toxics		
Gasoline aromatics (%)	28.4	(3)
Gasoline olefin (%)	10.3	(3)
Gasoline benzene (%)	0.8	(3)
Vapor percentage of gasoline at 200 F (%)	47.3 (summer) / 53.7 (winter)	(3)
Vapor percentage of gasoline at 300 F (%)	83.3	(3)
Oxygenate volume % of Ethanol or Ethyl Alcohol (Ethanol)	(10% volume, 8.6% market share, in 2004), (10% volume, 20% market share, in 2015, 2025)	(5)
Vehicle Fleet Characteristic		
Distribution of Vehicle Registrations	default	(6)
Disel fractions	default	(6)
Annual mileage accumulation rates	Ontario created by EC	(6)
Vehicle Miles Travaled (VMT) fraction	default	(6)
Natural gas vehicles (NGVs) fraction	default	(6)
Alternate emission factors for NGVs	Default	(6)
Vehicle Activity		
Fractions of Vehicle Miles Traveled (VMT)	Appendix 3	
VMT by facility, hour and speed	Appendix 3	
Starts per day	Appendix 3	
Distribution of vehicle starts during the day	default	(6)
Soak distribution	default	(6)
hot soak activity	default	(6)
Diurnal soak activity	default	(6)
Weekday trip length distribution	default	(6)
Weekend trip length distribution	default	(6)
Use weekend vehicle activity	default	(6)
Average speed (mph)	5,10,15,20,25,30,35,40,45,50	
Idle (mph)	Average speed=2.5 mph	

(1) ORTECH's Air Quality Assessnebt Work Plan
(2) US EPA, Office of Transportation and Air Quality,"Technical Guidance on the use of MOBILE6.2 for emission inventory preparation , EPA420-R-04-013, August 2004
(3) SENES Consultants Limited and Air Improvement Resource Inc., Emissions of Air Toxics from on-Highway Sources in Canada, M6C-02-E, 8 March 2002
(4) MOE Drive Clean Program
(5) http://www.ec.gc.ca/cleanair-airpur/CAOL/transport/publications/ethgas/ethgas3.htm
(6) Default file of MOBILE6.2C

The MOBILE 6.2C emission factors (for winter) for the bridge, Huron Church Road and Arterial Roads at select speeds for the pollutants of interest except PAHs are summarized in Table A7-2. Emission factors for PAHs are discussed in Section A7-4.

Table A7-2: Initial MOBILE6.2C Emission Factors (Winter) for Pollutants of Interest (excluding PAHs)

Area	Traffic Speed		CO	NOx	SO2	PM_{10} †	PM10 Road Dust	PM_{25} †	PM25 Road Dust	VOC (NMHC)	Benzene	Acetaldehyde	Formaldehyde	1,3-Butadiene	Acrolein	CO2	N2O	CH4
	mile/hr	km/hr	g/mile	g/mile	g/mile	g/mile	g/mile	g/mile	g/mile	g/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	g/mile	g/mile	g/mile
Present (Baseline)																		
Bridge	2.5	4	58.615	7.813	0.084	0.116	-	0.116	-	8.048	162.246	34.848	99.753	23.429	5.490	762.150	0.032	0.093
	30	48	11.206	4.516	0.084	0.141	-	0.141	-	1.014	23.658	7.720	21.556	3.903	1.127	762.150	0.032	0.093
	35	56	10.837	4.499	0.084	0.141	-	0.141	-	0.935	20.999	6.759	18.780	3.416	0.973	762.150	0.032	0.093
	40	64	11.110	4.601	0.084	0.141	-	0.141	-	0.890	19.752	6.151	17.018	3.164	0.874	762.150	0.032	0.093
Huron Church Road	2.5	4	62.154	6.210	0.061	0.081	-	0.081	-	8.660	174.936	31.442	88.394	24.363	4.620	660.930	0.034	0.103
	35	56	11.667	3.497	0.061	0.105	-	0.105	-	0.959	28.057	5.582	15.303	3.380	0.778	660.930	0.034	0.103
Arterial roads	2.5	4	86.080	4.390	0.029	0.035	-	0.035	-	13.106	230.513	32.218	87.265	31.197	4.040	523.100	0.035	0.116
	30	48	32.003	2.517	0.029	0.056	-	0.056	-	1.979	65.349	9.933	26.418	9.374	1.182	523.100	0.035	0.116
2011																		
Bridge	2.5	4	31.607	4.112	0.009	0.049	-	0.049	-	5.234	79.937	18.542	45.405	10.099	2.260	757.580	0.032	0.092
	30	48	6.646	2.306	0.009	0.074	-	0.074	-	0.526	12.228	4.462	11.283	1.885	0.545	757.580	0.032	0.092
	35	56	6.479	2.295	0.009	0.074	-	0.074	-	0.480	10.937	3.923	9.887	1.671	0.478	757.580	0.032	0.092
	40	64	6.703	2.349	0.009	0.074	-	0.074	-	0.450	10.320	3.571	8.952	1.556	0.435	757.580	0.032	0.092
Huron Church Road	2.5	4	32.669	3.750	0.009	0.042	-	0.042	-	5.444	82.926	17.478	42.082	10.331	2.116	711.880	0.033	0.097
	35	56	6.770	2.074	0.009	0.067	-	0.067	-	0.484	14.118	3.572	8.868	1.661	0.434	711.880	0.033	0.097
Arterial roads	2.5	4	48.675	2.443	0.008	0.016	-	0.016	-	6.631	113.307	15.521	33.117	13.543	1.783	522.910	0.035	0.116
	30	48	19.832	1.372	0.008	0.037	-	0.037	-	0.939	32.438	4.893	10.307	4.260	0.544	522.910	0.035	0.116
2021 (FDN) and 2021 (A)																		
Bridge	2.5	4	20.433	1.284	0.010	0.013	-	0.013	-	2.672	39.151	10.885	26.292	4.513	2.150	780.090	0.032	0.090
	30	48	4.391	0.701	0.010	0.039	-	0.039	-	0.380	6.208	2.899	7.332	0.979	0.326	780.090	0.032	0.090
	35	56	4.276	0.696	0.010	0.039	-	0.039	-	0.330	5.599	2.555	6.440	0.875	0.287	780.090	0.032	0.090
	40	64	4.442	0.713	0.010	0.039	-	0.039	-	0.300	5.322	2.322	5.819	0.815	0.260	780.090	0.032	0.090
Huron Church Road	2.5	4	20.433	1.284	0.010	0.013	-	0.013	-	2.672	40.681	10.885	26.292	4.513	1.289	780.090	0.033	0.096
	35	56	4.276	0.696	0.010	0.039	-	0.039	-	0.245	7.164	2.555	6.440	0.875	0.307	780.090	0.033	0.096
Arterial roads	2.5	4	32.179	0.986	0.008	0.006	-	0.006	-	3.401	56.491	7.400	14.143	5.505	0.883	523.710	0.035	0.116
	30	48	13.788	0.547	0.008	0.028	-	0.028	-	0.459	17.127	2.489	4.691	1.876	0.285	523.710	0.035	0.116
2021 (B) - Cars Only for Bridge																		
Bridge	2.5	4	24.697	0.777	0.0069	0.0043	-	0.0043	-	2.469	48.315	4.961	8.45	4.408	0.612	454.45	0.036	0.120
	30	48	5.613	0.381	0.007	0.025	-	0.025	-	0.244	7.188	0.829	1.411	0.738	0.103	454.450	0.036	0.120
	35	56	5.643	0.374	0.007	0.025	-	0.025	-	0.227	6.666	0.769	1.306	0.683	0.095	454.450	0.036	0.120
	40	64	6.042	0.380	0.007	0.025	-	0.025	-	0.220	6.547	0.757	1.282	0.670	0.093	454.450	0.036	0.120
Huron Church Road	2.5	4	20.433	1.284	0.010	0.013	-	0.013	-	2.672	40.681	10.885	26.292	4.513	1.289	780.090	0.033	0.096
	35	56	4.276	0.696	0.010	0.039	-	0.039	-	0.245	7.164	2.555	6.440	0.875	0.307	780.090	0.033	0.096
Arterial roads	2.5	4	32.179	0.986	0.008	0.006	-	0.006	-	3.401	56.491	7.400	14.143	5.505	0.883	523.710	0.035	0.116
	30	48	13.788	0.547	0.008	0.028	-	0.028	-	0.459	17.127	2.489	4.691	1.876	0.285	523.710	0.035	0.116
2021 (B) - Trucks Only for Bridge																		
Bridge	2.5	4	14.359	2.016	0.013	0.060	-	0.060	-	1.452	25.933	19.543	52.377	4.708	2.277	1251.100	0.027	0.043
	30	48	2.620	1.164	0.013	0.060	-	0.060	-	0.296	4.797	5.917	15.966	1.336	0.705	1251.100	0.027	0.043
	35	56	2.292	1.162	0.013	0.060	-	0.060	-	0.262	4.060	5.159	13.928	1.160	0.615	1251.100	0.027	0.043
	40	64	2.117	1.194	0.013	0.060	-	0.060	-	0.238	3.551	4.605	12.436	1.032	0.550	1251.100	0.027	0.043
Huron Church Road	2.5	4	20.433	1.284	0.010	0.013	-	0.013	-	2.672	40.681	10.885	26.292	4.513	1.289	780.090	0.033	0.096
	35	56	4.276	0.696	0.010	0.039	-	0.039	-	0.245	7.164	2.555	6.440	0.875	0.307	780.090	0.033	0.096
Arterial roads	2.5	4	32.179	0.986	0.008	0.006	-	0.006	-	3.401	56.491	7.400	14.143	5.505	0.883	523.710	0.035	0.116
	30	48	13.788	0.547	0.008	0.028	-	0.028	-	0.459	17.127	2.489	4.691	1.876	0.285	523.710	0.035	0.116

† Factors for total particulate matter emissions were used except for at 2.5 mile/hr (4 km/hr) where the factor for exhaust only particulate emission was used.

Table A7-2b: Updated MOBILE6.2C Emission Factors (Winter) for Pollutants of Interest

Area	Traffic Speed		Vehicle Type	NOx	PM_{10}†	PM_{25}†	Acrolein
	mile/hr	km/hr		g/mile	g/mile	g/mile	mg/mile
Present (Baseline)							
Bridge	2.5	4	All	7.813	0.116	0.116	5.490
	30	48	All	4.516	0.141	0.141	1.127
	35	56	All	4.499	0.141	0.141	0.973
	40	64	All	4.601	0.141	0.141	0.874
Huron Church Road	2.5	4	All	6.210	0.081	0.081	4.620
	35	56	All	3.497	0.105	0.105	0.778
Arterial roads	2.5	4	All	4.390	0.035	0.035	4.040
	30	48	All	2.517	0.056	0.056	1.182
2015 and 2025 (FDN)							
Bridge	2.5	4	All	2.844	0.034	0.034	1.785
			Cars Only	1.126	0.004	0.004	0.813
			Trucks Only	2.447	0.062	0.062	2.742
	30	48	All	1.603	0.061	0.061	0.487
			Cars Only	0.552	0.025	0.025	0.136
			Trucks Only	1.359	0.096	0.096	0.832
	35	56	All	1.597	0.061	0.061	0.427
	40	64	All	1.635	0.061	0.061	0.387
Huron Church Road	2.5	4	All	2.003	0.019	0.019	1.304
	35	56	All	1.078	0.043	0.043	0.278
Arterial roads	2.5	4	All	1.566	0.009	0.009	1.143
	30	48	All	0.876	0.031	0.031	0.343
2025 (A)							
Bridge	2.5	4	All	0.930	0.014	0.014	1.273
			Cars Only	0.676	0.004	0.004	0.543
			Trucks Only	1.227	0.026	0.026	2.133
	30	48	All	0.495	0.041	0.041	0.356
			Cars Only	0.329	0.025	0.025	0.091
			Trucks Only	0.691	0.059	0.059	0.666
	35	56	All	0.492	0.041	0.041	0.313
	40	64	All	0.504	0.041	0.041	0.284
Huron Church Road	2.5	4	All	0.838	0.010	0.010	1.004
	35	56	All	0.430	0.035	0.035	0.258
Arterial roads	2.5	4	All	0.807	0.006	0.006	0.794
	30	48	All	0.442	0.028	0.028	0.257
2025 (B)							
Bridge	2.5	4	Cars Only	0.676	0.004	0.004	0.543
			Trucks Only	1.227	0.026	0.026	2.133
	30	48	Cars Only	0.329	0.025	0.025	0.091
			Trucks Only	0.691	0.059	0.059	0.666
	35	56	Cars Only	0.323	0.025	0.025	0.084
			Trucks Only	0.690	0.059	0.059	0.582
	40	64	Cars Only	0.582	0.025	0.025	0.083
			Trucks Only	0.710	0.059	0.059	0.520
Huron Church Road	2.5	4	All	0.838	0.010	0.010	1.004
	35	56	All	0.430	0.035	0.035	0.258
Arterial roads	2.5	4	All	0.807	0.006	0.006	0.794
	30	48	All	0.442	0.028	0.028	0.257

† Factors for total particulate matter emissions were used except for at 2.5 mile/hr (4 km/hr) where the factor for exhaust only particulate emission was used.

A7-2: Comparison of Emission Factor Estimates made by MOBILE6.2 and 6.2C

Since the bridge at Windsor carries both Canadian and United States traffic, an investigation was made of the sensitivity of the emission factor estimates to the application of either MOBILE6.2 or MOBILE6.2C. In comparing these models, the default or site specific data as indicated in Table A7-1 were used for the Huron Church Road in both model versions. The sensitivity of the emission factor results to the model used is provided in Table A7-3. From Table A7-3, it is noted that the largest percentage differences in the estimates from the two model versions are for the present (baseline) scenario (ranging from +4.5% to +17.6%) with the Canadian model predicting higher non-methane hydrocarbon (NMHC), CO and NO_X emission at all vehicle speeds. The differences in estimates beyond 2021 are much smaller (ranging from -0.9% to +2.5%). For the present (baseline) scenario, the largest percentage differences were noted for CO and the smallest for NO_X. By 2021, the largest percentage differences are noted for NO_X, while MOBILE6.2C NMHC emission factors are slightly lower (-0.4% to -0.9%) than the corresponding estimates made by MOBILE6.2.

A7-3: Particulate Matter Emissions: PM_{10} and $PM_{2.5}$

Tier 1 treatment of particulate matter makes the conservative assumption that all particulate matter is $PM_{2.5}$ whereas in reality a significant portion of particulate matter emissions are larger than 2.5 microns (10^{-6} m). To illustrate the extent to which the Tier 1 assumption for particulate matter is conservative, MOBILE6.2C was used to estimate emission factors for both PM_{10} and $PM_{2.5}$ for the present (baseline) and future years for Huron Church Road. Table A7-4 summarizes the results that show that $PM_{2.5}$ as a percentage of total particulate matter (PM_{10}) is essentially independent of both vehicle speed and season, and varies from about 78% for the present (baseline) to 52% in 2021.

Table A7-3: Comparison of MOBILE6.2 and MOBILE6.2C for NMHC, CO and NO_X

Year	Speed	Pollutant		MOB6.2	MOB6.2C	Diff %		MOB6.2	MOB6.2C	Diff %
2004	2.5	Composite NMHC	JULY	7.06	7.715	8.5%	JANUARY	8.012	8.66	7.5%
2004		Composite CO	JULY	37.562	45.688	17.6%	JANUARY	54.721	62.154	12.0%
2004		Composite Nox	JULY	5.131	5.371	4.5%	JANUARY	5.893	6.21	5.1%
2004										
2004	5	Composite NMHC	JULY	2.998	3.366	10.9%	JANUARY	3.433	3.777	9.1%
2004		Composite CO	JULY	22.167	25.366	12.7%	JANUARY	31.486	35.423	11.1%
2004		Composite Nox	JULY	4.603	4.841	4.9%	JANUARY	5.281	5.593	5.6%
2004										
2004	10	Composite NMHC	JULY	1.728	1.926	10.2%	JANUARY	1.924	2.09	7.9%
2004		Composite CO	JULY	13.784	15.4	10.5%	JANUARY	19.365	21.348	9.3%
2004		Composite Nox	JULY	3.866	4.091	5.5%	JANUARY	4.437	4.73	6.2%
2004										
2004	15	Composite NMHC	JULY	1.342	1.497	10.4%	JANUARY	1.448	1.572	7.9%
2004		Composite CO	JULY	10.79	12.012	10.2%	JANUARY	15.203	16.696	8.9%
2004		Composite Nox	JULY	3.383	3.598	6.0%	JANUARY	3.887	4.164	6.7%
2004										
2004	20	Composite NMHC	JULY	1.133	1.268	10.6%	JANUARY	1.191	1.294	8.0%
2004		Composite CO	JULY	9.085	10.104	10.1%	JANUARY	12.941	14.189	8.8%
2004		Composite Nox	JULY	3.089	3.299	6.4%	JANUARY	3.558	3.827	7.6%
2004										
2004	25	Composite NMHC	JULY	1.002	1.125	10.9%	JANUARY	1.03	1.121	8.1%
2004		Composite CO	JULY	8.159	9.057	9.9%	JANUARY	11.64	12.736	8.6%
2004		Composite Nox	JULY	2.91	3.117	6.6%	JANUARY	3.361	3.625	7.3%
2004										
2004	30	Composite NMHC	JULY	0.92	1.034	11.0%	JANUARY	0.931	1.012	8.0%
2004		Composite CO	JULY	7.663	8.478	9.6%	JANUARY	10.933	11.922	8.3%
2004		Composite Nox	JULY	2.817	3.021	6.8%	JANUARY	3.255	3.516	7.4%
2004										
2004	35	Composite NMHC	JULY	0.855	0.959	10.8%	JANUARY	0.85	0.921	7.7%
2004		Composite CO	JULY	7.541	8.296	9.1%	JANUARY	10.758	11.667	7.8%
2004		Composite Nox	JULY	2.801	3.004	6.8%	JANUARY	3.238	3.497	7.4%
2004										
2004	40	Composite NMHC	JULY	0.818	0.918	10.9%	JANUARY	0.806	0.873	7.7%
2004		Composite CO	JULY	7.846	8.582	8.6%	JANUARY	11.217	12.096	7.3%
2004		Composite Nox	JULY	2.867	3.069	6.6%	JANUARY	3.313	3.572	7.3%
2004										
2004	45	Composite NMHC	JULY	0.789	0.885	10.8%	JANUARY	0.771	0.835	7.7%
2004		Composite CO	JULY	8.227	8.945	8.0%	JANUARY	11.763	12.612	6.7%
2004		Composite Nox	JULY	3.001	3.203	6.3%	JANUARY	3.46	3.718	6.9%
2004										
2004	50	Composite NMHC	JULY	0.762	0.856	11.0%	JANUARY	0.739	0.799	7.5%
2004		Composite CO	JULY	8.677	9.377	7.5%	JANUARY	12.389	13.207	6.2%
2004		Composite Nox	JULY	3.211	3.412	5.9%	JANUARY	3.686	3.943	6.5%

Year	Speed	Pollutant		MOB6.2	MOB6.2C	Diff %		MOB6.2	MOB6.2C	Diff %
2021	2.5	Composite NMHC	JULY	2.812	2.801	-0.4%	JANUARY	2.145	2.133	-0.6%
2021		Composite CO	JULY	14.209	14.3	0.6%	JANUARY	21.614	21.624	0.0%
2021		Composite Nox	JULY	0.998	1.014	1.6%	JANUARY	1.192	1.21	1.5%
2021										
2021	5	Composite NMHC	JULY	1.125	1.118	-0.6%	JANUARY	0.969	0.962	-0.7%
2021		Composite CO	JULY	8.982	9.063	0.8%	JANUARY	13.394	13.399	0.0%
2021		Composite Nox	JULY	0.887	0.902	1.7%	JANUARY	1.06	1.078	1.7%
2021										
2021	10	Composite NMHC	JULY	0.618	0.615	-0.5%	JANUARY	0.558	0.554	-0.7%
2021		Composite CO	JULY	5.765	5.811	0.8%	JANUARY	8.556	8.559	0.0%
2021		Composite Nox	JULY	0.734	0.749	2.0%	JANUARY	0.881	0.899	2.0%
2021										
2021	15	Composite NMHC	JULY	0.455	0.452	-0.7%	JANUARY	0.42	0.418	-0.5%
2021		Composite CO	JULY	4.452	4.484	0.7%	JANUARY	6.663	6.664	0.0%
2021		Composite Nox	JULY	0.635	0.65	2.3%	JANUARY	0.765	0.783	2.3%
2021										
2021	20	Composite NMHC	JULY	0.352	0.35	-0.6%	JANUARY	0.344	0.342	-0.6%
2021		Composite CO	JULY	3.661	3.685	0.7%	JANUARY	5.628	5.63	0.0%
2021		Composite Nox	JULY	0.577	0.591	2.4%	JANUARY	0.698	0.715	2.4%
2021										
2021	25	Composite NMHC	JULY	0.303	0.301	-0.7%	JANUARY	0.296	0.293	-0.7%
2021		Composite CO	JULY	3.236	3.255	0.6%	JANUARY	5.021	5.022	0.0%
2021		Composite Nox	JULY	0.541	0.555	2.5%	JANUARY	0.658	0.674	2.4%
2021										
2021	30	Composite NMHC	JULY	0.27	0.268	-0.7%	JANUARY	0.264	0.262	-0.8%
2021		Composite CO	JULY	3.01	3.025	0.5%	JANUARY	4.706	4.706	0.0%
2021		Composite Nox	JULY	0.522	0.535	2.4%	JANUARY	0.636	0.652	2.5%
2021										
2021	35	Composite NMHC	JULY	0.245	0.244	-0.4%	JANUARY	0.241	0.24	-0.4%
2021		Composite CO	JULY	2.931	2.945	0.5%	JANUARY	4.612	4.613	0.0%
2021		Composite Nox	JULY	0.517	0.531	2.6%	JANUARY	0.631	0.647	2.5%
2021										
2021	40	Composite NMHC	JULY	0.229	0.227	-0.9%	JANUARY	0.229	0.227	-0.9%
2021		Composite CO	JULY	3.047	3.06	0.4%	JANUARY	4.824	4.825	0.0%
2021		Composite Nox	JULY	0.53	0.543	2.4%	JANUARY	0.646	0.662	2.4%
2021										
2021	45	Composite NMHC	JULY	0.216	0.215	-0.5%	JANUARY	0.219	0.218	-0.5%
2021		Composite CO	JULY	3.198	3.21	0.4%	JANUARY	5.08	5.081	0.0%
2021		Composite Nox	JULY	0.554	0.568	2.5%	JANUARY	0.674	0.69	2.3%
2021										
2021	50	Composite NMHC	JULY	0.206	0.204	-0.5%	JANUARY	0.211	0.21	-0.5%
2021		Composite CO	JULY	3.381	3.394	0.4%	JANUARY	5.378	5.378	0.0%
2021		Composite Nox	JULY	0.592	0.606	2.3%	JANUARY	0.716	0.732	2.2%

Table A7-4: PM2.5 / PM10 Emission Factor Ratio

Year	Speed	Pollutant	Month	PM10	PM2.5	PM2.5/PM10 %	Month	PM10	PM2.5	PM2.5/PM10 %
2004	2.5	**Total PM**	JULY	0.1021	0.0793	77.7%	JANUARY	0.1052	0.0821	78.0%
2004	5	**Total PM**	JULY	0.1021	0.0793	77.7%	JANUARY	0.1052	0.0821	78.0%
2004	10	**Total PM**	JULY	0.1021	0.0793	77.7%	JANUARY	0.1052	0.0821	78.0%
2004	15	**Total PM**	JULY	0.1021	0.0793	77.7%	JANUARY	0.1052	0.0821	78.0%
2004	20	**Total PM**	JULY	0.1020	0.0793	77.7%	JANUARY	0.1052	0.0821	78.0%
2004	25	**Total PM**	JULY	0.1020	0.0793	77.7%	JANUARY	0.1051	0.0820	78.0%
2004	30	**Total PM**	JULY	0.1019	0.0792	77.7%	JANUARY	0.1050	0.0820	78.1%
2004	35	**Total PM**	JULY	0.1019	0.0792	77.7%	JANUARY	0.1050	0.0819	78.0%
2004	40	**Total PM**	JULY	0.1019	0.0792	77.7%	JANUARY	0.1050	0.0819	78.0%
2004	45	**Total PM**	JULY	0.1019	0.0792	77.7%	JANUARY	0.1050	0.0819	78.0%
2004	50	**Total PM**	JULY	0.1019	0.0792	77.7%	JANUARY	0.1050	0.0819	78.0%
2011	2.5	**Total PM**	JULY	0.0644	0.0447	69.4%	JANUARY	0.0671	0.0472	70.3%
2011	5	**Total PM**	JULY	0.0644	0.0447	69.4%	JANUARY	0.0671	0.0472	70.3%
2011	10	**Total PM**	JULY		0.0447		JANUARY		0.0472	
2011	15	**Total PM**	JULY		0.0447		JANUARY		0.0472	
2011	20	**Total PM**	JULY		0.0447		JANUARY		0.0472	
2011	25	**Total PM**	JULY	0.0644	0.0447	69.4%	JANUARY	0.0671	0.0472	70.3%
2011	30	**Total PM**	JULY		0.0447		JANUARY		0.0471	
2011	35	**Total PM**	JULY		0.0447		JANUARY		0.0471	
2011	40	**Total PM**	JULY	0.0644	0.0447	69.4%	JANUARY	0.0670	0.0471	70.3%
2011	45	**Total PM**	JULY		0.0447		JANUARY		0.0471	
2011	50	**Total PM**	JULY		0.0447		JANUARY		0.0471	
2017	2.5	**Total PM**	JULY	0.0413	0.0237	57.4%	JANUARY	0.0421	0.0244	58.0%
2017	5	**Total PM**	JULY	0.0413	0.0237	57.4%	JANUARY	0.0421	0.0244	58.0%
2017	10	**Total PM**	JULY		0.0237		JANUARY		0.0244	
2017	15	**Total PM**	JULY		0.0237		JANUARY		0.0244	
2017	20	**Total PM**	JULY		0.0237		JANUARY		0.0244	
2017	25	**Total PM**	JULY	0.0413	0.0237	57.4%	JANUARY	0.0421	0.0244	58.0%
2017	30	**Total PM**	JULY		0.0237		JANUARY		0.0244	
2017	35	**Total PM**	JULY		0.0237		JANUARY		0.0244	
2017	40	**Total PM**	JULY	0.0413	0.0237	57.4%	JANUARY	0.0421	0.0244	58.0%
2017	45	**Total PM**	JULY		0.0237		JANUARY		0.0244	
2017	50	**Total PM**	JULY		0.0237		JANUARY		0.0244	
2021	2.5	**Total PM**	JULY	0.0362	0.0188	51.9%	JANUARY	0.0366	0.0192	52.5%
2021	5	**Total PM**	JULY	0.0362	0.0188	51.9%	JANUARY	0.0366	0.0192	52.5%
2021	10	**Total PM**	JULY	0.0362	0.0188	51.9%	JANUARY	0.0366	0.0192	52.5%
2021	15	**Total PM**	JULY	0.0362	0.0188	51.9%	JANUARY	0.0366	0.0192	52.5%
2021	20	**Total PM**	JULY	0.0362	0.0188	51.9%	JANUARY	0.0366	0.0192	52.5%
2021	25	**Total PM**	JULY	0.0362	0.0188	51.9%	JANUARY	0.0366	0.0192	52.5%
2021	30	**Total PM**	JULY	0.0362	0.0188	51.9%	JANUARY	0.0366	0.0191	52.2%
2021	35	**Total PM**	JULY	0.0362	0.0188	51.9%	JANUARY	0.0366	0.0191	52.2%
2021	40	**Total PM**	JULY	0.0362	0.0188	51.9%	JANUARY	0.0366	0.0191	52.2%
2021	45	**Total PM**	JULY	0.0362	0.0188	51.9%	JANUARY	0.0366	0.0191	52.2%
2021	50	**Total PM**	JULY	0.0362	0.0188	51.9%	JANUARY	0.0366	0.0191	52.2%

A7-4: Polycyclic Aromatic Hydrocarbon (PAH) Emission Factors

MOBILE6.2C includes default emission factors that were used in this study for air toxics that include benzene, acetaldehyde, formaldehyde, 1,3-butadiene and acrolein. The MOBILE model also includes default emission factors for the PAH class of pollutants (hazardous air pollutants – HAPS). The default HAPS emission factors in MOBILE6.2C, were not used for the Windsor area, instead the default factors were replaced by emission factors specific to the Great Lakes Region obtained from a Great Lakes Commission report titled "Great Lakes Regional Toxic Air Emissions Inventory Steering Committee: Assessment of Benzo (a) Pyrene Air Emissions in the Great Lakes Region, March 2007" ("Great Lakes Commission Report"). PAH emission factors expressed as fractions of particulate matter are provided in the Great Lake Commission Report for light duty gasoline vehicles (as fraction PM_{10}), light duty diesel vehicles (as fraction of PM_{10}) and trucks and heavy duty diesel vehicles (as fraction of $PM_{2.5}$). Table A7-5 gives the emission factors extracted from the Great Lakes Commission Report that were used (with the exception of naphthalene) in this study.

Table A7-5: PAH Emission Factors

PAH	LDGV Fraction of PM10	LDDV Fraction of PM10	HDDV Fraction of PM2.5
benzo(a)anthracene	0.000100	0.000048	0.000040
benzo(a)pyrene	0.000100	0.000045	0.000013
benzo(b)fluoranthene	0.000120	0.000078	0.000011
benzo(k)fluoranthene	0.000120	0.000078	0.000011
chrysene	0.000100	0.000057	0.000007
dibenzo(a,h)anthacene	0.000000	0.000002	0.000000
indeno(1,2,3-cd)pyrene	0.000080	0.000021	0.000001
acenaphthlene	0.000730	0.000086	0.000024
acenaphthalene	0.004120	0.000971	0.000037
anthracene	0.000850	0.000182	0.000037
benzo(ghi)perylene	0.000260	0.000053	0.000009
fluoranthene	0.000910	0.000536	0.000022
fluorene	0.001510	0.000381	0.000049
naphthalene	0.090730	0.003663	0.001401
phenanthrene	0.002540	0.001058	0.000056
pyrene	0.001240	0.000689	0.000039

Naphthalene has a high vapour pressure compared to the other PAH compounds that are largely semi-volatile. The high vapour pressure of naphthalene suggests that it will partition in favour of the gas phase rather than the particulate phase which is favoured by other semi-volatile PAH compounds such as benzo (a) pyrene (Pankow, JF, 1987, Review and Comparative Analysis of the Theories on Partitioning between the Gas and Aerosol Particulate Phases in the Atmosphere, Atmospheric Environment, V21, p.2275-2283.). The default MOBILE6.2C emission factor file for PAH compounds contains emission factors for naphthalene in terms of the fraction of both VOC (the gas phase, RATIOVOC) and particulate matter (RATIOPM). The sensitivity of the naphthalene emission factors calculated by MOBILE6.2C to the choice of its association with either VOC or particulate matter was investigated; the results are shown in Table A7-6. It is evident from Table A7-6 that if naphthalene emission factors are expressed in terms of particulate matter, the factors are essentially independent of vehicle speed which is consistent with the particulate emission factors in Table A7-4 that shown very little dependence on speed. If the naphthalene emissions factors are expressed in terms of VOC (the gas phase) then, in terms of the model, naphthalene emissions decrease significantly with speed as do VOC emissions. In the present study, naphthalene is assumed to be associated with the gas phase and the factors expressed in term of VOC have been used.

The MOBILE 6.2C emission factors for the bridge, Huron Church Road and Arterial Roads at select speeds for PAHs are summarized in Table A7-7.

Table A7-6: Naphthalene Emission Factors

SPEED	JULY RATIOVOC	JULY RATIOPM	JANUARY RATIOVOC	JANUARY RATIOPM	SPEED	JULY RATIOVOC	JULY RATIOPM	JANUARY RATIOVOC	JANUARY RATIOPM
2.5 Htsk	0.002		0		**30 Htsk**	0.002		0	
Drnl	0.053		0		**Drnl**	0.053		0	
Rung	1.691		1.802		**Rung**	0.050		0.05287	
Rest	0.047		0.03215		**Rest**	0.047		0.03215	
Refu	0.055		0.06649		**Refu**	0.055		0.06649	
TOTAL	**1.848**	**1.204**	**1.901**	**1.24**	**TOTAL**	**0.207**	**1.194**	**0.152**	**1.23**
5 Htsk	0.002		0		**35 Htsk**	0.002		0	
Drnl	0.053		0		**Drnl**	0.053		0	
Rung	0.423		0.4504		**Rung**	0.043		0.04531	
Rest	0.047		0.1586		**Rest**	0.047		0.03215	
Refu	0.055		0.06649		**Refu**	0.055		0.06649	
TOTAL	**0.580**	**1.204**	**0.675**	**1.24**	**TOTAL**	**0.200**	**1.190**	**0.144**	**1.225**
10 Htsk	0.002		0		**40 Htsk**	0.002		0	
Drnl	0.053		0		**Drnl**	0.053		0	
Rung	0.149		0.1586		**Rung**	0.037		0.03965	
Rest	0.047		0.03215		**Rest**	0.047		0.03215	
Refu	0.055		0.06649		**Refu**	0.055		0.06649	
TOTAL	**0.306**	**1.204**	**0.257**	**1.24**	**TOTAL**	**0.194**	**1.190**	**0.138**	**1.225**
15 Htsk	0.002		0		**45 Htsk**	0.002		0	
Drnl	0.053		0		**Drnl**	0.053		0	
Rung	0.099		0.1057		**Rung**	0.033		0.03524	
Rest	0.047		0.03215		**Rest**	0.047		0.03215	
Refu	0.055		0.06649		**Refu**	0.055		0.06649	
TOTAL	**0.256**	**1.204**	**0.204**	**1.24**	**TOTAL**	**0.190**	**1.190**	**0.134**	**1.225**
20 Htsk	0.002		0		**50 Htsk**	0.002		0	
Drnl	0.053		0		**Drnl**	0.053		0	
Rung	0.074		0.0793		**Rung**	0.029		0.03039	
Rest	0.047		0.03215		**Rest**	0.047		0.03215	
Refu	0.055		0.06649		**Refu**	0.055		0.06649	
TOTAL	**0.232**	**1.204**	**0.178**	**1.24**	**TOTAL**	**0.186**	**1.190**	**0.129**	**1.225**
25 Htsk	0.002		0						
Drnl	0.053		0						
Rung	0.060		0.06344						
Rest	0.047		0.03215						
Refu	0.055		0.06649						
TOTAL	**0.217**	**1.199**	**0.162**	**1.235**					

Table A7-7: Initial MOBILE6.2C Emission Factors for PAHs

Area	Traffic Speed		acenaphthylene	acenaphthene	anthracene	benzo (a) anthracene	Benzo (a) pyrene	benzo (b) fluoranthene	benzo (g,h,i) pyrene	benzo (k) fluorene	chrysene	dibenzo (ah) anthracene	fluoranthene	fluorene	ideno (1,2,3-cd) pyrene	naphthalene	phenathrene	pyrene
	mile/hr	km/hr	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile
Present (Baseline)																		
Bridge	2.5	4	0.0641	0.0129	0.0161	0.0042	0.0028	0.0030	0.0047	0.0030	0.0023	5.5E-06	0.0164	0.0271	0.0013	1.4210	0.0441	0.0232
	30	48	0.0641	0.0129	0.0161	0.0042	0.0028	0.0030	0.0047	0.0030	0.0023	5.5E-06	0.0164	0.0271	0.0013	1.4210	0.0441	0.0232
	35	56	0.0640	0.0128	0.0160	0.0042	0.0028	0.0030	0.0047	0.0030	0.0022	5.5E-06	0.0164	0.0270	0.0013	1.4170	0.0440	0.0231
	40	64	0.0636	0.0128	0.0160	0.0042	0.0028	0.0030	0.0047	0.0030	0.0022	5.5E-06	0.0163	0.0269	0.0013	1.4100	0.0438	0.0230
Huron Church Road	2.5	4	0.0569	0.0110	0.0136	0.0029	0.0022	0.0025	0.0040	0.0025	0.0019	5.7E-06	0.0144	0.0233	0.0011	1.2400	0.0386	0.0201
	35	56	0.0566	0.0109	0.0136	0.0029	0.0022	0.0024	0.0040	0.0024	0.0019	5.7E-06	0.0143	0.0232	0.0011	1.2350	0.0384	0.0200
Arterial roads	2.5	4	0.0470	0.0084	0.0103	0.0011	0.0015	0.0017	0.0031	0.0017	0.0014	6.0E-06	0.0117	0.0181	0.0009	0.9950	0.0311	0.0159
	30	48	0.0464	0.0083	0.0102	0.0011	0.0014	0.0017	0.0030	0.0017	0.0014	6.0E-06	0.0115	0.0178	0.0009	0.9816	0.0307	0.0158
2011																		
Bridge	2.5	4	0.0327	0.0065	0.0079	0.0017	0.0013	0.0014	0.0023	0.0014	0.0011	1.03E-06	0.0079	0.0134	0.0006	0.7342	0.0217	0.0112
	30	48	0.0327	0.0065	0.0079	0.0017	0.0013	0.0014	0.0023	0.0014	0.0011	1.03E-06	0.0079	0.0134	0.0006	0.7342	0.0217	0.0112
	35	56	0.0326	0.0065	0.0079	0.0017	0.0013	0.0014	0.0023	0.0014	0.0011	1.03E-06	0.0079	0.0134	0.0006	0.7335	0.0217	0.0112
	40	64	0.0326	0.0064	0.0079	0.0017	0.0013	0.0014	0.0023	0.0014	0.0011	1.03E-06	0.0079	0.0134	0.0006	0.7324	0.0217	0.0112
Huron Church Road	2.5	4	0.0314	0.0061	0.0075	0.0015	0.0012	0.0013	0.0022	0.0013	0.0010	1.46E-06	0.0077	0.0128	0.0006	0.6994	0.0209	0.0107
	35	56	0.0314	0.0061	0.0075	0.0015	0.0012	0.0013	0.0022	0.0013	0.0010	1.46E-06	0.0076	0.0128	0.0006	0.6986	0.0208	0.0107
Arterial roads	2.5	4	0.0256	0.0046	0.0055	0.0004	0.0007	0.0009	0.0017	0.0009	0.0007	1.53E-06	0.0060	0.0097	0.0005	0.5544	0.0164	0.0082
	30	48	0.0254	0.0046	0.0055	0.0004	0.0007	0.0009	0.0017	0.0009	0.0007	1.53E-06	0.0060	0.0097	0.0005	0.5517	0.0163	0.0082
2021 (FDN) and 2021 (A)																		
Bridge	2.5	4	0.0182	0.0034	0.0040	0.0004	0.0005	0.0006	0.0012	0.0006	0.0005	2.0E-07	0.0042	0.0070	0.0004	0.4041	0.0116	0.0058
	30	48	0.0182	0.0034	0.0040	0.0004	0.0005	0.0006	0.0012	0.0006	0.0005	2.0E-07	0.0042	0.0070	0.0004	0.4041	0.0116	0.0058
	35	56	0.0182	0.0034	0.0040	0.0004	0.0005	0.0006	0.0012	0.0006	0.0005	2.0E-07	0.0042	0.0070	0.0004	0.4042	0.0116	0.0058
	40	64	0.0182	0.0034	0.0040	0.0004	0.0005	0.0006	0.0012	0.0006	0.0005	2.0E-07	0.0042	0.0070	0.0004	0.4045	0.0116	0.0058
Huron Church Road	2.5	4	0.0181	0.0033	0.0039	0.0003	0.0005	0.0006	0.0012	0.0006	0.0005	2.8E-07	0.0041	0.0069	0.0004	0.3991	0.0114	0.0057
	35	56	0.0181	0.0033	0.0039	0.0003	0.0005	0.0006	0.0012	0.0006	0.0005	2.8E-07	0.0041	0.0069	0.0004	0.3994	0.0114	0.0057
Arterial roads	2.5	4	0.0176	0.0031	0.0037	0.0001	0.0005	0.0005	0.0011	0.0005	0.0004	3.1E-07	0.0040	0.0065	0.0003	0.3857	0.0110	0.0054
	30	48	0.0176	0.0031	0.0037	0.0001	0.0005	0.0005	0.0011	0.0005	0.0004	3.1E-07	0.0040	0.0065	0.0003	0.3867	0.0110	0.0054
2021 (B) - Cars Only for Bridge																		
Bridge	2.5	4	0.0036	0.0031	0.0036	0.0174	0.0174	0.0175	0.0036	0.0175	0.0031	3.1E-03	0.0036	0.0000	0.0031	0.0000	0.0000	0.0000
	30	48	0.0036	0.0036	0.0036	0.0175	0.0175	0.0031	0.0000	0.0031	0.0031	3.1E-03	0.0000	0.0000	0.0036	0.0000	0.0004	0.0004
	35	56	0.0036	0.0036	0.0000	0.0175	0.0031	0.0031	0.0000	0.0031	0.0031	3.6E-03	0.0000	0.0000	0.0036	0.0004	0.0004	0.0004
	40	64	0.0036	0.0036	0.0000	0.0175	0.0031	0.0031	0.0000	0.0031	0.0031	3.6E-03	0.0000	0.0000	0.0036	0.0004	0.0004	0.0004
Huron Church Road	2.5	4	0.0181	0.0033	0.0039	0.0003	0.0005	0.0006	0.0012	0.0006	0.0005	2.8E-07	0.0041	0.0069	0.0004	0.3991	0.0114	0.0057
	35	56	0.0181	0.0033	0.0039	0.0003	0.0005	0.0006	0.0012	0.0006	0.0005	2.8E-07	0.0041	0.0069	0.0004	0.3994	0.0114	0.0057
Arterial roads	2.5	4	0.0176	0.0031	0.0037	0.0001	0.0005	0.0005	0.0011	0.0005	0.0004	3.1E-07	0.0040	0.0065	0.0003	0.3857	0.0110	0.0054
	30	48	0.0176	0.0031	0.0037	0.0001	0.0005	0.0005	0.0011	0.0005	0.0004	3.1E-07	0.0040	0.0065	0.0003	0.3867	0.0110	0.0054
2021 (B) - Trucks Only for Bridge																		
Bridge	2.5	4	0.0046	0.0038	0.0046	0.0194	0.0194	0.0194	0.0046	0.0193	0.0038	3.8E-03	0.0046	0.0009	0.0038	0.0009	0.0009	0.0009
	30	48	0.0046	0.0046	0.0046	0.0194	0.0193	0.0038	0.0009	0.0038	0.0038	3.8E-03	0.0009	0.0009	0.0046	0.0009	0.0007	0.0007
	35	56	0.0046	0.0046	0.0009	0.0193	0.0038	0.0038	0.0009	0.0038	0.0038	4.6E-03	0.0009	0.0009	0.0046	0.0007	0.0007	0.0007
	40	64	0.0046	0.0046	0.0009	0.0193	0.0038	0.0038	0.0009	0.0038	0.0038	4.6E-03	0.0009	0.0009	0.0046	0.0007	0.0007	0.0007
Huron Church Road	2.5	4	0.0181	0.0033	0.0039	0.0003	0.0005	0.0006	0.0012	0.0006	0.0005	2.8E-07	0.0041	0.0069	0.0004	0.3991	0.0114	0.0057
	35	56	0.0181	0.0033	0.0039	0.0003	0.0005	0.0006	0.0012	0.0006	0.0005	2.8E-07	0.0041	0.0069	0.0004	0.3994	0.0114	0.0057
Arterial roads	2.5	4	0.0176	0.0031	0.0037	0.0001	0.0005	0.0005	0.0011	0.0005	0.0004	3.1E-07	0.0040	0.0065	0.0003	0.3857	0.0110	0.0054
	30	48	0.0176	0.0031	0.0037	0.0001	0.0005	0.0005	0.0011	0.0005	0.0004	3.1E-07	0.0040	0.0065	0.0003	0.3867	0.0110	0.0054

A7-5: N_2O and CH_4 Vehicle Emission Factors

The MOBILE 6.2C model does not include predictions for nitrous oxide (N_2O) and methane (CH_4). Emission calculations for these pollutants of interest were developed using published data. Published vehicle exhaust emission factors for N_2O and CH_4 for light duty (LD) gasoline vehicles and heavy duty (HD) diesel vehicles were obtained from the USEPA (Office of Transportation and Air Quality) report titled "Update of Methane and Nitrous Oxide Emission Factors for On-Highway Vehicles" dated November 2004. The report provided a summary of the development of emission factors using methodology from the Intergovernmental Panel on Climate Change (IPCC) and the USEPA Federal test Procedures (FTP). The two sets of raw emission factors for light duty and heavy duty vehicles are summarized in Table A7-8.

The average raw emission factor was used to develop a composite emission factor for the air quality assessment. Similar to the MOBILE6 models, the vehicle exhaust composite emission factor (EF) was estimated as follows:

Composite EF = LD Gasoline EF x LD Fraction + HD Diesel EF x HD Fraction

The LD Fraction and HD Fraction refer to the fraction of light duty and heavy duty vehicles for each emission scenario and in each area (i.e., existing/replacement span, Huron Church Road in Local Study Area and Arterial Roads in Local Study Area). For simplicity, the composite emission factor was based on all light duty vehicles using unleaded gasoline and that all heavy duty vehicles using diesel. Only a small fraction of light duty vehicles are diesel whereas a large fraction of heavy duty vehicles are diesel. This approach will provide a conservative composite emission factor as it does not consider possible future improvements (reduction) in vehicle exhaust emission factors through changing fuel standards and emissions controls as predicted by the MOBILE model for other pollutants of interest.

The resulting composite N_2O and CH_4 emission factors are summarized in Table A7-9.

Table A7-8: Nitrous Oxide and Methane Raw Emission Factors

GHG Compound	Units	LD Gasoline Vehicle[(1)]			HD Diesel Vehicle[(2)]		
		IPCC	FTP	Average	IPCC	FTP	Average
N_2O	g/VmT	0.040	0.032	0.036	0.048	0.005	0.027
CH_4	g/VmT	0.15	0.10	0.12	0.081	0.004	0.043

Note: Data from USEPA (Office of Transportation and Air Quality: "Update of Methane and Nitrous Oxide Emission Factors for On-Highway Vehicles" November 2004. IPCC refers to emission factors developed using methodology from the Intergovernmental Panel on Climate Change (Revised 1996). FTP refers to emission factors developed using the Federal Test Procedure.

Note: (1) raw emission factor shown represents the average of the identified published data for gasoline passenger cars, light duty trucks and motorcycles (miscellaneous control technologies).

Note: (2) raw emission factor shown represents the average of the identified published data for heavy duty diesel vehicles (miscellaneous control technologies).

Table A7-9: Summary of Vehicle Emissions Composite N_2O and CH_4 Emission Factors

PAH Compound	Units	Raw Emission Factor[1]		Composite Emission Factor											
		LD Gasoline	HD Diesel	Bridge (Existing)			Bridge (Enhanced)			Huron Church Road (Local Study Area)			Arterial Roads (Local Study Area)		
				Baseline	2021 (FDN)	2021 (B)	2011	2021 (A)	2021 (B)	Baseline	2011	2021 (FDN), (A) & (B)	Baseline	2011	2021 (FDN), (A) & (B)
Percentage of Light Duty Vehicles[2]	%	-	-	62.8	59.4	100	62.3	59.4	0	75	68.1	66.5	91.7	91.7	91.7
Percentage of Heavy Duty Vehicles[3]	%	-	-	37.2	40.6	0	37.7	40.6	100	25	31.9	33.5	8.3	8.3	8.3
N_2O	g/VmT	3.6E-02	2.7E-02	3.2E-02	3.2E-02	3.6E-02	3.2E-02	3.2E-02	2.7E-02	3.4E-02	3.3E-02	3.3E-02	3.5E-02	3.5E-02	3.5E-02
CH_4	g/VmT	1.2E-01	4.3E-02	9.3E-02	9.0E-02	1.2E-01	9.2E-02	9.0E-02	4.3E-02	1.0E-01	9.7E-02	9.6E-02	1.2E-01	1.2E-01	1.2E-01

Note: (1) raw emission factor shown represents the average in the identified published data.
Note: (2) for the purpose of this analysis, light duty vehicles includes passenger cars, light duty trucks and motorcycles
Note: (3) for the purpose of this analysis, heavy duty vehicles includes buses and heavy duty vehicles (Class 2b to 8b)
Note: 2021 (FDN) refers to future operation of existing bridge only, 2021 (A) refers to future operation of ABEP only and 2021 (B) refers to future operation of ABEP plus existing bridge.

APPENDIX 8

Road Dust Emission Calculations
(9 pages)

A8-1: USEPA Road Dust Emission Factor Estimates

Particulate emissions from paved roads originate from the loose material present on the surface. The surface loading is moved or removed and is continuously replenished by other sources such as break wear, tire wear and spillage of material.

Dust emissions from paved roads have been shown to vary with the amount of material on the road, the average weight of the vehicles traveling the road as well as the amount of precipitation.

The road dust calculations are based on the results of tests conducted at numerous sources including paved public and industrial roads. The calculation is specifically applicable to freely flowing and slow moving or stop and go traffic on level roads. Elevated roadway sections will be much lower than the calculations predict.

Silt Loading

Silt loading (sL) refers to the mass of silt-sized particles (particles with a physical diameter equal to or less than 75 μm) per unit area of the travel surface.

The USEPA AP-42 "default ubiquitous baseline" silt loading value of 0.03 g/m^2 for a paved road with daily traffic flow >10,000 was used for the bridge (present and future), Huron Church Road and Arterial Roads. Based on daily traffic flow >10,000, the USEPA AP-42 "default ubiquitous winter baseline" silt loading multiplier during months with frozen precipitation is 1 and as such the winter silt loading value was also 0.03 g/m^2.

Each road segment was assigned this default average silt loading value in the calculation of the road dust emission factor.

Vehicle Weight

The same fleet profile used to estimate vehicle emissions described in the main body of the report (Section 4.1), was used to estimate the weight of vehicles traveling on the paved roads. The vehicle weight was assigned a value equivalent to the average gross vehicle weight rating (GVWR) provided in MOBILE6.2C for each vehicle class where available. This is conservative since the GVWR refers to the total weight of the vehicle plus load whereas in reality a fraction of these vehicles will have an empty payload and others will not be fully loaded. In cases where GVWR were not provided in MOBILE6.2C, vehicle weights for light duty passenger cars, motorcycles, school buses, transit and urban buses and Class 8b heavy duty vehicles were estimated based on information available on various government websites.

Precipitation Days

Precipitation data recorded by Environment Canada at the Windsor Airport for the period 2000 to 2007 was obtained and analyzed as described in detail below. Emission factors used for dispersion modelling utilized the conservative approach of assuming precipitation does not occur during the worst case emission scenario.

The average number of precipitation days per month was used in the calculation of annual road dust emission factors. Annual road dust emission calculations are discussed in detail in the main body of the report (Section 4.4).

USEPA AP-42 Section 13.2.1 provides an empirical expression to calculate the quantity of particulate emissions from re-suspension of loose material on the road surface due to vehicle travel on paved roads:

$$\mathbf{E = [k\ (sL/2)^{0.91}\ (W)^{1.02}\ ]\ x\ PCF\ x\ LCF}$$

Where:

E = particulate emission factor (having units of k, g/vehicle mile traveled)
k = particle size multiplier for particle size range and units of interest (= 0.62 g/vehicle kilometer traveled for airborne particulate matter with an aerodynamic diameter of 10 μm or less (PM_{10}); and 0.15 g/vehicle kilometer traveled for airborne particulate matter with an aerodynamic diameter of 2.5 μm or less ($PM_{2.5}$))
sL = ubiquitous baseline default road surface silt loading (= 0.03 g/m^2 for >10,000 vehicles per day)
W = average 'fleet' weight (tons) of all types of vehicles traveling the road
C = emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear (0.1005 g/VKT for $PM_{2.5}$ and 0.1317 g/VKT for PM_{10})
PCF = Precipitation correction factor = [(1-(P/4N)], where:

P = number of precipitation or "wet" days (any day with at least 0.254 mm (0.01 in) of total precipitation (rain and snow) during the averaging period
N = number of days in the averaging period.

LCF = Length conversion factor from kilometers to miles (1 mi = 1.609 km)

The USEPA AP-42 uses an emission factor quality rating system with "A" denoting the highest quality and "E" the lowest.

The above equation was developed based on a regression analysis of numerous emission tests, including 83 tests for PM_{10}. The sources that were tested include public paved roads, as well as controlled and uncontrolled industrial paved roads. It is important to note that all of the sources tested were under conditions of vehicles traveling on relatively level roads. Thus, the equation retains the data quality rating of "A" for PM_{10} ("D" for $PM_{2.5}$) if applied within the following range of source conditions that were tested in the development of the equation:

- Silt loading (sL): 0.03 – 400 g/m^2;
- Mean vehicle weight: 1.8 – 38 Mg (megagrams);
- Mean vehicle speed: 1 – 88 km/h.

The use of site-specific silt loading values is recommended with the above formula. However, site-specific silt loading data was not available for the study area and thus default silt loading values were used. As a consequence, the data quality ratings for the PM_{10} and $PM_{2.5}$ emission factors were downgraded 2 levels (data quality rating of "C" for PM_{10} and "E, the lowest quality rating for emission factors for $PM_{2.5}$).

The vehicle weights used in the calculation of road dust emissions are shown in Tables A8-1a to A8-1d and were based on average vehicle weights detailed in MOBILE6.2C (where available) supplemented by information available on various government websites for passenger cars, motorcycles, transit and urban buses. The average loaded vehicle weights (LVW) were used in the emission calculations.

An <u>average</u> weight of <u>all</u> vehicles traveling the road was calculated based on the percentage distribution for each vehicle weight class shown on Tables A8-1a to A8-1c for the fleet profile on the bridge, along Huron Church Road and the Arterial Roads. Emission factors were developed for present (baseline), construction / operation, future (do nothing) and future (ABEP) emission scenarios. It is important to note that the above equation is not intended to be used to calculate a separate emission factor for each vehicle weight class. Thus, a single emission factor, one for PM_{10} and one for $PM_{2.5}$, was calculated to represent the "fleet" average weight of all vehicles traveling the road.

For conservatism, the precipitation correction factor (PCF) was not applied to the hourly emission calculations (i.e., assumed no precipitation occurs in any hour for a given day and thus assume maximum PM_{10} and $PM_{2.5}$ emissions). The PCF was calculated based on monthly average and monthly minimum number of precipitation days recorded at Windsor Airport during the period (January 1, 2001 to June 6, 2007), which are summarized on Table A8-2.

The PCF was applied to the above equation to calculate annual emissions. Annual emission calculations are discussed in more detail in Appendix 10.

Tables A8-3a and A8-3b includes a summary of the PM_{10} and $PM_{2.5}$ hourly and annual emission factors. The PM_{10} and $PM_{2.5}$ emission factors were utilized for free flow road segments. Road dust contributions from queue and custom plaza idling segments were set to zero to account for these reduced speed zones.

Table A8-1a: Average "Fleet" Weights for Present (Baseline)

Category #	Vehicle Class Code	Vehicle Weight Distributions			AVG LVW (lbs)	Vehicle Weights (lbs)		
		Ambassador Bridge MOBILE6.2C	Local Study Area MOBILE6.2C	Local Study Area Cross Roads MOBILE6.2C		Fleet Weight AB	Fleet Weight HC	Fleet Weight Local
1	LDV	25.3%	30.2%	37.0%	3,000	758	907	1,109
2	LDT1	6.4%	7.6%	9.3%	1,875	119	143	174
3	LDT2	21.2%	25.4%	31.0%	4,751	1,008	1,205	1,474
4	LDT3	6.6%	7.9%	9.6%	1,875	123	147	180
5	LDT4	2.9%	3.5%	4.3%	4,751	139	166	203
16	MC	0.4%	0.4%	0.5%	500	2	2	3
14	HDBS	0.1%	*0.2%*	***0.2%***	10,000	13	20	20
15	HDBT	0.1%	*0.1%*	***0.1%***	15,000	10	15	15
6	HDV2B	12.5%	8.3%	2.7%	9,251	1,154	768	249
7	HDV3	1.2%	0.8%	0.3%	12,001	150	100	32
8	HDV4	0.9%	0.6%	0.2%	15,001	140	93	30
9	HDV5	0.6%	0.4%	0.1%	17,751	111	74	24
10	HDV6	2.5%	1.7%	0.5%	22,751	567	378	122
11	HDV7	3.1%	2.1%	0.7%	29,501	920	612	198
12	HDV8A	3.7%	2.5%	0.8%	46,501	1,740	1,158	375
13	HDV8B	12.5%	8.3%	2.7%	60,000	7,482	4,982	1,613
		100.0%	100.0%	**100.0%**	15,907	--	--	--
				Average Fleet Weight (lbs)		14,436	10,770	5,823
				Average Fleet Weight (tons)		7.2	5.4	2.9

\# conservative estimate

* Bus category reflects MOBILE6.2C default values. No bus data available within study area. Bus contributions in local study area are subtracted from the Truck category.

Table A8-1b: Average "Fleet" Weights for 2015 (Construction/Operation)

Category #	Vehicle Class Code	Vehicle Weight Distributions			AVG LVW (lbs)	Vehicle Weights (lbs)		
		Ambassador Bridge MOBILE6.2C	Local Study Area MOBILE6.2C	Local Study Area Cross Roads MOBILE6.2C		Fleet Weight AB	Fleet Weight HC	Fleet Weight Local
1	LDV	20.0%	30.1%	37.0%	3,000	600	904	1,109
2	LDT1	5.0%	7.6%	9.3%	1,875	94	142	174
3	LDT2	16.8%	25.3%	31.0%	4,751	797	1,200	1,474
4	LDT3	5.2%	7.8%	9.6%	1,875	97	147	180
5	LDT4	2.3%	3.5%	4.3%	4,751	110	166	203
16	MC	0.3%	0.4%	0.5%	500	1	2	3
14	HDBS	0.1%	*0.2%*	***0.2%***	10,000	13	20	20
15	HDBT	0.1%	*0.1%*	***0.1%***	15,000	10	15	15
6	HDV2B	16.9%	8.4%	2.7%	9,251	1,561	777	249
7	HDV3	1.7%	0.8%	0.3%	12,001	202	101	32
8	HDV4	1.3%	0.6%	0.2%	15,001	190	95	30
9	HDV5	0.8%	0.4%	0.1%	17,751	150	75	24
10	HDV6	3.4%	1.7%	0.5%	22,751	768	382	122
11	HDV7	4.2%	2.1%	0.7%	29,501	1,244	620	198
12	HDV8A	5.1%	2.5%	0.8%	46,501	2,354	1,172	375
13	HDV8B	16.9%	8.4%	2.7%	60,000	10,124	5,042	1,613
		100.0%	100.0%	**100.0%**	**15,907**	--	--	--
				Average Fleet Weight (lbs)		18,317	10,859	5,823
				Average Fleet Weight (tons)		9.2	5.4	2.9

\# conservative estimate

* Bus category reflects MOBILE6.2C default values. No bus data available within study area. Bus contributions in local study area are subtracted from the Truck category.

Table A8-1c: Average "Fleet" Weights for 2025

Category #	Vehicle Class Code	Vehicle Weight Distributions			AVG LVW (lbs)	Vehicle Weights (lbs)		
		Ambassador Bridge MOBILE6.2C	Local Study Area MOBILE6.2C	Local Study Area Cross Roads MOBILE6.2C		Fleet Weight AB	Fleet Weight HC	Fleet Weight Local
1	LDV	21.8%	28.7%	37.0%	3,000	653	862	1,109
2	LDT1	5.5%	7.2%	9.3%	1,875	103	136	174
3	LDT2	18.3%	24.1%	31.0%	4,751	868	1,146	1,474
4	LDT3	5.7%	7.5%	9.6%	1,875	106	140	180
5	LDT4	2.5%	3.3%	4.3%	4,751	120	158	203
16	MC	0.3%	0.4%	0.5%	500	2	2	3
14	HDBS	0.1%	*0.2%*	***0.2%***	10,000	13	20	20
15	HDBT	0.1%	*0.1%*	***0.1%***	15,000	10	15	15
6	HDV2B	15.4%	9.5%	2.7%	9,251	1,424	883	249
7	HDV3	1.5%	1.0%	0.3%	12,001	185	115	32
8	HDV4	1.2%	0.7%	0.2%	15,001	173	107	30
9	HDV5	0.8%	0.5%	0.1%	17,751	137	85	24
10	HDV6	3.1%	1.9%	0.5%	22,751	700	434	122
11	HDV7	3.8%	2.4%	0.7%	29,501	1,135	704	206
12	HDV8A	4.6%	2.9%	0.8%	46,501	2,148	1,332	375
13	HDV8B	15.4%	9.5%	2.7%	60,000	9,237	5,728	1,613
		100.0%	100.0%	**100.0%**	**15,907**	--	--	--
				Average Fleet Weight (lbs)		17,013	11,867	5,830
				Average Fleet Weight (tons)		8.5	5.9	2.9

\# conservative estimate

* Bus category reflects MOBILE6.2C default values. No bus data available within study area. Bus contributions in local study area are subtracted from the Truck category.

Table A8-2: Summary of Precipitation Days for Windsor Airport Precipitation Data (2000 to 2007)

Month	Average No. of Precipitation Days per Month	Minimum No. of Precipitation Days per Month
January	14	11
February	11	7
March	14	10
April	12	8
May	14	7
June	10	4
July	11	7
August	9	7
September	8	5
October	11	8
November	12	10
December	15	11
Total	141	95

Note: Based on 2000 - 2007 data recorded by Environment Canada (Windsor Airport)

Table A8-3a: Summary of PM_{10} and $PM_{2.5}$ Road Dust Emission Factors for Calculation of Hourly Emissions

Scenario	Ambassador Bridge MOBILE6.2C		Local Study Area MOBILE6.2C		Local Study Area Cross Roads MOBILE6.2C	
	PM_{10} (g/veh-mile)	$PM_{2.5}$ (g/veh-mile)	PM_{10} (g/veh-mile)	$PM_{2.5}$ (g/veh-mile)	PM_{10} (g/veh-mile)	$PM_{2.5}$ (g/veh-mile)
Present (Baseline)	0.44	0.21	0.36	0.19	0.25	0.16
2015 (Construction/Operation)	0.45	0.15	0.27	0.10	0.15	0.06
2025 (FDN)	0.40	0.13	0.29	0.10	0.15	0.006
2025 (A)	0.40	0.13	0.29	0.10	0.15	0.006
2025 (B) - Cars	0.10	0.04	0.29	0.10	0.15	0.006
2025 (B) - Trucks	0.78	0.23	0.29	0.10	0.15	0.006

Note: For conservatism, the precipitation correction factor (PCF) was not applied to the calculation of the hourly PM_{10} and $PM_{2.5}$ emission factors.

***** In situations where low silt loading and/or low average weight yield calculated negative emission factors based on the above equation, the emission factor calculated was set to zero as per USEPA AP-42.

Table A8-3b: Summary of PM_{10} and $PM_{2.5}$ Road Dust Emission Factors for Calculation of Annual Emissions

Scenario	Ambassador Bridge MOBILE6.2C	
	PM_{10} (g/veh-mile)	$PM_{2.5}$ (g/veh-mile)
Present (Baseline)	0.361	0.172
Future 2015 (Construction/Operation)	0.369	0.123
2025 (FDN)	0.328	0.107
2025 (A)	0.328	0.107

***** Annual average precipitation correction of 0.82 applied to all emission scenarios

APPENDIX 9

Construction Emission Calculations
(10 pages)

Particulate will be emitted from the general construction activities and particulate, nitrogen oxides and other pollutants of interest will be emitted from the diesel combustion engines of the equipment used during construction. The construction activity emission rate calculations are discussed in Sections A9-1 to A9-3 below.

A9-1: Heavy Construction Particulate Emissions

Particulate emissions from construction operations of the project have been computed using a PM_{10} emission factor developed by Midwest Research Institute (MRI) during 1996 (Ref.A.9-1). This emission factor is a refinement of the emission factor presented in the US EPA AP-42 document (Ref.A.9-2), which is based on studies in the 1970s and early 1990s. The MRI emission factor also includes the effects of typical control measures such as routine watering. These particulate emissions include emissions from land clearing, ground excavation, cut and fill operations, road dust from on-site vehicle traffic, vehicle tailpipe emissions and construction of the particular facility or structure.

The construction emission factors are:

PM_{10} Emission Factor = 0.11 tons / acre-month, or 0.25 tonnes / hectare-month

$PM_{2.5}$ Emission Factor = PM_{10} Emission Factor x 0.2
= 0.25 tonnes / hectare-month x 0.2
= 0.05 tonnes / hectare-month

The total area of the site from the Detroit River to Mall Street, north of Indian Road was estimated to be 125 hectares. Not all of this area will be under active construction at the same time, and therefore, it was assumed that $1/10^{th}$, or 12.5 hectares, would be under active construction.

Example Calculation

PM_{10} Emission = PM_{10} Emission Factor x 12.5 ha / 30 days/month / 24 h/day / 3600 s/h x 10^6 g/tonne
= 0.25 tonnes /ha-month x 12.5 ha / 30 days/month / 24 h/d / 3600 s/h x 10^6 g/tonne
= 1.21 g/s

Although the construction will not be for 30 days per month and 24 hours per day, the emission factor is an average for a 30 day month and 24-hours per day.

Construction of an expanded plaza would occur after completion of the replacement span pending increased vehicle volumes. Emission estimates follow the same methodology described above where the total area for plaza construction activities is 0.96 hectares.

The heavy construction particulate emission rate results are summarized in Table A9-1.

Table A9-1: Heavy Construction Particulate Emissions

Particulate	Emission (g/s)
PM_{10}	1.21
$PM_{2.5}$	0.24

A9-2: Diesel Combustion Engine Emissions

Diesel engines of the construction equipment on-site will emit combustion products such as nitrogen oxides, carbon monoxide and sulphur dioxide. These engines also emit particulate, however, the particulate emissions are included in the total heavy construction activities particulate emissions estimated above.

Nitrogen Oxides:

For licensed road equipment such as the haul trucks and concrete trucks an idling emission rate of 55 g/h per vehicle was used (Ref: A.9-3).

For the other on-site diesel powered equipment such as cranes, the US EPA Non-Road Level 3 limit of 4.0 g/kWh was used. Although this Level 3 limit of 4.0 g/kWh is for combined NO_X and NMHC, it was conservatively assumed to be all NO_X. This Level 3 limit was used together with the maximum number of each type of equipment operating simultaneously on-site, the kW rating of the equipment engines and the anticipated load factors to calculate the diesel engine nitrogen oxides emissions for the different construction activities. The nitrogen oxides emission rate results are summarized in Table A9-2.

Carbon Monoxide:

For licensed road equipment such as the haul trucks and concrete trucks an idling emission rate of 94 g/h per vehicle was used (Ref: A.9-3).

For the other on-site diesel powered equipment such as cranes, the US EPA Non-Road Level 3 limit of 3.5 g/kWh was used. This Level 3 limit was used together with the maximum number of each type of equipment operating simultaneously on-site, the kW rating of the equipment engines and the anticipated load factors to calculate the diesel engine carbon monoxide emissions for the different construction activities. The carbon monoxide emission rate results are summarized in Table A9-3.

Table A9-2: Construction Diesel Engine NO_X Emissions

Activity/ Source ID	Construction Activity	Equipment	Max Qty on Site	Average kW rating	g/kWh	% Load	Idling, g/h	g/s
1	Site Preparation	Excavators	3	180	4	50		0.30
		Haul trucks	6				55	0.09
		Compactors	3	350	4	50		0.58
		Diesel gen set	2	200	4	25		0.11
		Total						1.09
2	Tower Pier Foundation	Auger	1	500	4	50		0.28
		Haul trucks	3				55	0.05
		Excavator	1	180	4	50		0.10
		Crane	1	350	4	50		0.19
		Concrete trucks	3				55	0.05
		Diesel Gensets	2	200	4	25		0.11
		Total						0.78
3	Pylon Construction	Crane	1	150	4	50		0.08
		Concrete trucks	3				55	0.05
		Diesel Gensets	2	200	4	25		0.11
		Haul trucks	3	350			55	0.05
		Total						0.29
4	Pier Table Construction	Crane	1	150	4	50		0.08
		Concrete trucks	3				55	0.05
		Diesel Gensets	2	200	4	25		0.11
		Haul trucks	5	350			55	0.08
		Total						0.32
5	Balanced Cantilever Construction	Crane	2	150	4	50		0.17
		Barges	1	600	4	50		0.33
		Diesel Gensets	2	200	4	25		0.11
		Haul trucks	5				55	0.08
		Total						0.69
6	Back Span & Main Span Continuity	Crane	2	150	4	50		0.17
		Barges	1	600	4	50		0.33
		Diesel Gensets	2	200	4	25		0.11
		Haul trucks	2	350			55	0.03
		Total						0.64
7	Cdn Bridge - Tens Spans Excavation / Drilling of Footings	Pile Driver	1	350	4	50		0.19
		Haul Trucks	5				55	0.08
		Gen Sets	2	200	4	25		0.11
		Total						0.38
8	Forming / Pouring of Footings	Haul Trucks	4	350			55	0.06
		Concrete trucks	4				55	0.06
		Gen Sets	2	200	4	25		0.11
		Total						0.23
9	Forming / Pouring of Pier Columns & Caps	Haul Trucks	4				55	0.06
		Concrete Trucks	4				55	0.06
		Gen Sets	2	200	4	25		0.11
		Total						0.23
10	Erection of Beams	Haul Trucks	6				55	0.09
		Gen Sets	2	200	4	25		0.11
		Cranes	2	150	4	50		0.17
		Total						0.37
11	Bridge Deck Construction	Concrete Truck	6				55	0.09
		Gen Sets	2	200	4	25		0.11
		Haul trucks	4				55	0.06
		Concrete Finishing	1	100	4	50		0.06
		Total						0.32
12	Final Site Grading	Haul trucks	4				55	0.06
		Compactor	2	350	4	50		0.39
		Gen Sets	2	200	4	25		0.11
		Paver	1	100	4	50		0.06
		Total						0.62
13	Canadian Plaza Modifications (occurs after Final Site Grading)	Excavators	2	180	4	50		0.20
		Haul trucks	3				55	0.05
		Compactors	1	350	4	50		0.19
		Diesel gen set	2	200	4	25		0.11
		Paver	1	100	4	50		0.06
		Total						0.61

Notes: 1. NOx for nonroad vehicles based on US EPA Tier 3 limits of 4.0 g/kWh for both NOx and NMHC. Assumed worst case - all NOx.
2. NOx for road vehicles (Haul Trucks and Concrete Trucks) considered emission factor for long time period (>15 min) idling diesel truck engines of 135 g/h. However, alternate of 55 g/h for shorter idling times was used.
3. Nonroad equipment not operating at full rated load for full operation, assumed operating at 50% of average rated load.
4. Gensets operating at 25% of average rated load.

Table A9-3: Construction Diesel Engine CO Emissions

Activity/ Source ID	Construction Activity	Equipment	Max Qty on Site	Average kW rating	g/kWh	% Load	Idling, g/h	g/s
1	Site Preparation	Excavators	3	180	3.5	50		0.26
		Haul trucks	6				94	0.16
		Compactors	3	350	3.5	50		0.51
		Diesel gen set	2	200	3.5	25		0.10
		Total						1.03
2	Tower Pier Foundation	Auger	1	500	3.5	50		0.24
		Haul trucks	3				94	0.08
		Excavator	1	180	3.5	50		0.09
		Crane	1	350	3.5	50		0.17
		Concrete trucks	3				94	0.08
		Diesel Gensets	2	200	3.5	25		0.10
		Total						0.75
3	Pylon Construction	Crane	1	150	3.5	50		0.07
		Concrete trucks	3				94	0.08
		Diesel Gensets	2	200	3.5	25		0.10
		Haul trucks	3	350			94	0.08
		Total						0.33
4	Pier Table Construction	Crane	1	150	3.5	50		0.07
		Concrete trucks	3				94	0.08
		Diesel Gensets	2	200	3.5	25		0.10
		Haul trucks	5	350			94	0.13
		Total						0.38
5	Balanced Cantilever Construction	Crane	2	150	3.5	50		0.15
		Barges	1	600	3.5	50		0.29
		Diesel Gensets	2	200	3.5	25		0.10
		Haul trucks	5				94	0.13
		Total						0.67
6	Back Span & Main Span Continuity	Crane	2	150	3.5	50		0.15
		Barges	1	600	3.5	50		0.29
		Diesel Gensets	2	200	3.5	25		0.10
		Haul trucks	2	350			94	0.05
		Total						0.59
7	Cdn Bridge - Tens Spans Excavation / Drilling of Footings	Pile Driver	1	350	3.5	50		0.17
		Haul Trucks	5				94	0.13
		Gen Sets	2	200	3.5	25		0.10
		Total						0.40
8	Forming / Pouring of Footings	Haul Trucks	4	350			94	0.10
		Concrete trucks	4				94	0.10
		Gen Sets	2	200	3.5	25		0.10
		Total						0.31
9	Forming / Pouring of Pier Columns & Caps	Haul Trucks	4				94	0.10
		Concrete Trucks	4				94	0.10
		Gen Sets	2	200	3.5	25		0.10
		Total						0.31
10	Erection of Beams	Haul Trucks	6				94	0.16
		Gen Sets	2	200	3.5	25		0.10
		Cranes	2	150	3.5	50		0.15
		Total						0.40
11	Bridge Deck Construction	Concrete Truck	6				94	0.16
		Gen Sets	2	200	3.5	25		0.10
		Haul trucks	4				94	0.10
		Concrete Finishing	1	100	3.5	50		0.05
		Total						0.41
12	Final Site Grading	Haul trucks	4				94	0.10
		Compactor	2	350	3.5	50		0.34
		Gen Sets	2	200	3.5	25		0.10
		Paver	1	100	3.5	50		0.05
		Total						0.59
13	Canadian Plaza Modifications (occurs after Final Site Grading)	Excavators	2	180	3.5	50		0.18
		Haul trucks	3				94	0.08
		Compactors	1	350	3.5	50		0.17
		Diesel gen set	2	200	3.5	25		0.10
		Paver	1	100	3.5	50		0.05
		Total						0.57

Notes: 1. CO for nonroad vehicles based on US EPA Tier 3 limits of 3.5 g/kWh for both NOx and NMHC. Assumed worst case - all NOx.
2.CO for road vehicles (Haul Trucks and Concrete Trucks) used 94 g/h
3. Nonroad equipment not operating at full rated load for full operation, assumed operating at 50% of average rated load.
4. Gensets operating at 25% of average rated load.

Sulphur Dioxide:

For the all on-site diesel powered equipment, including the licensed road equipment and other on-site diesel powered equipment such as cranes, the US EPA AP-42 Section 3.3 (Table 3.3-1) sulphur dioxide emission factor was used. This emission factor was used together with the maximum number of each type of equipment operating simultaneously on-site, the kW rating of the equipment engines and the anticipated load factors to calculate the diesel engine sulphur dioxide emissions for the different construction activities. The sulphur dioxide emission rate results are summarized in Table A9-4.

Particulate – River Barges

Since the river barges will not be operating on the land based construction site, particulate emissions were calculated for the marine diesel engines of these barges in addition to the heavy construction particulate emissions described in Section A9-1. Emissions were calculated using a marine engine emission factor of 0.272 g/kWh, an engine rating of 600kW and a load factor of 50%. The rive barge particulate emissions were 0.023 g/s per barge.

A9-5: Scheduling of Construction Emissions

The overall site construction emissions will vary depending on the construction activity underway. Each construction activity will involve different equipment and will occur at different times during the approximate two year period of construction. Information on the construction activity scheduling and the number of equipment operating at the site for each activity was used together with the equipment emission rates to develop emissions schedules for the contaminants for each quarter in 2013 and 2015. Emissions schedules for nitrogen dioxide, carbon monoxide and sulphur dioxide are presented in Tables A9-5, 6 and 7, respectively.

It was assumed that the land based construction site particulate emissions will remain the same throughout the 2 year construction period. The river barge emissions would occur only for the last three quarters of 2014.

The worst case construction emission scenario involves operation of the river barges combined with the maximum land based quarterly emissions. For nitrogen oxides this scenario occurs during the fourth quarter of 2014. Cumulative impacts from traffic flow across the project site are further maximized by applying traffic emission data from the 2015 Operation scenario. Vehicular traffic represented by the 2015 operating scenario represents a conservative approximation of the 2014 emission year as marginally higher traffic volumes are predicted to occur.

Table A9-4: Construction Diesel Engine SO_2 Emissions

Activity/ Source ID	Construction Activity	Equipment	Max Qty on Site	Average kW rating	g/kWh	% Load	Idling, g/h	g/s
1	Site Preparation	Excavators	3	180	1.25	50		0.09
		Haul trucks	6	350	1.25	10		0.07
		Compactors	3	350	1.25	50		0.18
		Diesel gen set	2	200	1.25	25		0.03
		Total						0.38
2	Tower Pier Foundation	Auger	1	500	1.25	50		0.09
		Haul trucks	3	350	1.25	10		0.04
		Excavator	1	180	1.25	50		0.03
		Crane	1	350	1.25	50		0.06
		Concrete trucks	3	350	1.25	10		0.04
		Diesel Gensets	2	200	1.25	25		0.03
		Total						0.29
3	Pylon Construction	Crane	1	150	1.25	50		0.03
		Concrete trucks	3	350	1.25	10		0.04
		Diesel Gensets	2	200	1.25	25		0.03
		Haul trucks	3	350	1.25	10		0.04
		Total						0.13
4	Pier Table Construction	Crane	1	150	1.25	50		0.03
		Concrete trucks	3	350	1.25	10		0.04
		Diesel Gensets	2	200	1.25	25		0.03
		Haul trucks	5	350	1.25	10		0.06
		Total						0.16
5	Balanced Cantilever Construction	Crane	2	150	1.25	50		0.05
		Barges	1	600	1.25	50		0.10
		Diesel Gensets	2	200	1.25	25		0.03
		Haul trucks	5	350	1.25	10		0.06
		Total						0.25
6	Back Span & Main Span Continuity	Crane	2	150	1.25	50		0.05
		Barges	1	600	1.25	50		0.10
		Diesel Gensets	2	200	1.25	25		0.03
		Haul trucks	2	350	1.25	10		0.02
		Total						0.22
7	Cdn Bridge - Tens Spans Excavation / Drilling of Footings	Pile Driver	1	350	1.25	50		0.06
		Haul Trucks	5	350	1.25	10		0.06
		Gen Sets	2	200	1.25	25		0.03
		Total						0.16
8	Forming / Pouring of Footings	Haul Trucks	4	350	1.25	10		0.05
		Concrete trucks	4	350	1.25	10		0.05
		Gen Sets	2	200	1.25	25		0.03
		Total						0.13
9	Forming / Pouring of Pier Columns & Caps	Haul Trucks	4	350	1.25	10		0.05
		Concrete Trucks	4	350	1.25	10		0.05
		Gen Sets	2	200	1.25	25		0.03
		Total						0.13
10	Erection of Beams	Haul Trucks	6	350	1.25	10		0.07
		Gen Sets	2	200	1.25	25		0.03
		Cranes	2	150	1.25	50		0.05
		Total						0.16
11	Bridge Deck Construction	Concrete Truck	6	350	1.25	10		0.07
		Gen Sets	2	200	1.25	25		0.03
		Haul trucks	4	350	1.25	10		0.05
		Concrete Finishing	1	100	1.25	50		0.02
		Total						0.17
12	Final Site Grading	Haul trucks	4	350	1.25	10		0.05
		Compactor	2	350	1.25	50		0.12
		Gen Sets	2	200	1.25	25		0.03
		Paver	1	100	1.25	50		0.02
		Total						0.22
13	Canadian Plaza Modifications (occurs after Final Site Grading)	Excavators	2	180	1.25	50		0.06
		Haul trucks	3	350	1.25	10		0.04
		Compactors	1	350	1.25	50		0.06
		Diesel gen set	2	200	1.25	25		0.03
		Paver	1	100	1.25	50		0.02
		Total						0.21

Notes: 1. SO2 for nonroad vehicles based on US EPA AP-42 Sec 3.3 Table 3.3-1
2.Idling road vehicles (Haul Trucks and Concrete Trucks) used 10% load factor.
3. Nonroad equipment not operating at full rated load for full operation, assumed operating at 50% of average rated load.
4. Gensets operating at 25% of average rated load.

Table A9-5: Schedule of Construction NO_X Emissions

Schedule of Emissions

Timing	Nitrogen Dioxide (g/s Source Activity IDs													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
2013	Land Sources													
1st	1.09						0.382	0.23						1.70
2nd	1.09	0.78					0.382	0.23	0.23					2.71
3rd			0.29					0.23	0.23					0.75
4th			0.29						0.23	0.37				0.89
2014														
1st			0.29	0.32						0.37				0.97
2nd				0.32	0.35						0.32			0.99
3rd					0.35						0.32			0.67
4th					0.35	0.31						0.62		1.28
2015														
2nd													0.61	0.61
2013	Rivers Sources													
1st														0.00
2nd														0.00
3rd														0.00
4th														0.00
2014														
1st														0.00
2nd					0.33									0.33
3rd					0.33									0.33
4th						0.33								0.33

Source Activity IDs

1 Site Preparation
2 Tower Pier Foundation
3 Pylon Construction
4 Pier Table Construction
5 Balanced Cantilever Construction
6 Back Span & Main Span
7 Excavation / Drilling of Footings
8 Forming / Pouring of Footings
9 Forming / Pouring of Pier Columns & Caps
10 Erection of Beams
11 Bridge Deck Construction
12 Final Site Grading
13 Canadian Plaza Modifications

Table A9-6: Schedule of Construction CO Emissions

Timing	Carbon Monoxide (g/s) Source Activity IDs													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
2013	Land Sources													
1st	1.03						0.398	0.31						1.73
2nd	1.03	0.75					0.398	0.31	0.31					2.79
3rd			0.33					0.31	0.31					0.94
4th			0.33						0.31	0.40				1.03
2014														
1st			0.33	0.38						0.40				1.11
2nd				0.38	0.37						0.41			1.16
3rd					0.37						0.41			0.78
4th					0.37	0.30						0.59		1.26
2015														
2nd													0.57	0.57
2013	Rivers Sources													
1st														0.00
2nd														0.00
3rd														0.00
4th														0.00
2014														
1st														0.00
2nd					0.29									0.29
3rd					0.29									0.29
4th					0.29	0.29								0.58

Source Activity IDs

1 Site Preparation
2 Tower Pier Foundation
3 Pylon Construction
4 Pier Table Construction
5 Balanced Cantilever Construction
6 Back Span & Main Span
7 Excavation / Drilling of Footings
8 Forming / Pouring of Footings
9 Forming / Pouring of Pier Columns & Caps
10 Erection of Beams
11 Bridge Deck Construction
12 Final Site Grading
13 Canadian Plaza Modifications

Table A9-7: Schedule of Construction SO_2 Emissions

Timing	Sulphur Dioxide (g/s)													
	Source Activity IDs													
	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
2013	Land Sources													
1st	0.38						0.156	0.13						0.67
2nd	0.38	0.29					0.156	0.13	0.13					1.09
3rd			0.13					0.13	0.13					0.40
4th			0.13						0.13	0.16				0.43
2014														
1st			0.13	0.16						0.16				0.45
2nd				0.16	0.15						0.17			0.48
3rd					0.15						0.17			0.32
4th					0.15	0.11						0.22		0.48
2015														
2nd													0.21	0.21
2013	Rivers Sources													
1st														0.00
2nd														0.00
3rd														0.00
4th														0.00
2014														
1st														0.00
2nd					0.10									0.10
3rd					0.10									0.10
4th					0.10	0.10								0.21

Source Activity IDs

1 Site Preparation
2 Tower Pier Foundation
3 Pylon Construction
4 Pier Table Construction
5 Balanced Cantilever Construction
6 Back Span & Main Span
7 Excavation / Drilling of Footings
8 Forming / Pouring of Footings
9 Forming / Pouring of Pier Columns & Caps
10 Erection of Beams
11 Bridge Deck Construction
12 Final Site Grading
13 Canadian Plaza Modifications

A.9-6: References

1- Muleski, Greg. Improvement of Specific Emission Factors (BACM Project No. 1). Final Report. Midwest Research Institute, March 29, 1996
2- U.S. Environmental Protection Agency. Compilation of Air Pollutant Emission Factors, AP-42, Section 13.2.3 Fifth Edition, January 1995.
3- U.S. Environmental Protection Agency. Emission Facts Idling Vehicle Emissions, Office of Mobile Sources, EPA420-F-98-014, April 1998.

APPENDIX 10

Annual Bridge and Regional Emissions
(8 pages)

Annual releases associated with vehicles operating on the bridge and customs plaza were calculated for each emission scenario. Also, annual regional emissions from the nearest counties, specifically Essex County: Ontario and Wayne County: Michigan was calculated to assess the relative contribution of the annual emissions from the bridge.

A10-1: Annual Bridge Emissions

The following approach was used to estimate annual bridge emissions based on the emission factors for vehicle emissions and road dust developed as described in Appendix 7 and Appendix 8, respectively.

The annual vehicle volumes (total northbound and southbound) presented in Appendix 3 for each emission scenario (baseline, 2015 and 2025) were used. The 2006 monthly traffic volume (total northbound and southbound) collected by the Ambassador Bridge was used to assign these annual totals to two periods, winter and summer. For the purpose of this analysis, winter includes the months of November to March and summer includes the months April to October. Based on the 2006 monthly data, winter accounts for 48.9% of the total annual traffic volume across the bridge and summer accounts for 51.1%.

Vehicle emission factors generated using MOBILE 6.2C for the Ambassador Bridge and customs plaza area for winter and summer for two vehicle speeds (2.5 mph and 35 mph) were utilized. The vehicle emission factor at 35 mph was used to represent free flowing traffic on the bridge and customs plaza area. Although actual speeds in this area may vary somewhat, the results indicate that emission factors in the speed range of 15 to 40 mph do not change significantly. The vehicle emission factor at 2.5 mph was used to represent queuing (idling) traffic.

The road dust emission factors were generated using USEPA AP-42 (Section 13.2.1) as described in Appendix 8. The same road dust emission factors were applied for both winter and summer periods. This is supported by the fact that the USEPA AP-42 silt loading value used to calculate the emission factor for a paved roads with daily traffic flow >10,000 is the same for summer and winter months.

Annual road dust emission factors employ the precipitation correction factor to account for the number of ‘wet” days experienced in the Windsor area.

The total one way distance traveled on the Canadian side of the bridge and the customs plaza is 1.90 miles with the estimated distance representing free flowing traffic ranging from 0.33 miles (or 1.57 miles representing the distance for queuing traffic) for the 2021 (FDN) scenario to 1.74 miles (or 0.16 miles representing the distance for queuing traffic) for the present (baseline) scenario.

The annual emissions associated with free flow and queuing traffic on the bridge and in the customs plaza for the baseline, 2015 and 2025 emission scenarios are summarized in Tables A10-1 to A10-4.

Table A10-1: Annual Bridge Emissions – Present (Baseline)

Mobile 6.2C Emission Factor for: **Baseline**

Winter Vehicles: **4,666,353**
Summer Vehicles **4,873,647**
Total Vehicles: **9,540,000**

Factor: 1
0.001 (use 0.001 for toxics because the emisison factor for toxics is in mg/mile, but not PAH)
1,000,000 grams per metric tonne

Mobile 6.2C Emission Factor for: Ambassador Bridge

			CO		Nox		SO2		PM10		PM2.5		VOC	
	Average Speed (mph)	**Average Speed (kmph)**	Winter (g/mi)	Summer (g/mi)	Winter (g/mi)	Summer (g/mi)	Winter (g/mi)	Summer (g/mi)	Winter (g/mi)	Summer (g/mi)	Winter (g/mi)	Summer (g/mi)	Winter (g/mi)	Summer (g/mi)
	2.5	4.0	5.86E+01	4.22E+01	7.81E+00	6.99E+00	8.42E-02	8.41E-02	1.16E-01	1.11E-01	1.16E-01	1.11E-01	8.05E+00	7.17E+00
	35	56	1.08E+01	7.87E+00	4.50E+00	4.01E+00	8.42E-02	8.41E-02	1.16E-01	1.36E-01	1.16E-01	1.36E-01	9.01E-01	9.35E-01
Road Dust EF (g/VMT)									3.61E-01	3.61E-01	1.72E-01	1.72E-01		

			CO		Nox		SO2		PM10		PM2.5		VOC	
	Average Speed (mph)	**Trip Distance (mi)**	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)
Free Flow Vehicle Emissions	35	1.74	88.0	66.8	36.5	34.0	0.7	0.7	0.9	1.2	0.9	1.2	7.3	7.9
Total Queue	2.5	0.16	43.76	32.91	5.83	5.45	0.06	0.07	0.09	0.09	0.09	0.09	6.01	5.59
Estimated Emission (Free Flow + Queue)			**131.8**	**99.7**	**42.4**	**39.4**	**0.7**	**0.8**	**1.0**	**1.2**	**1.0**	**1.2**	**13.3**	**13.5**
Total Annual Emission (MT/yr)	**Total:**	**1.90**		**231.4**		**81.8**		**1.5**		**2.3**		**2.3**		**26.8**
Road Dust MT/yr									2.9	3.1	1.4	1.5		
Total Exhaust + Road Dust										**8.3**		**5.1**		

Note: Precipitation correction factor = 0.82

Mobile 6.2C Emission Factor for: **Baseline**

Winter Vehicles: **4,666,353**
Summer Vehicles **4,873,647**
Total Vehicles: **9,540,000**

Mobile 6.2C Emission Factor for: Ambassador Bridge

			benzene		acetaldehyde		formaldehyde		1,3-butadiene		acrolein		benzo (a) pyrene		CO2		N2O		CH4	
	Average Speed (mph)	**Average Speed (kmph)**	Winter (mg/mi)	Summer (mg/mi)	Winter (mg/mi)	Summer (mg/mi)	Winter (mg/mi)	Summer (mg/mi)	Winter (mg/mi)	Summer (mg/mi)	Winter (mg/mi)	Summer (mg/mi)	Winter (mg/mi)	Summer (mg/mi)	Winter (g/mi)	Summer (g/mi)	Winter (g/mi)	Summer (g/mi)	Winter (g/mi)	Summer (g/mi)
	2.5	4.0	1.62E+02	1.36E+02	3.48E+01	3.06E+01	9.98E+01	8.92E+01	2.34E+01	2.13E+01	5.49E+00	4.60E+00	2.80E-03	2.80E-03	7.62E+02	7.61E+02	3.20E-02	3.20E-02	9.30E-02	9.30E-02
	35	56	2.10E+01	1.84E+01	6.76E+00	6.16E+00	1.88E+01	1.73E+01	3.42E+00	3.18E+00	9.73E-01	8.52E-01	2.80E-03	2.80E-03	7.62E+02	7.61E+02	3.20E-02	3.20E-02	9.30E-02	9.30E-02
Road Dust EF (g/VMT)																				

			benzene		acetaldehyde		formaldehyde		1,3-butadiene		acrolein		benzo (a) pyrene		CO2		N2O		CH4	
	Average Speed (mph)	**Trip Distance (mi)**	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)
Free Flow Vehicle Emissions	35	1.74	0.17	0.16	0.05	0.05	0.15	0.15	0.03	0.03	0.01	0.01	2.E-05	2.E-05	6,188.2	6,457.2	0.3	0.3	0.8	0.8
Total Queue	2.5	0.16	0.12	0.11	0.03	0.02	0.07	0.07	0.02	0.02	0.00	0.00	2.E-06	2.E-06	569.03	593.77	0.02	0.02	0.07	0.07
Estimated Emission (Free Flow + Queue)			**0.29**	**0.26**	**0.08**	**0.08**	**0.23**	**0.22**	**0.05**	**0.04**	**0.01**	**0.01**	**2.E-05**	**3.E-05**	**6,757.3**	**7,051.0**	**0.3**	**0.3**	**0.8**	**0.9**
Total Annual Emission (MT/yr)	**Total:**	**1.90**		**0.55**		**0.16**		**0.44**		**0.09**		**0.02**		**5.E-05**		**13,808**		**0.6**		**1.7**

Table A10-2: Annual Bridge Emissions – 2015 (ABEP)

Mobile 6.2C Emission Factor for: **2015**

Winter Vehicles: **6,516,081** Factor: 1
Summer Vehicles **6,805,545** 0.001 (use 0.001 for toxics because the emisison factor for toxics is in mg/mile, but not PAH)
Total Vehicles: **13,321,626** 1,000,000 grams per metric tonne

Mobile 6.2C Emission Factor for: Ambassador Bridge

			CO		Nox		SO2		PM10		PM2.5		VOC	
	Average Speed (mph)	**Average Speed (kmph)**	Winter (g/mi)	Summer (g/mi)	Winter (g/mi)	Summer (g/mi)	Winter (g/mi)	Summer (g/mi)	Winter (g/mi)	Summer (g/mi)	Winter (g/mi)	Summer (g/mi)	Winter (g/mi)	Summer (g/mi)
	2.5	4	2.25E+01	1.53E+01	2.84E+00	2.50E+00	1.02E-02	1.02E-02	3.61E-01	3.60E-01	3.61E-01	3.60E-01	2.56E+00	3.32E+00
	35	56	4.61E+00	3.03E+00	1.60E+00	1.39E+00	1.02E-02	1.20E-02	6.06E-02	5.90E-02	6.06E-02	5.90E-02	3.30E-01	3.35E-01
Road Dust EF (g/VMT)									3.69E-01	3.69E-01	1.23E-01	1.23E-01		

			CO		Nox		SO2		PM10		PM2.5		VOC	
	Average Speed (mph)	**Trip Distance (mi)**	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)
Free Flow Vehicle Emissions	35	1.74	52.3	35.9	18.1	16.5	0.1	0.1	0.7	0.7	0.7	0.7	3.7	4.0
Total Queue	2.5	0.16	23.51	16.68	2.97	2.72	0.01	0.01	0.38	0.39	0.38	0.39	2.67	3.62
Estimated Emission (Free Flow + Queue)			**75.8**	**52.6**	**21.1**	**19.2**	**0.1**	**0.2**	**1.1**	**1.1**	**1.1**	**1.1**	**6.4**	**7.6**
Total Annual Emission (MT/yr)	**Total:**	**1.90**		**128.4**		**40.3**		**0.3**		2.2		2.2		**14.0**
Road Dust MT/yr									4.2	4.4	1.4	1.5		
Total Exhaust + Road Dust										**10.7**		**5.0**		

Note: Precipitation correction factor = 0.82

Mobile 6.2C Emission Factor for: **2015**

Winter Vehicles: **6,516,081**
Summer Vehicles **6,805,545**
Total Vehicles: **13,321,626**

Mobile 6.2C Emission Factor for: Ambassador Bridge

			benzene		acetaldehyde		formaldehyde		1,3-butadiene		acrolein		benzo (a) pyrene		CO2		N2O		CH4	
	Average Speed (mph)	**Average Speed (kmph)**	Winter (mg/mi)	Summer (mg/mi)	Winter (mg/mi)	Summer (mg/mi)	Winter (mg/mi)	Summer (mg/mi)	Winter (mg/mi)	Summer (mg/mi)	Winter (mg/mi)	Summer (mg/mi)	Winter (mg/mi)	Summer (mg/mi)	Winter (g/mi)	Summer (g/mi)	Winter (g/mi)	Summer (g/mi)	Winter (g/mi)	Summer (g/mi)
	2.5	4	4.96E+01	4.55E+01	1.51E+01	1.37E+01	3.72E+01	3.52E+01	5.84E+00	5.28E+00	1.79E+00	1.59E+00	9.38E-05	8.93E-05	8.57E+02	8.57E+02	3.20E-02	3.20E-02	8.11E-02	8.11E-02
	35	56	7.12E+00	6.09E+00	3.56E+00	3.35E+00	9.12E+00	8.82E+00	1.14E+00	1.07E+00	4.27E-01	3.98E-01	9.38E-05	8.93E-05	8.57E+02	8.57E+02	3.20E-02	3.20E-02	8.11E-02	8.11E-02
Road Dust EF (g/VMT)																				

			benzene		acetaldehyde		formaldehyde		1,3-butadiene		acrolein		benzo (a) pyrene		CO2		N2O		CH4	
	Average Speed (mph)	**Trip Distance (mi)**	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)	Winter (MT)	Summer (MT)
Free Flow Vehicle Emissions	35	1.74	0.081	0.072	0.040	0.040	0.103	0.104	0.013	0.013	0.005	0.005	1.E-06	1.E-06	9,721.2	10,153.0	0.4	0.4	0.9	1.0
Total Queue	2.5	0.16	0.052	0.050	0.016	0.015	0.039	0.038	0.006	0.006	0.002	0.002	1.E-07	1.E-07	893.90	933.61	0.03	0.03	0.08	0.09
Estimated Emission (Free Flow + Queue)			**0.13**	**0.12**	**0.06**	**0.05**	**0.14**	**0.14**	**0.02**	**0.02**	**0.01**	**0.01**	**1.E-06**	**1.E-06**	**10,615.1**	**11,086.6**	**0.4**	**0.4**	**1.0**	**1.0**
Total Annual Emission (MT/yr)	**Total:**	**1.90**		**0.25**		**0.11**		**0.28**		**0.04**		**0.01**		**2.E-06**		**21,701.7**		**0.8**		**2.1**

Table A10-3: Annual Bridge Emissions – 2025 (FDN)

Mobile 6.2C Emission Factor for: **2025 (Future Do Nothing)**

Winter Vehicles:	**7,555,598**	Factor:	1
Summer Vehicles	**7,891,241**		0.001 (use 0.001 for toxics because the emisison factor for toxics is in mg/mile, but not PAH)
Total Vehicles:	**15,446,839**		1,000,000 grams per metric tonne

Mobile 6.2C Emission Factor for: Ambassador Bridge

	Average Speed (mph)	Average Speed (kmph)	CO Winter (g/mi)	CO Summer (g/mi)	Nox Winter (g/mi)	Nox Summer (g/mi)	SO2 Winter (g/mi)	SO2 Summer (g/mi)	PM10 Winter (g/mi)	PM10 Summer (g/mi)	PM2.5 Winter (g/mi)	PM2.5 Summer (g/mi)	VOC Winter (g/mi)	VOC Summer (g/mi)
	2.5	4	1.90E+01	1.30E+01	9.30E-01	8.01E-01	9.90E-03	9.90E-03	4.06E-02	4.03E-02	4.06E-02	4.03E-02	1.85E+00	2.46E+00
	35	56	3.90E+00	2.56E+00	4.92E-01	4.15E-01	9.90E-03	9.90E-03	4.06E-02	4.03E-02	4.06E-02	4.03E-02	2.18E-01	2.24E-01
Road Dust EF (g/VMT)									3.28E-01	3.28E-01	1.07E-01	1.07E-01		

	Average Speed (mph)	Trip Distance (mi)	CO Winter (MT)	CO Summer (MT)	Nox Winter (MT)	Nox Summer (MT)	SO2 Winter (MT)	SO2 Summer (MT)	PM10 Winter (MT)	PM10 Summer (MT)	PM2.5 Winter (MT)	PM2.5 Summer (MT)	VOC Winter (MT)	VOC Summer (MT)
Free Flow Vehicle Emissions	35	1.74	51.3	35.2	6.5	5.7	0.1	0.1	0.5	0.6	0.5	0.6	2.9	3.1
Total Queue	2.5	0.16	22.97	16.37	1.12	1.01	0.01	0.01	0.05	0.05	0.05	0.05	2.24	3.11
Estimated Emission (Free Flow + Queue)			**74.3**	**51.5**	**7.6**	**6.7**	**0.1**	**0.1**	**0.6**	**0.6**	**0.6**	**0.6**	**5.1**	**6.2**
Total Annual Emission (MT/yr)	**Total:**	**1.90**		**125.8**		**14.3**		**0.3**		1.2		1.2		**11.3**
Road Dust MT/yr									4.3	4.5	1.4	1.5		
Total Exhaust + Road Dust										**10.0**		**4.1**		

Note: Precipitation correction factor = 0.82

Mobile 6.2C Emission Factor for: **2025 (Future Do Nothing)**

Winter Vehicles:	**7,555,598**
Summer Vehicles	**7,891,241**
Total Vehicles:	**15,446,839**

Mobile 6.2C Emission Factor for: Ambassador Bridge

	Average Speed (mph)	Average Speed (kmph)	benzene Winter (mg/mi)	benzene Summer (mg/mi)	acetaldehyde Winter (mg/mi)	acetaldehyde Summer (mg/mi)	formaldehyde Winter (mg/mi)	formaldehyde Summer (mg/mi)	1,3-butadiene Winter (mg/mi)	1,3-butadiene Summer (mg/mi)	acrolein Winter (mg/mi)	acrolein Summer (mg/mi)	benzo (a) pyrene Winter (mg/mi)	benzo (a) pyrene Summer (mg/mi)	CO2 Winter (g/mi)	CO2 Summer (g/mi)	N2O Winter (g/mi)	N2O Summer (g/mi)	CH4 Winter (g/mi)	CH4 Summer (g/mi)
	2.5	4	3.39E+01	3.28E+01	1.08E+01	1.01E+01	2.67E+01	2.60E+01	4.11E+00	3.87E+00	1.27E+00	1.17E+00	3.92E-05	3.86E-05	8.22E+02	8.22E+02	3.20E-02	3.20E-02	8.45E-02	8.45E-02
	35	56	4.88E+00	4.32E+00	2.62E+00	2.52E+00	6.69E+00	6.62E+00	8.29E-01	7.97E-01	3.13E-01	2.98E-01	3.92E-05	3.86E-05	8.22E+02	8.22E+02	3.20E-02	3.20E-02	8.45E-02	8.45E-02
Road Dust EF (g/VMT)																				

	Average Speed (mph)	Trip Distance (mi)	benzene Winter (MT)	benzene Summer (MT)	acetaldehyde Winter (MT)	acetaldehyde Summer (MT)	formaldehyde Winter (MT)	formaldehyde Summer (MT)	1,3-butadiene Winter (MT)	1,3-butadiene Summer (MT)	acrolein Winter (MT)	acrolein Summer (MT)	benzo (a) pyrene Winter (MT)	benzo (a) pyrene Summer (MT)	CO2 Winter (MT)	CO2 Summer (MT)	N2O Winter (MT)	N2O Summer (MT)	CH4 Winter (MT)	CH4 Summer (MT)
Free Flow Vehicle Emissions	35	1.74	0.064	0.059	0.034	0.035	0.088	0.091	0.011	0.011	0.004	0.004	5.E-07	5.E-07	10,805.3	11,285.3	0.4	0.4	1.1	1.2
Total Queue	2.5	0.16	0.041	0.041	0.013	0.013	0.032	0.033	0.005	0.005	0.002	0.001	5.E-08	5.E-08	993.59	1,037.73	0.04	0.04	0.10	0.11
Estimated Emission (Free Flow + Queue)			**0.11**	**0.10**	**0.05**	**0.05**	**0.12**	**0.12**	**0.02**	**0.02**	**0.01**	**0.01**	**6.E-07**	**6.E-07**	**11,798.9**	**12,323.0**	**0.5**	**0.5**	**1.2**	**1.3**
Total Annual Emission (MT/yr)	**Total:**	**1.90**		**0.21**		**0.09**		**0.24**		**0.03**		**0.01**		**1.E-06**		**24,121.9**		**0.9**		**2.5**

Table A10-4: Annual Bridge Emissions – 2025 (A)

Mobile 6.2C Emission Factor for: **2025 (A)**

Winter Vehicles: **7,555,598** Factor: 1
Summer Vehicles **7,891,241** 0.001 (use 0.001 for toxics because the emisison factor for toxics is in mg/mile, but not PAH)
Total Vehicles: **15,446,839** 1,000,000 grams per metric tonne

Mobile 6.2C Emission Factor for: Ambassador Bridge

	Average Speed (mph)	Average Speed (kmph)	CO Winter (g/mi)	CO Summer (g/mi)	Nox Winter (g/mi)	Nox Summer (g/mi)	SO2 Winter (g/mi)	SO2 Summer (g/mi)	PM10 Winter (g/mi)	PM10 Summer (g/mi)	PM2.5 Winter (g/mi)	PM2.5 Summer (g/mi)	VOC Winter (g/mi)	VOC Summer (g/mi)
	2.5	4	1.90E+01	1.30E+01	9.30E-01	8.01E-01	9.90E-03	9.90E-03	4.06E-02	4.03E-02	4.06E-02	4.03E-02	1.85E+00	2.46E+00
	35	56	3.90E+00	2.56E+00	4.92E-01	4.15E-01	9.90E-03	9.90E-03	4.06E-02	4.03E-02	4.06E-02	4.03E-02	2.18E-01	2.24E-01
Road Dust EF (g/VMT)									3.28E-01	3.28E-01	1.07E-01	1.07E-01		

	Average Speed (mph)	Trip Distance (mi)	CO Winter (MT)	CO Summer (MT)	Nox Winter (MT)	Nox Summer (MT)	SO2 Winter (MT)	SO2 Summer (MT)	PM10 Winter (MT)	PM10 Summer (MT)	PM2.5 Winter (MT)	PM2.5 Summer (MT)	VOC Winter (MT)	VOC Summer (MT)
Free Flow Vehicle Emissions	35	1.74	51.3	35.2	6.5	5.7	0.1	0.1	0.5	0.6	0.5	0.6	2.9	3.1
Total Queue	2.5	0.16	22.97	16.37	1.12	1.01	0.01	0.01	0.05	0.05	0.05	0.05	2.24	3.11
Estimated Emission (Free Flow + Queue)			**74.3**	**51.5**	**7.6**	**6.7**	**0.1**	**0.1**	0.6	0.6	0.6	0.6	**5.1**	**6.2**
Total Annual Emission (MT/yr)	**Total:**	**1.90**		**125.8**		**14.3**		**0.3**		1.2		1.2		**11.3**
Road Dust MT/yr									4.3	4.5	1.4	1.5		
Total Exhaust + Road Dust										**10.0**		**4.1**		

Note: Precipitation correction factor = 0.82

Mobile 6.2C Emission Factor for: **2025 (A)**

Winter Vehicles: **7,555,598**
Summer Vehicles **7,891,241**
Total Vehicles: **15,446,839**

Mobile 6.2C Emission Factor for: Ambassador Bridge

	Average Speed (mph)	Average Speed (kmph)	benzene Winter (mg/mi)	benzene Summer (mg/mi)	acetaldehyde Winter (mg/mi)	acetaldehyde Summer (mg/mi)	formaldehyde Winter (mg/mi)	formaldehyde Summer (mg/mi)	1,3-butadiene Winter (mg/mi)	1,3-butadiene Summer (mg/mi)	acrolein Winter (mg/mi)	acrolein Summer (mg/mi)	benzo (a) pyrene Winter (mg/mi)	benzo (a) pyrene Summer (mg/mi)	CO2 Winter (g/mi)	CO2 Summer (g/mi)	N2O Winter (g/mi)	N2O Summer (g/mi)	CH4 Winter (g/mi)	CH4 Summer (g/mi)
	2.5	4	3.39E+01	3.28E+01	1.08E+01	1.01E+01	2.67E+01	2.60E+01	4.11E+00	3.87E+00	1.27E+00	1.17E+00	3.92E-05	3.86E-05	8.22E+02	8.22E+02	3.20E-02	3.20E-02	8.45E-02	8.45E-02
	35	56	4.88E+00	4.32E+00	2.62E+00	2.52E+00	6.69E+00	6.62E+00	8.29E-01	7.97E-01	3.13E-01	2.98E-01	3.92E-05	3.86E-05	8.22E+02	8.22E+02	3.20E-02	3.20E-02	8.45E-02	8.45E-02
Road Dust EF (g/VMT)																				

	Average Speed (mph)	Trip Distance (mi)	benzene Winter (MT)	benzene Summer (MT)	acetaldehyde Winter (MT)	acetaldehyde Summer (MT)	formaldehyde Winter (MT)	formaldehyde Summer (MT)	1,3-butadiene Winter (MT)	1,3-butadiene Summer (MT)	acrolein Winter (MT)	acrolein Summer (MT)	benzo (a) pyrene Winter (MT)	benzo (a) pyrene Summer (MT)	CO2 Winter (MT)	CO2 Summer (MT)	N2O Winter (MT)	N2O Summer (MT)	CH4 Winter (MT)	CH4 Summer (MT)
Free Flow Vehicle Emissions	35	1.74	0.06	0.06	0.03	0.03	0.09	0.09	0.01	0.01	0.00	0.00	5.E-07	5.E-07	10,805.3	11,285.3	0.4	0.4	1.1	1.2
Total Queue	2.5	0.16	0.04	0.04	0.01	0.01	0.03	0.03	0.00	0.00	0.00	0.00	5.E-08	5.E-08	993.59	1,037.73	0.04	0.04	0.10	0.11
Estimated Emission (Free Flow + Queue)			**0.11**	**0.10**	**0.05**	**0.05**	**0.12**	**0.12**	**0.02**	**0.02**	**0.01**	**0.01**	**6.E-07**	**6.E-07**	**11,798.9**	**12,323.0**	**0.5**	**0.5**	**1.2**	**1.3**
Total Annual Emission (MT/yr)	**Total:**	**1.90**		**0.21**		**0.09**		**0.24**		**0.03**		**0.01**		**1.E-06**		**24,121.9**		**0.9**		**2.5**

A10-2: Essex County: Ontario

Essex County was defined using the Forward Sorting Areas (FSAs) using the first three characters of postal code. The Essex county FSAs are:

N0R, N8H, N8M, N8N, N8P, N8R, N8S, N8T, N8V, N8W, N8X, N8Y, N9A, N9B, N9C, N9E, N9G, N9H, N9J, N9K, N9V and N9Y.

The National Pollutant Release Inventory (NPRI), at search location http://www.ec.gc.ca/pdb/querysite/query_e.cfm, was used to obtain annual Criteria Air Contaminant (CAC) summaries for the FSAs. CAC emission summaries catalog vehicle emissions and open source releases as well as industrial point sources from NPRI Reports (http://www.ec.gc.ca/pdb/cac/cac_home_e.cfm). Reviewed data from the 2005 NPRI Reporting Year was used. Provincial summaries also show open source releases broken down into various categories including paved and unpaved roads. The Ontario ratio of paved plus unpaved road emissions to total open source releases was used to scale Essex County open source releases for road emissions.

The annual greenhouse gas (GHG) emission for the 2005 NPRI Reporting Year includes only a total of 85 facilities for all of Ontario. The average of the ratios of annual CAC emissions from Essex County versus annual CAC emissions from Ontario (5%) was used to scale the annual Ontario GHG emissions to Essex County GHG emissions. NPRI reports GHG emissions in tonnes CO_{2e} so this data was converted into tonnes of the individual GHG species using Global Warming Potentials (1 for CO_2, 21 for CH_4 and 310 for N_2O). It should be noted that GHG Emissions summary from the 2005 NPRI Reporting Year includes only 85 industrial emitters above the defined threshold (Point Sources) and not vehicle emissions. Although this will underestimate the annual regional emissions, in the absence other more recent annual GHG emissions data, the above data was used for the purpose of comparing with emissions related to the bridge.

Annual vehicle emissions of benzo (a) pyrene were scaled from annual vehicle emissions of PM_{10}. This approach is consistent with the "Assessment of Benzo(a)pyrene Air Emissions In the Great Lakes Region - A Report of the Great Lakes Regional Toxic Air Emissions Inventory Steering Committee" March 2007 as discussed in detail in Appendix 7. The scaling was performed for each vehicle class. Annual emissions of other air toxics (benzene, formaldehyde, etc.) were calculated using emission factors from MOBILE6.2C for local roads for the present (baseline) scenario to determine scaling factors (versus VOC's), for each vehicle class. For aircraft and rail emissions, an average of vehicle emissions ratios for the contaminant versus benzo(a)pyrene was used for scaling.

A10-3: Wayne County: Michigan

The US EPA AirData website (http://www.epa.gov/air/data/) provides publicly accessible air pollution data for the United States. AirData presents annual summaries of air pollution data from two EPA databases; the Air Quality System (AQS) database and the National Emission Inventory (NEI) database. The NEI was used to provide the annual regional emissions for Wayne County, Michigan.

The NEI database contains information for sources that emit Criteria Air Pollutants (CAPs) and Hazardous Air Pollutants (HAPs). The database provides annual air pollutant emission estimates on both the state and county level for point, non-point and mobile sources.

There are six CAPs that have health-based standards set by the US EPA. NEI provides information on four of these substances; carbon monoxide, nitrogen oxides and particulate matter as PM_{10} and $PM_{2.5}$. Ozone, one of the two remaining CAPs, is not included in CAP database. The NEI also includes emission data for volatile organic compounds as these substances enable the formation of CAPs.

The NEI database provides annual CAP emission estimates on the county and state level for years 1990 through 2001. In 2002, the NEI was replaced by two separate EPA databases for emissions of criteria air pollutants (National Emission Trends, or NET) and hazardous air pollutants (National Toxics Inventory, or NTI). However, these new databases do not provide a breakdown of emissions on the county level.

HAPs are substances that are known or suspected to cause serious health problems such as cancer. NEI provides emission data for 181 individual compounds, the sum of all 188 US EPA designated HAPs and the sum of all 33 US EPA designated Urban HAPs. The NEI provides HAPs emission estimates for 1999 on the county and state level for all types of sources.

Greenhouse gas emission estimates were not publicly accessible on the county level. However, a Michigan Department of Environmental Quality report entitled “Michigan Greenhouse Gas Inventory 1990 and 2002” provided emission estimates for carbon dioxide, methane and nitrous oxide on the state level. In order to provide an approximate Wayne County value for greenhouse gases, the ratio of the nitrogen oxides emissions in Wayne County versus the nitrogen oxides emission in Michigan was determined using the NEI database 2001 CAP emission estimates. It was determined that approximately 15% of Michigan’s nitrogen oxides emissions were produced in Wayne County.

The greenhouse gas emissions published in the Michigan Department of Environmental Quality report were reported as carbon equivalent amounts. Carbon dioxide, methane and nitrous oxide have carbon equivalent factors of 1, 21 and 310, respectively. The published emissions for 2002 were converted from carbon equivalent metric tonnes to metric tonnes and multiplied by 15% to obtain an estimate of the greenhouse gases produced by Wayne County.

Benzo(a)pyrene emission estimates were not publicly accessible on the county. A Great Lakes Commission report entitled "Assessment of Benzo(a)pyrene Air Emissions in the Great Lakes Region" provided emission estimates for Michigan State. The published emissions for 2002 were also multiplied by 15% to obtain an estimate of benzo(a)pyrene emissions for Wayne County.

APPENDIX 11

Dispersion Modelling
(27 pages)

Air dispersion modeling analysis was performed to assess the impact of vehicular emissions, road dust and emissions from the construction activities, on the air quality for various emission scenarios. The US EPA CAL3QHCR model was employed to assess the impact of vehicular emissions and road dust on the air quality. The US EPA AERMOD model was used to assess the impact of emissions resulting from the construction activities. The ground-level ozone production was assessed using the Ozone Isopleth Method, as described in Appendix 12. The air dispersion modeling analysis was based on the Air Dispersion Modelling Guideline for Ontario (ADMGO), version 2.0, March 2009.

A11-1: Selection of Air Dispersion Models

The revised EA Guideline states *"Dispersion modeling should be undertaken using a recognized model (such as the US EPA's CAL3QHCR) for each of the pollutants identified…"*

CAL3QHCR is a more refined version based on CAL3QHC that requires local meteorological data. CAL3QHC is a CALINE3 based CO model with queuing and hot spot calculations and with a traffic model to calculate delays and queues that occur at signalized intersections. It is one of the preferred / recommended models by the US EPA. It is also one of the acceptable alternative models, particularly recommended for modeling of intersections, in the ADMGO. Accordingly, the CAL3QHCR model was selected to assess the impact of emissions, except those resulting from the construction activities, on the air quality.

AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain. It is one of the preferred / recommended models by the US EPA, and one of the approved dispersion models by the MOE. It's flexibility in handling variable emissions makes it a suitable model for simulating the dispersions of emissions from construction activities.

A11-2: CAL3QHCR Model

CAL3QHCR is an enhanced, but separate, version of CAL3QHC. CAL3QHCR has been programmed to process up to a year of hourly meteorological data (MET), and vehicular emissions, traffic and signalization (ETS) data in one run using the basic algorithms from CAL3QHC. CAL3QHCR calculates 1-hour and running 8-hour average concentrations when run in carbon monoxide (CO) mode or 24-hour and annual block averaged concentrations when run particulate matter (PM) mode.

Flexibility has been built into CAL3QHCR to allow a two tired approach. In the first approach, called Tier 1, a full year of hourly MET data are entered into CAL3QHCR, along with one hour of ETS data reflective of peak hourly traffic flow as discussed in Appendix 3. In the second approach, called Tier 2, the same MET data as used in Tier 1 approach are entered into the model. The EST data however, are more detailed and reflect traffic conditions for each hour of a week. The refined Tier 2 hourly traffic flow is discussed in Appendix 3. CAL3QHCR is capable of reading up to 7 sets of hourly ETS data to form diurnal patterns (one for each day of the week).

There are four major types of data sets that have to be prepared before using the CAL3QHCR model. These data sets contain the Site Geometry, ETS, MET and the input control data as described below.

A11-2-1: Site Geometry

Site geometry refers to data related to roadway links and receptors. All roadway links and receptors are defined in UTM projection (NAD83).

For this project, more than 100 links were defined for modeling analysis as detailed in Tables A11-1 to A11-6 and shown in Figure A11-1, for the Local Study Area. The links were modified for the different scenarios to simulate the different queue lengths and locations for both the existing and new bridge and the two bridges operating simultaneously.

The roadway links and receptors are described in more detail below.

A11-2-1-1: Roadway Links

Links are defined as straight-line segments. A link can be specified as either a free flow link or a queue link. The program automatically sums the contributions from each link to each receptor.

Free Flow Links

A free flow link is defined as a straight segment of roadway having a constant width, height, traffic flow, travel speed, and vehicle emission factor. The location of the link is specified by its end point coordinates, XL1, YL1, and XL2, YL2.

Link width, or mixing zone width (WL) is defined as the width of the traveled roadway (lanes of moving traffic only) plus 3 meters on each side to account for the dispersion of the plume generated by the wake of moving vehicles. For this project, the width of a single lane was set at 3 meters. For the new bridge, the lane width was set at 3.5 meters.

Link height (HL) can be elevated or depressed, but is limited within +10 m for elevated links and -10 m for depressed links. For this project, only the bridge was assumed to be elevated (Bridge), all other roadways included in the study area were assumed to be at grade (i.e., the height is zero meters). On each side of the bridge, the link height on a sloping up section was set at 5 m above grade and on the remaining section of the bridge was set at 10 m above grade. This will result in a conservative assessment as the elevation of a significant portion of the existing and new bridge is considerably greater than 10 m above grade.

The queuing vehicles on the bridge and inspection plaza were simulated as free flow links using the emission factor at 2.5 miles per hour derived by the MOBILE6.2C.

Queue Links

A queue link is defined as a straight segment of roadway with a constant width and vehicle emission factor, on which vehicles are idling for a specified period of time. The location of a queue link is determined by its beginning point (i.e., XL1, YL1 coordinates of the locations at which vehicles start queuing at an intersection "stopping line") and an end point (i.e., XL2, YL2 coordinates of any point along the line where the queue is forming). The purpose of specifying a queue link end point is to specify the direction of the queue, and also the maximum queue length for that segment. The actual length of the queue is estimated by CAL3QHCR based on the traffic flow and the capacity of the approach.

Queue link width is determined by the width of the traveled roadway only (width of the lanes on which vehicles are idling). Three meters are not added on each side to account for the mixing zone as for free flow links since vehicles are not moving and no wake is generated. Similarly to the free flow links, the width of a single lane was assumed to be 3 meters and 3.5 meters for the new bridge.

A11-2-1-2: Receptors

Virtual receptor locations are specified in terms of X, Y, and Z coordinates. The virtual receptors are located outside the "mixing zone" of the free flow links. The mixing zone is considered to be the area of uniform emissions but with turbulent air flow extending 3 meters on either side of the edge of the road for free flow links.

In consideration of the limit of 60 receptors imposed by CAL3QHCR, the virtual receptor grid was set up on approximately parallel lines with the following densities:

- about 10 m away from the edge of the mixing zone (i.e. about 13 m from the edge of the road), and then every 50 m extending out to approximately 300 m;
- approximately 50 m spacing along Huron Church Road and the bridge, increased to about 100 m spacing and placed in the middle along uniform links; and
- residences at the University of Windsor.

All the receptors were entered at an assigned breathing height of 1.8 m above grade, except for the residences at the University of Windsor which were assumed to be at 10 m above grade, the same height as the link height used for bridge.

Within the Local Study Area, a total of 875 receptors were entered, as shown in Figure A11-1.

Because of the limitation of 60 receptors, the CAL3QHCR model with all links, was run for groups of 60 receptors. The results were then merged together for all the receptors.

A11-2-2: Emissions, Traffic and Signalization Data (ETS)

Separate emissions estimates must be provided as input data for each free flow and queue link. Emissions from vehicles traveling on a free flow link are calculated using the composite emission factor for the length of the link. When vehicles are idling at an intersection, emissions are calculated using the idle emission rate for the duration of the idling time.

A11-2-2-1: ETS for Free Flow Links

Vehicles are assumed to be traveling without delay along free flow links. The ETS input for a free flow link includes the emission factor (g/mile) and traffic flow (vehicles/hour). The emission factor depends on the traffic speed (miles/hour). The traffic speed for each free flow link used for this project was based on the posted speed limits rounded down to the closest speed bin used in the MOBILE 6.2C, as shown in Tables A11-6 and A11-7.

The emission factors (representing the maximum emission factor for summer or winter) used for each link for the different emission scenarios are tabulated in Tables A11-6 and A11-7, for the Local Study Area.

The peak traffic flow for each free flow link is tabulated in Tables A11-1 through A11-5.

A11-2-2-2: ETS for Queue Links

The ETS input for a queue link includes:

- idling emission rate (g/hour);
- traffic flow (vehicles/hour);
- average signal cycle length (seconds);
- average red light time length (seconds);
- clearance lost time (seconds);
- saturation flow (vehicles/hour);
- signal type (pre-timed, actuated, or semi-actuated); and
- arrival rate (worst, below average, average, above average, best progression).

For the Tier 2 analysis, a pattern consisting of 24 hours of hourly ETS data is required. CAL3QHCR is capable of processing up to 7 patterns, one for each day of the week. The analysis utilizes the same traffic one week patterns throughout the year or the period of the time being modeled.

The idling emission rate for a queue link is calculated by:

Idle emission rate (g/hour) = emission factor (g/mile) @ 2.5 mph x 2.5 mph

The other input parameters at peak traffic flow are presented in Tables A11-1 through A11-5.

Detailed ETS pattern is discussed in Appendix 3.

A11-2-3: Meteorological Data (MET)

A 5-year meteorological data set (2002-2006) was provided by the MOE (Air Modelling and Emissions Unit). The CAL3QHCR was run for the consecutive 5 years for CO for the present (baseline) emission scenario, with the year that predicted the highest CO concentrations (2005) selected for subsequent model runs. The details are described in Appendix 6.

A11-2-4: Input Control Data

The main input control data includes:

- Run averaging time (minutes) – 60-minute was used in this project;
- Roughness length (cm) – 400 cm used for Local Study Area;
- Settling velocity (cm/s) – set to 0.0 cm/s for this project;
- Deposition velocity (cm/s) – set to 0.0 cm/s for this project;
- Rural (R)/Urban (U) switch – Urban was used for both study areas;
- Pollutant type – the model was run in PM mode for all pollutants of interest except CO and VOC (non-methane hydrocarbon) which were modeled in CO mode;
- Output unit (meter or feet) – meter was used for this project; and
- Meteorological data - as described in Appendix 6.

A11-3: AERMOD

AERMOD is a steady-state plume model, formulated based on the "state-of-science" modeling platform. It is applicable to rural and urban areas, flat and complex terrain, surface and elevated releases, and multiple sources (including point, area and volume sources).

In the stable boundary layer, the concentration distribution is assumed to be Gaussian in both the vertical and horizontal dimensions. In the convective boundary, the horizontal distribution is assumed to be Gaussian, but the vertical distribution is described with a bi-Gaussian probability density function. One of the major improvements that AERMOD brings to applied dispersion modelling is its ability to characterize the Planetary Boundary Layer (PBL) through both surface and mixed layer scalings based on measurements and extrapolation of those measurements using similarity theory. Additionally, AERMOD treats the penetration of the plume into the top of PBL and re-entering of plume back to PBL when and if appropriate.

AERMOD also incorporates the two fundamental features associated with the building downwash: enhanced plume dispersion coefficients due to the turbulent wake and reduced plume rise caused by a combination of the descending streamlines in the lee of the building and the increased entrainment in the wake. It addresses the entire structure of the wake from the cavity immediately downwind of the building to the far wake.

A11-3-1: Air Dispersion Model Options

A11-3-1-1: Model Selection

The most recent version of the AERMOD model (Version 09292) was used to assess emissions originating from plaza improvements whereas AERMOD (Version 07026) was used to assess bridge construction reflecting the current model at the time of assessment.

A11-3-1-2: Regulatory Options

The default regulatory options were selected for the dispersion modelling run.

A11-3-1-3: Dispersion Coefficients

The Auer land-use approach as per the USEPA guideline was used to determine the urban versus rural dispersion options for the construction site. Over 50% of the land use is classified as urban, the 'urban' dispersion coefficients therefore, were selected.

A11-3-2*: Coordinate System*

The Universal Transverse Mercator (UTM) projection (NAD 83, Zone 17) was used as the coordinate system for defining all model objects.

A11-3-3: Source Information

A11-3-3-1: Source Summary

Construction activities span over the construction sites. All the emissions were modeled as two lines sources, one representing the construction activities on the land and the other representing the construction activities on the river (i.e. barges). Construction activities related to the Canadian Plaza were modeled separately as a single line source.

The modelling input parameters are listed in Table A11-8.

The constructions activities were assumed to occur between 7:00 am and 5:00 pm, on Monday through Friday.

A11-3-3-2: Building Downwash

Because all the emissions were modeled as line sources, no building downwash was considered.

A11-3-4: Receptor Information

The following virtual receptor grid layout, as shown in Figure A11-3, was used in the dispersion modelling:

- 10 m spacing along the property line;
- 20 m spacing within 200 m of the property line;
- 50 m spacing from 200-300 m;

Because the emissions from construction activities are predominantly ground based low release sources, all virtual receptors were set to 1.8 m above grade consistent with CAL3QHCR modeling. The impact on elevated receptors would be lower than that predicted for the 1.8 m receptors.

A11-3-5: Terrain Conditions

The United States Geographical Service (USGS) 7.5-minute Ontario data set was used as digital terrain input to the AERMAP processor used with AERMOD.

The US EPA recommended elevation data import technique was used to import the elevations for receptors and sources.

A11-3-6: Meteorological Data

The processing of the meteorological data is discussed in Appendix 6.

A11-4: Benchmarking

The highest concentrations at various averaging time periods calculated by CAL3QHCR were taken as the designed concentrations for comparing with standards. Elimination of the single highest 24-hour concentration and the 8 highest 1-hour concentrations for each year of meteorological data as allowed by the ADMGO was not practical due to the format of the output from the CAL3QHCR model.

The highest 24-hour average predicted concentrations and the 8 highest 1-hour average predicted concentrations in each single meteorological year were eliminated from the AERMOD modelling results as per the ADMGO (Section 6.6).

For the bridge construction activities, AERMOD was run for NO_X. The predicted maximum concentrations for other pollutants of interest were calculated based on the dispersion factors derived for NO_X. For the plaza construction activities, AERMOD was run with an emission rate of 1 g/s. The predicted maximum concentrations for pollutants of interested were then calculated based on the unit dispersion factor.

For the 2015 emission scenarios, with both construction activities (AERMOD) and vehicle traffic on the existing bridge (CAL3QHCR) were considered. The maximum concentrations were predicted by taking the higher of the following:

- maximum concentration predicted by AERMOD plus the maximum concentration predicted by CAL3QHCR at the receptor of the maximum concentration predicted by AERMOD; and
- maximum concentration predicted by CAL3QHCR plus the maximum concentration predicted by AERMOD at the receptor of the maximum concentration predicted by CAL3QHCR.

A11-5: Modelling Results

A11-5-1: Modelling Results in Local Study Area

Table A11-11 to A11-16 summarizes the modeling results (maximum concentrations) for different emission scenarios in Local Study Area.

Table A11-1: Initial Link Parameters and Peak Traffic Flow for Present (Baseline) Emission Scenario in Local Study Area

CAL3QHCR - Link Parameters (METERS) for 2004

Variabl	Type	Unit	Description
LNK=	Character	na	Link ID (up to 20 characters)
TYP=	Character	na	Link Type: AG = at grade, FL = fill, BR = bridge, DP = depressed
XL1=	Real	Meters	X coordinate for Endpoint 1 at intersection stopping line
YL1=	Real	Meters	Y coordinate for Endpoint 1 at intersection stopping line
XL2=	Real	Meters	X coordinate for Endpoint 2
YL2=	Real	Meters	Y coordinate for Endpoint 2
HL=	Real	Meters	Source height
WL=	Real	Meters	Mixing zone width
VPHL=	Real	vehicle/hour	Traffic volume for free flow links and approach traffic volume for queue links
NLANE	Integer	na	Number of travel lanes in queue link
CAVG	Integer	Seconds	Average total signal cycle length
RAVG	Integer	Seconds	Average red total signal cycle length
YFAC	Real	Seconds	Clearance lost time (portion of the yellow phase that is not used by motorist)
SFR=	Interger	vehicle/hour-lane	Saturation flow rate [vehicles per hour of effective green time]
ST=	Integer	na	Traffic signal type [pretimed (=1), actuated (=2), or semiactuated (=3)]
AT=	Integer	na	Arrival type of vehicle platoon [worst (=1) through most favorable (=5)]
DESCR	Character	na	Link description

LNK	TYP	XL1	YL1	XL2	YL2	HL	WL	VPHL	NLANES	CAVG	RAVG	YFAC	SFR	ST	AT	DESCRIP
1	AG	330921	4682388	330561	4683201	0	15	1340								NB Sect 100
2	AG	330566	4683186	330914	4682406	0	9	1340	3	110	49	4	1750	2	3	NB Sect 100Q
3	AG	330553	4683195	330912	4682387	0	15	2027								SB Sect 100
4	AG	330905	4682404	330557	4683184	0	9	2027	3	110	49	4	1750	2	3	SB Sect 100Q
5	AG	331250	4682322	330922	4682387	0	9	191								WWB Sect100
6	AG	330937	4682384	331250	4682322	0	3	174	1	110	86	4	1750	2	3	EWB Sect100Q
7	AG	330500	4682385	330915	4682384	0	9	184								WEB Sect 100
8	AG	330898	4682384	330500	4682385	0	3	184	1	110	86	4	1750	2	3	WEB Sect100Q
9	AG	330562	4683198	330413	4683549	0	15	1373								NB Sect 90
10	AG	330420	4683533	330550	4683229	0	9	1373	3	110	48	4	1750	2	3	NB Sect 90Q
11	AG	330403	4683546	330552	4683195	0	15	1933								SB Sect 90
12	AG	330540	4683225	330410	4683530	0	9	1933	3	110	48	4	1750	2	3	SB Sect 90Q
13	AG	330644	4683242	330557	4683210	0	9	227								EWB Sect 90
14	AG	330572	4683215	330643	4683242	0	3	227	1	110	86	4	1750	2	3	EWB Sect 90Q
15	AG	330352	4683115	330553	4683199	0	9	281								WEB Sect 90
16	AG	330535	4683192	330352	4683115	0	3	281	1	110	86	4	1750	2	3	WEB Sect 90Q
17	AG	330412	4683551	330330	4683763	0	15	1194								NB Sect 80
18	AG	330335	4683752	330403	4683573	0	9	1194	3	110	50	4	1750	2	3	NB Sect 80Q
19	AG	330319	4683759	330401	4683547	0	15	1876								SB Sect 80
20	AG	330392	4683570	330321	4683749	0	9	1876	3	110	50	4	1750	2	3	SB Sect 80Q
21	AG	330671	4683667	330415	4683553	0	9	139								EWB Sect 80
22	AG	330424	4683557	330667	4683665	0	3	139	1	110	84	4	1750	2	3	EWB Sect 80Q
23	AG	330158	4683580	330403	4683539	0	9	77								WEB Sect 80
24	AG	330387	4683542	330158	4683580	0	3	77	1	110	84	4	1750	2	3	WEB Sect 80Q
25	AG	330329	4683764	330206	4684041	0	15	1136								NB Sect 70
26	AG	330218	4684014	330311	4683797	0	9	1136	3	110	50	4	1750	2	3	NB Sect 70Q
27	AG	330192	4684037	330315	4683760	0	15	1780								SB Sect 70
28	AG	330300	4683792	330207	4684009	0	9	1780	3	110	50	4	1750	2	3	SB Sect 70Q
29	AG	330399	4683811	330328	4683776	0	9	149								EWB Sect 70
30	AG	330332	4683779	330401	4683811	0	3	149	1	110	83	4	1750	2	3	EWB Sect 70Q
31	AG	330222	4683698	330322	4683762	0	9	52								WEB Sect 70
32	AG	330306	4683751	330222	4683698	0	3	52	1	110	83	4	1750	2	3	WEB Sect 70Q
33	AG	330205	4684042	329972	4684576	0	15	1072								NB Sect 50
34	AG	329982	4684551	330193	4684067	0	9	1072	3	110	72	4	1750	1	1	NB Sect 50Q
35	AG	329959	4684571	330192	4684037	0	15	1743								SB Sect 50
36	AG	330180	4684063	329969	4684547	0	9	1743	3	110	72	4	1750	1	1	SB Sect 50Q
37	AG	330451	4684163	330197	4684046	0	12	551								EWB Sect 50
38	AG	330227	4684059	330451	4684163	0	6	551	2	110	75	4	1750	1	1	EWB Sect 50Q
39	AG	329902	4683911	330199	4684039	0	12	376								WEB Sect 50
40	AG	330174	4684029	329902	4683911	0	6	376	2	110	75	4	1750	1	1	WEB Sect 50Q
41	AG	329971	4684576	329791	4684994	0	15	1040								NB Sect 30
42	AG	329805	4684959	329962	4684599	0	9	1040	3	110	50	4	1750	2	3	NB Sect 30Q
43	AG	329777	4684984	329957	4684566	0	15	1819								SB Sect 30
44	AG	329948	4684593	329791	4684953	0	9	1819	3	110	50	4	1750	2	3	SB Sect 30Q
45	AG	329678	4684431	329966	4684573	0	9	37								WEB Sect 30
46	AG	329946	4684563	329678	4684431	0	3	37	1	110	84	4	1750	2	3	WEB Sect 30Q
47	AG	330027	4685146	329785	4684998	0	9	316								EWB Sect 10
48	AG	329801	4685007	330025	4685146	0	3	316	1	110	84	4	1750	2	3	EWB Sect 10Q
49	AG	329508	4684821	329786	4684991	0	12	265								WEB Sect 10
50	AG	329759	4684974	329508	4684821	0	12	265	4	130	82	4	1750	2	3	WEB Sect 10Q
51	AG	329791	4684994	329767	4685077	0	12	886								passing canadian plaza (NB) no stop 1
52	AG	329767	4685077	329859	4685193	0	12	886								passing canadian plaza (NB) no stop 2
53	AG	329859	4685193	329769	4685361	0	12	886								passing canadian plaza (NB) no stop 3
54	AG	329769	4685361	329601	4685375	0	12	886								passing canadian plaza (NB) no stop 4
55	BR	329601	4685375	329474	4685649	5	12	886								bridge NB (sloping up)
56	BR	329474	4685648	329056	4686518	10	12	886								bridge NB elevated section (canada)
57	BR	329056	4686518	328794	4687069	10	12	886								bridge NB elevated section (US)
58	BR	328794	4687068	328751	4687152	10	12	886								bridge NB slopdown 1
59	BR	328751	4687152	328668	4687233	10	12	886								bridge NB slopdown 2
60	BR	328668	4687233	328609	4687350	10	12	886								bridge NB slopdown 3
61	BR	328609	4687349	328564	4687450	5	12	886								bridge NB sloping down 4
62	AG	328564	4687451	328532	4687643	0	30	886								US plaza for NB inspection
63	AG	328448	4687617	328542	4687444	0	15	1839								SB starts
64	BR	328543	4687443	328596	4687342	5	12	1839								after US Palaza SB, sloping up
65	BR	328596	4687343	328661	4687216	10	12	1839								bridge SB elevated section 1
66	BR	328661	4687216	328741	4687136	10	12	1839								bridge SB elevated section 2
67	BR	328741	4687136	329049	4686494	10	12	1839								bridge SB elevated section (end of US)
68	BR	329049	4686494	329459	4685640	10	12	1839								bridge SB elevated (Canada)
69	BR	329460	4685640	329593	4685357	5	12	1839								bridge SB sloping down
70	AG	329594	4685356	329756	4685248	0	30	1839								Canadian plaza for SB inspection
71	AG	329756	4685247	329714	4685135	0	12	1839								After Canadian plaza inspection to SB Sect 10
72	AG	329714	4685135	329778	4684984	0	12	1839								After Canadian plaza inspection SB to Sect 10
73	AG	329769	4685002	329714	4685134	0	9	811	3	110	54	4	1750	2	3	SB Sect 10Q 1
74	AG	329714	4685134	329756	4685247	0	9	811	3	110	54	4	1750	2	3	SB Sect 10Q 2
75	AG	329773	4684989	329505	4684827	0	9	260								WWB SECT 10
76	AG	329507	4684828	329758	4684980	0	3	260	1	110	82	4	1750	2	3	WWB Sect 10Q
77	AG	329790	4684994	330030	4685142	0	12	401								EEB SECT 10
78	AG	330029	4685142	329803	4685003	0	6	401	2	110	82	4	1750	2	3	EEB SECT 10Q
79	AG	330185	4684041	329901	4683917	0	12	370								WWB SECT 50
80	AG	329905	4683919	330172	4684035	0	6	370	2	110	75	4	1750	1	1	WWB SECT 50Q
81	AG	330205	4684043	330454	4684158	0	12	619								EEB SECT 50
82	AG	330453	4684158	330229	4684054	0	6	619	2	110	75	4	1750	1	1	EEB SECT 50Q
83	AG	330311	4683761	330220	4683702	0	9	86								WWB SECT 70
84	AG	330304	4683756	330221	4683704	0	3	86	1	110	83	4	1750	2	3	WWB SECT 70Q
85	AG	330329	4683769	330402	4683804	0	9	105								EEB SECT 70
86	AG	330400	4683804	330336	4683772	0	3	105	1	110	83	4	1750	2	3	EEB SECT 70Q
87	AG	330398	4683547	330158	4683585	0	9	99								WWB SECT 80
88	AG	330160	4683585	330387	4683548	0	3	99	1	110	84	4	1750	2	3	WWB SECT 80Q
89	AG	330416	4683549	330674	4683664	0	9	174								EEB SECT 80
90	AG	330669	4683662	330425	4683553	0	3	174	1	110	84	4	1750	2	3	EEB SECT 80Q
91	AG	330544	4683203	330351	4683122	0	9	396								WWB SECT 90
92	AG	330351	4683123	330533	4683199	0	3	396	1	110	86	4	1750	2	3	WWB SECT 90Q
93	AG	330560	4683204	330646	4683237	0	9	169								EEB SECT 90
94	AG	330644	4683237	330574	4683209	0	3	169	1	110	86	4	1750	2	3	EEB SECT 90Q
95	AG	330903	4682390	330499	4682390	0	9	191								WWB SECT100
96	AG	330505	4682390	330897	4682390	0	3	191	1	110	86	4	1750	2	3	WWB SECT100Q
97	AG	330921	4682384	331247	4682319	0	9	73								EEB SECT100
98	AG	331238	4682321	330937	4682381	0	3	73	1	110	86	4	1750	2	3	EEB SECT100Q
99	AG	329950	4684570	329676	4684435	0	9	116								WWB SECT 30
100	AG	329945	4684567	329678	4684437	0	3	116	1	110	84	4	1750	2	3	WWB SECT 30Q

Table A11-2: Initial Link Parameters and Peak Traffic Flow for 2011 Emission Scenario in Local Study Area

CAL3QHCR - Link Parameters (METERS) for 2011

Variabl	Type	Unit	Description
LNK=	Character	na	Link ID (up to 20 characters)
TYP=	Character	na	Link Type: AG = at grade, FL = fill, BR = bridge, DP = depressed
XL1=	Real	Meters	X coordinate for Endpoint 1 at intersection stopping line
YL1=	Real	Meters	Y coordinate for Endpoint 1 at intersection stopping line
XL2=	Real	Meters	X coordinate for Endpoint 2
YL2=	Real	Meters	Y coordinate for Endpoint 2
HL=	Real	Meters	Source height
WL=	Real	Meters	Mixing zone width
VPHL=	Real	vehicle/hour	Traffic volume for free flow links and approach traffic volume for queue links
EFL=	Real	gram/vehicle-mile	Free flow emission factor
EFL_Q=	Real	grams/vehicle-hour	Idle emission factor for queue links
NLANE	Integer	na	Number of travel lanes in queue link
CAVG	Integer	Seconds	Average total signal cycle length
RAVG	Integer	Seconds	Average red total signal cycle length
YFAC	Real	Seconds	Clearance lost time (portion of the yellow phase that is not used by motorist)
SFR=	Interger	vehicle/hour-lane	Saturation flow rate [vehicles per hour of effective green time]
ST=	Integer	na	Traffic signal type [pretimed (=1), actuated (=2), or semiactuated (=3)]
AT=	Integer	na	Arrival type of vehicle platoon [worst (=1) through most favorable (=5)]
DESCR	Character	na	Link description

LNK	TYP	XL1	YL1	XL2	YL2	HL	WL	VPHL	NLANES	CAVG	RAVG	YFAC	SFR	ST	AT	DESCRIP
1	AG	330921	4682388	330561	4683201	0	15	1497								NB Sect 100
2	AG	330566	4683186	330914	4682406	0	9	1497	3	110	49	4	1750	2	3	NB Sect 100Q
3	AG	330553	4683195	330912	4682387	0	15	2220								SB Sect 100
4	AG	330905	4682404	330557	4683184	0	9	2220	3	110	49	4	1750	2	3	SB Sect 100Q
5	AG	331250	4682322	330922	4682387	0	9	213								WWB Sect100
6	AG	330937	4682384	331250	4682322	0	3	193	1	110	86	4	1750	2	3	EWB Sect100Q
7	AG	330500	4682385	330915	4682384	0	9	205								WEB Sect 100
8	AG	330898	4682384	330500	4682385	0	3	205	1	110	86	4	1750	2	3	WEB Sect100Q
9	AG	330562	4683198	330413	4683549	0	15	1534								NB Sect 90
10	AG	330420	4683533	330550	4683229	0	9	1534	3	110	48	4	1750	2	3	NB Sect 90Q
11	AG	330403	4683546	330552	4683195	0	15	2116								SB Sect 90
12	AG	330540	4683225	330410	4683530	0	9	2116	3	110	48	4	1750	2	3	SB Sect 90Q
13	AG	330644	4683242	330557	4683210	0	9	253								EWB Sect 90
14	AG	330572	4683215	330643	4683242	0	3	253	1	110	86	4	1750	2	3	EWB Sect 90Q
15	AG	330352	4683115	330553	4683199	0	9	313								WEB Sect 90
16	AG	330535	4683192	330352	4683115	0	3	313	1	110	86	4	1750	2	3	WEB Sect 90Q
17	AG	330412	4683551	330330	4683763	0	15	1334								NB Sect 80
18	AG	330335	4683752	330403	4683573	0	9	1334	3	110	50	4	1750	2	3	NB Sect 80Q
19	AG	330319	4683759	330401	4683547	0	15	2055								SB Sect 80
20	AG	330392	4683570	330321	4683749	0	9	2055	3	110	50	4	1750	2	3	SB Sect 80Q
21	AG	330671	4683667	330415	4683553	0	9	155								EWB Sect 80
22	AG	330424	4683557	330667	4683665	0	3	155	1	110	84	4	1750	2	3	EWB Sect 80Q
23	AG	330158	4683580	330403	4683539	0	9	140								WEB Sect 80
24	AG	330387	4683542	330158	4683580	0	3	140	1	110	84	4	1750	2	3	WEB Sect 80Q
25	AG	330329	4683764	330206	4684041	0	15	1269								NB Sect 70
26	AG	330218	4684014	330311	4683797	0	9	1269	3	110	50	4	1750	2	3	NB Sect 70Q
27	AG	330192	4684037	330315	4683760	0	15	1948								SB Sect 70
28	AG	330300	4683792	330207	4684009	0	9	1948	3	110	50	4	1750	2	3	SB Sect 70Q
29	AG	330399	4683811	330328	4683776	0	9	177								EWB Sect 70
30	AG	330332	4683779	330401	4683811	0	3	177	1	110	83	4	1750	2	3	EWB Sect 70Q
31	AG	330222	4683698	330322	4683762	0	9	58								WEB Sect 70
32	AG	330306	4683751	330222	4683698	0	3	58	1	110	83	4	1750	2	3	WEB Sect 70Q
33	AG	330205	4684042	329972	4684576	0	15	1198								NB Sect 50
34	AG	329982	4684551	330193	4684067	0	9	1198	3	110	72	4	1750	1	1	NB Sect 50Q
35	AG	329959	4684571	330192	4684037	0	15	1896								SB Sect 50
36	AG	330180	4684063	329969	4684547	0	9	1896	3	110	72	4	1750	1	1	SB Sect 50Q
37	AG	330451	4684163	330197	4684046	0	12	600								EWB Sect 50
38	AG	330227	4684059	330451	4684163	0	6	600	2	110	75	4	1750	1	1	EWB Sect 50Q
39	AG	329902	4683911	330199	4684039	0	12	419								WEB Sect 50
40	AG	330174	4684029	329902	4683911	0	6	419	2	110	75	4	1750	1	1	WEB Sect 50Q
41	AG	329971	4684576	329791	4684994	0	15	1163								NB Sect 30
42	AG	329805	4684959	329962	4684599	0	9	1163	3	110	50	4	1750	2	3	NB Sect 30Q
43	AG	329777	4684984	329957	4684566	0	15	1990								SB Sect 30
44	AG	329948	4684593	329791	4684953	0	9	1990	3	110	50	4	1750	2	3	SB Sect 30Q
45	AG	329678	4684431	329966	4684573	0	9	41								WEB Sect 30
46	AG	329946	4684563	329678	4684431	0	3	41	1	110	84	4	1750	2	3	WEB Sect 30Q
47	AG	330027	4685146	329785	4684998	0	9	353								EWB Sect 10
48	AG	329801	4685007	330025	4685146	0	3	353	1	110	84	4	1750	2	3	EWB Sect 10Q
49	AG	329508	4684821	329786	4684991	0	12	295								WEB Sect 10
50	AG	329759	4684974	329508	4684821	0	12	295	4	130	82	4	1750	2	3	WEB Sect 10Q
51	AG	329791	4684994	329767	4685077	0	12	990								passing canadian plaza (NB) no stop 1
52	AG	329767	4685077	329859	4685193	0	12	990								passing canadian plaza (NB) no stop 2
53	AG	329859	4685193	329769	4685361	0	12	990								passing canadian plaza (NB) no stop 3
54	AG	329769	4685361	329581	4685377	0	12	990								passing canadian plaza (NB) no stop 4
55	BR	329581	4685377	329455	4685647	5	16	990								bridge NB (sloping up)
56	BR	329455	4685648	329037	4686518	10	16	990								bridge NB elevated section (canada)
57	BR	329036	4686519	328819	4686968	10	16	990								bridge NB elevated section (US)
58	BR	328822	4686962	328735	4687129	10	16	990								bridge NB slopdown 1
59	BR	328734	4687130	328684	4687219	10	16	990								bridge NB slopdown 2
60	BR	328683	4687220	328621	4687335	10	16	990								bridge NB slopdown 3
61	BR	328619	4687336	328566	4687450	5	16	990								bridge NB sloping down 4
62	AG	328564	4687451	328532	4687643	0	30	990								US plaza for NB inspection
63	AG	328444	4687617	328538	4687444	0	16	2013								SB starts
64	BR	328539	4687445	328593	4687339	5	16	2013								after US Palaza SB, sloping up
65	BR	328593	4687338	328659	4687211	10	16	2013								bridge SB elevated section 1
66	BR	328661	4687210	328708	4687132	10	16	2013								bridge SB elevated section 2
67	BR	328709	4687132	329024	4686496	10	16	2013								bridge SB elevated section (end of US)
68	BR	329026	4686494	329308	4685906	10	16	2013								bridge SB elevated (Canada)
69	BR	329307	4685909	329564	4685357	10	16	2013								bridge SB sloping down
70	AG	329565	4685358	329756	4685248	0	30	2013								Canadian plaza for SB inspection
71	AG	329756	4685247	329714	4685135	0	12	2013								After Canadian plaza inspection to SB Sect 10
72	AG	329714	4685135	329778	4684984	0	12	2013								After Canadian plaza inspection SB to Sect 10
73	AG	329769	4685002	329714	4685134	0	9	2091	3	110	54	4	1750	2	3	SB Sect 10Q 1
74	AG	329714	4685134	329756	4685247	0	9	2091	3	110	54	4	1750	2	3	SB Sect 10Q 2
75	AG	329773	4684989	329505	4684827	0	9	290								WWB SECT 10
76	AG	329507	4684828	329758	4684980	0	3	290	1	110	82	4	1750	2	3	WWB Sect 10Q
77	AG	329790	4684994	330030	4685142	0	12	447								EEB SECT 10
78	AG	330029	4685142	329803	4685003	0	6	447	2	110	82	4	1750	2	3	EEB SECT 10Q
79	AG	330185	4684041	329901	4683917	0	12	412								WWB SECT 50
80	AG	329905	4683919	330172	4684035	0	6	412	2	110	75	4	1750	1	1	WWB SECT 50Q
81	AG	330205	4684043	330454	4684158	0	12	690								EEB SECT 50
82	AG	330453	4684158	330229	4684054	0	6	690	2	110	75	4	1750	1	1	EEB SECT 50Q
83	AG	330311	4683761	330220	4683702	0	9	107								WWB SECT 70
84	AG	330304	4683756	330221	4683704	0	3	107	1	110	83	4	1750	2	3	WWB SECT 70Q
85	AG	330329	4683769	330402	4683804	0	9	117								EEB SECT 70
86	AG	330400	4683804	330336	4683772	0	3	117	1	110	83	4	1750	2	3	EEB SECT 70Q
87	AG	330398	4683547	330158	4683585	0	9	131								WWB SECT 80
88	AG	330160	4683585	330387	4683548	0	3	131	1	110	84	4	1750	2	3	WWB SECT 80Q
89	AG	330416	4683549	330674	4683664	0	9	193								EEB SECT 80
90	AG	330669	4683662	330425	4683553	0	3	193	1	110	84	4	1750	2	3	EEB SECT 80Q
91	AG	330544	4683203	330351	4683122	0	9	441								WWB SECT 90
92	AG	330351	4683123	330533	4683199	0	3	441	1	110	86	4	1750	2	3	WWB SECT 90Q
93	AG	330560	4683204	330646	4683237	0	9	223								EEB SECT 90
94	AG	330644	4683237	330574	4683209	0	3	223	1	110	86	4	1750	2	3	EEB SECT 90Q
95	AG	330903	4682390	330499	4682390	0	9	213								WWB SECT100
96	AG	330505	4682390	330897	4682390	0	3	213	1	110	86	4	1750	2	3	WWB SECT100Q
97	AG	330921	4682384	331247	4682319	0	9	81								EEB SECT100
98	AG	331238	4682321	330937	4682381	0	3	81	1	110	86	4	1750	2	3	EEB SECT100Q
99	AG	329950	4684570	329676	4684435	0	9	129								WWB SECT 30
100	AG	329945	4684567	329678	4684437	0	3	129	1	110	84	4	1750	2	3	WWB SECT 30Q

Table A11-3: Initial Link Parameters and Peak Traffic Flow for 2021 (FDN) Emission Scenario in Local Study Area

CAL3QHCR - Link Parameters (METERS) 2021 Future Do Nothing

Variabl	Type	Unit	Description
LNK=	Character	na	Link ID (up to 20 characters)
TYP=	Character	na	Link Type: AG = at grade, FL = fill, BR = bridge, DP = depressed
XL1=	Real	Meters	X coordinate for Endpoint 1 at intersection stopping line
YL1=	Real	Meters	Y coordinate for Endpoint 1 at intersection stopping line
XL2=	Real	Meters	X coordinate for Endpoint 2
YL2=	Real	Meters	Y coordinate for Endpoint 2
HL=	Real	Meters	Source height
WL=	Real	Meters	Mixing zone width
VPHL=	Real	vehicle/hour	Traffic volume for free flow links and approach traffic volume for queue links
EFL=	Real	gram/vehicle-mile	Free flow emission factor
EFL_Q=	Real	grams/vehicle-hour	Idle emission factor for queue links
NLANE	Integer	na	Number of travel lanes in queue link
CAVG	Integer	Seconds	Average total signal cycle length
RAVG	Integer	Seconds	Average red total signal cycle length
YFAC	Real	Seconds	Clearance lost time (portion of the yellow phase that is not used by m
SFR=	Interger	vehicle/hour-lane	Saturation flow rate [vehicles per hour of effective green time]
ST=	Integer	na	Traffic signal type [pretimed (=1), actuated (=2), or semiactuated (=3)]
AT=	Integer	na	Arrival type of vehicle platoon [worst (=1) through most favorable (=5)]
DESCR	Character	na	Link description

LNK	TYP	XL1	YL1	XL2	YL2	HL	WL	VPHL	NLANES	CAVG	RAVG	YFAC	SFR	ST	AT	DESCRIP
1	AG	330921	4682388	330561	4683201	0	15	2047								NB Sect 100
2	AG	330566	4683186	330914	4682406	0	9	2047	3	130	57	4	1750	2	3	NB Sect 100Q
3	AG	330553	4683195	330912	4682387	0	15	2408								SB Sect 100
4	AG	330905	4682404	330557	4683184	0	9	2408	3	130	57	4	1750	2	3	SB Sect 100Q
5	AG	331250	4682322	330922	4682387	0	9	264								WWB Sect100
6	AG	330937	4682384	331250	4682322	0	3	243	1	130	104	4	1750	2	3	EWB Sect100Q
7	AG	330500	4682385	330915	4682384	0	9	255								WEB Sect 100
8	AG	330898	4682384	330500	4682385	0	3	255	1	130	104	4	1750	2	3	WEB Sect100Q
9	AG	330562	4683198	330413	4683549	0	15	2171								NB Sect 90
10	AG	330420	4683533	330550	4683229	0	9	2171	3	130	51	4	1750	2	3	NB Sect 90Q
11	AG	330403	4683546	330552	4683195	0	15	2297								SB Sect 90
12	AG	330540	4683225	330410	4683530	0	9	2297	3	130	51	4	1750	2	3	SB Sect 90Q
13	AG	330644	4683242	330557	4683210	0	9	307								EWB Sect 90
14	AG	330572	4683215	330643	4683242	0	3	307	1	130	103	4	1750	2	3	EWB Sect 90Q
15	AG	330352	4683115	330553	4683199	0	9	372								WEB Sect 90
16	AG	330535	4683192	330352	4683115	0	3	372	1	130	103	4	1750	2	3	WEB Sect 90Q
17	AG	330412	4683551	330330	4683763	0	15	1880								NB Sect 80
18	AG	330335	4683752	330403	4683573	0	9	1880	3	130	52	4	1750	2	3	NB Sect 80Q
19	AG	330319	4683759	330401	4683547	0	15	2232								SB Sect 80
20	AG	330392	4683570	330321	4683749	0	9	2232	3	130	52	4	1750	2	3	SB Sect 80Q
21	AG	330671	4683667	330415	4683553	0	9	202								EWB Sect 80
22	AG	330424	4683557	330667	4683665	0	3	202	1	130	103	4	1750	2	3	EWB Sect 80Q
23	AG	330158	4683580	330403	4683539	0	9	224								WEB Sect 80
24	AG	330387	4683542	330158	4683580	0	3	224	1	130	103	4	1750	2	3	WEB Sect 80Q
25	AG	330329	4683764	330206	4684041	0	15	1798								NB Sect 70
26	AG	330218	4684014	330311	4683797	0	9	1798	3	130	52	4	1750	2	3	NB Sect 70Q
27	AG	330192	4684037	330315	4683760	0	15	2117								SB Sect 70
28	AG	330300	4683792	330207	4684009	0	9	2117	3	130	52	4	1750	2	3	SB Sect 70Q
29	AG	330399	4683811	330328	4683776	0	9	233								EWB Sect 70
30	AG	330332	4683779	330401	4683811	0	3	233	1	130	103	4	1750	2	3	EWB Sect 70Q
31	AG	330222	4683698	330322	4683762	0	9	96								WEB Sect 70
32	AG	330306	4683751	330222	4683698	0	3	96	1	130	103	4	1750	2	3	WEB Sect 70Q
33	AG	330205	4684042	329972	4684576	0	15	1840								NB Sect 50
34	AG	329982	4684551	330193	4684067	0	9	1840	3	130	82	4	1750	1	1	NB Sect 50Q
35	AG	329959	4684571	330192	4684037	0	15	2052								SB Sect 50
36	AG	330180	4684063	329969	4684547	0	9	2052	3	130	82	4	1750	1	1	SB Sect 50Q
37	AG	330451	4684163	330197	4684046	0	12	674								EWB Sect 50
38	AG	330227	4684059	330451	4684163	0	6	674	2	130	94	4	1750	1	1	EWB Sect 50Q
39	AG	329902	4683911	330199	4684039	0	12	487								WEB Sect 50
40	AG	330174	4684029	329902	4683911	0	6	487	2	130	94	4	1750	1	1	WEB Sect 50Q
41	AG	329971	4684576	329791	4684994	0	15	1830								NB Sect 30
42	AG	329805	4684959	329962	4684599	0	9	1830	3	130	55	4	1750	2	3	NB Sect 30Q
43	AG	329777	4684984	329957	4684566	0	15	2160								SB Sect 30
44	AG	329948	4684593	329791	4684953	0	9	2160	3	130	55	4	1750	2	3	SB Sect 30Q
45	AG	329678	4684431	329966	4684573	0	9	78								WEB Sect 30
46	AG	329946	4684563	329678	4684431	0	3	78	1	130	102	4	1750	2	3	WEB Sect 30Q
47	AG	330027	4685146	329785	4684998	0	9	416								EWB Sect 10
48	AG	329801	4685007	330025	4685146	0	3	416	1	130	100	4	1750	2	3	EWB Sect 10Q
49	AG	329508	4684821	329786	4684991	0	12	353								WEB Sect 10
50	AG	329759	4684974	329508	4684821	0	12	353	4	130	100	4	1750	2	3	WEB Sect 10Q
51	AG	329791	4684994	329767	4685077	0	12	1773								passing canadian plaza (NB) no stop 1
52	AG	329767	4685077	329859	4685193	0	12	1773								passing canadian plaza (NB) no stop 2
53	AG	329859	4685193	329769	4685361	0	12	1773								passing canadian plaza (NB) no stop 3
54	AG	329769	4685361	329601	4685375	0	12	1773								passing canadian plaza (NB) no stop 4
55	BR	329601	4685375	329474	4685649	5	12	1773								bridge NB (sloping up)
56	BR	329474	4685648	329056	4686518	10	12	1773								bridge NB elevated section (canada)
57	BR	329056	4686518	328794	4687069	10	12	1773								bridge NB elevated section (US)
58	BR	328794	4687068	328751	4687152	10	12	1773								bridge NB slopdown 1
59	BR	328751	4687152	328668	4687233	10	12	1773								bridge NB slopdown 2
60	BR	328668	4687233	328609	4687350	10	12	1773								bridge NB slopdown 3
61	BR	328609	4687349	328564	4687450	5	12	1773								bridge NB sloping down 4
62	AG	328564	4687451	328532	4687643	0	30	1773								US plaza for NB inspection
63	AG	328448	4687617	328542	4687444	0	15	2853								SB starts
64	BR	328543	4687443	328596	4687342	5	12	2853								after US Palaza SB, sloping up
65	BR	328596	4687343	328661	4687216	10	12	2853								bridge SB elevated section 1
66	BR	328661	4687216	328741	4687136	10	12	2853								bridge SB elevated section 2
67	BR	328741	4687136	329049	4686494	10	12	2853								bridge SB elevated section (end of US)
68	BR	329049	4686494	329459	4685640	10	12	2853								bridge SB elevated (Canada)
69	BR	329460	4685640	329593	4685357	5	12	2853								bridge SB sloping down
70	AG	329594	4685356	329756	4685248	0	30	2853								Canadian plaza for SB inspection
71	AG	329756	4685247	329714	4685135	0	12	2853								After Canadian plaza inspection to SB Sect 10
72	AG	329714	4685135	329778	4684984	0	12	2853								After Canadian plaza inspection SB to Sect 10
73	AG	329769	4685002	329714	4685134	0	9	2853	3	130	59	4	1750	2	3	SB Sect 10Q 1
74	AG	329714	4685134	329756	4685247	0	9	2853	3	130	59	4	1750	2	3	SB Sect 10Q 2
75	AG	329773	4684989	329505	4684827	0	9	348								WWB SECT 10
76	AG	329507	4684828	329758	4684980	0	3	348	1	130	100	4	1750	2	3	WWB Sect 10Q
77	AG	329790	4684994	330030	4685142	0	12	518								EEB SECT 10
78	AG	330029	4685142	329803	4685003	0	6	518	2	130	100	4	1750	2	3	EEB SECT 10Q
79	AG	330185	4684041	329901	4683917	0	12	480								WWB SECT 50
80	AG	329905	4683919	330172	4684035	0	6	480	2	130	94	4	1750	1	1	WWB SECT 50Q
81	AG	330205	4684043	330454	4684158	0	12	780								EEB SECT 50
82	AG	330453	4684158	330229	4684054	0	6	780	2	130	94	4	1750	1	1	EEB SECT 50Q
83	AG	330311	4683761	330220	4683702	0	9	158								WWB SECT 70
84	AG	330304	4683756	330221	4683704	0	3	158	1	130	103	4	1750	2	3	WWB SECT 70Q
85	AG	330329	4683769	330402	4683804	0	9	161								EEB SECT 70
86	AG	330400	4683804	330336	4683772	0	3	161	1	130	103	4	1750	2	3	EEB SECT 70Q
87	AG	330398	4683547	330158	4683585	0	9	191								WWB SECT 80
88	AG	330160	4683585	330387	4683548	0	3	191	1	130	103	4	1750	2	3	WWB SECT 80Q
89	AG	330416	4683549	330674	4683664	0	9	243								EEB SECT 80
90	AG	330669	4683662	330425	4683553	0	3	243	1	130	103	4	1750	2	3	EEB SECT 80Q
91	AG	330544	4683203	330351	4683122	0	9	511								WWB SECT 90
92	AG	330351	4683123	330533	4683199	0	3	511	1	130	103	4	1750	2	3	WWB SECT 90Q
93	AG	330560	4683204	330646	4683237	0	9	300								EEB SECT 90
94	AG	330644	4683237	330574	4683209	0	3	300	1	130	103	4	1750	2	3	EEB SECT 90Q
95	AG	330903	4682390	330499	4682390	0	9	264								WWB SECT100
96	AG	330505	4682390	330897	4682390	0	3	264	1	130	104	4	1750	2	3	WWB SECT100Q
97	AG	330921	4682384	331247	4682319	0	9	122								EEB SECT100
98	AG	331238	4682321	330937	4682381	0	3	122	1	130	104	4	1750	2	3	EEB SECT100Q
99	AG	329950	4684570	329676	4684435	0	9	174								WWB SECT 30
100	AG	329945	4684567	329678	4684437	0	3	174	1	130	102	4	1750	2	3	WWB SECT 30Q

Table A11-4: Initial Link Parameters and Peak Traffic Flow for 2021 (A) Emission Scenario in Local Study Area

CAL3QHCR - Link Parameters (METERS) for 2021

Variabl	Type	Unit	Description
LNK=	Character	na	Link ID (up to 20 characters)
TYP=	Character	na	Link Type: AG = at grade, FL = fill, BR = bridge, DP = depressed
XL1=	Real	Meters	X coordinate for Endpoint 1 at intersection stopping line
YL1=	Real	Meters	Y coordinate for Endpoint 1 at intersection stopping line
XL2=	Real	Meters	X coordinate for Endpoint 2
YL2=	Real	Meters	Y coordinate for Endpoint 2
HL=	Real	Meters	Source height
WL=	Real	Meters	Mixing zone width
VPHL=	Real	vehicle/hour	Traffic volume for free flow links and approach traffic volume for queue links
EFL=	Real	gram/vehicle-mile	Free flow emission factor
EFL_Q=	Real	grams/vehicle-hour	Idle emission factor for queue links
NLANE	Integer	na	Number of travel lanes in queue link
CAVG	Integer	Seconds	Average total signal cycle length
RAVG	Integer	Seconds	Average red total signal cycle length
YFAC	Real	Seconds	Clearance lost time (portion of the yellow phase that is not used by motorist)
SFR=	Interger	vehicle/hour-lane	Saturation flow rate [vehicles per hour of effective green time]
ST=	Integer	na	Traffic signal type [pretimed (=1), actuated (=2), or semiactuated (=3)]
AT=	Integer	na	Arrival type of vehicle platoon [worst (=1) through most favorable (=5)]
DESCR	Character	na	Link description

LNK	TYP	XL1	YL1	XL2	YL2	HL	WL	VPHL	NLANES	CAVG	RAVG	YFAC	SFR	ST	AT	DESCRIP
1	AG	330921	4682388	330561	4683201	0	15	2047								NB Sect 100
2	AG	330566	4683186	330914	4682406	0	9	2047	3	110	49	4	1750	2	3	NB Sect 100Q
3	AG	330553	4683195	330912	4682387	0	15	2408								SB Sect 100
4	AG	330905	4682404	330557	4683184	0	9	2408	3	110	49	4	1750	2	3	SB Sect 100Q
5	AG	331250	4682322	330922	4682387	0	9	264								WWB Sect100
6	AG	330937	4682384	331250	4682322	0	3	243	1	110	86	4	1750	2	3	EWB Sect100Q
7	AG	330500	4682385	330915	4682384	0	9	255								WEB Sect 100
8	AG	330898	4682384	330500	4682385	0	3	255	1	110	86	4	1750	2	3	WEB Sect100Q
9	AG	330562	4683198	330413	4683549	0	15	2171								NB Sect 90
10	AG	330420	4683533	330550	4683229	0	9	2171	3	110	48	4	1750	2	3	NB Sect 90Q
11	AG	330403	4683546	330552	4683195	0	15	2297								SB Sect 90
12	AG	330540	4683225	330410	4683530	0	9	2297	3	110	48	4	1750	2	3	SB Sect 90Q
13	AG	330644	4683242	330557	4683210	0	9	307								EWB Sect 90
14	AG	330572	4683215	330643	4683242	0	3	307	1	110	86	4	1750	2	3	EWB Sect 90Q
15	AG	330352	4683115	330553	4683199	0	9	372								WEB Sect 90
16	AG	330535	4683192	330352	4683115	0	3	372	1	110	86	4	1750	2	3	WEB Sect 90Q
17	AG	330412	4683551	330330	4683763	0	15	1880								NB Sect 80
18	AG	330335	4683752	330403	4683573	0	9	1880	3	110	50	4	1750	2	3	NB Sect 80Q
19	AG	330319	4683759	330401	4683547	0	15	2232								SB Sect 80
20	AG	330392	4683570	330321	4683749	0	9	2232	3	110	50	4	1750	2	3	SB Sect 80Q
21	AG	330671	4683667	330415	4683553	0	9	202								EWB Sect 80
22	AG	330424	4683557	330667	4683665	0	3	202	1	110	84	4	1750	2	3	EWB Sect 80Q
23	AG	330158	4683580	330403	4683539	0	9	224								WEB Sect 80
24	AG	330387	4683542	330158	4683580	0	3	224	1	110	84	4	1750	2	3	WEB Sect 80Q
25	AG	330329	4683764	330206	4684041	0	15	1798								NB Sect 70
26	AG	330218	4684014	330311	4683797	0	9	1798	3	110	50	4	1750	2	3	NB Sect 70Q
27	AG	330192	4684037	330315	4683760	0	15	2117								SB Sect 70
28	AG	330300	4683792	330207	4684009	0	9	2117	3	110	50	4	1750	2	3	SB Sect 70Q
29	AG	330399	4683811	330328	4683776	0	9	233								EWB Sect 70
30	AG	330332	4683779	330401	4683811	0	3	233	1	110	83	4	1750	2	3	EWB Sect 70Q
31	AG	330222	4683698	330322	4683762	0	9	96								WEB Sect 70
32	AG	330306	4683751	330222	4683698	0	3	96	1	110	83	4	1750	2	3	WEB Sect 70Q
33	AG	330205	4684042	329972	4684576	0	15	1840								NB Sect 50
34	AG	329982	4684551	330193	4684067	0	9	1840	3	110	72	4	1750	1	1	NB Sect 50Q
35	AG	329959	4684571	330192	4684037	0	15	2052								SB Sect 50
36	AG	330180	4684063	329969	4684547	0	9	2052	3	110	72	4	1750	1	1	SB Sect 50Q
37	AG	330451	4684163	330197	4684046	0	12	674								EWB Sect 50
38	AG	330227	4684059	330451	4684163	0	6	674	2	110	75	4	1750	1	1	EWB Sect 50Q
39	AG	329902	4683911	330199	4684039	0	12	487								WEB Sect 50
40	AG	330174	4684029	329902	4683911	0	6	487	2	110	75	4	1750	1	1	WEB Sect 50Q
41	AG	329971	4684576	329791	4684994	0	15	1830								NB Sect 30
42	AG	329805	4684959	329962	4684599	0	9	1830	3	110	50	4	1750	2	3	NB Sect 30Q
43	AG	329777	4684984	329957	4684566	0	15	2160								SB Sect 30
44	AG	329948	4684593	329791	4684953	0	9	2160	3	110	50	4	1750	2	3	SB Sect 30Q
45	AG	329678	4684431	329966	4684573	0	9	78								WEB Sect 30
46	AG	329946	4684563	329678	4684431	0	3	78	1	110	84	4	1750	2	3	WEB Sect 30Q
47	AG	330027	4685146	329785	4684998	0	9	416								EWB Sect 10
48	AG	329801	4685007	330025	4685146	0	3	416	1	110	84	4	1750	2	3	EWB Sect 10Q
49	AG	329508	4684821	329786	4684991	0	12	353								WEB Sect 10
50	AG	329759	4684974	329508	4684821	0	12	353	4	130	82	4	1750	2	3	WEB Sect 10Q
51	AG	329791	4684994	329767	4685077	0	12	1773								passing canadian plaza (NB) no stop 1
52	AG	329767	4685077	329859	4685193	0	12	1773								passing canadian plaza (NB) no stop 2
53	AG	329859	4685193	329769	4685361	0	12	1773								passing canadian plaza (NB) no stop 3
54	AG	329769	4685361	329581	4685377	0	12	1773								passing canadian plaza (NB) no stop 4
55	BR	329581	4685377	329455	4685647	5	16	1773								bridge NB (sloping up)
56	BR	329455	4685648	329037	4686518	10	16	1773								bridge NB elevated section (canada)
57	BR	329036	4686519	328819	4686968	10	16	1773								bridge NB elevated section (US)
58	BR	328822	4686962	328735	4687129	10	16	1773								bridge NB slopdown 1
59	BR	328734	4687130	328684	4687219	10	16	1773								bridge NB slopdown 2
60	BR	328683	4687220	328621	4687335	10	16	1773								bridge NB slopdown 3
61	BR	328619	4687336	328566	4687450	5	16	1773								bridge NB sloping down 4
62	AG	328564	4687451	328532	4687643	0	30	1773								US plaza for NB inspection
63	AG	328444	4687617	328538	4687444	0	16	2853								SB starts
64	BR	328539	4687445	328593	4687339	5	16	2853								after US Palaza SB, sloping up
65	BR	328593	4687338	328659	4687211	10	16	2853								bridge SB elevated section 1
66	BR	328661	4687210	328708	4687132	10	16	2853								bridge SB elevated section 2
67	BR	328709	4687132	329024	4686496	10	16	2853								bridge SB elevated section (end of US)
68	BR	329026	4686494	329308	4685906	10	16	2853								bridge SB elevated (Canada)
69	BR	329307	4685909	329564	4685357	10	16	2853								bridge SB sloping down
70	AG	329565	4685358	329756	4685248	0	30	2853								Canadian plaza for SB inspection
71	AG	329756	4685247	329714	4685135	0	12	2853								After Canadian plaza inspection to SB Sect 10
72	AG	329714	4685135	329778	4684984	0	12	2853								After Canadian plaza inspection SB to Sect 10
73	AG	329769	4685002	329714	4685134	0	9	2853	3	110	54	4	1750	2	3	SB Sect 10Q 1
74	AG	329714	4685134	329756	4685247	0	9	2853	3	110	54	4	1750	2	3	SB Sect 10Q 2
75	AG	329773	4684989	329505	4684827	0	9	348								WWB SECT 10
76	AG	329507	4684828	329758	4684980	0	3	348	1	110	82	4	1750	2	3	WWB Sect 10Q
77	AG	329790	4684994	330030	4685142	0	12	518								EEB SECT 10
78	AG	330029	4685142	329803	4685003	0	6	518	2	110	82	4	1750	2	3	EEB SECT 10Q
79	AG	330185	4684041	329901	4683917	0	12	480								WWB SECT 50
80	AG	329905	4683919	330172	4684035	0	6	480	2	110	75	4	1750	1	1	WWB SECT 50Q
81	AG	330205	4684043	330454	4684158	0	12	780								EEB SECT 50
82	AG	330453	4684158	330229	4684054	0	6	780	2	110	75	4	1750	1	1	EEB SECT 50Q
83	AG	330311	4683761	330220	4683702	0	9	158								WWB SECT 70
84	AG	330304	4683756	330221	4683704	0	3	158	1	110	83	4	1750	2	3	WWB SECT 70Q
85	AG	330329	4683769	330402	4683804	0	9	161								EEB SECT 70
86	AG	330400	4683804	330336	4683772	0	3	161	1	110	83	4	1750	2	3	EEB SECT 70Q
87	AG	330398	4683547	330158	4683585	0	9	191								WWB SECT 80
88	AG	330160	4683585	330387	4683548	0	3	191	1	110	84	4	1750	2	3	WWB SECT 80Q
89	AG	330416	4683549	330674	4683664	0	9	243								EEB SECT 80
90	AG	330669	4683662	330425	4683553	0	3	243	1	110	84	4	1750	2	3	EEB SECT 80Q
91	AG	330544	4683203	330351	4683122	0	9	511								WWB SECT 90
92	AG	330351	4683123	330533	4683199	0	3	511	1	110	86	4	1750	2	3	WWB SECT 90Q
93	AG	330560	4683204	330646	4683237	0	9	300								EEB SECT 90
94	AG	330644	4683237	330574	4683209	0	3	300	1	110	86	4	1750	2	3	EEB SECT 90Q
95	AG	330903	4682390	330499	4682390	0	9	264								WWB SECT100
96	AG	330505	4682390	330897	4682390	0	3	264	1	110	86	4	1750	2	3	WWB SECT100Q
97	AG	330921	4682384	331247	4682319	0	9	122								EEB SECT100
98	AG	331238	4682321	330937	4682381	0	3	122	1	110	86	4	1750	2	3	EEB SECT100Q
99	AG	329950	4684570	329676	4684435	0	9	174								WWB SECT 30
100	AG	329945	4684567	329678	4684437	0	3	174	1	110	84	4	1750	2	3	WWB SECT 30Q

Table A11-5: Initial Link Parameters and Peak Traffic Flow for 2021 (B) Emission Scenario in Local Study Area

CAL3QHCR - Link Parameters (METERS) Two Bridge Operation 2021 (B)

Variabl	Type	Unit	Description
LNK=	Character	na	Link ID (up to 20 characters)
TYP=	Character	na	Link Type: AG = at grade, FL = fill, BR = bridge, DP = depressed
XL1=	Real	Meters	X coordinate for Endpoint 1 at intersection stopping line
YL1=	Real	Meters	Y coordinate for Endpoint 1 at intersection stopping line
XL2=	Real	Meters	X coordinate for Endpoint 2
YL2=	Real	Meters	Y coordinate for Endpoint 2
HL=	Real	Meters	Source height
WL=	Real	Meters	Mixing zone width
VPHL=	Real	vehicle/hour	Traffic volume for free flow links and approach traffic volume for queue links
EFL=	Real	gram/vehicle-mile	Free flow emission factor
EFL_Q=	Real	grams/vehicle-hour	Idle emission factor for queue links
NLANE	Integer	na	Number of travel lanes in queue link
CAVG	Integer	Seconds	Average total signal cycle length
RAVG	Integer	Seconds	Average red total signal cycle length
YFAC	Real	Seconds	Clearance lost time (portion of the yellow phase that is not used by m
SFR=	Interger	vehicle/hour-lane	Saturation flow rate [vehicles per hour of effective green time]
ST=	Integer	na	Traffic signal type [pretimed (=1), actuated (=2), or semiactuated (=3)]
AT=	Integer	na	Arrival type of vehicle platoon [worst (=1) through most favorable (=5)]
DESCR	Character	na	Link description

LNK	TYP	XL1	YL1	XL2	YL2	HL	WL	VPHL	NLANES	CAVG	RAVG	YFAC	SFR	ST	AT	DESCRIP
1	AG	330921	4682388	330561	4683201	0	15	2047								NB Sect 100
2	AG	330566	4683186	330914	4682406	0	9	2047	3	110	49	4	1750	2	3	NB Sect 100Q
3	AG	330553	4683195	330912	4682387	0	15	2408								SB Sect 100
4	AG	330905	4682404	330557	4683184	0	9	2408	3	110	49	4	1750	2	3	SB Sect 100Q
5	AG	331250	4682322	330922	4682387	0	9	264								WWB Sect100
6	AG	330937	4682384	331250	4682322	0	3	243	1	110	86	4	1750	2	3	EWB Sect100Q
7	AG	330500	4682385	330915	4682384	0	9	255								WEB Sect 100
8	AG	330898	4682384	330500	4682385	0	3	255	1	110	86	4	1750	2	3	WEB Sect100Q
9	AG	330562	4683198	330413	4683549	0	15	2171								NB Sect 90
10	AG	330420	4683533	330550	4683229	0	9	2171	3	110	48	4	1750	2	3	NB Sect 90Q
11	AG	330403	4683546	330552	4683195	0	15	2297								SB Sect 90
12	AG	330540	4683225	330410	4683530	0	9	2297	3	110	48	4	1750	2	3	SB Sect 90Q
13	AG	330644	4683242	330557	4683210	0	9	307								EWB Sect 90
14	AG	330572	4683215	330643	4683242	0	3	307	1	110	86	4	1750	2	3	EWB Sect 90Q
15	AG	330352	4683115	330553	4683199	0	9	372								WEB Sect 90
16	AG	330535	4683192	330352	4683115	0	3	372	1	110	86	4	1750	2	3	WEB Sect 90Q
17	AG	330412	4683551	330330	4683763	0	15	1880								NB Sect 80
18	AG	330335	4683752	330403	4683573	0	9	1880	3	110	50	4	1750	2	3	NB Sect 80Q
19	AG	330319	4683759	330401	4683547	0	15	2232								SB Sect 80
20	AG	330392	4683570	330321	4683749	0	9	2232	3	110	50	4	1750	2	3	SB Sect 80Q
21	AG	330671	4683667	330415	4683553	0	9	202								EWB Sect 80
22	AG	330424	4683557	330667	4683665	0	3	202	1	110	84	4	1750	2	3	EWB Sect 80Q
23	AG	330158	4683580	330403	4683539	0	9	224								WEB Sect 80
24	AG	330387	4683542	330158	4683580	0	3	224	1	110	84	4	1750	2	3	WEB Sect 80Q
25	AG	330329	4683764	330206	4684041	0	15	1798								NB Sect 70
26	AG	330218	4684014	330311	4683797	0	9	1798	3	110	50	4	1750	2	3	NB Sect 70Q
27	AG	330192	4684037	330315	4683760	0	15	2117								SB Sect 70
28	AG	330300	4683792	330207	4684009	0	9	2117	3	110	50	4	1750	2	3	SB Sect 70Q
29	AG	330399	4683811	330328	4683776	0	9	233								EWB Sect 70
30	AG	330332	4683779	330401	4683811	0	3	233	1	110	83	4	1750	2	3	EWB Sect 70Q
31	AG	330222	4683698	330322	4683762	0	9	96								WEB Sect 70
32	AG	330306	4683751	330222	4683698	0	3	96	1	110	83	4	1750	2	3	WEB Sect 70Q
33	AG	330205	4684042	329972	4684576	0	15	1840								NB Sect 50
34	AG	329982	4684551	330193	4684067	0	9	1840	3	110	72	4	1750	1	1	NB Sect 50Q
35	AG	329959	4684571	330192	4684037	0	15	2052								SB Sect 50
36	AG	330180	4684063	329969	4684547	0	9	2052	3	110	72	4	1750	1	1	SB Sect 50Q
37	AG	330451	4684163	330197	4684046	0	12	674								EWB Sect 50
38	AG	330227	4684059	330451	4684163	0	6	674	2	110	75	4	1750	1	1	EWB Sect 50Q
39	AG	329902	4683911	330199	4684039	0	12	487								WEB Sect 50
40	AG	330174	4684029	329902	4683911	0	6	487	2	110	75	4	1750	1	1	WEB Sect 50Q
41	AG	329971	4684576	329791	4684994	0	15	1830								NB Sect 30
42	AG	329805	4684959	329962	4684599	0	9	1830	3	110	50	4	1750	2	3	NB Sect 30Q
43	AG	329777	4684984	329957	4684566	0	15	2160								SB Sect 30
44	AG	329948	4684593	329791	4684953	0	9	2160	3	110	50	4	1750	2	3	SB Sect 30Q
45	AG	329678	4684431	329966	4684573	0	9	78								WEB Sect 30
46	AG	329946	4684563	329678	4684431	0	3	78	1	110	84	4	1750	2	3	WEB Sect 30Q
47	AG	330027	4685146	329785	4684998	0	9	416								EWB Sect 10
48	AG	329801	4685007	330025	4685146	0	3	416	1	110	84	4	1750	2	3	EWB Sect 10Q
49	AG	329508	4684821	329786	4684991	0	12	353								WEB Sect 10
50	AG	329759	4684974	329508	4684821	0	12	353	4	130	82	4	1750	2	3	WEB Sect 10Q
51	AG	329791	4684994	329767	4685077	0	12	1773								passing canadian plaza (NB) no stop 1
52	AG	329767	4685077	329859	4685193	0	12	1773								passing canadian plaza (NB) no stop 2
53	AG	329859	4685193	329769	4685361	0	12	1773								passing canadian plaza (NB) no stop 3
54	AG	329769	4685361	329566	4685376	0	12	382								passing canadian plaza (NB) no stop 4
55	BR	329566	4685376	329437	4685644	5	16	382								bridge NB (sloping up)
56	BR	329437	4685644	329018	4686515	10	16	382								bridge NB elevated section (canada)
57	BR	329018	4686515	328800	4686965	10	16	382								bridge NB elevated section (US)
58	BR	328800	4686965	328712	4687133	10	16	382								bridge NB slopdown 1
59	BR	328712	4687133	328684	4687219	10	16	382								bridge NB slopdown 2
60	BR	328684	4687219	328621	4687335	10	16	382								bridge NB slopdown 3
61	BR	328619	4687336	328566	4687450	5	16	382								bridge NB sloping down 4
62	AG	328564	4687451	328532	4687643	0	30	382								US plaza for NB inspection
63	AG	328444	4687617	328538	4687444	0	16	2853								SB starts
64	BR	328539	4687445	328593	4687339	5	16	645								after US Palaza SB, sloping up
65	BR	328593	4687338	328659	4687211	10	16	645								bridge SB elevated section 1
66	BR	328661	4687210	328695	4687133	10	16	645								bridge SB elevated section 2
67	BR	328695	4687133	329009	4686495	10	16	645								bridge SB elevated section (end of US)
68	BR	329009	4686495	329480	4685501	10	16	645								bridge SB elevated (Canada)
69	BR	329480	4685501	329550	4685354	10	16	645								bridge SB sloping down
70	AG	329550	4685354	329756	4685248	0	30	645								Canadian plaza for SB inspection
71	AG	329756	4685248	329714	4685135	0	12	2853								After Canadian plaza inspection to SB Sect 10
72	AG	329714	4685135	329778	4684984	0	12	2853								After Canadian plaza inspection SB to Sect 10
73	AG	329769	4685002	329714	4685134	0	9	2853	3	110	54	4	1750	2	3	SB Sect 10Q 1
74	AG	329714	4685134	329756	4685247	0	9	2853	3	110	54	4	1750	2	3	SB Sect 10Q 2
75	AG	329773	4684989	329505	4684827	0	9	348								WWB SECT 10
76	AG	329507	4684828	329758	4684980	0	3	348	1	110	82	4	1750	2	3	WWB Sect 10Q
77	AG	329790	4684994	330030	4685142	0	12	518								EEB SECT 10
78	AG	330029	4685142	329803	4685003	0	6	518	2	110	82	4	1750	2	3	EEB SECT 10Q
79	AG	330185	4684041	329901	4683917	0	12	480								WWB SECT 50
80	AG	329905	4683919	330172	4684035	0	6	480	2	110	75	4	1750	1	1	WWB SECT 50Q
81	AG	330205	4684043	330454	4684158	0	12	780								EEB SECT 50
82	AG	330453	4684158	330229	4684054	0	6	780	2	110	75	4	1750	1	1	EEB SECT 50Q
83	AG	330311	4683761	330220	4683702	0	9	158								WWB SECT 70
84	AG	330304	4683756	330221	4683704	0	3	158	1	110	83	4	1750	2	3	WWB SECT 70Q
85	AG	330329	4683769	330402	4683804	0	9	161								EEB SECT 70
86	AG	330400	4683804	330336	4683772	0	3	161	1	110	83	4	1750	2	3	EEB SECT 70Q
87	AG	330398	4683547	330158	4683585	0	9	191								WWB SECT 80
88	AG	330160	4683585	330387	4683548	0	3	191	1	110	84	4	1750	2	3	WWB SECT 80Q
89	AG	330416	4683549	330674	4683664	0	9	243								EEB SECT 80
90	AG	330669	4683662	330425	4683553	0	3	243	1	110	84	4	1750	2	3	EEB SECT 80Q
91	AG	330544	4683203	330351	4683122	0	9	511								WWB SECT 90
92	AG	330351	4683123	330533	4683199	0	3	511	1	110	86	4	1750	2	3	WWB SECT 90Q
93	AG	330560	4683204	330646	4683237	0	9	300								EEB SECT 90
94	AG	330644	4683237	330574	4683209	0	3	300	1	110	86	4	1750	2	3	EEB SECT 90Q
95	AG	330903	4682390	330499	4682390	0	9	264								WWB SECT100
96	AG	330505	4682390	330897	4682390	0	3	264	1	110	86	4	1750	2	3	WWB SECT100Q
97	AG	330921	4682384	331247	4682319	0	9	122								EEB SECT100
98	AG	331238	4682321	330937	4682381	0	3	122	1	110	86	4	1750	2	3	EEB SECT100Q
99	AG	329950	4684570	329676	4684435	0	9	174								WWB SECT 30
100	AG	329945	4684567	329678	4684437	0	3	174	1	110	84	4	1750	2	3	WWB SECT 30Q
101	AG	329769	4685361	329601	4685375	0	12	1390								exiting bridge passing canadian plaza (NB) no stop 4
102	BR	329601	4685375	329474	4685649	5	12	1390								exiting bridge NB (sloping up)
103	BR	329474	4685648	329056	4686518	10	12	1390								exiting bridge NB elevated section (canada)
104	BR	329056	4686518	328842	4686969	10	12	1390								exiting bridge NB elevated section (US)
105	BR	328842	4686969	328751	4687152	10	12	1390								exiting bridge NB slopdown 1
106	BR	328751	4687152	328668	4687233	10	12	1390								exiting bridge NB slopdown 2
107	BR	328668	4687233	328609	4687350	10	12	1390								exiting bridge NB slopdown 3
108	BR	328609	4687349	328564	4687450	5	12	1390								exiting bridge NB sloping down 4
109	AG	328564	4687450	328532	4687643	0	30	1390								US plaza for NB inspection cars
110	BR	328543.41	4687443	328596.03	4687342	5	12	2208								exiting bridge after US Palaza SB, sloping up
111	BR	328596.28	4687343	328660.91	4687216	10	12	2208								exiting bridge SB elevated section 1
112	BR	328660.91	4687216	328741	4687136	10	12	2208								exiting bridge SB elevated section 2
113	BR	328741	4687136	329049	4686494	10	12	2208								exiting bridge SB elevated section (end of US)
114	BR	329049	4686494	329320	4685933	10	12	2208								exiting bridge SB elevated (Canada)
115	BR	329320	4685933	329605.44	4685330.02	5	12	2208								exiting bridge SB sloping down
116	AG	329605.44	4685330.02	329756	4685248	0	30	2208								Canadian plaza for SB inspection cars

Table A11-6: Initial Traffic Speed and Emission Factors Used for Each Link in Local Study Area

Area	Traffic Speed		Link IDs	CO	NOx	SO2	PM_{10} †	PM10 Road Dust	PM_{25} †	PM25 Road Dust	VOC (NMHC)	Benzene	Acetaldehyde	Formaldehyde	1,3-Butadiene	Acrolein	Benzo (a) pyrene	Naphthalene	Phenanthrene	CO2	N2O	CH4
	mile/hr	km/hr		g/mile	g/mile	g/mile	g/mile	g/mile	g/mile	g/mile	g/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	mg/mile	g/mile	g/mile	g/mile
Present (Baseline)																						
Bridge	2.5	4	57-62, 68-70,73-74*	58.615	7.813	0.084	0.116	-	0.116	-	8.048	162.246	34.848	99.753	23.429	5.490	0.003	1.421	0.044	762.150	0.032	0.093
	30	48	51-54, 71-72	11.206	4.516	0.084	0.141	-	0.141	-	1.014	23.658	7.720	21.556	3.903	1.127	0.003	1.421	0.044	762.150	0.032	0.093
	35	56	63-64	10.837	4.499	0.084	0.141	-	0.141	-	0.935	20.999	6.759	18.780	3.416	0.973	0.003	1.421	0.044	762.150	0.032	0.093
	40	64	55-56, 65-67	11.110	4.601	0.084	0.141	-	0.141	-	0.890	19.752	6.151	17.018	3.164	0.874	0.003	1.421	0.044	762.150	0.032	0.093
Huron Church Road	2.5	4	2, 4, 10, 12, 18, 20, 26, 28, 34, 36, 42, 44	62.154	6.210	0.061	0.081	-	0.081	-	8.660	174.936	31.442	88.394	24.363	4.620	0.002	1.240	0.039	660.930	0.034	0.103
	35	56	1, 3, 9, 11, 17, 19, 25, 27, 33, 35, 41, 43	11.667	3.497	0.061	0.105	-	0.105	-	0.959	28.057	5.582	15.303	3.380	0.778	0.002	1.240	0.039	660.930	0.034	0.103
Arterial roads	2.5	4	6, 8, 14, 16, 22, 24, 30, 32, 38, 40, 46, 48, 50, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100	86.080	4.390	0.029	0.035	-	0.035	-	13.106	230.513	32.218	87.265	31.197	4.040	0.001	0.995	0.031	523.100	0.035	0.116
	30	48	5, 7, 13, 15, 21, 23, 29, 31, 37, 39, 45, 47, 49, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99	32.003	2.517	0.029	0.056	-	0.056	-	1.979	65.349	9.933	26.418	9.374	1.182	0.001	0.995	0.031	523.100	0.035	0.116
2011																						
Bridge	2.5	4	58-62, 69-70,73-74*	31.607	4.112	0.009	0.049	-	0.049	-	5.234	79.937	18.542	45.405	10.099	2.260	0.001	0.734	0.022	757.580	0.032	0.092
	30	48	51-54, 71-72	6.646	2.306	0.009	0.074	-	0.074	-	0.526	12.228	4.462	11.283	1.885	0.545	0.001	0.734	0.022	757.580	0.032	0.092
	35	56	63-64	6.479	2.295	0.009	0.074	-	0.074	-	0.480	10.937	3.923	9.887	1.671	0.478	0.001	0.734	0.022	757.580	0.032	0.092
	40	64	55-57, 65-68	6.703	2.349	0.009	0.074	-	0.074	-	0.450	10.320	3.571	8.952	1.556	0.435	0.001	0.734	0.022	757.580	0.032	0.092
Huron Church Road	2.5	4	2, 4, 10, 12, 18, 20, 26, 28, 34, 36, 42, 44	32.669	3.750	0.009	0.042	-	0.042	-	5.444	82.926	17.478	42.082	10.331	2.116	0.001	0.699	0.021	711.880	0.033	0.097
	35	56	1, 3, 9, 11, 17, 19, 25, 27, 33, 35, 41, 43	6.770	2.074	0.009	0.067	-	0.067	-	0.484	14.118	3.572	8.868	1.661	0.434	0.001	0.699	0.021	711.880	0.033	0.097
Arterial roads	2.5	4	6, 8, 14, 16, 22, 24, 30, 32, 38, 40, 46, 48, 50, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100	48.675	2.443	0.008	0.016	-	0.016	-	6.631	113.307	15.521	33.117	13.543	1.783	0.001	0.554	0.016	522.910	0.035	0.116
	30	48	5, 7, 13, 15, 21, 23, 29, 31, 37, 39, 45, 47, 49, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99	19.832	1.372	0.008	0.037	-	0.037	-	0.939	32.438	4.893	10.307	4.260	0.544	0.001	0.554	0.016	522.910	0.035	0.116
2021 (FDN) and 2021 (A)																						
Bridge	2.5	4	55-62, 64-70,71-72, 73-74*	20.433	1.284	0.010	0.013	-	0.013	-	2.672	39.151	10.885	26.292	4.513	2.150	0.001	0.404	0.012	780.090	0.032	0.090
	30	48	51-54	4.391	0.701	0.010	0.039	-	0.039	-	0.380	6.208	2.899	7.332	0.979	0.326	0.001	0.404	0.012	780.090	0.032	0.090
	35	56	63	4.276	0.696	0.010	0.039	-	0.039	-	0.330	5.599	2.555	6.440	0.875	0.287	0.001	0.404	0.012	780.090	0.032	0.090
	40	64	65-67	4.442	0.713	0.010	0.039	-	0.039	-	0.300	5.322	2.322	5.819	0.815	0.260	0.001	0.404	0.012	780.090	0.032	0.090
Huron Church Road	2.5	4	2, 4, 10, 12, 18, 20, 26, 28, 34, 36, 42, 44	20.433	1.284	0.010	0.013	-	0.013	-	2.672	40.681	10.885	26.292	4.513	1.289	0.001	0.399	0.011	780.090	0.033	0.096
	35	56	1, 3, 9, 11, 17, 19, 25, 27, 33, 35, 41, 43	4.276	0.696	0.010	0.039	-	0.039	-	0.245	7.164	2.555	6.440	0.875	0.307	0.001	0.399	0.011	780.090	0.033	0.096
Arterial roads	2.5	4	6, 8, 14, 16, 22, 24, 30, 32, 38, 40, 46, 48, 50, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100	32.179	0.986	0.008	0.006	-	0.006	-	3.401	56.491	7.400	14.143	5.505	0.883	0.000	0.386	0.011	523.710	0.035	0.116
	30	48	5, 7, 13, 15, 21, 23, 29, 31, 37, 39, 45, 47, 49, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99	13.788	0.547	0.008	0.028	-	0.028	-	0.459	17.127	2.489	4.691	1.876	0.285	0.000	0.386	0.011	523.710	0.035	0.116
2021 (B) - Cars Only for Bridge																						
Bridge	2.5	4	105-109, 115, 116 Note: links 71-74 are represented by 2021 (A) with combined traffic flow	24.697	0.777	0.0069	0.0043	-	0.0043	-	2.469	48.315	4.961	8.45	4.408	0.612	0.0004237	0.3827	0.01076	454.45	0.036	0.120
	30	48	101	5.613	0.381	0.007	0.025	-	0.025	-	0.244	7.188	0.829	1.411	0.738	0.103	0.000	0.383	0.011	454.450	0.036	0.120
	35	56		5.643	0.374	0.007	0.025	-	0.025	-	0.227	6.666	0.769	1.306	0.683	0.095	0.000	0.383	0.011	454.450	0.036	0.120
	40	64	102-10, 110-114	6.042	0.380	0.007	0.025	-	0.025	-	0.220	6.547	0.757	1.282	0.670	0.093	0.000	0.383	0.011	454.450	0.036	0.120
Huron Church Road	2.5	4	2, 4, 10, 12, 18, 20, 26, 28, 34, 36, 42, 44	20.433	1.284	0.010	0.013	-	0.013	-	2.672	40.681	10.885	26.292	4.513	1.289	0.001	0.399	0.011	780.090	0.033	0.096
	35	56	1, 3, 9, 11, 17, 19, 25, 27, 33, 35, 41, 43	4.276	0.696	0.010	0.039	-	0.039	-	0.245	7.164	2.555	6.440	0.875	0.307	0.001	0.399	0.011	780.090	0.033	0.096
Arterial roads	2.5	4	6, 8, 14, 16, 22, 24, 30, 32, 38, 40, 46, 48, 50, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100	32.179	0.986	0.008	0.006	-	0.006	-	3.401	56.491	7.400	14.143	5.505	0.883	0.000	0.386	0.011	523.710	0.035	0.116
	30	48	5, 7, 13, 15, 21, 23, 29, 31, 37, 39, 45, 47, 49, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99	13.788	0.547	0.008	0.028	-	0.028	-	0.459	17.127	2.489	4.691	1.876	0.285	0.000	0.386	0.011	523.710	0.035	0.116
2021 (B) - Trucks Only for Bridge																						
Bridge	2.5	4	59-62, 69, 70 Note: links 71-74 are represented by 2021 (A) with combined traffic flow	14.359	2.016	0.013	0.060	-	0.060	-	1.452	25.933	19.543	52.377	4.708	2.277	0.001	0.438	0.013	1251.100	0.027	0.043
	30	48	54	2.620	1.164	0.013	0.060	-	0.060	-	0.296	4.797	5.917	15.966	1.336	0.705	0.001	0.437	0.013	1251.100	0.027	0.043
	35	56	55-58, 64	2.292	1.162	0.013	0.060	-	0.060	-	0.262	4.060	5.159	13.928	1.160	0.615	0.001	0.437	0.013	1251.100	0.027	0.043
	40	64	65-68	2.117	1.194	0.013	0.060	-	0.060	-	0.238	3.551	4.605	12.436	1.032	0.550	0.001	0.437	0.013	1251.100	0.027	0.043
Huron Church Road	2.5	4	2, 4, 10, 12, 18, 20, 26, 28, 34, 36, 42, 44	20.433	1.284	0.010	0.013	-	0.013	-	2.672	40.681	10.885	26.292	4.513	1.289	0.001	0.399	0.011	780.090	0.033	0.096
	35	56	1, 3, 9, 11, 17, 19, 25, 27, 33, 35, 41, 43	4.276	0.696	0.010	0.039	-	0.039	-	0.245	7.164	2.555	6.440	0.875	0.307	0.001	0.399	0.011	780.090	0.033	0.096
Arterial roads	2.5	4	6, 8, 14, 16, 22, 24, 30, 32, 38, 40, 46, 48, 50, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100	32.179	0.986	0.008	0.006	-	0.006	-	3.401	56.491	7.400	14.143	5.505	0.883	0.000	0.386	0.011	523.710	0.035	0.116
	30	48	5, 7, 13, 15, 21, 23, 29, 31, 37, 39, 45, 47, 49, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99	13.788	0.547	0.008	0.028	-	0.028	-	0.459	17.127	2.489	4.691	1.876	0.285	0.000	0.386	0.011	523.710	0.035	0.116

† Factors for total particulate matter emissions were used except for at 2.5 mile/hr (4 km/hr) where the factor for exhaust only particulate emission was used.

Table A11-7: Updated Traffic Speed and Emission Factors Used for Each Link in Local Study Area

Area	Traffic Speed		Vehicle Type	Link IDs	NOx	PM_{10} †	PM_{25} †	Acrolein
	mile/hr	km/hr			g/mile	g/mile	g/mile	mg/mile
Present (Baseline)								
Bridge	2.5	4	All	57-62, 68-70,73-74*	7.813	0.116	0.116	5.490
	30	48	All	51-54, 71-72	4.516	0.141	0.141	1.127
	35	56	All	63-64	4.499	0.141	0.141	0.973
	40	64	All	55-56, 65-67	4.601	0.141	0.141	0.874
Huron Church Road	2.5	4	All	2, 4, 10, 12, 18, 20, 26, 28, 34, 36, 42, 44	6.210	0.081	0.081	4.620
	35	56	All	1, 3, 9, 11, 17, 19, 25, 27, 33, 35, 41, 43	3.497	0.105	0.105	0.778
Arterial roads	2.5	4	All	6, 8, 14, 16, 22, 24, 30, 32, 38, 40, 46, 48, 50, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100	4.390	0.035	0.035	4.040
	30	48	All	5, 7, 13, 15, 21, 23, 29, 31, 37, 39, 45, 47, 49, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99	2.517	0.056	0.056	1.182
2015 and 2025 (FDN)								
Bridge	2.5	4	All	58-62, 69	2.844	0.034	0.034	1.785
			Cars Only	70, 73	1.126	0.004	0.004	0.813
			Trucks Only	101, 107	2.447	0.062	0.062	2.742
	30	48	All	54-54	1.603	0.061	0.061	0.487
			Cars Only	71, 72	0.552	0.025	0.025	0.136
			Trucks Only	102-105	1.359	0.096	0.096	0.832
	35	56	All	63-64	1.597	0.061	0.061	0.427
	40	64	All	55-57, 65-68	1.635	0.061	0.061	0.387
Huron Church Road	2.5	4	All	2, 4, 10, 12, 18, 20, 26, 28, 34, 36, 42, 44	2.003	0.019	0.019	1.304
	35	56	All	1, 3, 9, 11, 17, 19, 25, 27, 33, 35, 41, 43	1.078	0.043	0.043	0.278
Arterial roads	2.5	4	All	6, 8, 14, 16, 22, 24, 30, 32, 38, 40, 46, 48, 50, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100	1.566	0.009	0.009	1.143
	30	48	All	5, 7, 13, 15, 21, 23, 29, 31, 37, 39, 45, 47, 49, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99	0.876	0.031	0.031	0.343
2025 (A)								
Bridge	2.5	4	All	71-72, 112, 113-116, 122	0.930	0.000	0.000	1.273
			Cars Only	73, 123	0.676	0.000	0.000	0.543
			Trucks Only	107, 124	1.227	0.000	0.000	2.133
	30	48	All	51-53, 108,	0.495	0.000	0.000	0.356
			Cars Only	71-72	0.329	0.000	0.000	0.091
			Trucks Only	102-105	0.691	0.000	0.000	0.666
	35	56	All	117	0.492	0.000	0.000	0.084
	40	64	All	109-111, 118-121	0.504	0.000	0.000	0.083
Huron Church Road	2.5	4	All	2, 4, 10, 12, 18, 20, 26, 28, 34, 36, 42, 44	0.838	0.000	0.000	1.000
	35	56	All	1, 3, 9, 11, 17, 19, 25, 27, 33, 35, 41, 43	0.430	0.000	0.000	0.230
Arterial roads	2.5	4	All	6, 8, 14, 16, 22, 24, 30, 32, 38, 40, 46, 48, 50, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100	0.807	0.000	0.000	0.790
	30	48	All	5, 7, 13, 15, 21, 23, 29, 31, 37, 39, 45, 47, 49, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99	0.442	0.000	0.000	0.260
2025 (B)								
Bridge	2.5	4	Cars Only	73, 112-116, 122, 123	0.676	0.000	0.000	0.543
			Trucks Only	58-62, 69, 101, 107	1.227	0.000	0.000	2.133
	30	48	Cars Only	71, 72, 108	0.329	0.000	0.000	0.091
			Trucks Only	54, 102-105	0.691	0.000	0.000	0.666
	35	56	Cars Only	117	0.323	0.000	0.000	0.084
			Trucks Only	63, 64	0.690	0.000	0.000	0.582
	40	64	Cars Only	109-111, 118-121	0.582	0.000	0.000	0.083
			Trucks Only	55-57, 65-68	0.710	0.000	0.000	0.520
Huron Church Road	2.5	4	All	2, 4, 10, 12, 18, 20, 26, 28, 34, 36, 42, 44	0.838	0.000	0.000	1.000
	35	56	All	1, 3, 9, 11, 17, 19, 25, 27, 33, 35, 41, 43	0.430	0.000	0.000	0.230
Arterial roads	2.5	4	All	6, 8, 14, 16, 22, 24, 30, 32, 38, 40, 46, 48, 50, 76, 78, 80, 82, 84, 86, 88, 90, 92, 94, 96, 98, 100	0.807	0.000	0.000	0.790
	30	48	All	5, 7, 13, 15, 21, 23, 29, 31, 37, 39, 45, 47, 49, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 95, 97, 99	0.442	0.000	0.000	0.260

† Factors for total particulate matter emissions were used except for at 2.5 mile/hr (4 km/hr) where the factor for exhaust only particulate emission was used.

Table A11-8: Source Input Parameters for AERMOD

```
Plaza Construction Sources

LINE Source ID = PLAZA
DESCRSRC New Plaza Construction
Length of Side = 45.00
Emission Rate = 1.0
Elevated
Vertical Dimension = 12.00
SZINIT = 2.79
Nodes = 2
329692.41, 4684808.01, 180.00, 6.00, 0.00
329569.97, 4685057.92, 180.19, 6.00, 0.00



Bridge Construction Sources

LINE Source ID = LAND2
DESCRSRC
Length of Side = 100.00
Emission Rate = 0.36
Vertical Dimension = 6.00
SZINIT = 2.79
Nodes = 2
329692.41, 4684808.01, 180.00, 3.00, 0.00
329569.97, 4685057.92, 180.19, 3.00, 0.00

LINE Source ID = LAND1
DESCRSRC
Length of Side = 50.00
Emission Rate = 2.35
Elevated
Vertical Dimension = 12.00
SZINIT = 2.79
Nodes = 2
329671.06, 4685109.60, 180.00, 6.00, 0.00
329170.77, 4686191.70, 180.00, 6.00, 0.00

LINE Source ID = RIVER
DESCRSRC
Length of Side = 45.00
Emission Rate = 0.0
Elevated
Vertical Dimension = 12.00
SZINIT = 2.79
Nodes = 2
329148.64, 4686243.30, 180.00, 6.00, 0.00
329047.92, 4686468.82, 179.00, 6.00, 0.00
```

Table A11-11: Summary of Maximum Modelling Results for Present (Baseline) Emission Scenario in Local Study Area

Emission Scenario:	Baseline

Emission Scenario	Relevant Averaging Period	Units	Tier	Maximum CALQ3HCR Concentration
Pollutants and Precursors				
CO	1 hr	µg/m^3	1	5039
NOx	1 hr	µg/m^3	2	652
NOx	24 hr	µg/m^3	2	248
SO_2	1 hr	µg/m^3	1	18
SO_2	24 hr	µg/m^3	1	6.9
PM_{10}	24 hr	µg/m^3	2	20
$PM_{2.5}$	24 hr	µg/m^3	2	11.7
VOC	1 hr	ppm	1	0.50
Air Toxics				
benzene	24 hr	µg/m^3	1	6.8
acetaldehyde	24 hr	µg/m^3	1	1.4
formaldehyde	24 hr	µg/m^3	1	3.6
1,3-butadiene	24 hr	µg/m^3	1	0.94
acrolein	24 hr	µg/m^3	2	0.11
benzo (a) pyrene	24 hr	µg/m^3	1	0.0001
Greenhouse Gases				
CO_2	annual	µg/m^3	-	-
N_2O	24 hr	µg/m^3	1	2.6
CH_4	annual	µg/m^3	-	-
Other				
ozone	1 hr	µg/m^3		< 80

Note: ozone estimate includes background ozone.

Table A11-12: Summary of Maximum Modelling Results for 2015 (Construction) Emission Scenario in Local Study Area

Emission Scenario:	2015 (Construction)

Emission Scenario	Relevant Averaging Period	Units	Tier	at Maximum AERMOD Receptor Location[1]		at Maximum CALQ3HCR Receptor Location[2]		Maximum[3] Modelling Concentration
				CALQ3HCR Concentration at Maximum AERMOD Receptor Location	Maximum AERMOD Concentration	Maximum CALQ3HCR Concentration	AERMOD Concentration at Maximum CALQ3HCR Receptor Location	
Pollutants and Precursors								
CO	*1 hr*	*µg/m³*	*1*	*0.40*	*0.36*	*2.5*	*0.055*	*2.6*
NOx	**1 hr**	**µg/m³**	**2**	**120**	**105**	**218**	**15**	**233**
NOx	**24 hr**	**µg/m³**	**2**	**30**	**18**	**84**	**1.130**	**85**
SO_2	*1 hr*	*µg/m³*	*1*	*0.30*	*165*	*1.9*	*17*	*165*
SO_2	*24 hr*	*µg/m³*	*1*	*0.13*	*21*	*0.99*	*0.038*	*21*
PM_{10}	**24 hr**	**µg/m³**	**2**	**8.2**	**37**	**18**	**0.019**	**45**
$PM_{2.5}$	**24 hr**	**µg/m³**	**2**	**1.2**	**2.7**	**6.6**	**0.0982**	**6.7**
VOC	*1 hr*	*ppm*	*1*	-	-	*0.20*	-	-
Air Toxics								
benzene	*24 hr*	*µg/m³*	*1*	-	-	*3.4*	-	-
acetaldehyde	*24 hr*	*µg/m³*	*1*	-	-	*0.66*	-	-
formaldehyde	*24 hr*	*µg/m³*	*1*	-	-	*2.1*	-	-
1,3-butadiene	*24 hr*	*µg/m³*	*1*	-	-	*0.38*	-	-
acrolein	*24 hr*	*µg/m³*	*2 (1)*	-	-	*0.054*	-	-
benzo (a) pyrene	*24 hr*	*µg/m³*	*1*	-	-	*< 0.00001*	-	-
Greenhouse Gases								
CO_2	*annual*	*µg/m³*	-	-	-	-	-	-
N_2O	*24 hr*	*µg/m³*	*1*	-	-	*3.2*	-	-
CH_4	*annual*	*µg/m³*	-	-	-	-	-	-
Other								
ozone	*1 hr*	*µg/m³*	*0*	-	-	*< 80*	-	-

Note: (1) represented by the maximum concentration receptor predicted with AERMOD for construction activities. The contribution from vehicles travelling on the bridge, Huron Church Road and Arterial Roads predicted with CALQ3HCR at this same receptor are given.

Note: (2) represented by the maximum concentration receptor predicted with CALQ3HCR from vehicles travelling on the bridge, Huron Church Road and Arterial Roads. The contribution from construction activities predicted with AERMOD at this same receptor are given.
Note: (3) represents the overall maximum concentration considering both construction activities and vehicle traffic.
Note: ozone estimate includes background ozone.

Table A11-13: Summary of Maximum Modelling Results for 2015 (Operation) Emission Scenario in Local Study Area

Emission Scenario:	2015 (Operation)

Emission Scenario	Relevant Averaging Period	Units	Tier	Maximum CALQ3HCR Concentration
Pollutants and Precursors				
CO	*1 hr*	*ppm*	*1*	*2.5*
NOx	**1 hr**	**µg/m^3**	**2**	**218**
NOx	**24 hr**	**µg/m^3**	**2**	**84**
SO_2	*1 hr*	*µg/m^3*	*1*	*1.9*
SO_2	*24 hr*	*µg/m^3*	*1*	*0.99*
PM_{10}	**24 hr**	**µg/m^3**	**2**	**18**
$PM_{2.5}$	**24 hr**	**µg/m^3**	**2**	**6.6**
VOC	*1 hr*	*ppm*	*1*	*0.20*
Air Toxics				
benzene	*24 hr*	*µg/m^3*	*1*	*3.4*
acetaldehyde	*24 hr*	*µg/m^3*	*1*	*0.66*
formaldehyde	*24 hr*	*µg/m^3*	*1*	*2.1*
1,3-butadiene	*24 hr*	*µg/m^3*	*1*	*0.38*
acrolein	*24 hr*	*µg/m^3*	*2 (1)*	*0.054*
benzo (a) pyrene	*24 hr*	*µg/m^3*	*1*	*< 0.00001*
Greenhouse Gases				
CO_2	*annual*	*µg/m^3*	-	-
N_2O	*24 hr*	*µg/m^3*	*1*	*3.2*
CH_4	*annual*	*µg/m^3*	-	-
Other				
ozone	*1 hr*	*µg/m^3*		*< 80*

Note: ozone estimate includes background ozone.

Table A11-14: Summary of Maximum Modelling Results for 2025 (FDN) Emission Scenario in Local Study Area

Emission Scenario:	2025 (FDN)

Emission Scenario	Relevant Averaging Period	Units	Tier	Maximum CALQ3HCR Concentration
Pollutants and Precursors				
CO	*1 hr*	*ppm*	*1*	*2.6*
NOx	**1 hr**	**µg/m^3**	**2**	**106**
NOx	**24 hr**	**µg/m^3**	**2**	**38**
SO_2	*1 hr*	*µg/m^3*	*1*	*2.2*
SO_2	*24 hr*	*µg/m^3*	*1*	*1.3*
PM_{10}	**24 hr**	**µg/m^3**	**2**	**21**
$PM_{2.5}$	**24 hr**	**µg/m^3**	**2**	**7.3**
VOC	*1 hr*	*ppm*	*1*	*0.40*
Air Toxics				
benzene	*24 hr*	*µg/m^3*	*1*	*2.9*
acetaldehyde	*24 hr*	*µg/m^3*	*1*	*0.72*
formaldehyde	*24 hr*	*µg/m^3*	*1*	*2.2*
1,3-butadiene	*24 hr*	*µg/m^3*	*1*	*0.21*
acrolein	*24 hr*	*µg/m^3*	*2*	*0.044*
benzo (a) pyrene	*24 hr*	*µg/m^3*	*1*	*< 0.00001*
Greenhouse Gases				
CO_2	*annual*	*µg/m^3*	-	-
N_2O	*24 hr*	*µg/m^3*	*1*	*4.2*
CH_4	*annual*	*µg/m^3*	-	-
Other				
ozone	*1 hr*	*µg/m^3*		*< 130*

Note: 2025 (FDN) refers to future operation of existing bridge only.
Note: ozone estimate includes background ozone.

Table A11-15: Summary of Maximum Modelling Results for 2025 (A) Emission Scenario in Local Study Area

Emission Scenario:	2025 (A)

Emission Scenario	Relevant Averaging Period	Units	Tier	Maximum CALQ3HCR Concentration
Pollutants and Precursors				
CO	*1 hr*	*ppm*	*1*	*2.0*
NOx	**1 hr**	**µg/m^3**	**2**	**106**
NOx	**24 hr**	**µg/m^3**	**2**	**38**
SO_2	*1 hr*	*µg/m^3*	*1*	*2.2*
SO_2	*24 hr*	*µg/m^3*	*1*	*1.3*
PM_{10}	**24 hr**	**µg/m^3**	**2**	**21**
$PM_{2.5}$	**24 hr**	**µg/m^3**	**2**	**7.3**
VOC	*1 hr*	*ppm*	*1*	*0.23*
Air Toxics				
benzene	*24 hr*	*µg/m^3*	*1*	*2.9*
acetaldehyde	*24 hr*	*µg/m^3*	*1*	*1.3*
formaldehyde	*24 hr*	*µg/m^3*	*1*	*3.6*
1,3-butadiene	*24 hr*	*µg/m^3*	*1*	*0.21*
acrolein	*24 hr*	*µg/m^3*	*2*	*0.034*
benzo (a) pyrene	*24 hr*	*µg/m^3*	*1*	*< 0.00001*
Greenhouse Gases				
CO_2	*annual*	*µg/m^3*	-	-
N_2O	*24 hr*	*µg/m^3*	*1*	*4.3*
CH_4	*annual*	*µg/m^3*	-	-
Other				
ozone	*1 hr*	*µg/m^3*		*< 130*

Note: 2025 (A) refers to future operation of ABEP only.
Note: ozone estimate includes background ozone.

Table A11-16: Summary of Maximum Modelling Results for 2025 (B) Emission Scenario in Local Study Area

Emission Scenario:	2025 (B)

Emission Scenario	Relevant Averaging Period	Units	Tier	Maximum CALQ3HCR Concentration
Pollutants and Precursors				
CO	*1 hr*	*ppm*	*1*	*2.4*
NOx	**1 hr**	**µg/m^3**	**2**	**106**
NOx	**24 hr**	**µg/m^3**	**2**	**38**
SO_2	*1 hr*	*µg/m^3*	*1*	*2.2*
SO_2	*24 hr*	*µg/m^3*	*1*	*1.3*
PM_{10}	**24 hr**	**µg/m^3**	**2**	**21**
$PM_{2.5}$	**24 hr**	**µg/m^3**	**2**	**7.3**
VOC	*1 hr*	*ppm*	*1*	*0.23*
Air Toxics				
benzene	*24 hr*	*µg/m^3*	*1*	*2.9*
acetaldehyde	*24 hr*	*µg/m^3*	*1*	*1.3*
formaldehyde	*24 hr*	*µg/m^3*	*1*	*3.6*
1,3-butadiene	*24 hr*	*µg/m^3*	*1*	*0.21*
acrolein	*24 hr*	*µg/m^3*	*2*	*0.034*
benzo (a) pyrene	*24 hr*	*µg/m^3*	*1*	*< 0.00001*
Greenhouse Gases				
CO_2	*annual*	*µg/m^3*	-	-
N_2O	*24 hr*	*µg/m^3*	*1*	*4.3*
CH_4	*annual*	*µg/m^3*	-	-
Other				
ozone	*1 hr*	*µg/m^3*		*< 130*

Note: 2025 (B) refers to future operation of ABEP plus existing bridge.
Note: ozone estimate includes background ozone.

Figure A11-1: Links and Receptors for Local Study Area

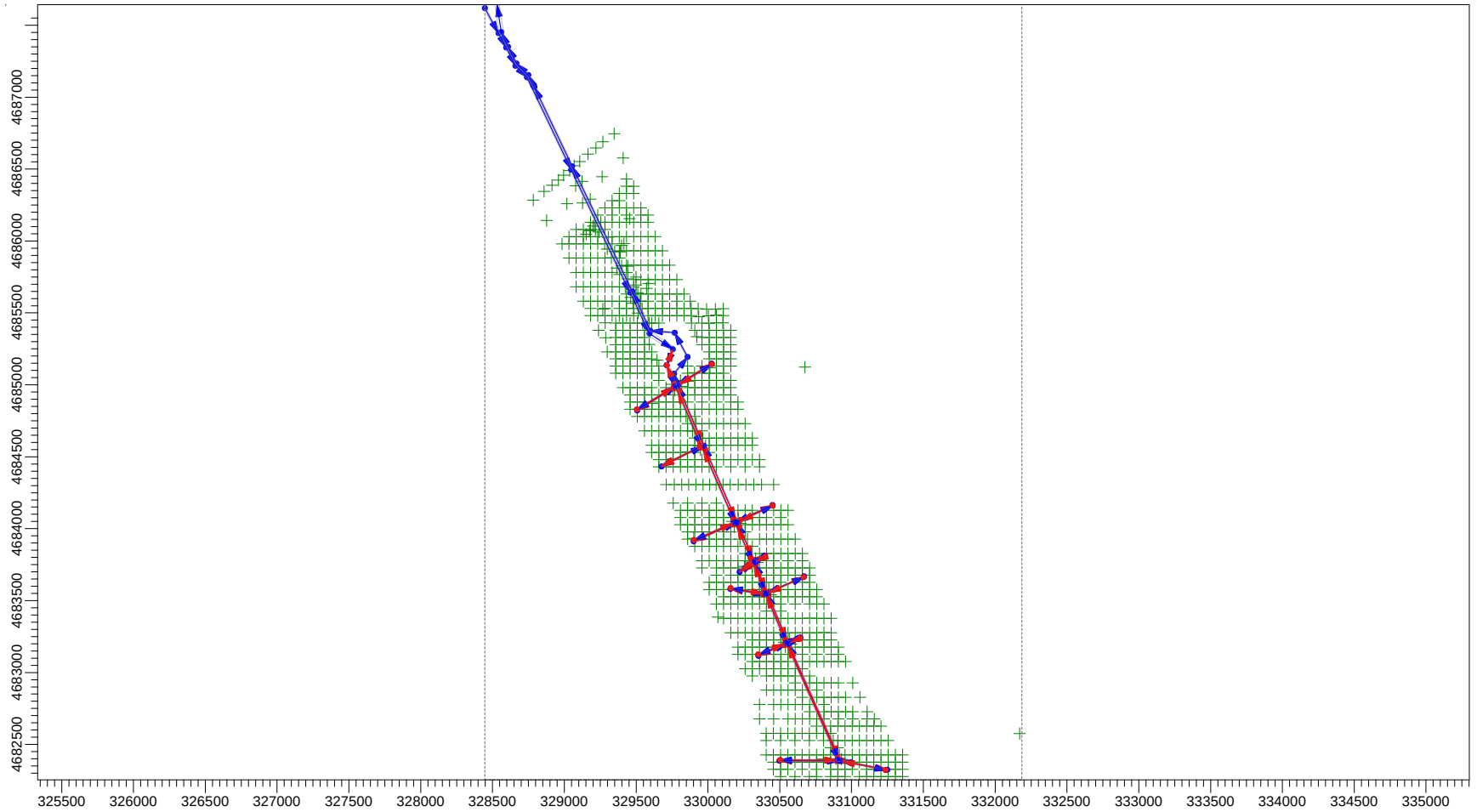


Figure A11-3: Receptors for Modelling Construction Activities

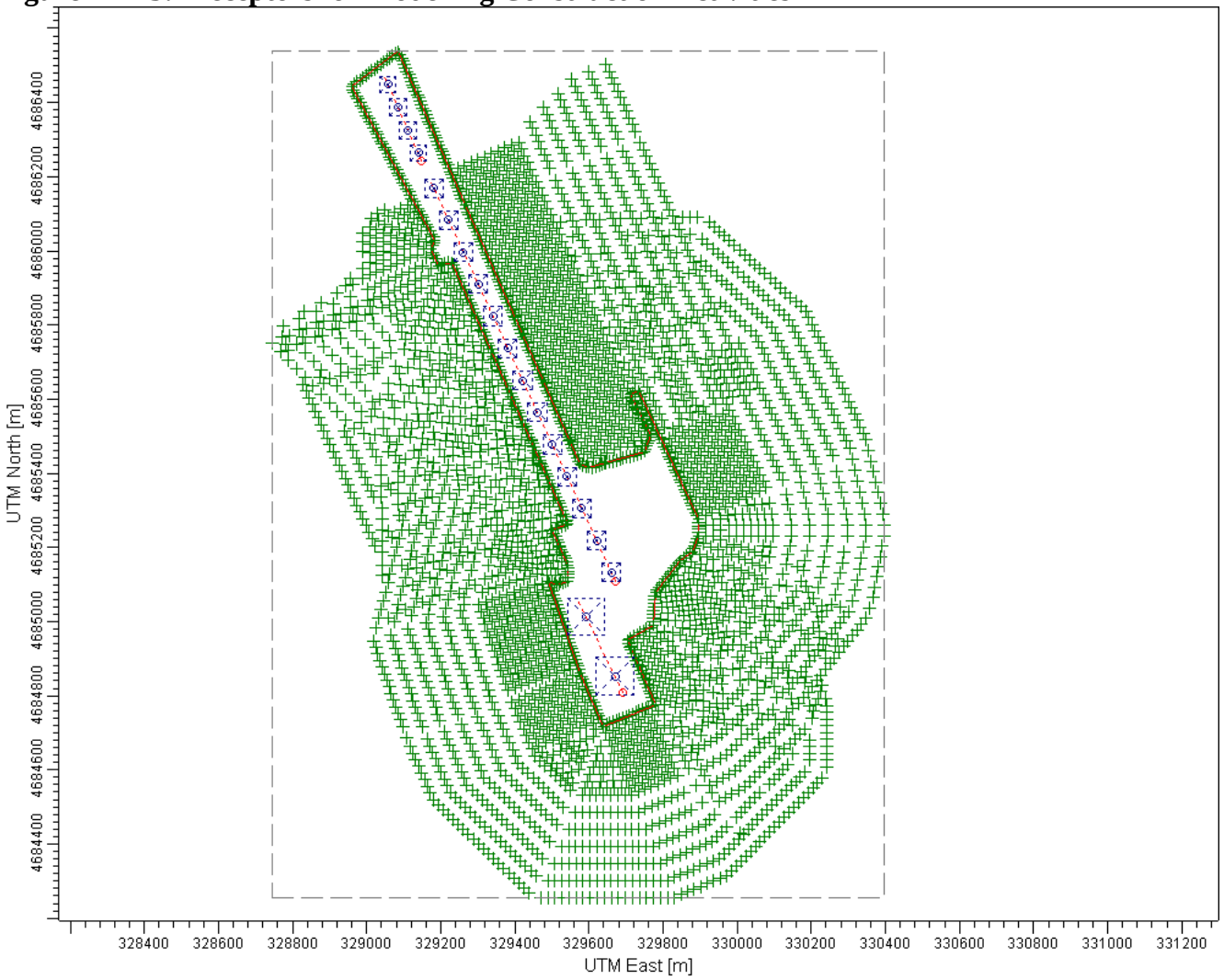


Figure A11-5: Cross Section Profile for PM_{10} (Baseline and 2025(FDN) Scenarios)

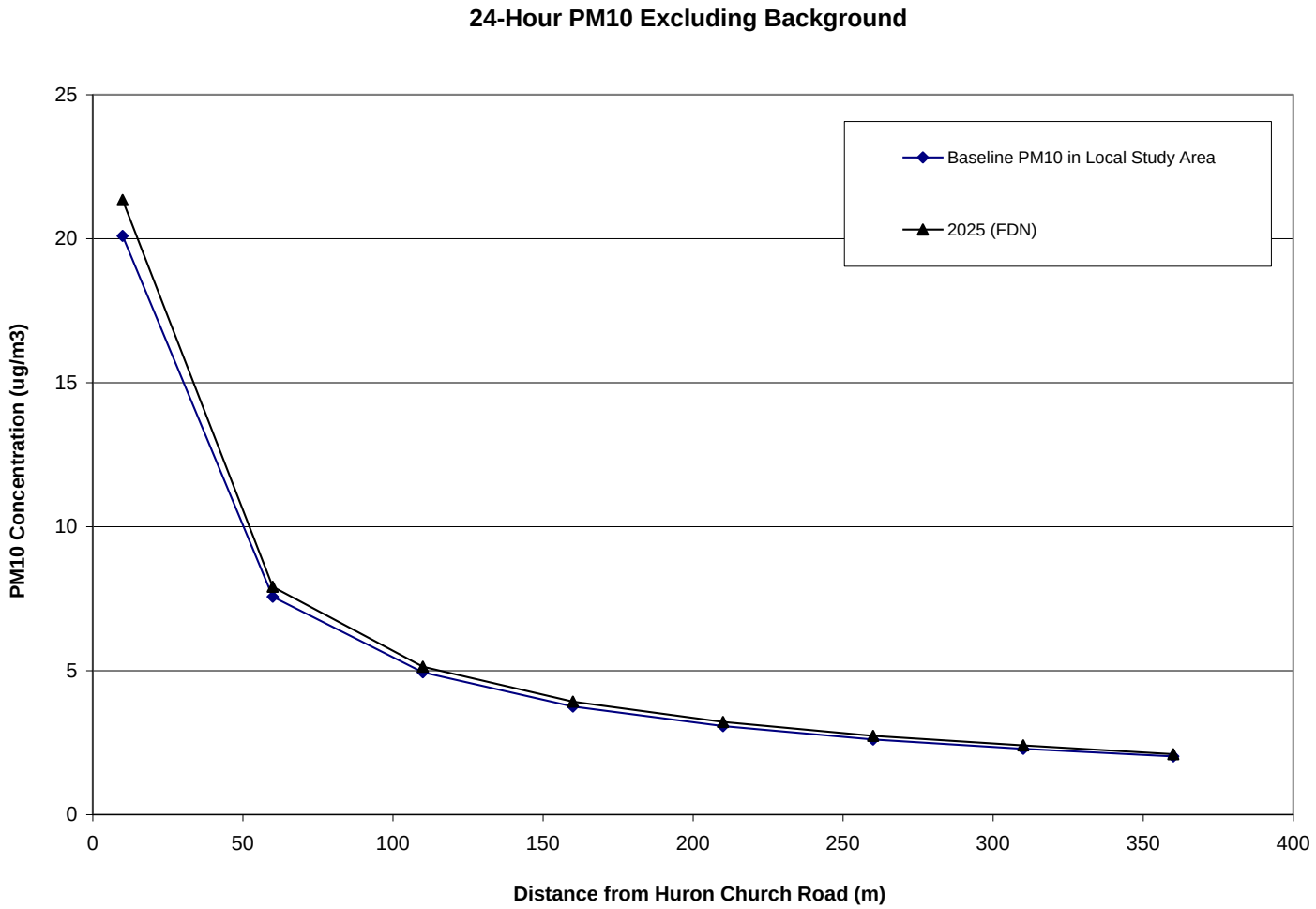
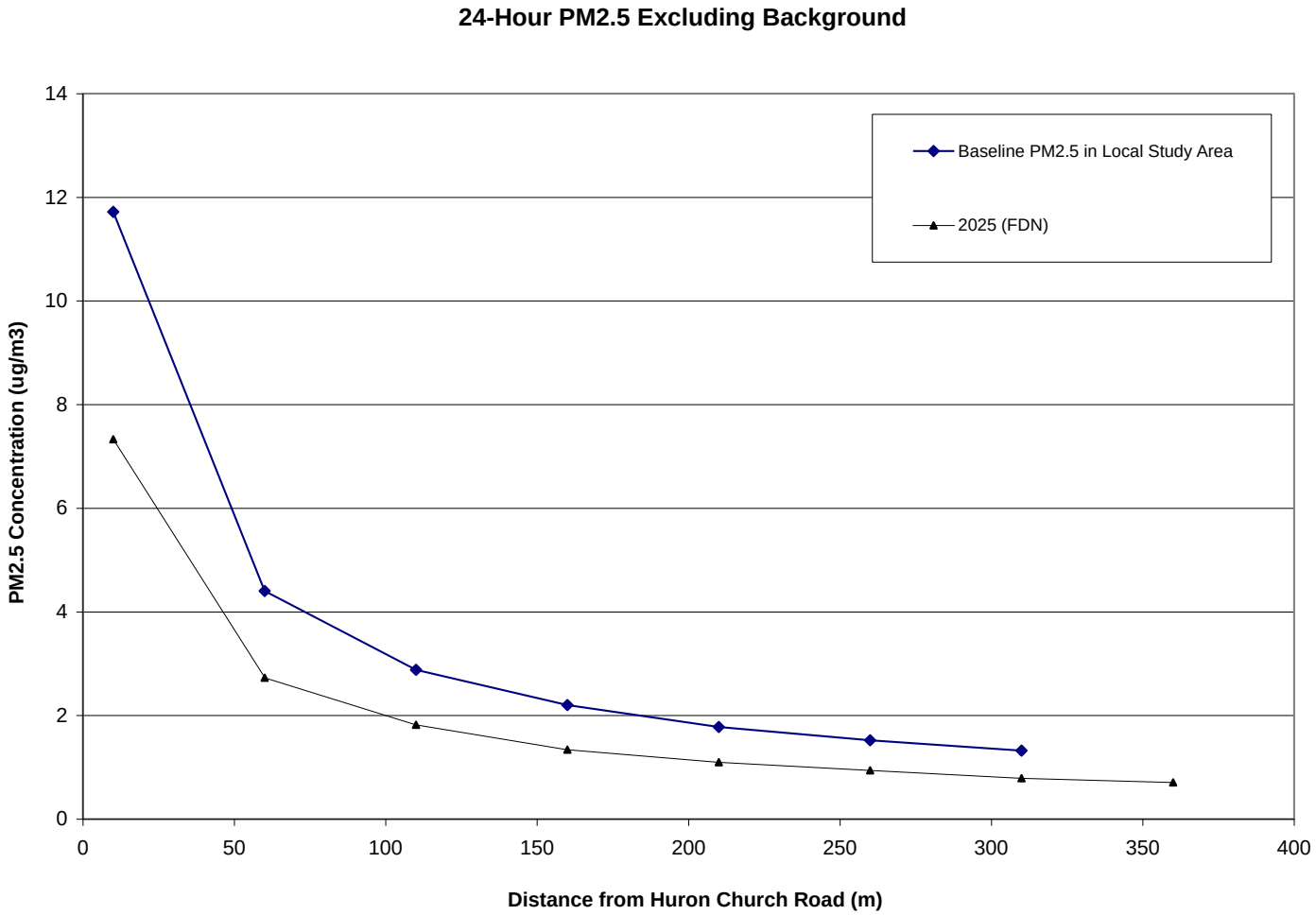


Figure A11-6: Cross Section Profile for $PM_{2.5}$ (Baseline and 2025(FDN) Scenarios)



APPENDIX 12

Ozone Isopleth Method
(2 pages)

A12-1: Background Approach

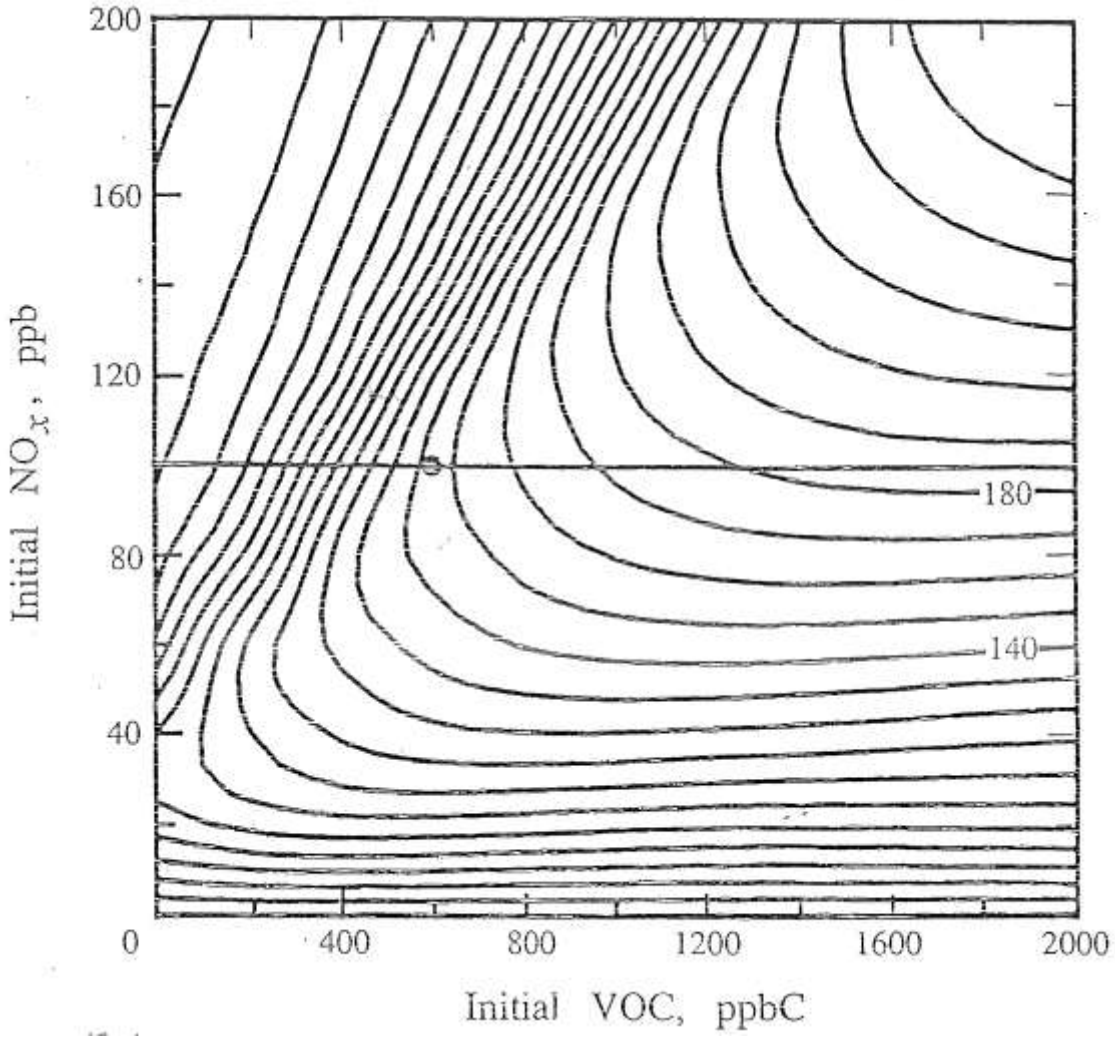
To address the potential impacts due to O_3 (ground level ozone), the NO_X and VOC (NMHC) output from the CAL3QHCR model was combined with the Ozone Isopleth Method (Seinfeld, J.H. and S. N. Pandis, Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, John Wiley, NY, 1326 pages, 1998). This method uses emission changes in O_3 precursors (e.g. NO_X and VOCs) and their ratio to predict maximum downwind ambient O_3 concentration changes. As the factors involved in ozone generation are complex, only an approximation can be expected by this simplified method.

A reported O_3 isopleth profile for Atlanta, as a function of initial NO_X and NMHC concentrations within the downtown urban source area in combination with box model simulations and other fixed conditions, is shown in Figure A12-1. The resulting downwind short-term maximum O_3 concentrations, which include a background level representative of the region, are then depicted by the empirically-based isopleths contours. This approach may be applicable to other urban areas with the assumption of similar air shed conditions (e.g., background VOC species concentrations, mixing heights, upper air O_3/VOC levels which enter the cell as well as relevant solar/meteorological conditions).

A12-2: Data Application

The maximum modelling concentrations of the mobile source NO_X and NMHC for the baseline and future years were applied to the isopleths to predict the approximate peak O_3 concentrations which would occur downwind of the source area. The calculated source NMHC concentrations were converted to the relevant ppb_c units on the basis that the mobile NMHC emissions represented propane-equivalent emission rates. It was also assumed that the predicted peak ozone concentrations represented hourly averaged levels. For the present (baseline), and future years (2011 representing 2015 and 2021 representative of 2025) the predicted maximum ozone concentrations were beyond the isopleth plot boundaries and presumed below the lowest extrapolated O_3 isobar concentration (VOC limited region below the elevated ozone ridge). These conditions were predicted to result in peak downwind ozone concentrations, including background, of <80 $\mu g/m^3$ (≈ <40 ppb). The future year operating scenarios predict peak downwind O_3 concentrations, including background, in the range of approximately <80 to 110 $\mu g/m^3$ (≈ <40 to 55 ppb) and was assigned a conservative value of <130 $\mu g/m^3$ (≈ 65 ppb) ozone. It is pertinent to note that the maximum hourly O_3 concentration measured at either of the two MOE Windsor sites during 2005 was approximately 220 $\mu g/m^3$ or 111 ppb (see Appendix 2, Table A2-3) which most likely reflects input for other distant source emissions.

Figure A12-1: Ozone isopleths plot based on simulations of chemistry along air trajectories in Atlanta (Jeffries and Crouse, 1990). Each isopleths is 10 ppb higher in O_3 as one moves upward and to the right (Seinfeld and Pandis, 1998)



APPENDIX 13

Concentration Contours
(18 pages)

Figure A13-1: Nitrogen Oxides (24-hour) – Present (Baseline)

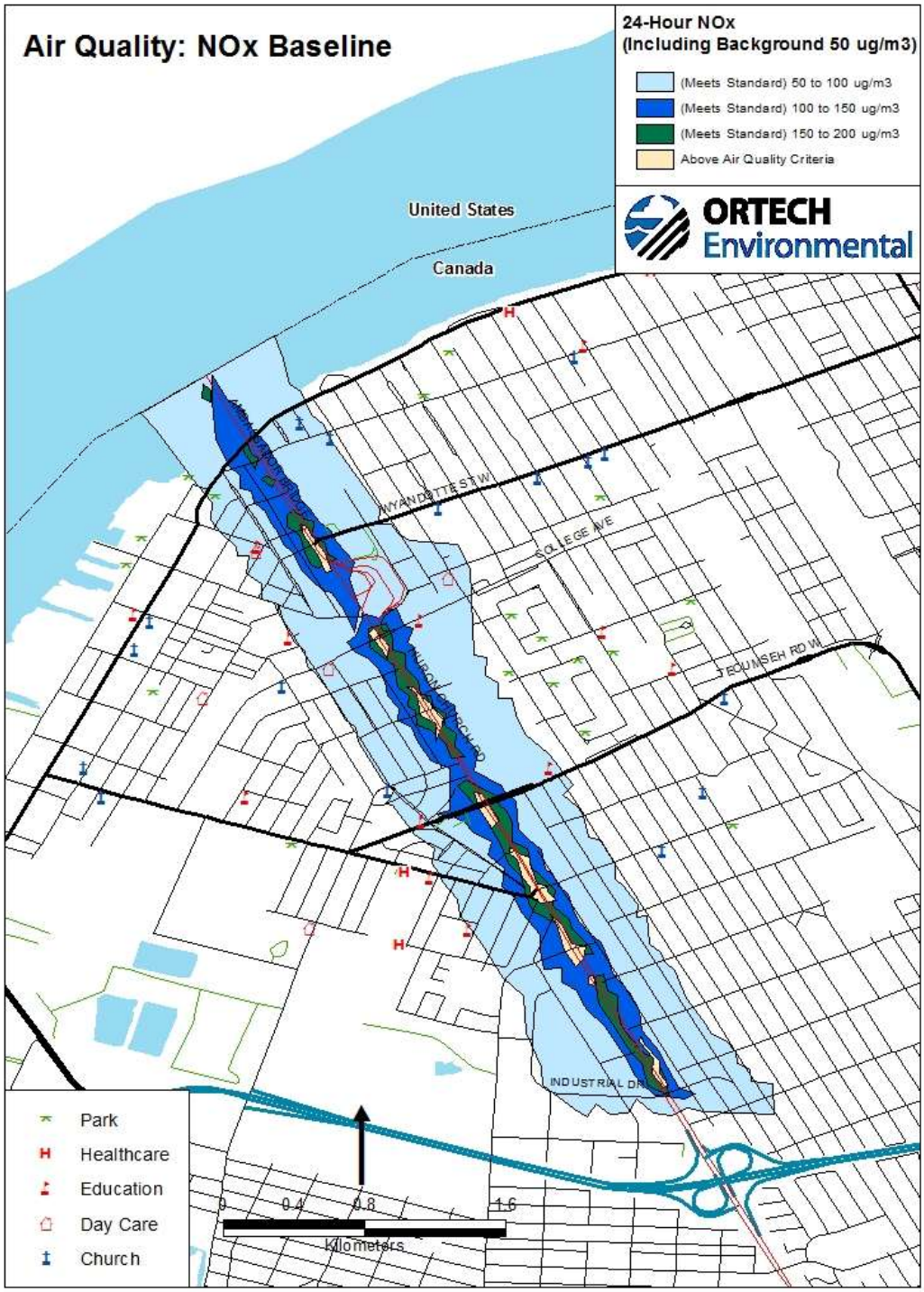


Figure A13-2: Nitrogen Oxides (24-hour) – 2015 Operation (ABEP)

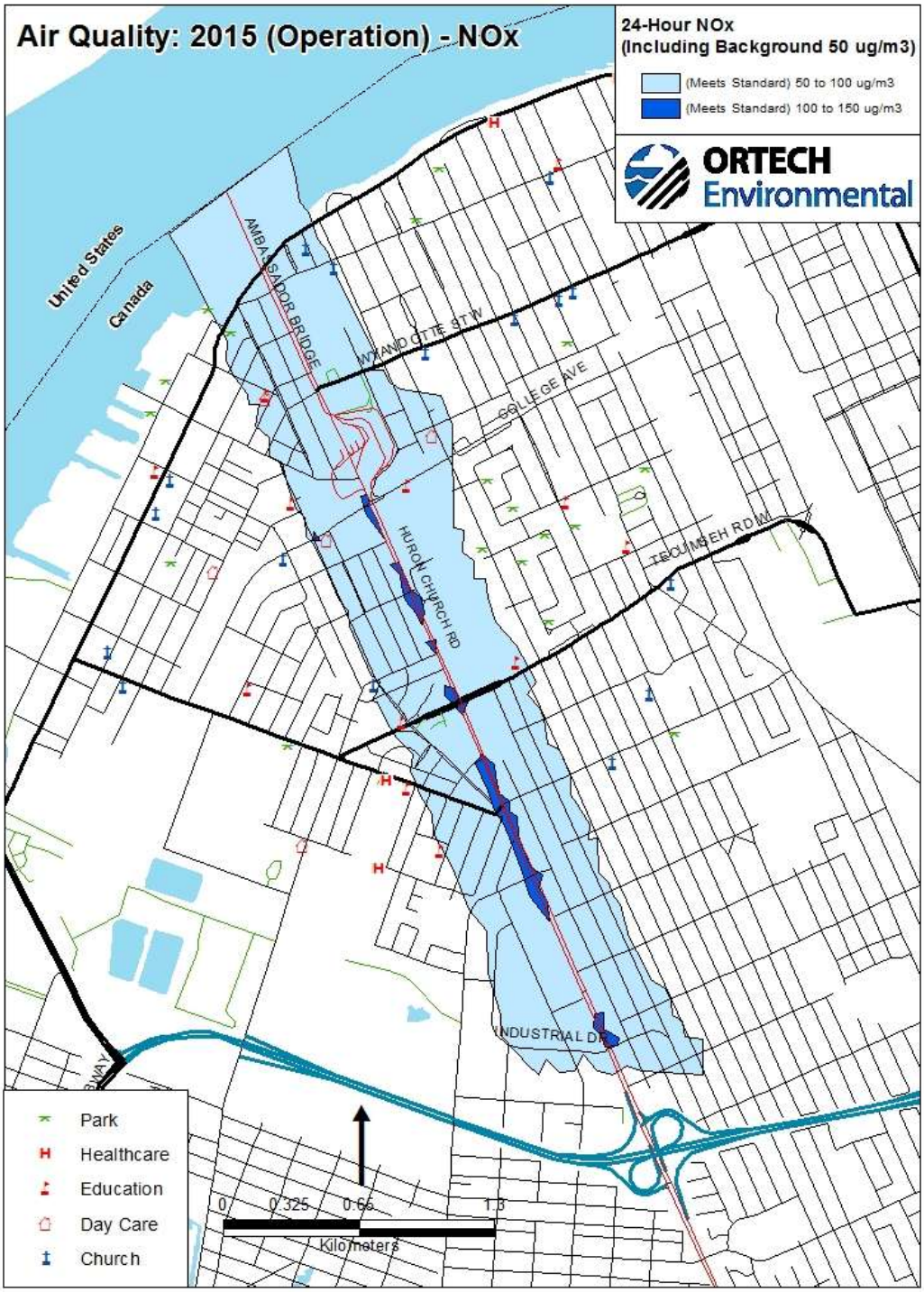


Figure A13-3: Nitrogen Oxides (24 hour) – 2015 Operation (ABEP) and Construction

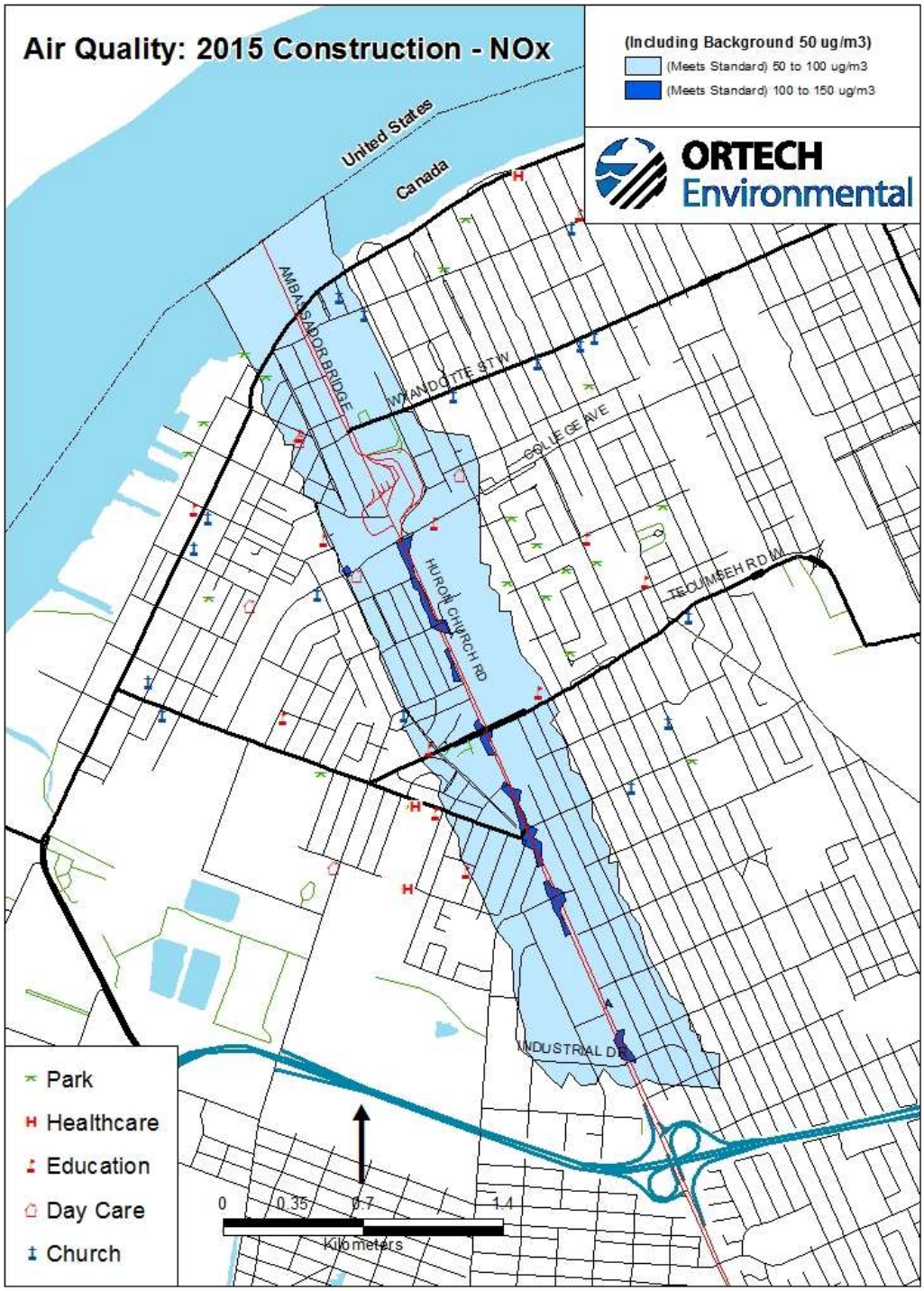


Figure A13-4: Nitrogen Oxides (24-hour) – 2025 (FDN)

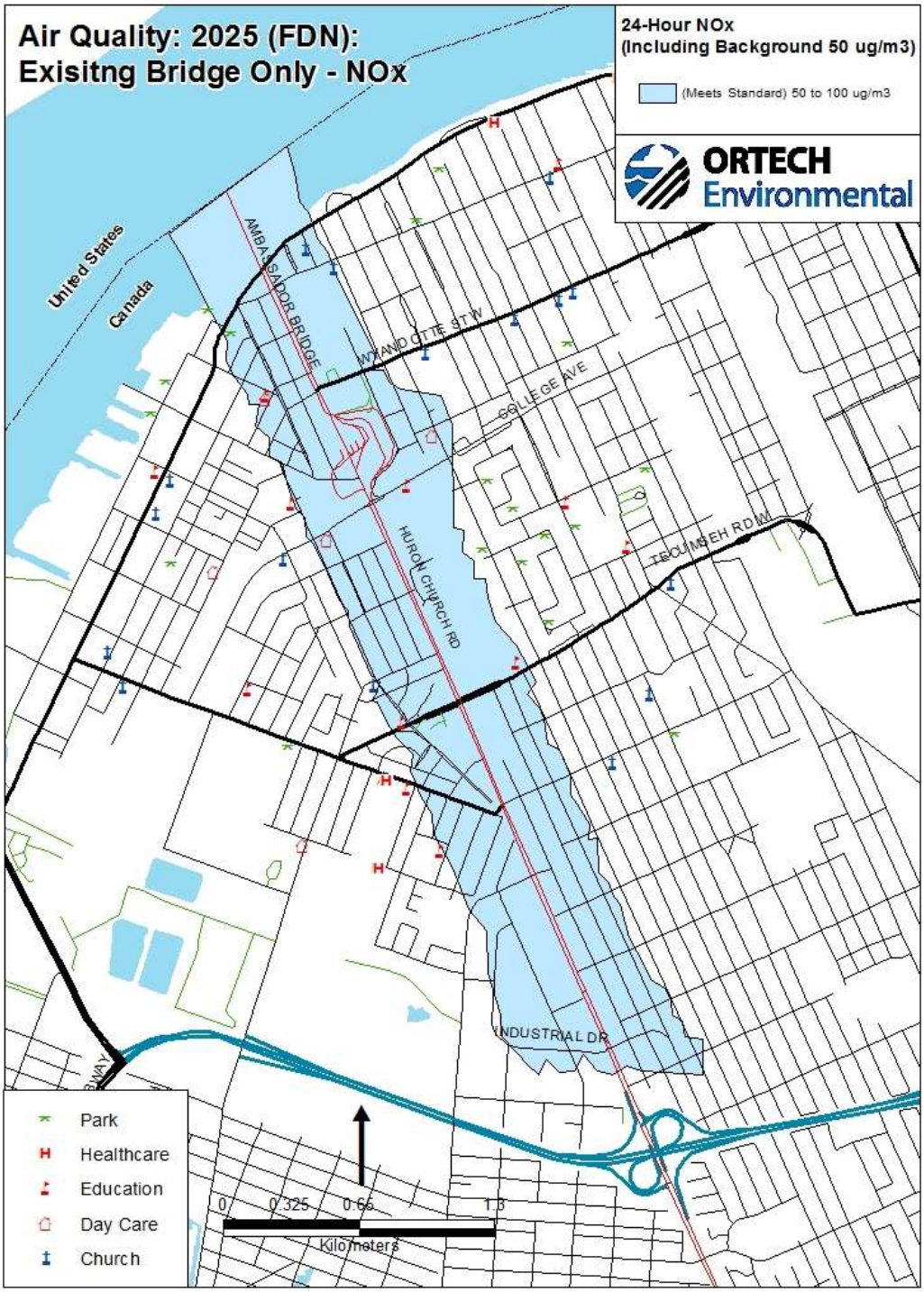


Figure A13-5: Nitrogen Oxides (24-hour) – 2025 (A)

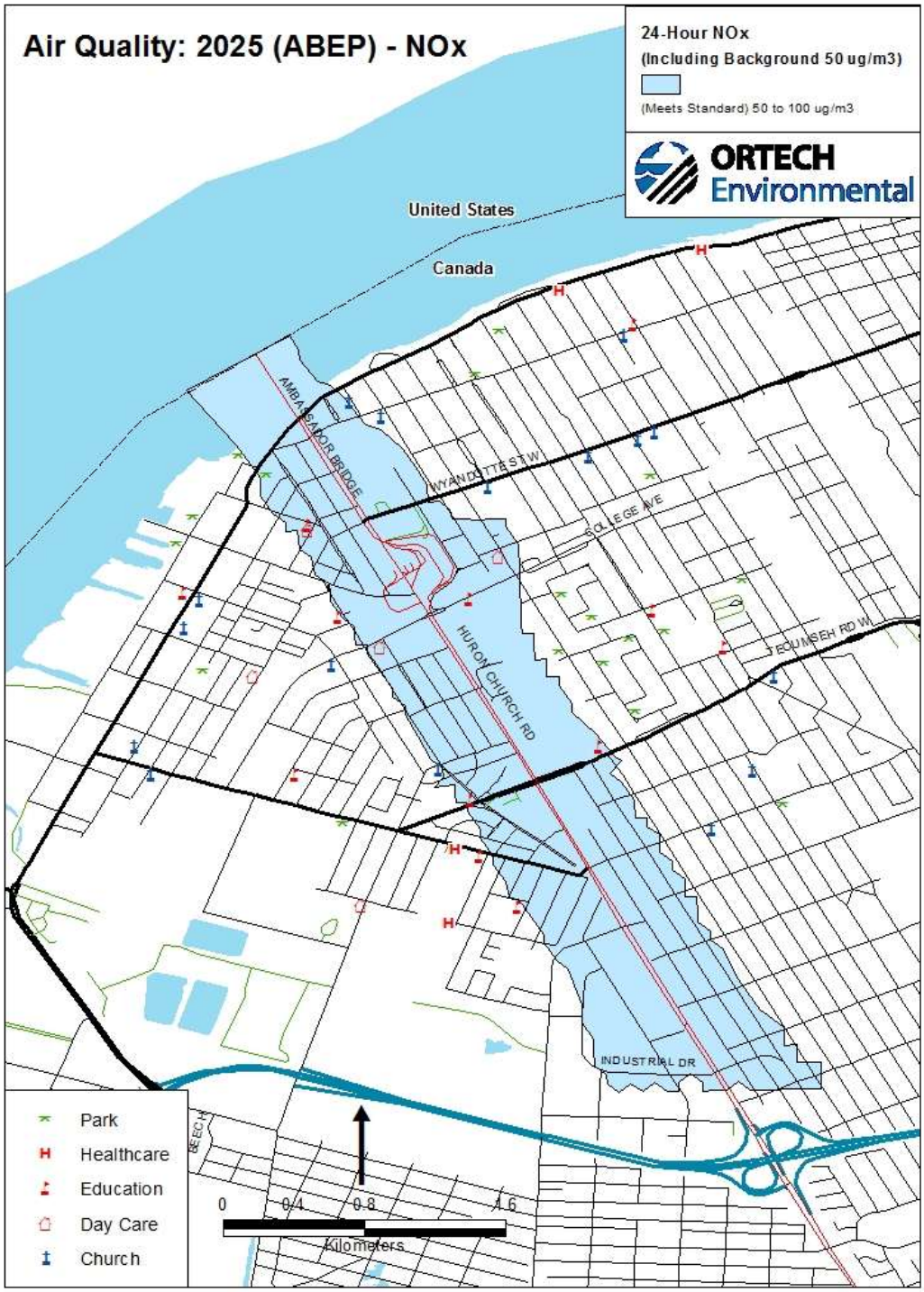


Figure A13-6: Nitrogen Oxides (24-hour) – 2025 (B)

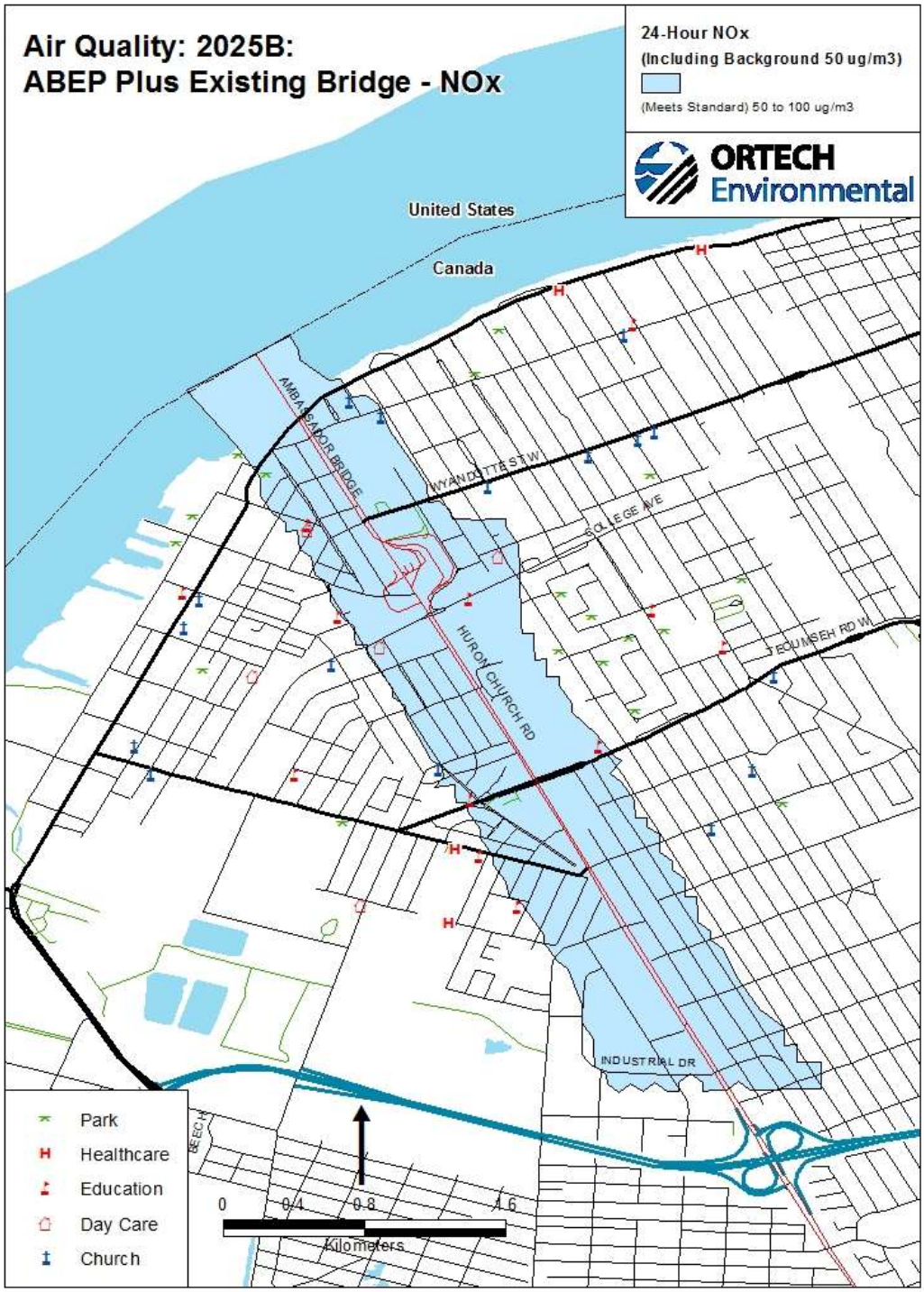


Figure A13-7: PM10 (24 hour) - Baseline

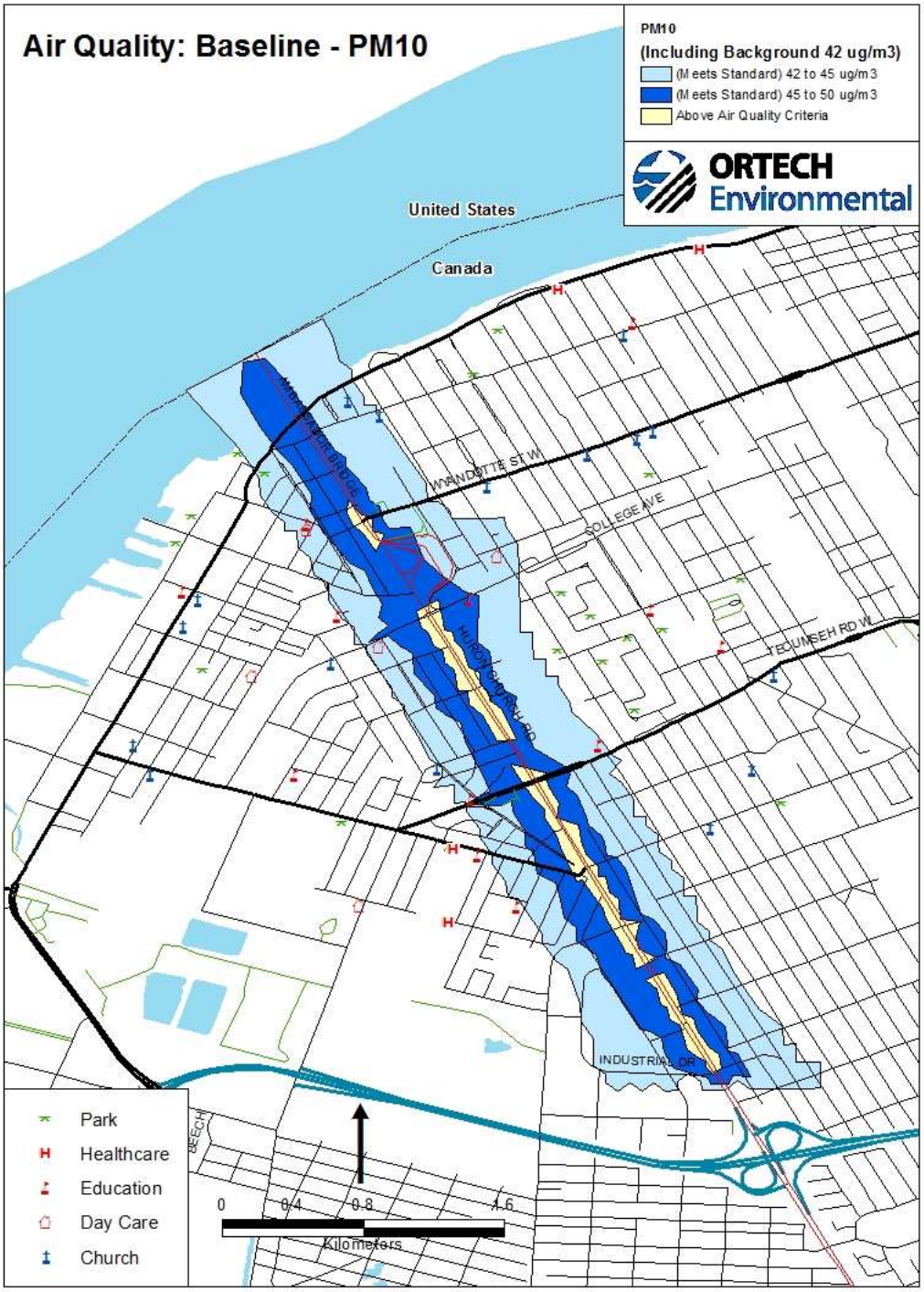


Figure A13-8: PM10 (24 hour) – 2015 Operation (ABEP)

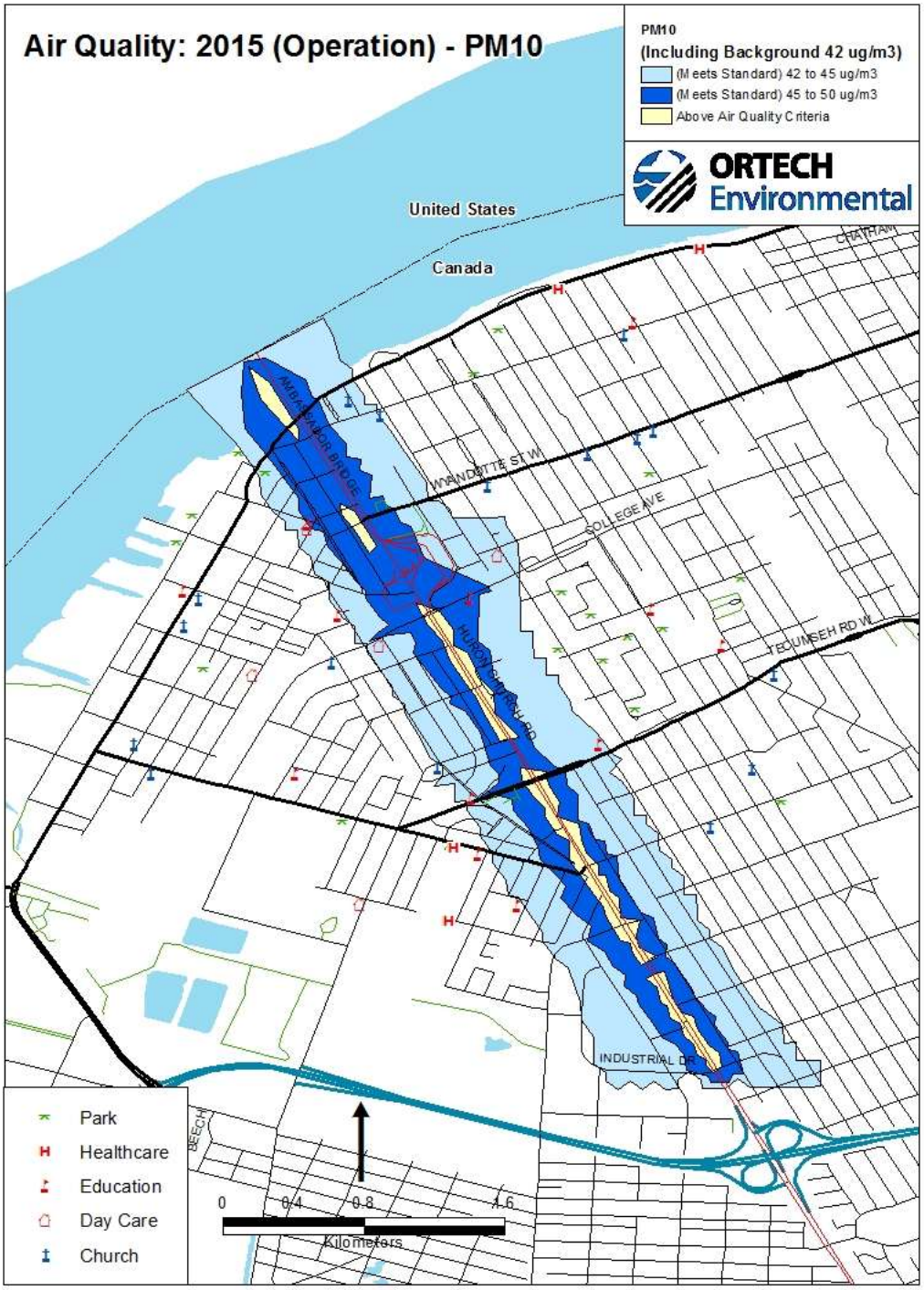


Figure A13-9: PM10 (24 hour) – 2015 Construction and Operation (ABEP)

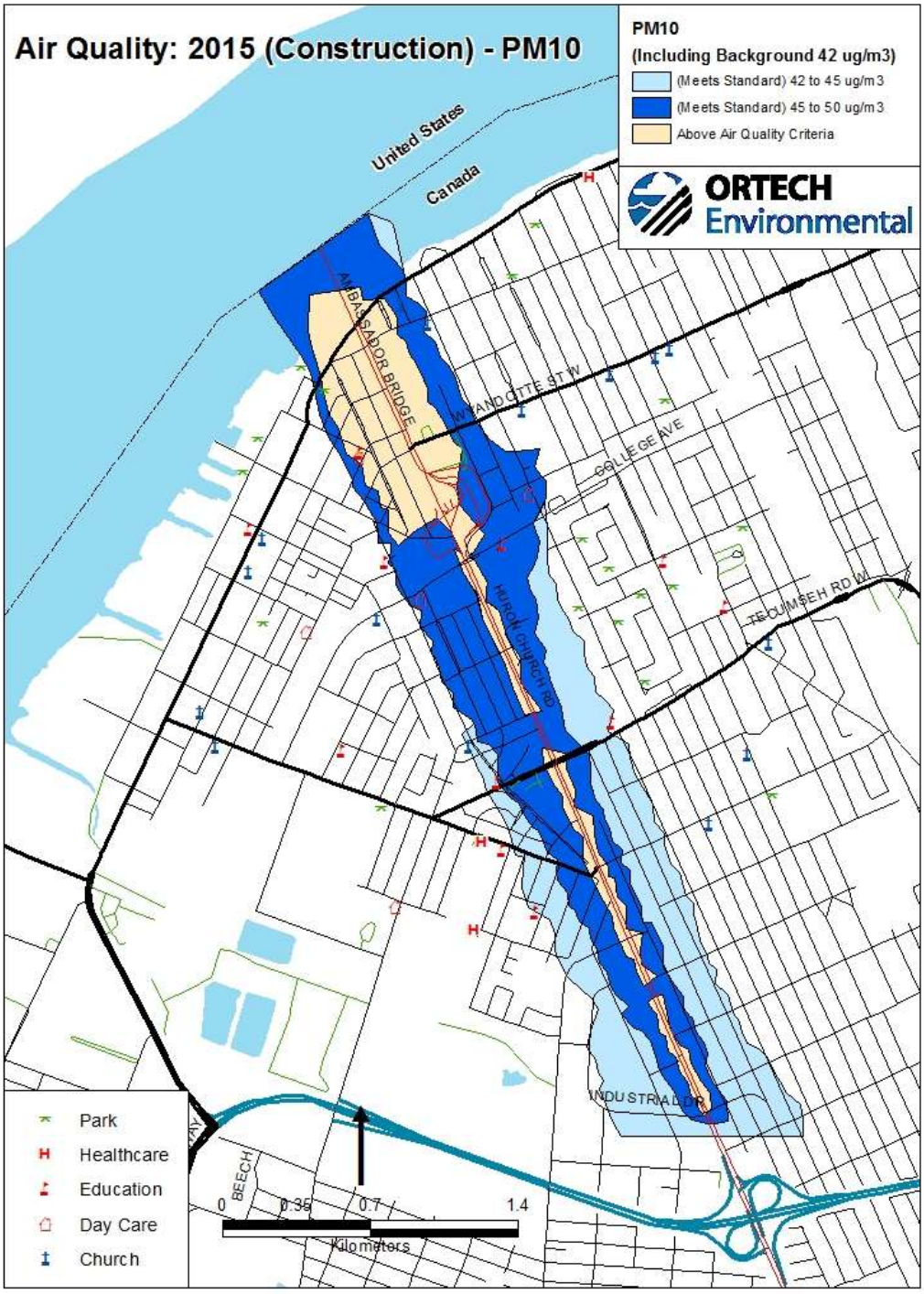


Figure A13-10: PM10 (24 hour) – 2025 Future Do Nothing

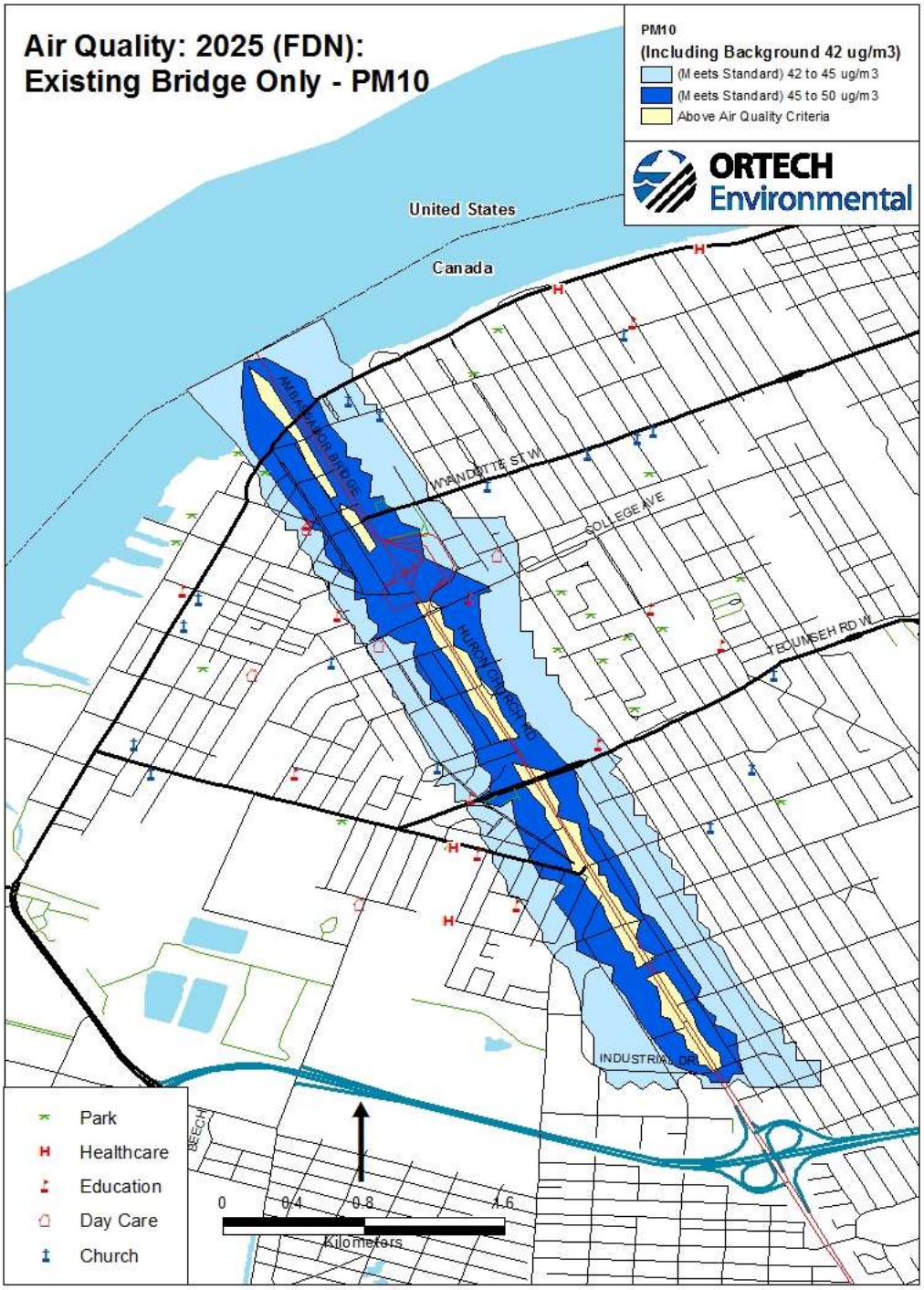


Figure A13-11: PM10 (24 hour) – 2025 (A) Operation (ABEP)

Figure A13-12: PM10 (24 hour) – 2025 (B)

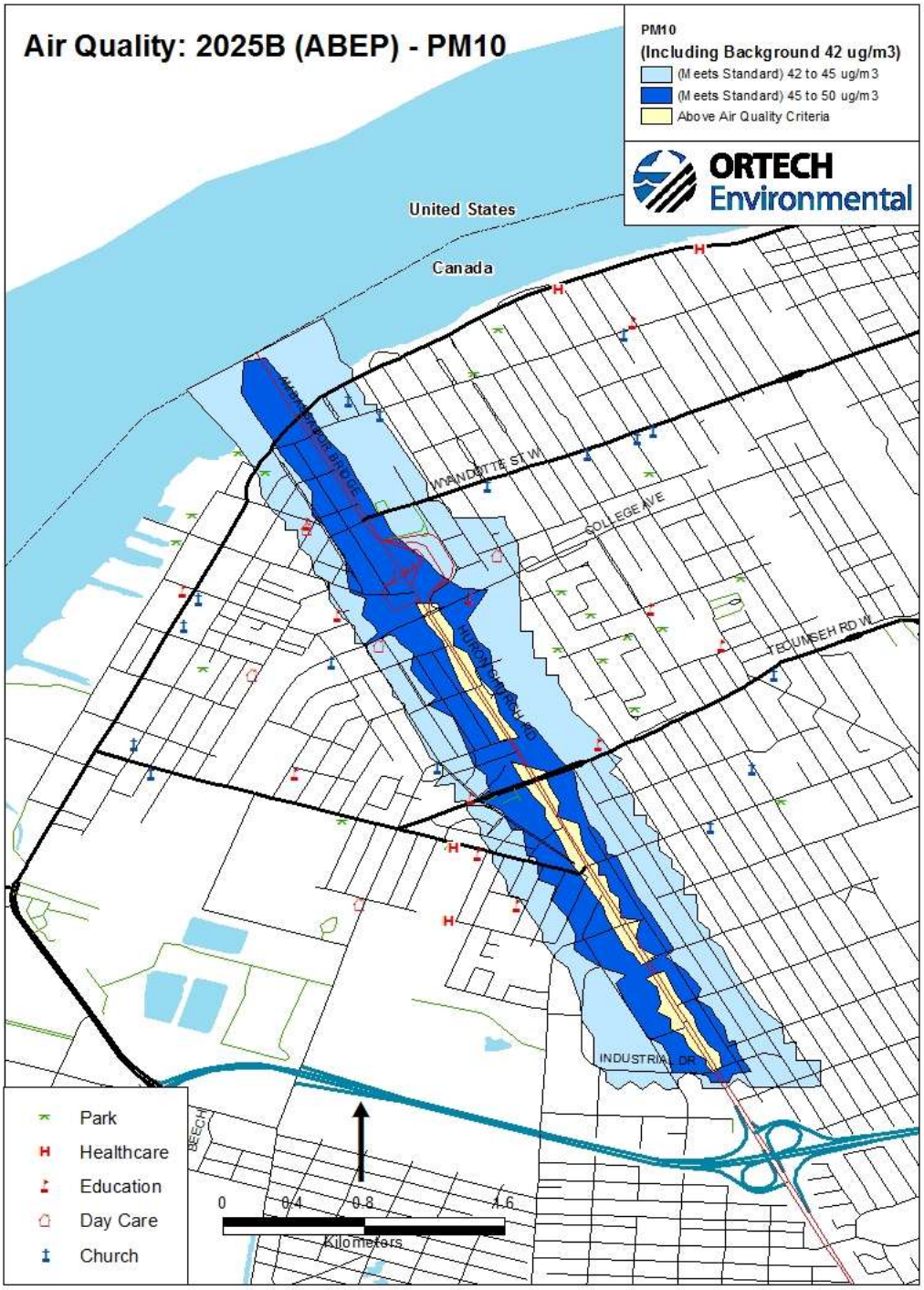


Figure A13-13: $PM_{2.5}$ (24-hour) – Present (Baseline)

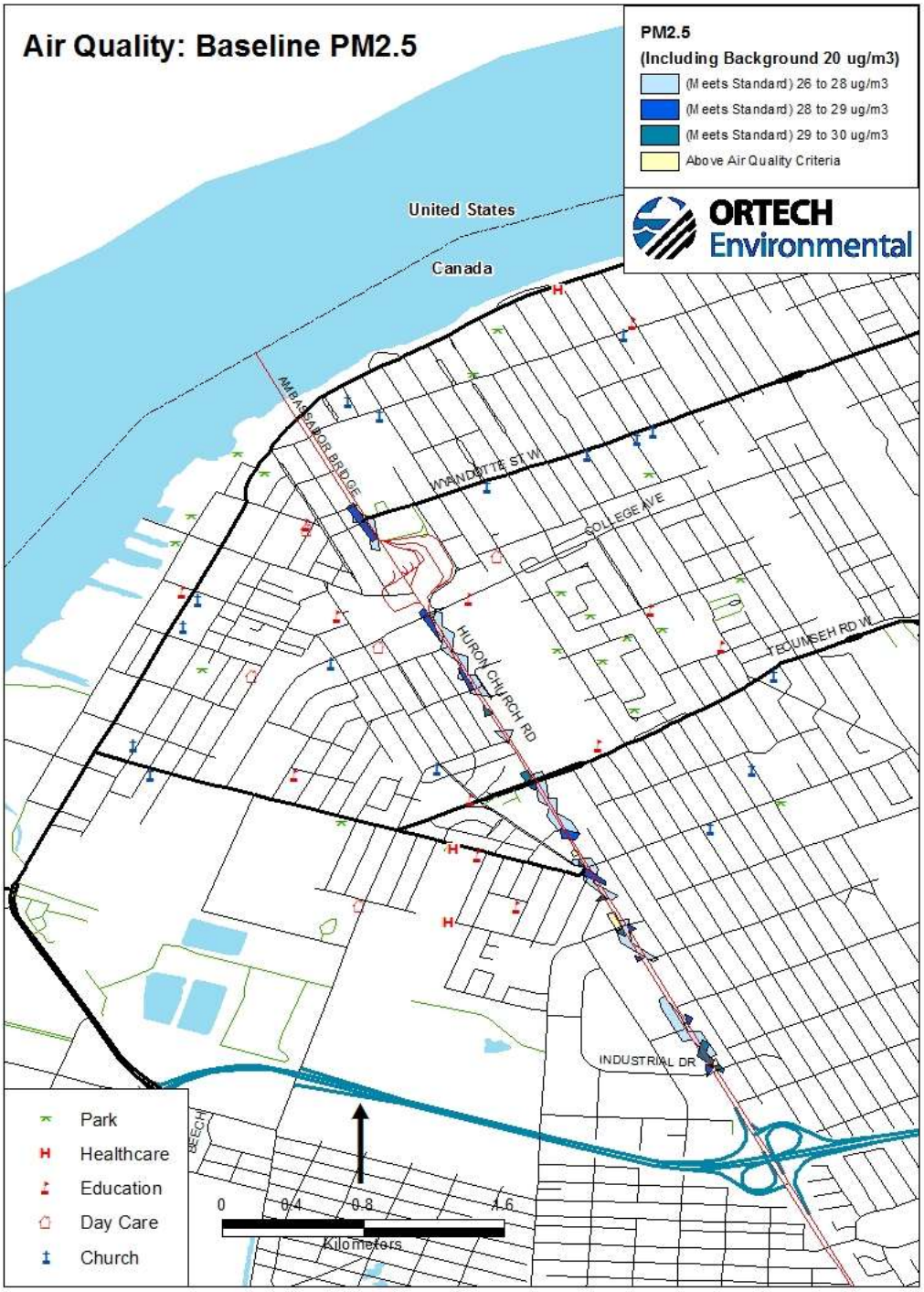


Figure A13-14: $PM_{2.5}$ (24-hour) – 2015 Operation (ABEP)

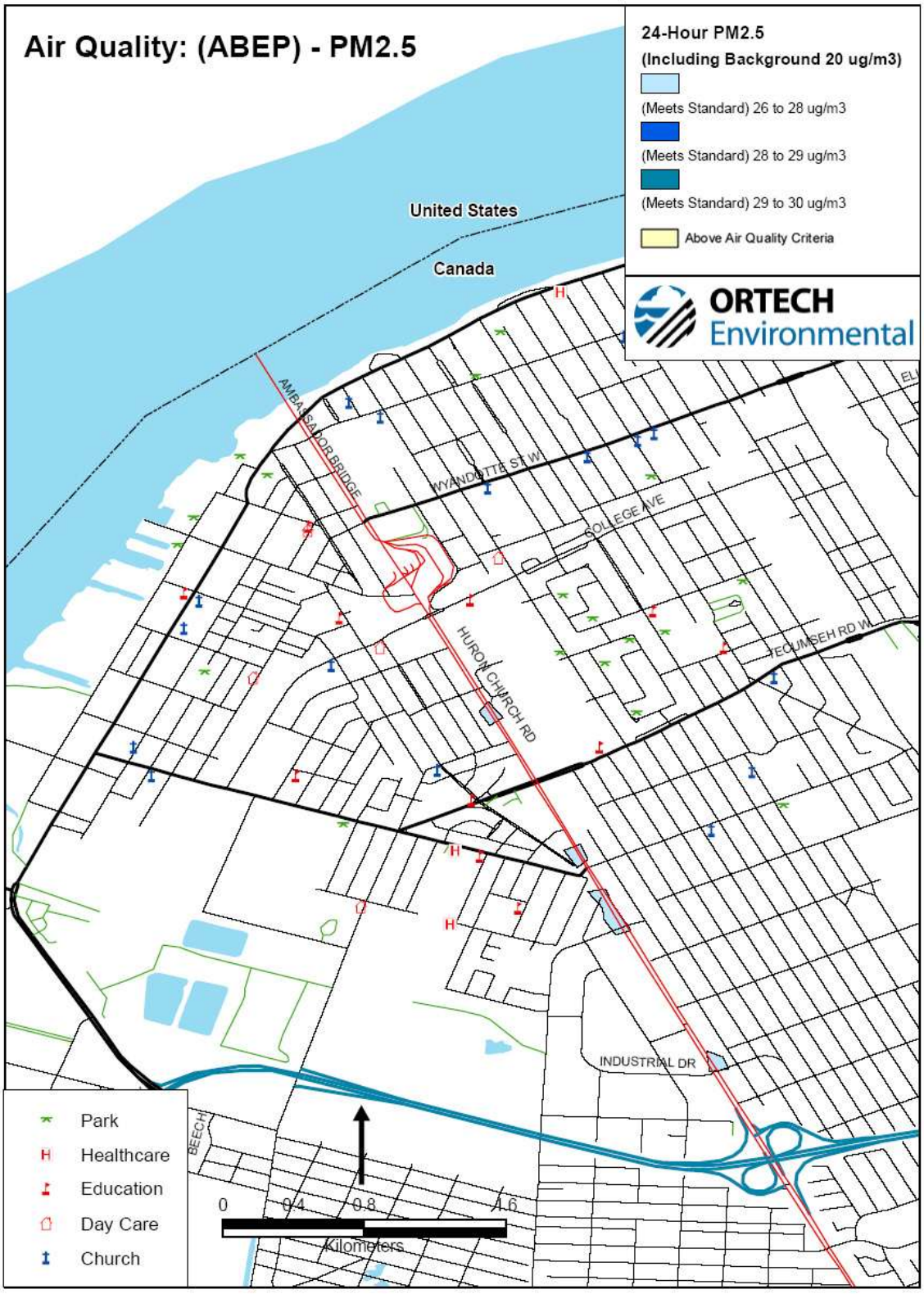


Figure A13-15: $PM_{2.5}$ (24-hour) – 2015 Construction and Operation (ABEP)

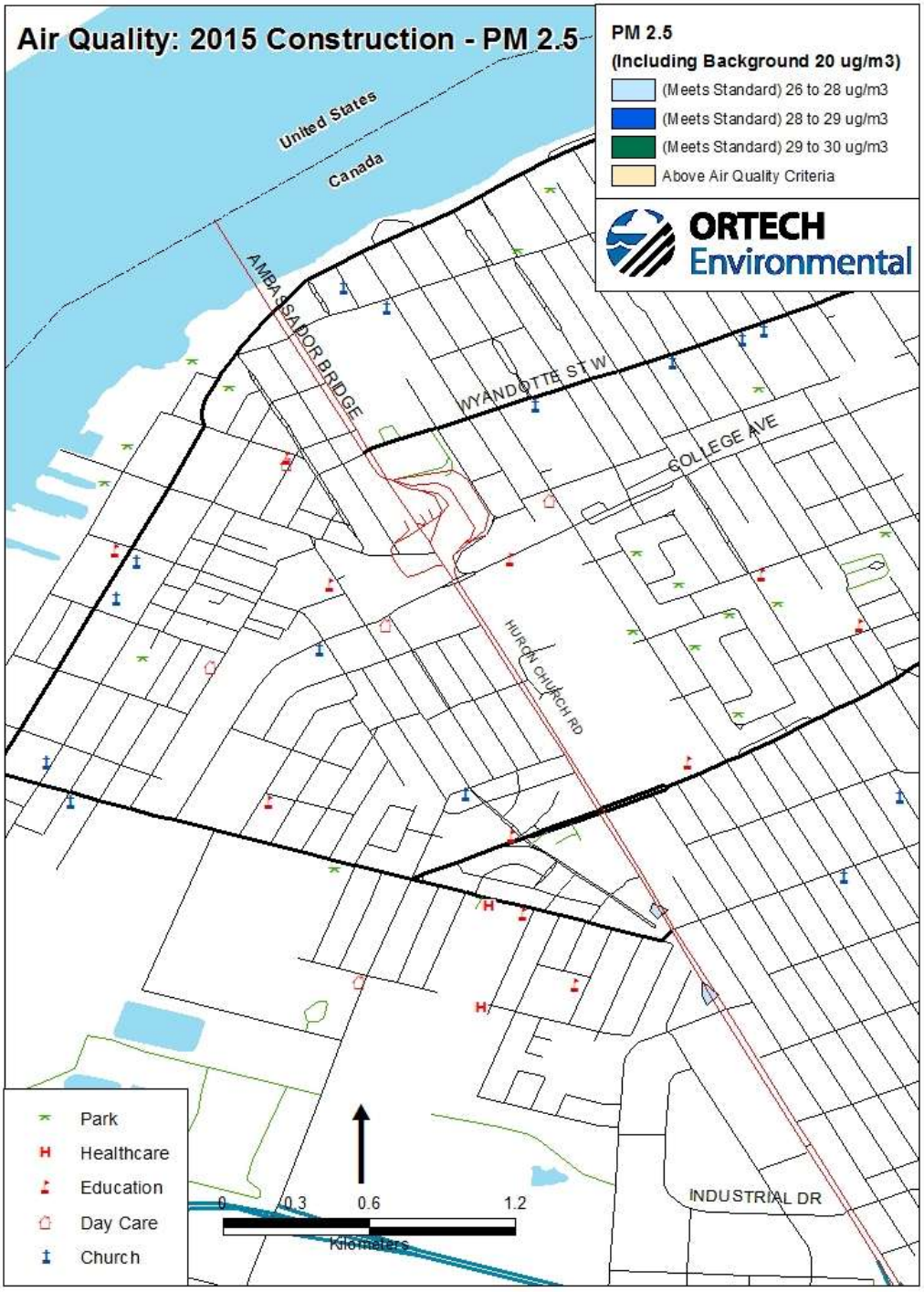


Figure A13-16: $PM_{2.5}$ (24-hour) – 2025 (FDN)

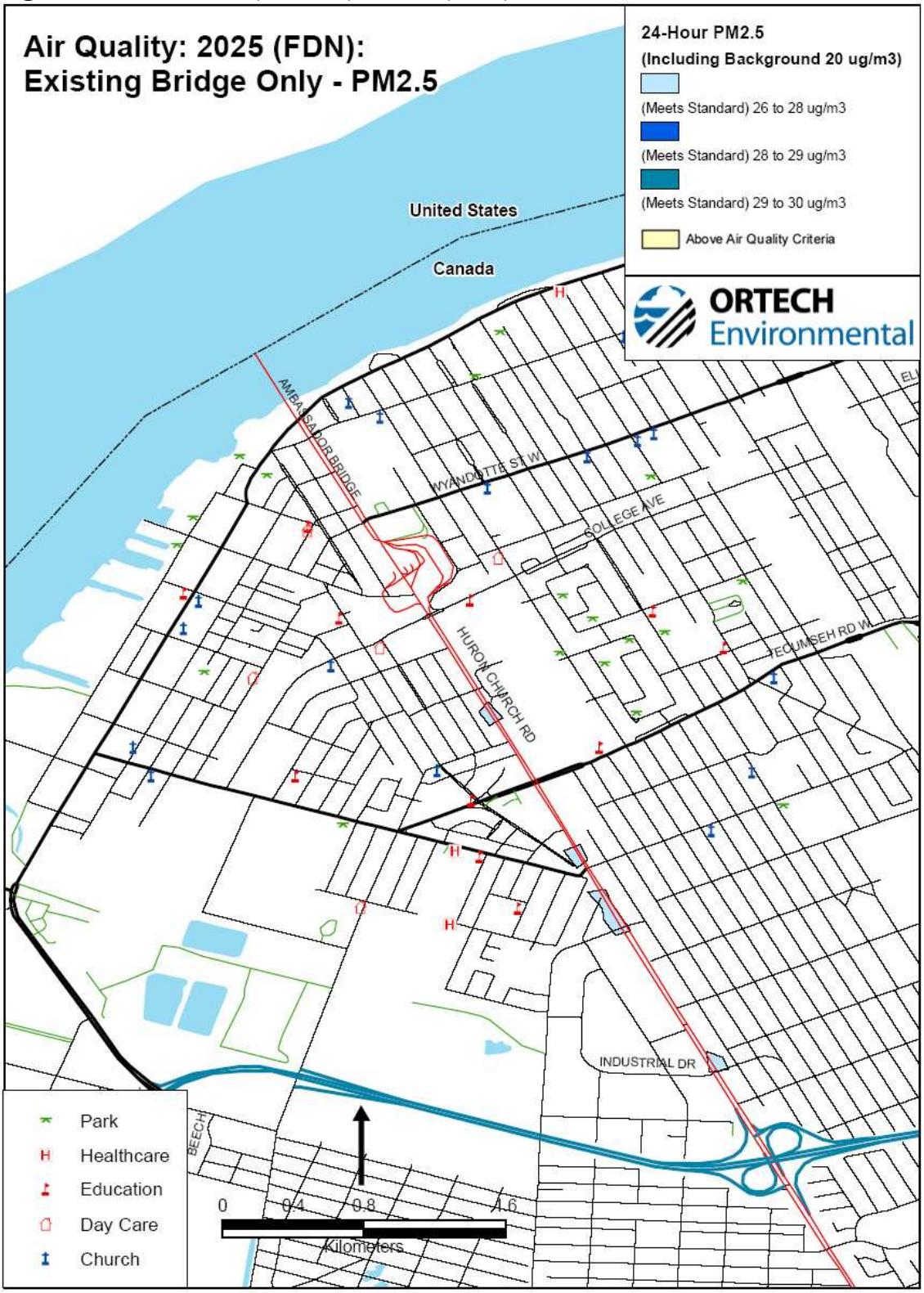


Figure A13-17: $PM_{2.5}$ (24-hour) – 2025 (A)

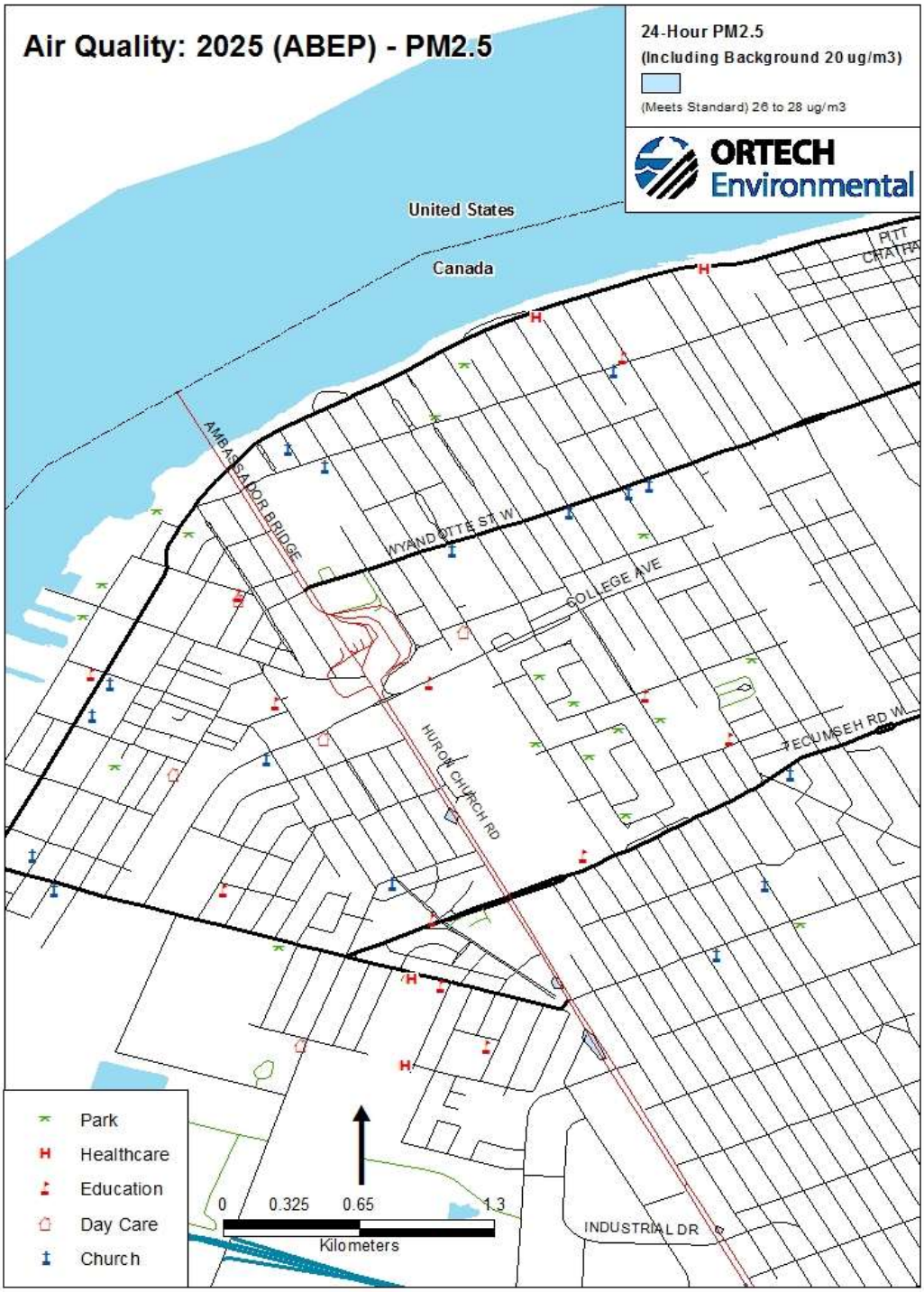
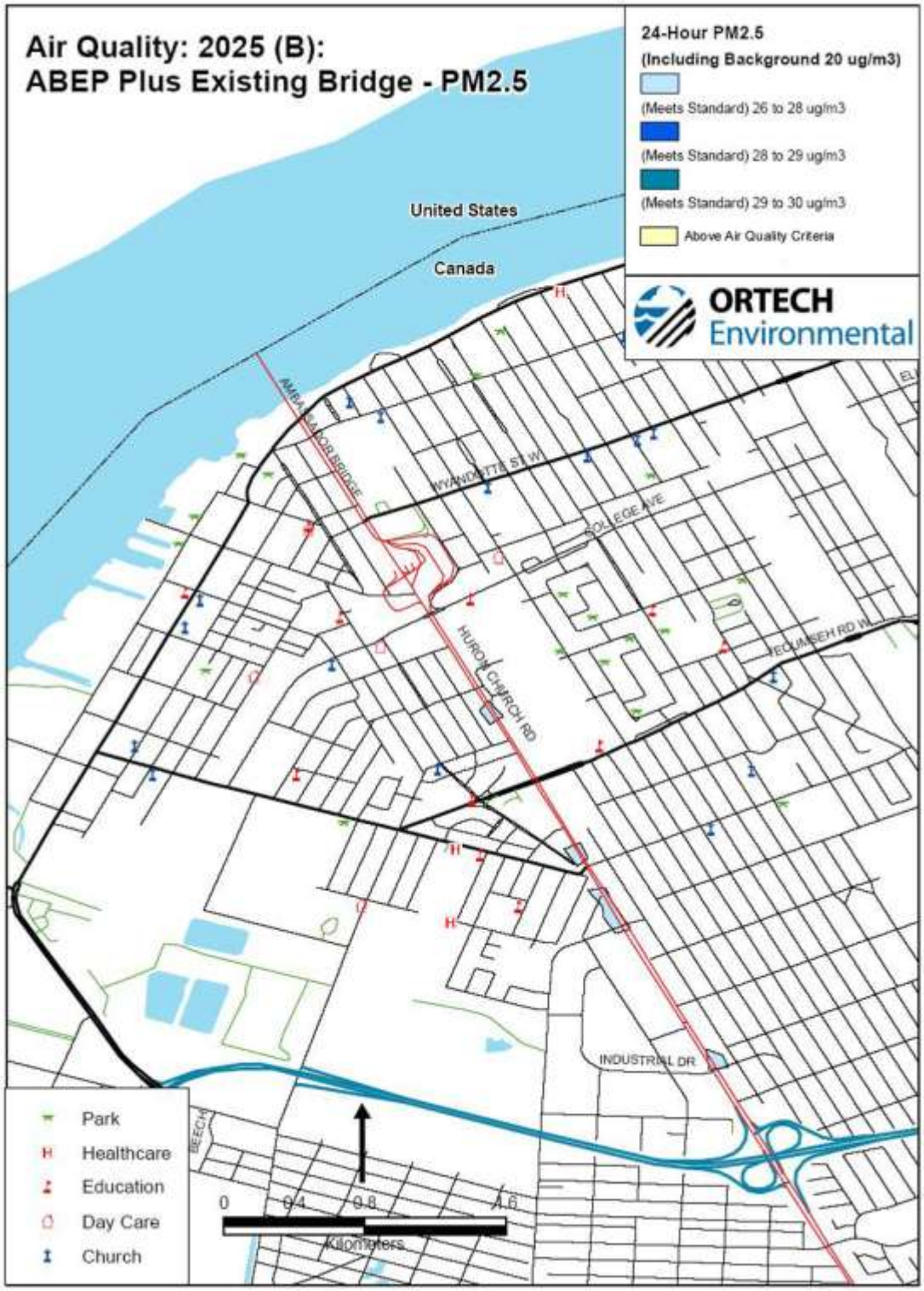


Figure A13-18: $PM_{2.5}$ (24-hour) – 2025 (B)



APPENDIX 14

Mitigation Measures for Construction Activities
(14 pages)

A14-1: Introduction

During bridge construction traffic across the existing Ambassador Bridge will be maintained. Emissions related to construction activities described in Appendix 9 are additive to the mobile on road emissions from the bridge described in Appendix 7.

Due to the proximity of construction activities relative to residential receptors, primarily along Indian Road, construction emissions may impact the surrounding community.

The temporary nature of construction differentiates it from other emission sources as to estimation and control of emissions. Generally, construction consists of a series of different operations each with a unique combination of equipment activity and emission generation potential. For this reason the approach for construction has been to estimate fleet-based emissions for nitrogen oxides (NO_X) and area wide emissions for fugitive dust. Emissions are assumed to be evenly distributed over the active construction area and impacts determined via AERMOD dispersion modeling as described in Appendix 11.

Under specific meteorological conditions and equipment activity scenarios, concentrations of fine particulate matter above the air quality criteria within the immediate vicinity of the construction site may occur. Project planning during the construction phase demonstrates compliance with the NOx air quality criterion. Emissions of these substances are therefore the subject to practical mitigation controls.

The development of a formalized mitigation plan for the control of construction emissions is proposed as a means towards ensuring the replacement span can be constructed with minimal impacts on the environment and surrounding community ensuring no adverse environmental effects. Several mitigation measures are presented within this section to provide the constructor limited flexibility in selecting appropriate mitigation control measures and alternate control measures. Alternate methods proposed by the constructor should be proven to achieve at least the same level of control as those methods outlined in below. Development of the formalized mitigation plan for the control of construction and demolition emissions should refer to the document entitled "Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities" (2005).

A14-2: Mitigation of Nitrogen Oxides

Heavy Duty Diesel non-road engines historically have not been subjected to the stringent emission regulations of on road vehicles and can be a significant source of NO_X and fine particulate matter ($PM_{10}/PM_{2.5}$). An initial mitigation control strategy assumes all non-road vehicles, with the exception of marine engines, will comply with USEPA Tier 3 heavy duty diesel emission standards for NO_X and fine particulate matter.

Construction of the main bridge span across the Detroit River will require the use of Tug Boats and Barges to position sections of the main span under the cantilever bridge crane traversing along the constructed bridge deck. Marine diesel engines below 30 liters per cylinder displacement are not subject to USEPA Tier 3 type emission standards until 2009 with larger engines achieving this standard in 2012. USEPA Tier 3 diesel standards for non-road engines (including marine) seek to reduce emissions of NO_X and particulate matter by 80 to 90% from current (2004) levels.

USEPA Tier 3 emission standards apply to new engines and there is currently no requirement to retrofit existing engines. For this reason it may not be practical to impose USEPA Tier 3 emissions standards on construction equipment specific to bridge work, such as rotary augers and cantilever bridge cranes. Additionally, limited verified retrofit technology for NO_X reduction is available for non-road diesel engines. Table A14-1 provides a summary of verified retrofit technologies from the USEPA website. Consideration shall be given to the use of available equipment conforming to USEPA Tier 3 non-road emission standards.

Table A14-1: Diesel Retrofit Verified Technologies

Verified Retrofit Technologies			
Manufacturer	**Technology**	**Applicability**	**Reduction %** NOx
[Caterpillar, Inc.]b	[Emissions Upgrade Group]b	[Caterpillar model 3306 diesel engines for nonroad applications with model years from 1988 to 1995 with mechanical direct fuel injection.]b	[27] b
Clean Diesel Technologies, Inc.	Platinum Plus Purifier System (fuel borne catalyst plus DOC)	Highway, medium heavy- and heavy heavy-duty, 4 cycle, model year 1988 - 2003, turbocharged or naturally aspirated engines	0 to 5
Clean Diesel Technologies, Inc.	Platinum Plus Fuel Borne Catalyst/Catalyzed Wire Mesh Filter (FBC/CWMF) System	Highway, medium heavy-duty, 4 cycle, model year 1991 - 2003, non-EGR, turbocharged or naturally aspirated engines	0 to 9
International Truck & Engine Corp.	Green Diesel Technology-Low NOx Calibration plus Diesel Oxidation Catalyst with Ultra Low Sulfur Diesel (ULSD)	Highway, light heavy-duty, 4 cycle, Navistar/International engines, model years 1999 - 2003 in the following families: XNVXH0444ANA, YNVXH0444ANB, 1NVXH0444ANB, 2NVXH0444ANB, 3NVXH0444ANB	25
Lubrizol	PuriNOx Water emulsion fuel	Highway & Non-road, heavy-duty, 2 & 4 cycle	9 to 20
Various	Biodiesel (1 to 100%)	Highway, heavy-duty, 2 & 4 cycle	-10 to 0
Various	Cetane Enhancers	Highway, heavy-duty, 4 cycle, non-EGR-equipped engines	0 to 5

a - Total PM reduction figures reflect reductions from both tailpipe and crankcase emissions.
b - This verification is conditional. Full verification will be achieved upon completion of additional testing and other requirements.
Note: For after-treatment devices the reductions are based on the installation of retrofits to engines that were originally produced without diesel oxidation catalysts or diesel particulate filters.

A second mitigation strategy for the reduction of non-road based NO_X emissions is enforcement of the City of Windsor anti-idling bylaw. City of Windsor by-law number 233-2001 *"A by-law to prohibit excessive idling of vehicles and boats"* specifies that;

> *2. (1) "No person shall cause of permit a vehicle or boat to idle for more than five (5) minutes in a sixty minute period.'*
> *2. (2) subsection 2 (1) does not apply to:*
> *(c) boats not at anchor or tied to a dock*
> *(l) vehicles or boats when the ambient temperature inside a vehicle or boat is:*
> *(i) more than twenty-seven degrees Celsius (27^{oC}); or*
> *(ii) less than five degrees Celsius (5^{oC}).*

Enforcement of the anti-idling by-law will reduce both aggregate emissions during bridge construction as well as off-property impacts by effectively reducing the number of "active" vehicles on site.

A third mitigation strategy, a reduction in the number of "active" vehicles on site, was not considered practical as this would not support efficient construction operations. A reduction in the number of active vehicles on site would reduce short term air quality impacts but would also extend the construction period of the bridge and impacts on the local community. Increasing the duration of construction activities would further have the potential to increase impacts related to fugitive emissions of fine particulate matter. In specific construction phases a reduction in the number of active vehicles would not likely be practical due to the requirement to supply the project with materials on a timely basis.

A14-3: Mitigation of Fugitive Dust

Similar to NO_X, fugitive dust emissions associated with construction are additive to the mobile source particulate matter (PM_{10}/$PM_{2.5}$) contributions from the existing bridge and local roads. Although fugitive dust considers all particulate matter size ranges, focus has been given to the fine particulate fraction (PM_{10}/$PM_{2.5}$). Control measures for fine particulate matter will also effectively address total suspended particulate matter (TSP).

Fugitive dust emitted from construction activities may originate from:

- vehicle traffic across unpaved and paved road areas;
- material handling;
- wind erosion;
- material storage piles;
- material track out and transport; and
- engine exhaust emissions.

The amount of particulate emission is related to several factors including:

- silt content of traveled surfaces;
- meteorological conditions (wind and precipitation);
- frequency of disturbances of aggregate piles and surfaces; and
- control measures in place to mitigate dust emissions.

Several jurisdictions in North America, including Ontario and Michigan, have developed policies surrounding the development of "Best Management Plans" (BMP) for the control of fugitive dust emissions from industrial and construction activities. The Ontario Ministry of the Environment Technical bulletin "Review of Approaches to Manage Industrial Fugitive Dust Sources" (January 2004) indicates that the following elements should be incorporated into a BMP for controlling fugitive emissions:

- identify the sources of fugitive dust emissions;
- review the composition and size range of the fugitive dust;
- describe how fugitive dust will be controlled from each source;
- contain a schedule by which the plan will be implemented;
- describe how the plan will be implemented;
- describe inspection and maintenance procedures, and
- describe methods of monitoring and record keeping to verify compliance with the plan.

The elements are described in detail below.

A14-3.1: Identification of Fugitive Dust Sources

The various stages of bridge construction will differ in their potential to emit fugitive dust emissions based upon equipment activity levels, type and quantity of materials used in the construction operation and mobility of the equipment. Table A14-2 provides a summary of fugitive dust sources associated with each phase of construction.

The General Construction Activities category identifies sources of emissions related to operations occurring throughout the construction site whereas subsequent category descriptions cover specific construction events related to defined areas of the site. The greatest potential for fugitive dust emissions will occur during site preparation and final site grading. Emissions from these activities are representative of the general emission factor related to Heavy Construction Operations associated with building and road construction as described in Appendix 9.

Table A14-2: Sources of Fugitive Dust Emissions

Activity/ Source ID	Construction Activity	Sources of Fugitive Particulate Emissions
1	General Construction Activities	Paved and Unpaved Roads Material Handling Wind Erosion Material Storage Piles Material Trackout and Transport Engine Exhaust Emissions
2	Site Preparation	Paved and Unpaved Roads Material Handling Wind Erosion Material Storage Piles Material Trackout and Transport
3	Tower Pier Foundation	Material Handling Material Storage Piles
4	Pylon Construction	Material Handling Material Storage Piles
5	Pier Table Construction	Material Handling Material Storage Piles
6	Balanced Cantilever Construction	Material Handling Material Storage Piles
7	Back Span & Main Span Continuity	Material Handling Material Storage Piles
8	Cdn Bridge - Tens Spans Excavation / Drilling of Footings	Material Handling Material Storage Piles
9	Forming / Pouring of Footings	Material Handling Material Storage Piles
10	Forming / Pouring of Pier Columns & Caps	Material Handling Material Storage Piles
11	Erection of Beams	not identified as a significant source
12	Bridge Deck Construction	not identified as a significant source
13	Final Site Grading	Paved and Unpaved Roads Material Handling Wind Erosion Material Storage Piles
14	Canadian Plaza Modifications (occurs after Final Site Grading)	Paved and Unpaved Roads Material Handling Wind Erosion Material Storage Piles Material Trackout and Transport

A14-3.2: Composition and Size Range of Particulate Matter

The construction area consists of previously developed single family residential and institutionally zoned areas. During site preparation and final grading, topsoil and underlying soil layers will be exposed to disturbances from vehicle traffic and material handling activities. These soil layers will have a significant PM_{10} fraction and may exhibit high variability within the construction area.

Backfill and construction aggregate will consist of relatively coarser materials and hence have a lower potential for fugitive fine particulate emissions.

A14-3.3: Best Management Plan for Controlling Fugitive Dust Emissions

The Best Management Plan (BMP) plan for controlling fugitive dust emissions is described in Sections A14-3.3.1 through A14-3.3.10. This program is based on limiting the causes of dust emissions from the major source categories through physical, design and/or operational controls.

The following sections discuss the dust management program for the sources of fugitive particulate emissions identified in Table A14-1. Implementation, inspection and record keeping requirements are discussed separately.

A14-3.3.1: Road Dust from Unpaved Roads and Surfaces

Dust emissions due to traffic on unpaved roads are influenced by the following:

Particle Size: Emissions increase as the fines content of the road bed or surface loading material increases. Minimizing the number of trips helps to reduce crushing of the material on the road surface, which helps to limit the silt content. Unpaved sections will not be used as primary haul routes within the construction area, but will be required to access the construction site. In general these distances will be kept to less than 100 meters in length. Unpaved road sections greater than 100 meters shall be covered with coarse gravel within the construction site as a control measure to reduce surface silt loadings and hence particulate emissions.

Moisture Content: Emissions of dust are reduced as the moisture content increases. Special attention to moisture content is required during dry conditions at any time of the year. A water truck operated by the constructor to apply water to on-site unpaved roadways will ensure adequate moisture of the surface to prevent excessive particulate emissions from unpaved roads. The control efficiency is dependant upon how fast the road surface dries, the quantity (per unit area) of water added at each application as well as the weight and speed of vehicles traveling over the surface. An increase of two in the moisture ratio, defined as the moisture content of controlled surfaces over uncontrolled surfaces, results in predicted control efficiency of 75%. (US EPA, AP-42, 13.2.2)

Similarly chemical dust suppressants may be utilized to control emissions and may prove to be a more cost effective method to control emissions. Control efficiencies of up to 80% may be achieved when chemical suppressants are applied to unpaved roads at regular intervals of 2 weeks to 1 month (US EPA, AP-42, 13.2.2).

Distance: The emissions increase as the total distance traveled increases. In order to minimize this, the best approach is to minimize the number of times the material is handled and to choose direct routes. To this end, consideration will be given to the removal of excavated materials directly from the construction site and backfill material brought onto the construction site directly to the area under construction. When these materials are directed to temporary staging areas for future use, efforts will be made to limit traffic in these areas as a further means to reduce emissions and trackout of material from the area.

Weight: The emissions increase as the weight of the vehicle and loads increase.

Speed: The emissions decrease as the vehicle speeds decrease. Vehicle speeds across unpaved sections will be limited to 10 kilometers per hour.

A14-3.3.2: Road Dust from Paved Roads and Surfaces

Particulate emissions from paved roads result from re-suspension of loose material on the road surface. These emissions are influence by:

Silt Loading: Emissions increase with increasing silt loadings. Road silt loading may significantly increase in the vicinity of material storage piles and unpaved road sections resulting from material track out, spillage and wind erosion. Access and egress routes to the construction site, as well as local roads adjacent to the site, should be maintained in a manner to prevent the accumulation of material on the surface of paved roads. The frequency of cleanup and road sweeping activities required to maintain this level is dependent upon construction activity, implementation of BMP and weather conditions such as precipitation.

Distance: The emissions increase as the total distance traveled increases. In order to minimize this, the best approach is to minimize the number of times the material is handled and to choose direct routes. To this end, consideration will be given to the removal of excavated materials directly from the construction site and backfill material brought onto the construction site directly to the area under construction. When these materials are directed to temporary staging areas for future use, efforts will be made to limit traffic in these areas as a further means to reduce emissions and track out of material from the area.

Weight: The emissions increase as the average weight of the vehicles traversing the road increase.

Other factors: Although not direct inputs into the emission factor equation, average daily traffic volume, number of lanes, and the presence/absence of curbs is believed to influence fugitive dust emissions from paved roads.

A14-3.3.3: Material Handling

Emissions due to material handling are influenced and controlled by the following:

Volume of Material Handled: The volume of material handled is minimized by minimizing the number of times the material is handled. To this end, consideration will be given to maximize efficiencies by minimizing double handling of materials. Careful planning to limit the volume of material stored within the construction site will have further benefits to emissions caused by vehicle traffic and wind erosion.

Moisture Content: Emissions of dust are reduced as the moisture content increases. Watering and the use of chemical wetting agents are the principal means for control of aggregate storage piles. Watering is useful to reduce emissions from vehicle traffic operating adjacent to the storage pile whereas chemical agents (such as surfactants) permit more through wetting of the storage pile. Consideration will be given to these control methods if on site storage of soil, aggregates or backfill materials is required. Prompt removal and or deliver of materials are additional control strategies which should be balanced against efficient construction methods.

Particle Size: Emissions increase as the fines content of the material being handled increases. Therefore materials with higher fines content, such as topsoil, require more controls for materials handling than coarse granular "A" type material with lower fines content.

Wind Speed: Emissions increase as the wind speed increases. Working in protected areas reduces the emissions from material handling sources. The erection of hoarding and or wind screens around the construction site combined with maintaining trees and vegetation is an effective means to reduce wind blown fugitive emissions from the site. Halting work during high wind events may be required for specific phases of construction such as site preparation and final grading where large sections of disturbed soil may be exposed. For other construction activities, such as bridge deck construction, continuation of work and thus minimizing the amount of time unprotected areas are exposed to natural elements, may be the most effective means to control fugitive emissions.

Drop Heights: Decreases in drop heights decrease the potential for dust to become entrained. Elevated stacking conveyors for aggregate handling will not be used on site and drop heights will be kept to minimum levels practical.

A14-3.3.4: Wind Erosion

Dust emissions due to wind erosion are influenced by the following:

Active Surface Area: The larger the active surface, the larger the potential for wind erosion. The total construction site area for the replacement span is 125 hectares, in effort to control emissions it is recommended that the simultaneous active site area(s) be kept to within 10% or 12.5 hectares. The site aea for the Canadian Plaza is considerably smaller at 0.96 hectares. Consistent with material handling control strategies outlined above, minimizing the time that material spends in holding piles limits the surface area. Where material must be stored in long term inactive areas, application of controls, such as wetting agents or covers, also limits the surfaces open to wind erosion.

Consideration will be given to maintaining vegetation within the construction area as a means to reduce the exposed surface area. Coordination of final site grading requirements and construction activities will be conducted as a control measure to reduce the time period and extent of wind erosion from the site. Covering of large exposed areas with coarse material, such as mulch is a viable alternative control measure.

Moisture Content: Emissions of dust are reduced as the moisture content increases. Special attention is paid to moisture content during dry conditions at any time of the year. The amount of moisture that can be added must be considered to prevent track out emissions. Sufficient time should be allowed between the application of dust suppressants and vehicle traffic to allow for penetration of the wetting agent through the top layer of soil.

Particle Size: Emissions increase as the fines content of the material decreases. Covering of large exposed areas with coarse material, such as mulch is a viable control measure which should be coordinated with final site grading and other activities.

Wind Speed: Emissions increase as the wind speed increases. Working in protected areas reduces the emissions due to wind erosion. Erection of hoarding or wind screens around the construction site in conjunction with maintaining existing trees is an effective measure to reduce ground level wind speeds.

Surface Roughness: Contouring and shaping reduces turbulence, resulting in reduced wind erosion. The general topography of the construction site is flat, evenly graded land. Limiting the size and height of storage piles on site is an effective measure to reduce the overall surface roughness of the site.

A14-3.3.5: Material Track out

Dust emissions due to material track out result from materials adhered onto the wheels of vehicles leaving the site and from spillage/leakage of material away from material storage piles. Material track out results in increase paved and unpaved road dust and wind erosion emissions. Measures to control the quantity of material tracked out from the site include:

Vehicle Inspections: Vehicles traveling over unpaved surfaces either during precipitation events or following such events should be inspected prior to leaving the site to remove excess quantities of material from tires and undercarriages. Due to the arrangement of the construction site and multiple points of access/egress the establishment of multiple truck or tire wash station(s) may not be a practical mitigation measure.

Vehicle Maintenance: Seals and latches on haul trucks should be inspected and maintained to prevent the release of materials onto the roadway.

Cleanup: Egress locations and material storage piles located throughout the construction site should be routinely inspected and accumulation of debris promptly removed.

A14-3.3.6: Vehicle Emissions

Particulate emissions from engine exhaust will be controlled as with vehicle NO_X emissions as described in section A14-2.

A14-3.3.7: Best Management Plan Schedule

The BMP will be finalized by the constructor, submitted to the owner and implemented as construction progresses.

A14-3.3.8: Implementation of Best Management Plan

The constructor will develop the final BMP based upon a review of the proposed fugitive dust mitigation measures for each source. Table 14-3 provides a framework for the development of the BMP. Upon completion of the BMP, the constructor shall provide training to personnel on the construction site prior to commencing with the applicable project phase. The constructor shall ensure materials and or structures are in place, or readily available, as required by the BMP prior to commencing the applicable project phase.

A14-3.3.9: Inspection and Maintenance Procedures

The constructor shall conduct routine inspections of the construction site, record site conditions and initiate corrective measures as appropriate consistent with the BMP.

A14-3.3.10: Monitoring and Record Keeping

The constructor shall be responsible for the development of a daily log sheet consistent with the requirements of the BMP to assist with the recording of activities identified in the BMP. Records shall be kept on site.

Table A14-3: Development of a Fugitive Dust Best Management Plan

Fugitive Dust Management Plan: Ambassador Bridge Enhancement Project

Item: 1	Fugitive Dust Source:	Unpaved Roads and Routes
	Control Method:	
	Frequency of Application/Inspection:	
	Record Keeping Requirements:	
	Monitoring of Control Efforts:	
	Summary of Mitigation Methods:	

Item: 2	Fugitive Dust Source:	Paved Roads
	Control Method:	
	Frequency of Application/Inspection:	
	Record Keeping Requirements:	
	Monitoring of Control Efforts:	
	Summary of Mitigation Methods:	

Item: 3	Fugitive Dust Source:	Material Handling
	Control Method:	
	Frequency of Application/Inspection:	
	Record Keeping Requirements:	
	Monitoring of Control Efforts:	
	Summary of Mitigation Methods:	

Item: 4	Fugitive Dust Source:	Loading and Unloading Operations
	Control Method:	
	Frequency of Application/Inspection:	
	Record Keeping Requirements:	
	Monitoring of Control Efforts:	
	Summary of Mitigation Methods:	

Table A14-3: Development of a Fugitive Dust Best Management Plan (continued)

Fugitive Dust Management Plan: Ambassador Bridge Enhancement Project

Item: 5	**Fugitive Dust Source:**	**Wind Erosion**
	Control Method:	
	Frequency of Application/Inspection:	
	Record Keeping Requirements:	
	Monitoring of Control Efforts:	
	Summary of Mitigation Methods:	

Item: 6	**Fugitive Dust Source:**	**Material Storage Piles**
	Control Method:	
	Frequency of Application/Inspection:	
	Record Keeping Requirements:	
	Monitoring of Control Efforts:	
	Summary of Mitigation Methods:	

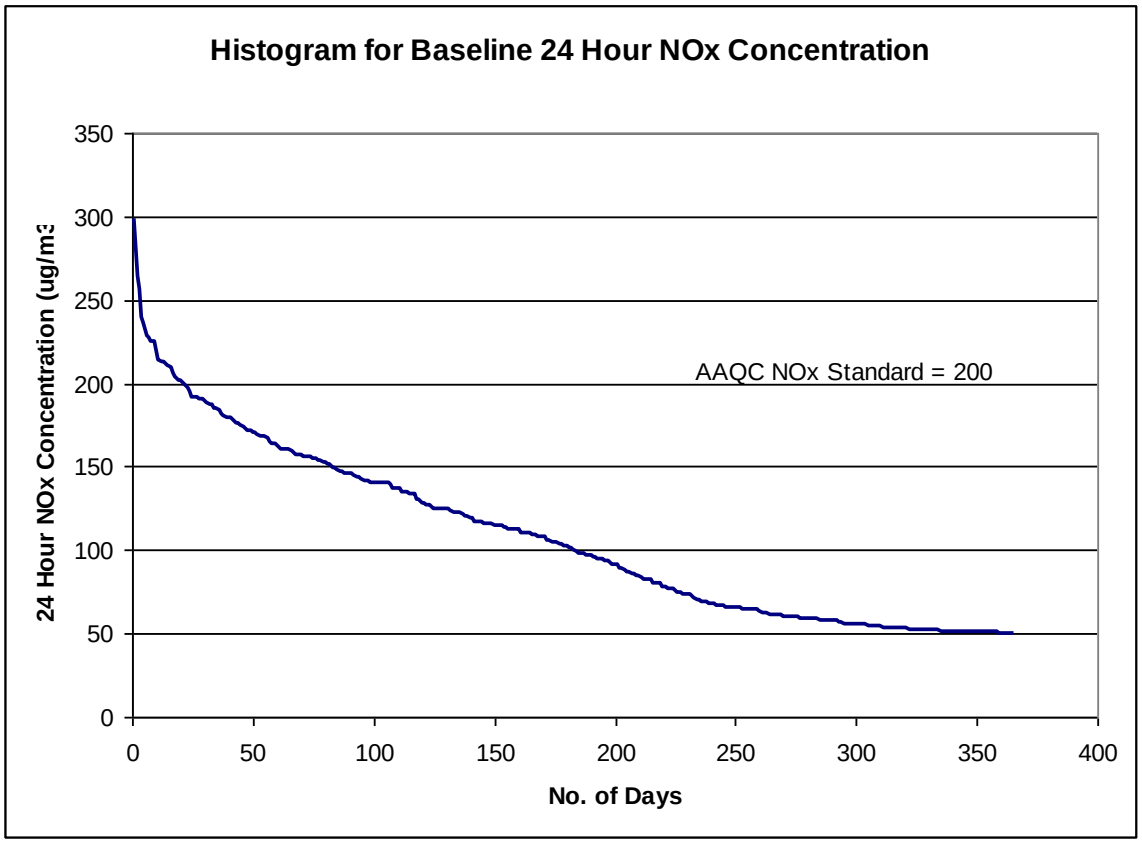
Item: 7	**Fugitive Dust Source:**	**Material Trackout and Transport**
	Control Method:	
	Frequency of Application/Inspection:	
	Record Keeping Requirements:	
	Monitoring of Control Efforts:	
	Summary of Mitigation Methods:	

Item: 8	**Fugitive Dust Source:**	**Engine Exhaust Emissions**
	Control Method:	
	Frequency of Application/Inspection:	
	Record Keeping Requirements:	
	Monitoring of Control Efforts:	
	Summary of Mitigation Methods:	

APPENDIX 15

Frequency Plots
(3 pages)

Figure A15-1: Frequency Histogram for Virtual Receptor with Maximum 24-hour NOx Air Quality Concentration (Including Background): Present (Baseline)



Note: background level = µg/m^3

Figure A15-2: Frequency Histogram for Virtual Receptor with Maximum 24-hour PM2.5 Air Quality Concentration (Including Background): Present (Baseline)

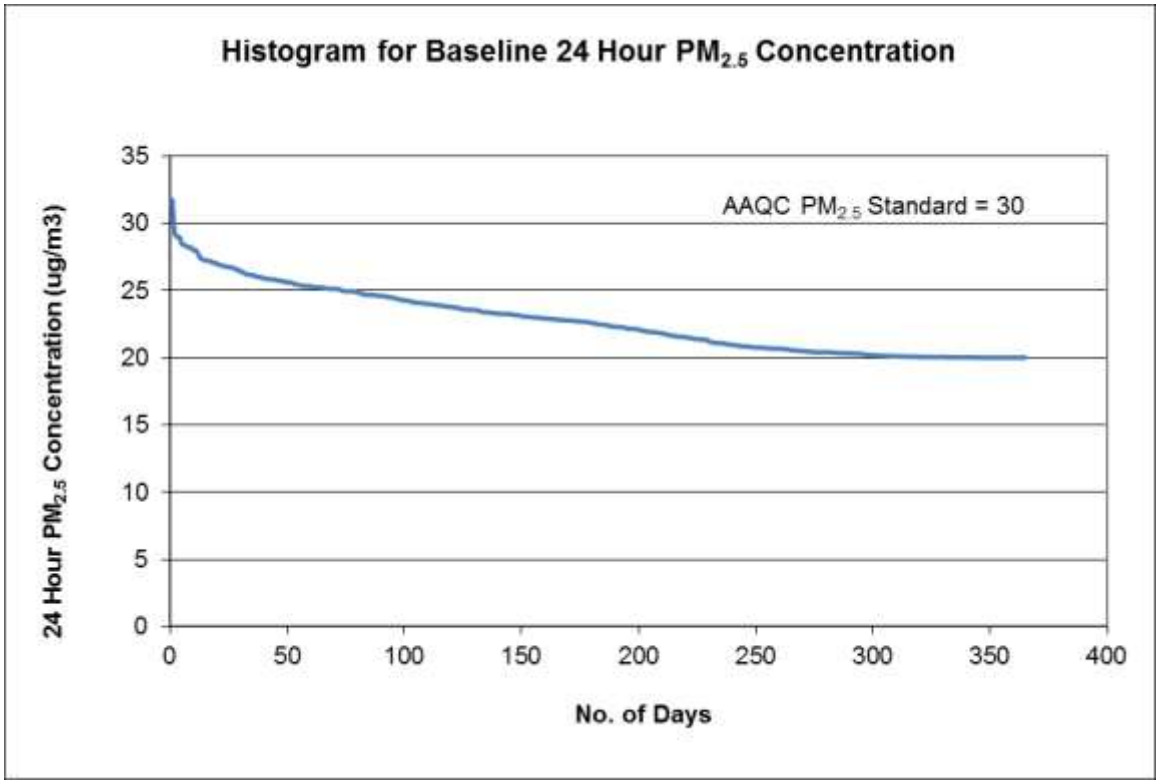
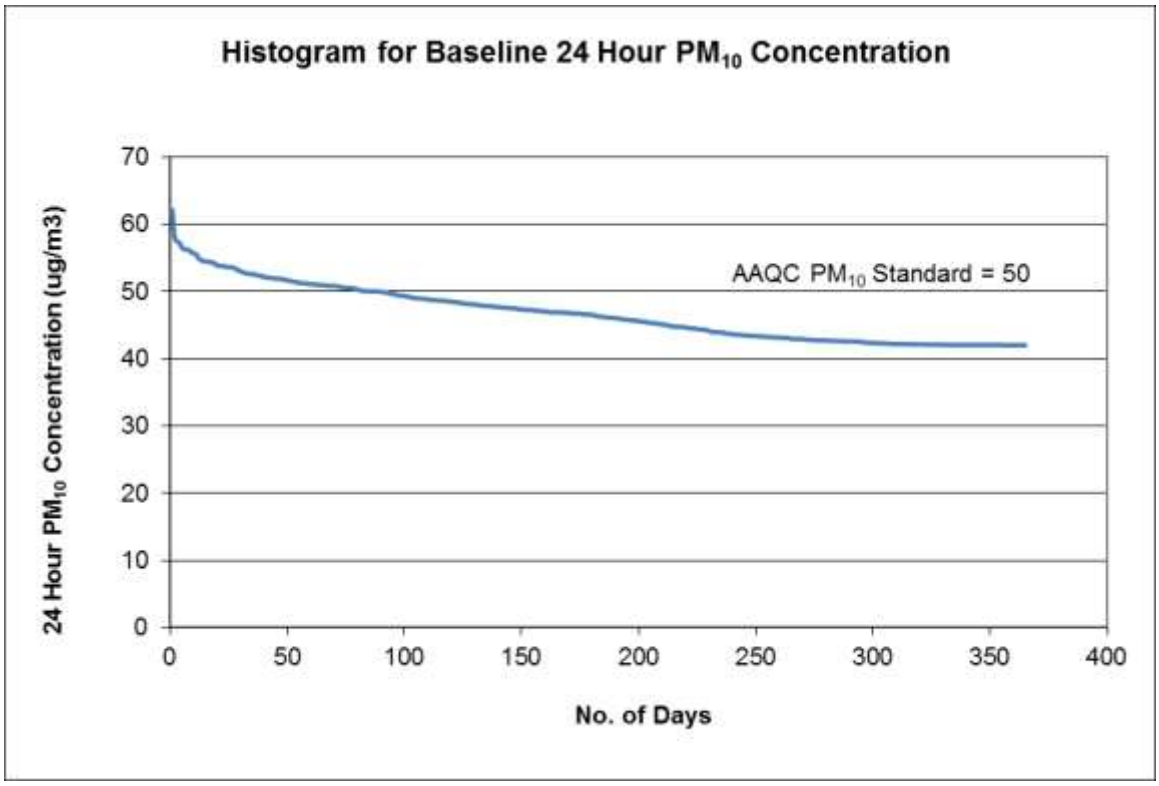


Figure A15-3: Frequency Histogram for Virtual Receptor with Maximum 24-hour PM10 Air Quality Concentration (Including Background): Present (Baseline)



APPENDIX 16

Air Quality Monitoring Plan
(8 pages)

ORTECH Environmental
a division of ORTECH Consulting Inc.

Proposed Air Monitoring Concept for The Canadian Transit Company

A Report to: The Canadian Transit Company
780 Huron Church Road, Suite 202
Windsor, Ontario
N9C 2K2

Attention: Mr. Dan Stamper
Tel: (313) 849-5244
Fax: (313) 849-1063

Submitted by: Rod Brooks
Sarnia Manager

Tel: (519) 336-3327
Fax: (519) 336-8580
E-mail: rbrooks@ortech.ca

Report No.: 50,700 revision 1
6 pages

Date: October 22, 2012

TABLE OF CONTENTS

Page

INTRODUCTION 1

1. DESIGN CONSIDERATIONS 2
   - 1.1 General Synopsis of Approach 2
   - 1.2 Monitoring Locations 2
   - 1.3 Measurement Frequency and Scheduling 3

2. PROPOSED METHODOLOGY 4
   - 2.1 Monitoring Methods 4
   - 2.2 Quality Assurance Procedures 4

3. REPORTING 6

INTRODUCTION

ORTECH Environmental (ORTECH) was contracted by the Canadian Transit Company (CTC) to carry out an air quality assessment as part of the Environmental Impact Statement related to the Ambassador Bridge Enhancement Project in Windsor Ontario. Following completion, the assessment was submitted to Environment Canada (EC) for comment. In these comments EC requested that a plan be presented to address potential high ambient air concentrations of NO_x, PM_{10} and $PM_{2.5}$ that could result from the Project. ORTECH is presenting this real-time ambient air monitoring concept, as requested by EC as a means to assess the effectiveness of construction and operational mitigation efforts. The monitoring program will further facilitate the prompt identification of elevated levels or exceedances of air contaminants so that timely actions can be taken regarding mitigation measures.

1. DESIGN CONSIDERATIONS

1.1 General Synopsis of Approach

The primary objective of this air monitoring concept, as understood by ORTECH, is to measure ambient air levels of NO_x, PM_{10}, and $PM_{2.5}$ in the area of the Ambassador Bridge Enhancement Project. This plan will be used to assess the effectiveness of construction and operational mitigation efforts regarding concentrations of these air constituents prior to and during construction activities.

It is planned to provide real-time NO_x, PM_{10}, and $PM_{2.5}$ monitoring at various locations in the area of the Ambassador Bridge and Huron Church Road via a mobile unit that will be operated when conditions are conducive to elevated levels of these parameters. Meteorological data will be collected from both the Windsor airport as well as a portable meteorological tower (approx.10 feet high) installed on the mobile unit. Various quality assurance practices will be incorporated routinely in conjunction with both sampling and analysis throughout the program.

The real-time monitoring program will be conducted in three phases: pre-construction to determine background levels, bridge construction and finally, plaza improvement construction.

1.2 Monitoring Locations

In each of the three phases of the program, the mobile may be sited at several locations during each of the monitoring days.

Pre-Construction:
It is suggested that mobile monitoring will be conducted downwind and upwind of two major intersections along Huron Church Road during the pre-construction phase of the project to determine background levels of NO_x, PM_{10}, and $PM_{2.5}$. The mobile unit will be located at a number of distances (30 to 200 meters) downwind of these intersections.

Bridge Construction:
Mobile monitoring during this phase of the enhancement project will be conducted primarily downwind of the construction activities in Canada. It is proposed that monitoring will be conducted in the area of the construction at various distances to determine the maximum resulting concentrations of NO_x, PM_{10}, and $PM_{2.5}$. The mobile will be position to avoid sources between the study area and the monitors. Upwind monitoring will occur during periods when elevated downwind samples are recorded as a measure of the effectiveness of mitigation plans.

Plaza Improvement:
During this phase, mobile monitoring will be conducted using the same approach as described during bridge construction.

1.3 Measurement Frequency and Scheduling

Mobile monitoring will be initiated during the three phases of the Enhancement Project. It is suggested that trigger values will initiate the requirement to initiate additional mitigation efforts including modification or curtailment of construction activities. For the purpose of this study the hourly background trigger levels proposed are 120 ppb and 27 µg/m³ for NO_x and $PM_{2.5,}$ respectively. The NO_x level is based on 60% of the hourly criterion and the rational for the $PM_{2.5}$ level is based on 60% of the one-hour level of concern defined by the Ontario MOE in the report "Preliminary Air Quality Assessment Related to Traffic Congestion at Windsor's Ambassador Bridge, 2004. In this report they stated that a three-hour average concentration of 45 µg/m³ for $PM_{2.5}$ was statistically equivalent to the twenty-four hour standard (30 µg/m³) for this constituent. Therefore they concluded that a one-hour average of 45 µg/m³ for $PM_{2.5}$ represented a one-hour level of concern. Upwind ambient sampling during these trigger conditions will serve to determine if elevated ambient readings result from background or construction impacts.

Pre-Construction:
To achieve both replication and a condition-specific range of concentrations, it is suggested that the monitoring will be conducted until approximately 30 one-hour readings are collected upwind and downwind from two (2) major intersections along Huron Church Road within the Local Study Area.

Bridge and Plaza Construction:
Monitoring will continue throughout both of these phases of construction during periods of project related activity. Ambient monitoring activities are not proposed for periods when active construction does not occur.

2. PROPOSED METHODOLOGY

2.1 Monitoring Methods

Nitrogen Oxides (NO_X) – Nitrogen oxide (NO_X) emissions, consisting of nitric oxide (NO) and nitrogen dioxide (NO_2) will be measured continuously utilizing an EPA approved chemiluminescence analyzer. In this method ambient air is continuously drawn into the analyzer whereby NO is reacted with ozone producing a chemiluminescence reaction. The intensity of the reaction is directly proportional to the concentration of NO in the ambient air. NO_2 present in the air stream is non-reactive and thus is catalytically converted to NO allowing a second chemiluminescence reaction to occur. The difference in intensity between these two reactions represents the concentration of NO_2 present in the ambient air stream. The data will be directly downloaded from the sampler at the end of each sampling day.

Particulates (PM_{10} and $PM_{2.5}$) - Thermo Scientific SHARP model 5030 real-time monitors will be utilized for this program. Two of these monitors will be required with one configured for $PM_{2.5}$ (EPA Automated Equivalent Method EQPM-0609-184) and the other for PM_{10}. These monitors are currently installed in many of the Ministry of the Environment monitoring sites in Ontario. The SHARP 5030 monitor combines light scattering photometry and beta radiation attenuation for continuous measurement of either $PM_{2.5}$ or $PM_{10.}$ Digital filtering is used to continuously mass calibrate the nephelometric measurements resulting in accurate and precise data. The data will be stored and retrieved for PC display with custom software for mass distribution in µg/m3 for both PM_{10} and $PM_{2.5}$.

Meteorological data from the Windsor airport as well as a portable met tower mounted on the mobile monitoring unit will be utilized for this program.

The NO_x and Particulate analyzers, portable meteorological tower and associated batteries will be mounted in a portable instrument rack that can be easily mounted in any small pickup truck or van.

2.2 Quality Assurance Procedures

To maintain an appropriate level of quality assurance with regard to the monitoring, various quality assurance practices will be incorporated into the sampling and analysis methods, as routinely done, in effort to enhance the measurement validity. Some of these QA/QC measures will include:

Field Sample Analysis and Record Keeping

- Operators proficient in this method will be responsible for the collection of samples and will follow all applicable Standard Operating Procedures and/or instrument manuals;
- Samples will be collected at 5 to 10 feet above ground and approximately 60 feet or further from trees and other obstructions, if possible;
- All sample periods will start at the top of the hour to facilitate comparison to airport meteorological and MOE station data;
- All wetted sample train parts will be Teflon, glass, stainless steel or some other suitable inert material;
- All sample lines will be Teflon and of the same length and fittings will be Teflon or stainless steel;
- Field sampling logs will provide the following information: sample I.D., operator name, sample location (UTM co-ordinates), date and time, approximate weather observations (wind speed, direction and temperature), other information or observations (odours, nearby activities with potential impact, etc.); and
- Calibration of the analyzers will be verified and documented in the field sampling log before and after every sampling day.

3. REPORTING

Reporting of the monitoring data will be directed to CTC immediately after the completion of each sample day. During the construction phase this will enable them to initiate, without delay, any required mitigative measures in a timely manner as well as to evaluate the effectiveness of these measures. Each sample day CTC will determine the appropriateness of the sampling locations based on the construction activities and meteorological conditions. Unless otherwise required, the daily report will include the specific data and summarized tabulations such as:

- A summary of the NO_x, PM_{10}, and $PM_{2.5}$ measurement results at each sampling location and the MOE fixed stations;
- A map depicting the sample locations including UTM co-ordinates;
- summaries of the meteorological data, including wind speed/direction, temperature, rainfall, relative humidity and barometric pressure acquired for each sample interval; and
- Electronic copy of time stamped NO_x, PM_{10} and $PM_{2.5}$ measurements and meteorological data.

A final formal report including hard and electronic copies will be issued within three weeks of the final sample analysis.