Norval West Bypass Transportation Corridor - Municipal Class Environmental Assessment Air Quality Impact Assessment Report

Final Report

December 8, 2025

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Executive Summary

Stantec Consulting Ltd. (Stantec) was retained by the Region of Halton to undertake a Municipal Class Environmental Assessment (MCEA) for the Norval West Bypass Transportation Corridor Improvements, Highway 7 to 10 Side Road (Regional Road 10). The study is assessing the need for a new Norval West Bypass between Highway 7 and 10 Side Road, as well as improvements to 10 Side Road between Tenth Line and Adamson Street/Winston Churchill Boulevard (the Project).

The objective of this study is to characterize baseline (2016) air pollutant emissions and predict air quality effects within the Study Area after implementation of the Project in the Future Build (2031) scenario using background air quality and traffic data. The 2031-time horizon has been selected only for analysis purposes and does not represent actual timing of Project implementation. Predicted future emissions and effects with Project implementation (Future Build) are compared to baseline emissions and effects (Baseline), and to predicted future emissions and effects without implementation of the Project (Future No Build) for a total of 3 assessment scenarios. Changes in greenhouse gas (GHG) emissions are also assessed in this study. Additionally, potential air quality impacts during Project construction are assessed qualitatively. This study has been conducted following guidance from the Ontario Ministry of Transportation's (MTO's) "Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Projects" (MTO Guide) (MTO, 2020).

The air contaminants of potential concern (CoPC) selected for this study are based on the most relevant transportation-related contaminants listed in the MTO Guide and include nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter with diameter less than 10 micrometres (PM_{10}), particulate matter with diameter less than 2.5 micrometres ($PM_{2.5}$), acrolein, benzene, 1,3-butadiene, benzo(a)pyrene (B(a)P), acetaldehyde and formaldehyde. Greenhouse gas (GHG) emissions in the form of carbon dioxide equivalent (CO_2e) were also quantified.

Baseline ambient air quality conditions were characterized from historical data obtained from Environment and Climate Change Canada's (ECCC's) National Air Pollution Surveillance (NAPS) Network and the Ontario Ministry of the Environment, Conservation and Parks (MECP) for stations located near the Study Area.

The United States Environmental Protection Agency's (US EPA's) MOtor Vehicle Emission Simulator (MOVES) model version 3 (MOVES3) was used to estimate baseline and future emission rates from motor vehicles. The US EPA dispersion model, AERMOD was used to predict the maximum 1-hour, 8-hour, 24-hour, and annual average ground level concentrations (GLCs) at special receptors for the following three scenarios:

- 2016 – Baseline (existing conditions)
- 2031 – Future No Build (future conditions without the Project)
- 2031 – Future Build (future conditions with the Project)

The predicted ambient air quality results for each scenario were compared against relevant provincial Ambient Air Quality Criteria (AAQC) and Canadian Ambient Air Quality Standards (CAAQS) while GHG emissions were compared to National and Provincial totals for 2021 and 2030 emissions targets.

The following conclusions were made from the air quality and greenhouse gas impact assessment:

Operation Phase – Project Alone

- For the Baseline scenario, maximum predicted Project Alone GLCs of all CoPC are below their applicable criteria other than the hourly average NO_2 CAAQS and 24-hour and annual average B(a)P AAQC.
- The maximum predicted Project Alone GLCs of all CoPC are below their relevant AAQC and/or CAAQS at all special receptors for the Future Build and Future No Build scenarios.

Operation Phase – Cumulative (Project Plus Background Levels)

- Maximum predicted cumulative GLCs of CoPC other than NO_2, benzene and B(a)P are below their relevant AAQC and/or CAAQS at all special receptors for all scenarios.
- Predicted cumulative 98th percentile daily 1-hour maximum concentrations of NO_2 exceed the 2025 1-hour CAAQS by 24% at one sensitive receptor in the Future No Build scenario. There are no cumulative exceedances of the NO_2 CAAQS in the Future Build scenario. Maximum predicted 1-hour and 24-hour average cumulative NO_2 concentrations are well below the provincial AAQC for all scenarios.
- The maximum predicted cumulative annual average benzene concentration is above the AAQC by 4% for the Baseline scenario. The maximum predicted cumulative 24-hour and annual average concentrations of benzene are below the AAQC for the Future No Build and Future Build scenarios and are lower than the Baseline scenario due to expected future improvements in engine technology and cleaner fuels.

- Maximum predicted cumulative concentrations of B(a)P exceed the 24-hour and annual average AAQCs at all special receptor locations for all scenarios, with the background concentrations alone exceeding the 24-hour and annual average AAQCs by 2,529% and 2,347% respectively. The maximum predicted 24-hour and annual average cumulative B(a)P concentrations for the Future Build scenario are 1% lower than the Future No Build scenario. The maximum cumulative B(a)P concentrations are predicted to decrease in the Future Build and Future No Build scenarios relative to the Baseline scenario also due to expected future improvements in engine technology and cleaner fuels.
- Releases of GHGs from the Project are expected to be insignificant (less than 0.1%) in comparison to the 2021 Canada and Ontario totals and the 2030 emissions targets. Implementation of the Project is predicted to result in a decrease in GHG emissions of 1.4 kt CO_2e per year relative to the current road configuration.
- During Project construction, industry best management practices should be followed to minimize emissions.

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Acronyms / Abbreviations

AAQC	Ambient Air Quality Criteria
ADMGO	Air Dispersion Modelling Guideline for Ontario
ADT	Average Daily Traffic
AP-42	U.S. Environmental Protection Agency Compilation of Air Pollution Emission Estimation Factors Document
CAAQS	Canadian Ambient Air Quality Standards
CAC	Criteria Air Contaminants
CAS	Chemical Abstracts Service
CCME	Canadian Council of Ministers of the Environment
CoPC	Contaminants of Potential Concern
D1HM	Daily 1-hour maximum
ECCC	Environment and Climate Change Canada
EA	Environmental Assessment
EPA	*Environmental Protection Act*
GHG	Greenhouse gas
GLC	Ground Level Concentrations
GWP	Global Warming Potential
Max	Maximum
MCEA	Municipal Class Environmental Assessment
MECP	Ontario Ministry of the Environment, Conservation and Parks
MTO	Ontario Ministry of Transportation
N/A	Not Applicable
NAPS	National Air Pollution Surveillance
Stantec	Stantec Consulting Ltd.
US EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VMT	Vehicle Mile Travelled

UNITS OF MEASUREMENT		
cm	centimetre	
km	kilometre	
m	metre	
mm	millimetre	
Mass/Weight		
Re. Orders of Magnitude: x 10^2 = x 100, x10^3 = x 1000		
g	gram	
mg	milligrams	1 x 10^{-3} grams
µg	microgram	1 x 10^{-6} grams
pg	picrogram	1 x 10^{-12} grams
kg	kilogram	1 x 10^3 g
Mg	Megagram	1 x 10^6 g
t	metric tonne	1 x 10^3 kg
lb	pound	1 lb = 453.592 grams
Concentration		
ppm	parts per million	
µg/m^3	micrograms per cubic metre	
Temperature		
°C	degrees Celsius	
Speed		
km/h	kilometres per hour	
mph	miles per hour	
Time		
s	second	
hr	hour	
y	year	

Compounds	
B(a)P	Benzo(a)pyrene
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
THC	Total Hydrocarbons
N_2O	Nitrous Oxide
NO_x	Nitrogen Oxides
NO_2	Nitrogen Dioxide
NO	Nitric Oxide
O_3	Ozone
PAH	Polycyclic Aromatic Hydrocarbon
PM_{10}	Particulate Matter smaller than 10 microns
$PM_{2.5}$	Particulate Matter smaller than 2.5 microns
VOC	Volatile Organic Compounds

Glossary

Term	Definition
Air Contaminant Emissions	For stationary or mobile sources, the release or discharge of a pollutant (i.e., air contaminant) from a facility or operation into the ambient air either by means of a stack, vent, exhaust pipe or as a fugitive dust, mist, or vapour.
Canadian Council of Ministers of the Environment (CCME)	A council made up of environmental ministers from provincial, federal and territorial levels of government that proposes nationally consistent environmental standards and objectives to achieve high levels of environmental quality for waste management, air pollution, and toxic chemicals across Canada.
Carbon Monoxide (CO)	A colourless, odourless gas produced by incomplete fossil fuel combustion.
Combustion Product	Substance produced during the burning or oxidation of a material.
Combustion	1. Burning, or rapid oxidation, accompanied by the release of energy in the form of heat and light. 2. Refers to controlled burning of waste, in which heat chemically alters organic compounds, converting into stable compounds such as carbon dioxide and water.
Concentration	In air quality, concentration is defined as the abundance (mass or volume) of a substance suspended in a unit volume of ambient air.
Dust	A term used to describe particles of a solid or liquid that are suspended in air. Also referred to as particulate or suspended particulate.
Mitigation	Measures taken to reduce adverse effects on the environment.
Monitoring	Periodic or continuous surveillance or testing to determine the characteristics of a substance or the level of compliance with statutory requirements and/or pollutant levels in various media or in humans, plants, and animals.
Particulate	A particle of a solid or liquid that is suspended in air.
Particulate Matter	A particle in solid or liquid phase that is suspended in air.

Term	Definition
Pollutant	Generally, any substance introduced into the environment that can adversely affect the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	Generally, the presence of a substance in the environment that because of its chemical composition or quantity can prevent the functioning of natural processes and produce undesirable environmental and health effects
Receptor	A person, plant or wildlife species that may be affected due to exposure to a contaminant.
United States Environmental Protection Agency AP-42 (US EPA AP-42)	US EPA document Compilation of Air Emission Factors, Volume 1: Stationary Point and Area Sources.

1 Introduction

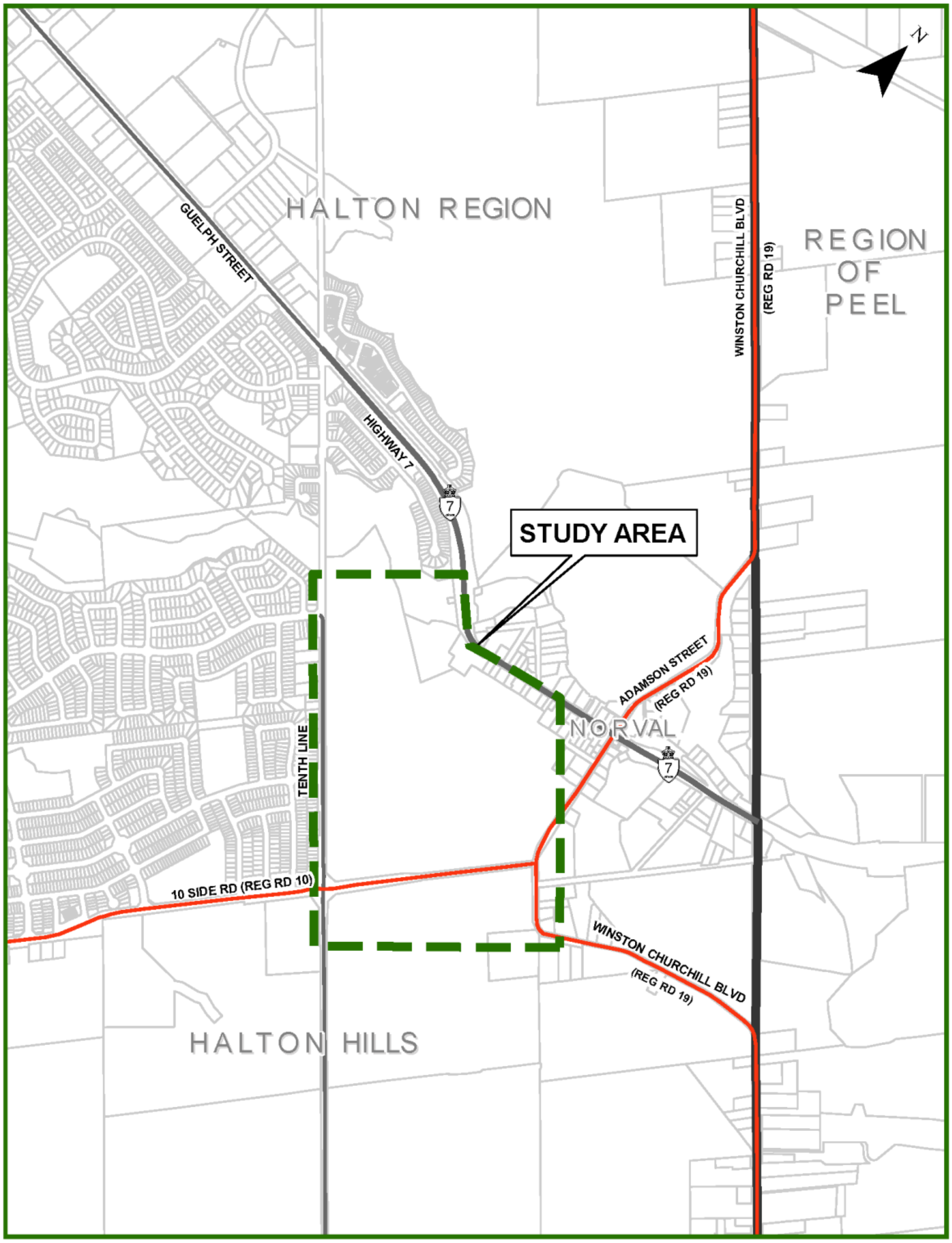
Stantec Consulting Ltd. (Stantec) was retained by the Region of Halton to undertake a Municipal Class Environmental Assessment (MCEA) for the Norval West Bypass Transportation Corridor Improvements, Highway 7 to 10 Side Road (Regional Road 10). The study is assessing the need for a new Norval West Bypass between Highway 7 and 10 Side Road, as well as improvements to 10 Side Road between Tenth Line and Adamson Street/Winston Churchill Boulevard (the Project).

The study provided herein is the air quality assessment which is part of the MCEA.

1.1 Study Area

A map of the Norval West Bypass MCEA Study Area is provided in Figure 1.1. The Air Quality Study Area used for assessing potential impacts of air contaminant emissions extends 500 m from the edge of the Project. The Air Quality Assessment Area and recommended design are provided in Appendix A.

Figure 1.1: Project Study Area



1.2 Study Objectives

The objective of this study is to characterize baseline (2016) ambient air quality and to predict the potential impacts of Project activities on air quality within the Air Quality Study Area. This is done by considering the implementation of the Project in 2031 (the Future Build scenario) and comparing the results to the predicted future (2031) emissions and effects without implementation of the Project - referred to as the Future No Build scenario. Changes in greenhouse gas (GHG) emissions are also assessed in this study. Future Build 2031 traffic volumes provided by the project design team (Stantec 2023a, 2023b, and 2023c) were determined using the Halton Region transportation forecasting EMME model. The EMME 2016 model traffic volumes were provided, therefore, 2016 was selected as the baseline year for this study. The 2031 horizon has been selected only for analysis purposes and does not represent actual timing of Project implementation.

This study has been completed following guidance from the Ontario Ministry of Transportation's (MTO's) "Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Projects" (MTO Guide) (MTO, 2020).

1.3 Project Description

The recommended preliminary preferred design for the study includes the implementation of the Norval West Bypass transportation corridor between Highway 7 and 10 Side Road (Regional Road 10) to supply 4 traffic lanes of additional capacity, including 3.5 m multi-use pathways on either side of the road to support a multimodal transportation network. A single lane roundabout at the Highway 7 and the Norval West Bypass intersection will be installed and will accommodate safe pedestrian crossings. The Norval West Bypass will be a 42 m right-of-way, with 3.5 m wide vehicular lanes, and a 3 m boulevard separating vehicular traffic from the multi-use paths.

The recommended design for the Project is presented in Appendix A.

2 Methodology

The potential impacts of the Project construction have been assessed qualitatively while operation is assessed quantitatively. Operation activities on air quality were assessed by conducting dispersion modelling to predict the downwind concentrations of the most relevant transportation-related air contaminants and comparing these predictions to regulatory criteria and standards.

2.1 Overview

The assessment of potential air quality impacts related to the Project consisted of the following elements:

- Review the air contaminants of potential concern (CoPC) for consistency with the MTO Guide (MTO 2020).
- Establish background concentrations for each relevant transportation-related air contaminant using representative historical monitoring data from the nearest Ministry of the Environment, Conservation and Parks (MECP) or Environment and Climate Change Canada’s (ECCC’s) National Air Pollution Surveillance (NAPS) monitoring station.
- Establish baseline quantities of greenhouse gases (GHGs) released to the atmosphere using published provincial and national GHG emissions data.
- Predict vehicle tailpipe emissions using the United States Environmental Protection Agency’s (US EPA’s) MOtor Vehicle Emission Simulator (MOVES) and estimate road dust emissions using the US EPA AP-42 calculation methodology for Project operation related traffic.
- Identify critical and representative sensitive receptor locations within 500 m of the Air Quality Study Area.
- Predict maximum contaminant concentrations using the US EPA AERMOD dispersion model at the critical and sensitive receptors due to emissions from Project-related traffic.
- Estimate cumulative air quality concentrations by combining the maximum predicted concentrations with background air quality concentrations and compare the results to the applicable provincial and federal current and future ambient air quality criteria and standards.
- For receptors where the maximum concentration of relevant air contaminants exceeds a criterion or a standard, assess the potential frequency of exceeding the air quality criteria or standard, through a more detailed assessment of the Project-related concentrations.
- Estimate GHG emissions for each assessment scenario and compare to the provincial and national GHG emissions levels and targets.
- Qualitatively assess the potential air quality impacts during construction and provide recommendations on construction mitigation measures.

2.1.1 Air Contaminants of Potential Concern

The air contaminant emission sources expected from the Project operation phase are mobile sources that emit combustion gases from burning fossil fuels (e.g., gasoline and diesel) and fugitive dust from road traffic. Combustion emissions depend on the combustion device type (engine type), the fuel composition, the fuel consumption rate and operating time. Fugitive dust emissions are generated by road traffic during the movement of mobile sources (e.g., cars and trucks). The air contaminants of potential concern (CoPC) selected for this study are based on the most relevant transportation-related contaminants as listed in the MTO Guide (MTO, 2020).

2.1.2 Air Quality Contaminants

The expected CoPC that would likely be emitted during the Project construction and operation are primarily criteria air contaminants (CACs), volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). The CACs include nitrogen oxides (NOx), carbon monoxide (CO), particulate matter less than 10 µm in diameter (PM_{10}) and particulate matter less than 2.5 µm in diameter ($PM_{2.5}$) (MTO, 2020).

Nitrogen oxides or NOx is produced in most combustion processes, consisting of nitric oxide (NO) and nitrogen dioxide (NO_2). Nitric oxide is a colourless gas with no substantive direct effects on health or vegetation at ambient levels and with no regulatory criteria. NO_2 is the regulated form of NOx. Effects on human health of particulate are primarily associated with PM_{10} and $PM_{2.5}$ as particles of these sizes can become trapped by the upper airways or in the case of $PM_{2.5}$, can make their way deep into the lungs.

Total hydrocarbons (THC) and volatile organic compounds (VOCs) constitute two other groupings of CoPC for the Project. Key VOCs from fuel combustion processes which are included in the study are benzene, 1,3-butadiene, formaldehyde, acetaldehyde, and acrolein. The compliance status of these speciated VOCs are indicative of the compliance of other VOCs.

Polycyclic aromatic hydrocarbons (PAHs) are a subset of total hydrocarbons, of which the key representative substance is benzo(a)pyrene (B(a)P) which can be considered as a surrogate of total PAHs.

A summary of the applicable Ontario Ambient Air Quality Criteria (AAQC) and Canadian Ambient Air Quality Standards (CAAQS) used in this study are presented in Table 2.1.

Table 2.1: Summary of Applicabale Air Quality Criteria and Standards

CoPC	CAS	Averaging Period (hours)	Air Quality Criteria/Standard ($\mu g/m^3$)	Regulatory Framework
CO	630-08-0	1	36,200	AAQC
		8	15,700	
NO_2	10102-44-0	1	400	AAQC
			119 [A, B]	2020 CAAQS
			83 [A, B]	2025 CAAQS
		24	200	AAQC
		Annual	34 [A, C]	2020 CAAQS
			24 [A, C]	2025 CAAQS
PM_{10}	N/A	24	50 [D]	AAQC
$PM_{2.5}$	N/A	24	27 [E]	2020 CAAQS
		Annual	8.8 [F]	2020 CAAQS
Benzene	71-43-2	24	2.3	AAQC
		Annual	0.45	AAQC
Benzo(a)pyrene [G]	50-32-8	24	0.00005	AAQC
		Annual	0.00001	AAQC
1,3-Butadiene	106-99-0	24	10	AAQC
		Annual	2	AAQC
Formaldehyde	50-00-0	24	65	AAQC
Acetaldehyde	75-07-0	0.5	500	AAQC
		24	500	AAQC
Acrolein	107-02-8	1	4.5	AAQC
		24	0.4	AAQC

Notes:

A. Converted to $\mu g/m^3$ assuming 10°C and 760 mmHg, consistent with the approach for converting AAQCs (MTO, 2020).

B. The 3-year average of the annual 98^{th} percentile daily maximum 1-hour (DM1H) average concentrations.

C. The average over a single calendar year of all the 1-hour average concentrations.

D. AAQC for PM_{10} is an interim AAQC provided as a guide for decision-making.

E. The 3-year average of the annual 98^{th} percentile of the daily 24-hour average concentrations.

F. The 3-year average of the annual average concentrations.

G. As a surrogate of total polycyclic aromatic hydrocarbons (PAHs).

2.1.3 Greenhouse Gases

A greenhouse gas (GHG) is any gas that contributes to potential climate change by trapping heat in the atmosphere. GHGs are known to contribute to warming of the climate, leading to many other changes around the world: in the atmosphere; on land; and in the oceans (IPCC, 2021).

Common GHGs include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Other GHGs include hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6), and nitrogen trifluoride (NF_3). HFCs and PFCs are used mainly as refrigerants, SF_6 is commonly found in electrical equipment, and NF_3 is used in the plasma etching of silicon wafers. The Project is expected to emit CO_2, CH_4, and N_2O from the combustion of fuels in vehicles and all three of these GHGs are assessed in this study. The other GHGs, such as HFCs, PFCs, SF_6 and NF_3, are not expected to occur in notable quantities related to the Project. Therefore, impacts associated with these gases are not assessed in this study.

GHGs absorb heat radiated by the earth and subsequently warm the atmosphere, leading to what is commonly known as the greenhouse effect. The relative measure of how much heat a GHG absorbs in the atmosphere is characterized as the global warming potential (GWP), relative to CO_2. The GWPs of CO_2, CH_4 and N_2O are 1, 28, and 265, respectively, based on the Intergovernmental Panel on Climate Change's (IPCC's) Fifth Assessment Report (IPCC 2013). Because different GHGs contribute to different extents to the greenhouse effect, the unit of kilotonnes of carbon dioxide equivalent (kt CO_2e) is used to express the total quantity of GHGs. This unit is calculated by multiplying the tonnage emission of each GHG by its global warming potential, then summing the contributions from all relevant GHGs. For this assessment, CO_2e emissions are predicted based on CO_2, CH_4 and N_2O emission factors from MOVES.

As identified in guidance provided on assessing climate change in environmental assessments, "the contribution of an individual project to climate change cannot be measured" (Federal-Provincial-Territorial Committee on Climate Change and Environmental Assessment 2003). Therefore, evaluation of Project effects will focus on estimation of GHG releases and comparison of Project GHG releases in relation to provincial (Ontario) and national (Canada) GHG totals.

3 Existing Conditions

Ambient air quality in the Air Quality Study Area is primarily influenced by emissions from vehicular traffic. Meteorology and climatology play an important role in air contaminant formation, dispersion, and transport. The local meteorology and ambient air quality data are discussed in this section.

3.1 Climate

The following sections describe the general climatology of the Air Quality Study Area. The climatology is based on 30-year (1981 to 2010) Canadian Climate Normal data obtained from Environment and Climate Change Canada (ECCC) for two meteorological stations: one at the Georgetown WWTP meteorological station and one at the Toronto Lester B. Pearson International Airport. These are the closest stations to the Air Quality Study Area that contain complete climate normal data.

3.1.1 Temperature

A summary of the daily average, daily maximum, and daily minimum temperatures on a monthly basis over the period 1981 to 2010 is presented in Table 3.1. The daily average temperature for the area varies from -6.3°C to 20°C with an annual average temperature of 7.1°C.

Table 3.1: Summary of Average Temperature Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Daily Average (°C)	-6.3	-5.2	-0.9	6	12.3	17.4	20	19	14.8	8.4	2.8	-2.9	7.1
Daily Maximum (°C)	-1.7	-0.2	4.6	12.1	19.1	24.4	26.9	25.8	21.4	14.3	7.3	1.1	12.9
Daily Minimum (°C)	-10.9	-10.2	-6.4	-0.2	5.3	10.4	13	12.1	8.1	2.4	-1.7	-6.9	1.3

Notes:
SOURCE: Environment and Climate Change Canada Canadian Climate Normal – Georgetown WWTP meteorological station.

3.1.2 Precipitation

A summary of the monthly average rainfall, snowfall, and total precipitation (as equivalent rainfall based on a conversion factor for snowfall to equivalent rainfall of 0.1) over the period 1981 to 2010 is presented in Table 3.2. The annual average total precipitation for the area is 877.4 millimetres (mm).

Table 3.2: Summary of Average Precipitation Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Rainfall (mm)	29.7	28.4	35.2	71.3	79	74.8	73.5	79.3	86.2	67.8	79.9	36.4	741.5
Snowfall (cm)	38.1	31.7	22.1	5.2	0.3	0	0	0	0	0.5	8.6	29.5	135.9
Precipitation (mm)	67.8	60	57.2	76.5	79.3	74.8	73.5	79.3	86.2	68.3	88.5	65.9	877.4

Notes:
SOURCE: Environment and Climate Change Canada Canadian Climate Normal – Georgetown WWTP meteorological station.

3.1.3 Humidity

A summary of the average morning and afternoon relative humidity on a monthly basis over the period 1981 to 2010 is presented in Table 3.3. The annual average relative humidity in the morning is 81.3% and in the afternoon is 61.3%.

Table 3.3: Summary of Average Relative Humidity Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Relative Humidity - 0600LST (%)	80.8	79.3	78.1	75.4	77.2	79.8	81.9	85.7	87.4	85.2	83.3	81.8	81.3
Average Relative Humidity - 1500LST (%)	72	68.4	61.4	54.4	53.5	54.9	53.3	55.8	58.5	62.1	69.2	72.5	61.3

Notes:
SOURCE: Environment and Climate Change Canada Canadian Climate Normal – Toronto Lester B. Pearson International Airport meteorological station.

3.1.4 Wind Speed and Direction

The climate normal data with respect to wind speed and directionality are presented in Table 3.4. The annual average wind speed for the area is 15 km/h and the most frequent wind direction, on an annual basis, is wind blowing from the west.

Table 3.4: Summary of Wind Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Speed (km/h)	17.6	17	16.9	16.8	14.4	13.2	12.9	11.9	12.7	14	15.7	16.7	15
Most Frequent Direction (1)	W	W	N	N	N	N	W	N	W	W	W	W	W
Max Hourly Speed (km/h)	77	77	97	81	71	63	61	71	77	92	80	76	97
Max Gust Speed (km/h)	115	105	124	115	109	107	135	115	106	104	122	109	135
Direction of Max Gust (1)	E	W	SW	W	W	W	NW	NE	NW	NW	SW	S	NW

Notes:

SOURCE: Environment and Climate Change Canada Canadian Climate Normal – Toronto Lester B. Pearson International Airport meteorological station.

Note: 1 denotes the direction *from which* the wind is blowing most frequently.

3.2 Special Receptors

The assessment of impacts on air quality is carried out at locations in the Air Quality Study Area referred to as special receptors. Special receptors are placed (i.e., located) to assess air quality at locations where human activity takes place on a regular basis. The MTO Guide recommends that the local air quality impacts be studied within 500 m from a Project at both sensitive (residences) and critical receptors (schools, hospitals, retirement homes, childcare centres, and other similar institutional buildings).

Table 3.5 lists thirty-four (34) special receptors identified in the Air Quality Study Area and includes representative residences, schools/daycares, and places of worship. These receptors were considered in the assessment. The locations of the special receptors are shown in a receptor map in Appendix B.

Table 3.5: List of Special Receptors

Receptor ID	Receptor Description	Receptor Type	UTM Coordinates		
			Zone	Easting (m)	Northing (m)
R1	Residence on Russell Street	Sensitive	17	591219	4833254
R2	Residence on Russell Street	Sensitive	17	591250	4833258
R3	Residence on Russell Street	Sensitive	17	591267	4833287
R4	Residence on Guelph Street	Sensitive	17	591501	4833209
R5	Residence on Guelph Street	Sensitive	17	591532	4833203
R6	Georgetown Daycare Centre& Nursery School Inc.	Critical	17	591571	4833241
R7	Residence on Guelph Street	Sensitive	17	591609	4833154

Receptor ID	Receptor Description	Receptor Type	UTM Coordinates		
			Zone	Easting (m)	Northing (m)
R8	Residence on Guelph Street	Sensitive	17	591629	4833161
R9	Residence on Guelph Street	Sensitive	17	591657	4833166
R10	St. George Syriac Orthodox Church	Sensitive	17	591687	4833169
R11	Residence on Guelph Street	Sensitive	17	591743	4833182
R12	Residence on Guelph Street	Sensitive	17	591767	4833187
R13	Norval Presbyterian Church	Sensitive	17	591787	4833253
R14	Residence on Guelph Street	Sensitive	17	591807	4833198
R15	Residence on Guelph Street	Sensitive	17	591856	4833203
R16	Residence on Guelph Street	Sensitive	17	591890	4833177
R17	Residence on Green Street	Sensitive	17	591973	4833140
R18	St Paul's Anglican Church	Sensitive	17	592098	4833167
R19	St Paul's Anglican Church Hall	Sensitive	17	592107	4833133
R20	Residence on Adamson Street	Sensitive	17	592097	4832870
R21	Residence on Winston Churchill Boulevard	Sensitive	17	592283	4832731
R22	Residence on Winston Churchill Boulevard	Sensitive	17	592318	4832719
R23	Residence on Winston Churchill Boulevard	Sensitive	17	592378	4832672
R24	Residence on Winston Churchill Boulevard	Sensitive	17	592329	4832506
R25	Residence on Tenth Line	Sensitive	17	591658	4832318
R26	Residence on Tenth Line	Sensitive	17	591600	4832378
R27	Residence on Tenth Line	Sensitive	17	591503	4832473
R28	Residence on Tenth Line	Sensitive	17	591429	4832548
R29	Residence on Tenth Line	Sensitive	17	591344	4832636
R30	Residence on Tenth Line	Sensitive	17	591263	4832711
R31	Residence on Tenth Line	Sensitive	17	591186	4832779
R32	Residence on Tenth Line	Sensitive	17	591128	4832850
R33	Residence on Tenth Line	Sensitive	17	591083	4832890
R34	Residence on Tenth Line	Sensitive	17	591027	4832944

3.3 Local Air Quality

3.3.1 Available Published Ambient Monitoring Data

Ambient air quality monitoring has been conducted by the National Air Pollution Surveillance Program (NAPS) operated by ECCC in populated regions of Canada. NAPS was established in 1969 with the goal of the program to provide accurate and long-term air quality data of a uniform standard across Canada. NAPS continuously measures ambient concentrations of NO_2, CO, O_3, and $PM_{2.5}$ and integrated measurements of select carbonyls (i.e., acetaldehyde, acrolein and formaldehyde), VOCs and PAHs.

The NAPS network data for the most recent five years currently available (2017-2021) at the nearest monitoring stations to the Project were reviewed to establish background air quality concentrations. Monitoring station data were reviewed considering the proximity of the station to the Air Quality Study Area, the data completeness, the proximity of the monitoring station to an existing major roadway, having a land use similar to that in the Air Quality Study Area, and/or similar population size. These features were considered in the selection of the monitoring station to represent background concentrations in the Air Quality Study Area. The NAPS stations that were considered for this study are presented in Table 3.6 with the stations selected for quantifying background levels highlighted in grey.

Table 3.6 NAPS Locations Considered in the Study

NAPS ID	Location	Station Name	Contaminant [A]	Availability of Data
60512	Elgin & Kelly	Beasley Park Hamilton Downtown	CO	2017 – 2021
60430	125 Resources Road	Toronto West	CO	2017 – 2021
60438	401w – 125 Resources Rd.	Roadside 401W Toronto	CO	2017 – 2021
			formaldehyde, acetaldehyde	2017 – 2019
			acrolein	2017 – 2018
60512	Elgin & Kelly	Beasley Park Hamilton Downtown	NO_2, $PM_{2.5}$	2017 – 2021
60450	109 McLaughlin Rd. S.	Brampton	NO_2, $PM_{2.5}$, O_3	2017 – 2021[C]
67001	Main St East	Milton	NO_2, $PM_{2.5}$, O_3	2019 – 2021[D]
60434	Mississauga Rd	Mississauga	NO_2, $PM_{2.5}$, O_3	2017 – 2021
61802	Exhibition Park & Clark St	Guelph	NO_2, $PM_{2.5}$, O_3	2017 – 2021
60521	Fennel Av W	Hamilton Mountain	NO_2, $PM_{2.5}$, O_3	2019 – 2021[E]
61603	8th Line & Glenashton Dr	Oakville	NO_2, $PM_{2.5}$, O_3	2016 – 2021
60512	Elgin & Kelly	Beasley Park Hamilton Downtown	B(a)P	2014, 2016 – 2018[F]
			benzene, 1,3-butadiene	2014 – 2017 & 2019[G]

NAPS ID	Location	Station Name	Contaminant [A]	Availability of Data
62601	Experimental Farm	Simcoe	B(a)P	2016 – 2018[H]
			acetaldehyde, formaldehyde	2014 – 2015, 2017 – 2019[I]
			acrolein	2014 – 2015 & 2017[J]
			benzene, 1,3-butadiene	2014 – 2015, 2017 – 2018[K]
60904	St. Julien Street	London	benzene, 1,3-butadiene	2015 – 2019[L]
61502	West Ave & Homewood	Kitchener	benzene, 1,3-butadiene	2015 – 2019[M]

Notes:

A – Only contaminants pertinent to this study are listed.

B – Grey shaded locations were selected for the study.

C – Station started operation in 2017.

D – Station started operation in 2019.

E – Station started operation in 2020.

F – Data availability is less than 75% for 2015 and 2019 – 2021.

G – Data availability is less than 75% for 2018 and 2020 – 2021.

H – Data availability is less than 75% for 2014, 2015 and 2019.

I – Data availability is less than 75% for 2016.

J – Data availability is less than 75% for 2016. No data for 2018 and 2019.

K – Data for 2014 and 2015 are available for a 24-hour sampling period. Data availability is less than 75% for 2016. Data for 2017 and 2018 are available for a 4-hour sampling period.

L – Data availability is less than 75% for 2021. No data for 2021 on NAPs website.

M – Data availability is less than 75% for 2021. No data for 2021 on NAPs website.

3.3.2 Background Concentration Levels

Background concentrations are used in dispersion modelling to represent the effect of the existing sources of air contaminants, both anthropogenic and biogenic, in the area. The background values are added to the values predicted from the modelling of the Project emissions to arrive at a total (cumulative) value to be compared against the regulatory thresholds, guidelines, or standards. The MTO Guide (MTO, 2020) recommends that the background pollutant concentrations to be used in this analysis are the 90th percentile of the most recently measured and complete concentration data from the nearest MECP or ECCC monitoring stations. The use of 90th percentile levels is to account for spatial and temporal variations between the monitoring location(s) and the Study Area, while still providing a conservative assessment. The background levels used in this study were therefore based on the 90th percentile values for short term averages. For annual averages, an annual average value was used as the background level.

The maximum, minimum, average and 90th percentile concentrations for applicable time periods for each CoPC are presented in Table 3.7. The following observations were made from the ambient monitoring data:

- The maximum measured 1-hour and 8-hour average CO concentrations of 1,869 µg/m^3 and 1,326 µg/m^3 respectively at the Toronto West station were well below the applicable 1-hour and 8-hour AAQC of 36,200 µg/m^3 and 15,700 µg/m^3.
- The maximum measured 1-hour and 24-hour average NO_2 concentrations at the Brampton station of 123.3 µg/m^3 and 77.4 µg/m^3 were below the applicable 1-hour and 24-hour AAQC of 400 µg/m^3 and 200 µg/m^3, respectively.
- Ambient PM_{10} concentrations were estimated based on $PM_{2.5}$ measurements at the Brampton station using a ratio of $PM_{2.5}$ / PM_{10} = 0.54 (Lall et al 2004). Based on this estimation methodology, the maximum PM_{10} background concentration of 74.1 µg/m^3 exceeded the interim PM_{10} AAQC of 50 µg/m^3.
- The maximum measured 24-hour and annual average $PM_{2.5}$ concentrations are 40 µg/m^3 and 7 µg/m^3, respectively.
- The maximum measured 24-hour benzene concentration of 1.9 µg/m^3 at the Kitchener station was below the 24-hour AAQC of 2.3 µg/m^3. The maximum measured annual average benzene concentration of 0.41 µg/m^3 was 91% of the annual average AAQC of 0.45 µg/m^3.
- The maximum measured 24-hour and annual average B(a)P concentrations of 0.00273 µg/m^3 and 0.000235 µg/m^3 respectively at the Beasley Park Hamilton Downtown station were above the 24-hour and annual average AAQC of 0.00005 µg/m^3 and 0.00001 µg/m^3.
- The maximum measured 24-hour and annual average 1,3-butadiene concentrations of 0.15 µg/m^3 and 0.024 µg/m^3 respectively at the Kitchener station were well below the applicable 24-hour and annual average AAQC of 10 µg/m^3 and 2 µg/m^3.
- The maximum measured 24-hour average formaldehyde concentration of 3.5 µg/m^3 at the Simcoe Experimental Farm station was well below the applicable 24-hour AAQC of 65 µg/m^3.
- The maximum measured 24-hour average acetaldehyde concentration of 12.1 µg/m^3 at the Simcoe Experimental Farm station was well below the applicable half-hour and 24-hour AAQC of 500 µg/m^3. Since acetaldehyde is not measured for shorter averaging periods, the 24-hour average concentration was converted to a half-hour concentration using the MECP averaging period conversion factor equation per the Air Dispersion Modelling Guideline for Ontario (ADMGO) (MECP, 2017).
- The maximum measured 24-hour average acrolein concentration of 0.072 µg/m^3 at the Simcoe Experimental Farm station was well below the applicable 1-hour and 24-hour AAQC of 4.5 and 0.4 µg/m^3, respectively. Since acrolein is not measured for shorter averaging periods, the 24-hour average concentration was converted to a 1-hour concentration using the MECP averaging period conversion factor equation (MECP, 2017).

Table 3.7: Summary of CoPC Background Concentrations

Contaminant	CAS	Averaging Period	Background Concentration (µg/m³)				Air Quality Criteria	Source	% of Criteria
		(hours)	Maximum	Minimum	Mean	90th Percentile	(µg/m³)		
CO[A]	630-08-0	1	1869	0	287	422	36,200	AAQC	1%
		8	1326	0	287	362	15,700		2%
NO_2[A]	10102-44-0	1	123.3	0	15.1	39.8	400	AAQC	10%
							119	2020 CAAQS	-[B]
							83	2025 CAAQS	-[B]
		24	77.4	1.2	15.1	32.9	200	AAQC	16%
		Annual	-	-	15.1	-	34	2020 CAAQS	45%
							24	2025 CAAQS	64%
PM_{10}[D]	N/A	24	74.1	0	13.0	24.1	50	AAQC	48%
$PM_{2.5}$	N/A	24	40.0	0	7.0	13.0	27	2020 CAAQS	-[C]
		Annual	-	-	7.0	-	8.8	2020 CAAQS	-[C]
Benzene	71-43-2	24	1.9	0.113	0.41	0.81	2.3	AAQC	35%
		Annual	-	-	0.41	-	0.45	AAQC	91%
Benzo(a)pyrene	50-32-8	24	0.00273	0	0.000235	0.001265	0.00005	AAQC	2529%
		Annual	-	-	0.000235	-	0.00001	AAQC	2347%
1,3-Butadiene	106-99-0	24	0.15	0.0063	0.024	0.054	10	AAQC	1%
		Annual	-	-	0.024	-	2	AAQC	1%
Formaldehyde	50-00-0	24	3.5	0.0036	0.62	1.9	65	AAQC	3%

Contaminant	CAS	Averaging Period (hours)	Background Concentration ($\mu g/m^3$) Maximum	Minimum	Mean	90^{th} Percentile	Air Quality Criteria ($\mu g/m^3$)	Source	% of Criteria
Acetaldehyde[E]	75-07-0	0.5	-	-	-	20.7	500	AAQC	4%
		24	12.1	0	0.79	7.0	500	AAQC	1%
Acrolein[E]	107-02-8	1	-	-	-	0.073	4.5	AAQC	2%
		24	0.072	0	0.0089	0.030	0.4	AAQC	7%

Notes:

A. The monitoring data was converted to $\mu g/m^3$ based on a standard temperature of 10 °C and pressure of 1 atm.

B. The background hourly NO_2 concentration is not explicitly compared with the CAAQS as the 1-hour CAAQS for NO_2 is referenced to the three-year average of the annual 98^{th} percentile of the DM1H average concentrations while the background concentration is the 90^{th} percentile of hourly values, and therefore the calculation basis for these two parameters is inconsistent.

C. Background concentrations of $PM_{2.5}$ are not explicitly compared with the CAAQS as the 24-hour and annual standards are referenced to the 98^{th} percentile daily average concentration averaged over 3 consecutive years, and 3-year average of the annual average concentrations, respectively. The background concentrations are 90^{th} percentile of hourly values and single year annual averages and therefore the calculation basis for these parameters is inconsistent.

D. Background concentrations of PM_{10} are estimated based on a ratio of $PM_{2.5}/PM_{10}$ = 0.54 (Lall et al 2004).

E. Monitoring data are based on 24-hour measurements. The 24-hour background concentration is converted to the appropriate averaging period following guidance in the Air Dispersion Modelling Guideline of Ontario (ADMGO) (MECP 2017).

3.4 Existing Greenhouse Gas Emissions

Existing national and provincial GHG emission totals were obtained from Canada's 2023 National Inventory Report (ECCC, 2023) and are provided in Table 3.8. The table also shows the national (ECCC, 2022) and provincial (MECP, 2018) GHG emission reduction targets for 2030.

Table 3.8: National and Provincial GHG Emissions

Year	GHG Emissions (kt CO_2e)	
	Canada	Ontario
2016	705,000	160,000
2017	712,000	156,000
2018	725,000	163,000
2019	724,000	163,000
2020	659,000	147,000
2021	670,000	151,000
2030 Target	443,000	144,000

4 Emission Inventory

The methods and results of the air and GHG emissions estimations are provided in this section for the baseline and future assessment years.

4.1 Vehicle Emissions

The U.S. EPA MOtor Vehicle Emission Simulator (MOVES) version 3 (MOVES3) was used to estimate baseline and future emission rates from motor vehicle traffic on local roads (US EPA, 2020). MOVES is the U.S. EPA's tool for estimating vehicle emissions due to the combustion of fuel, brake and tire wear, fuel evaporation, permeation and refueling leaks. It was used to estimate vehicle emissions based on vehicle type, fuel type, road type, model year, and average vehicle speed. Vehicle types, distribution, peak hour, and average daily traffic (ADT) volumes in the Study Area were provided by the project design team (Stantec 2023a, 2023b and 2023c).

Both peak hour and average daily traffic data were used as inputs to the dispersion model and are provided in Appendix C. A summary of the MOVES input parameters is provided in Table 4.1.

Table 4.1: Summary of MOVES Inputs

Parameter	Input
Modelling Scale	Project Scale
Calculation Type	Emission Rates
Years	2016, 2031
Evaluation Months	January and July
Geographic Bounds	Niagara County, NY (36063) (closest to Air Quality Study Area)
Source Use Types and Distribution	96% Passenger Car 3% Single Unit Short-haul Truck 1% Combination Short-haul Truck
Road Type	Rural Unrestricted Access
Contaminants	CACs - CO, NO_x, NO_2, PM_{10}, $PM_{2.5}$, Acetaldehyde, Formaldehyde, 1,3-Butadiene, Benzene, Acrolein, and Benzo(a)pyrene GHGs - Atmospheric CO_2, CH_4 and N_2O
Meteorology (ambient temp., relative humidity)	Canadian Climate Normals, 1981-2010 for Georgetown WWTP Daily Average temperatures: January -6.3 degrees C July 20 degrees C Canadian Climate Normals, 1981-2010 for Toronto Lester B Pearson International Airport Average relative humidity: January 80.8% (AM) and 72% (PM) July 81.9% (AM) and 53.3% (PM)
Fuel Type	MOVES defaults

Parameter	Input
Fuel Data	Ontario
Vehicle Age Distribution	U.S. EPA default for the model year
Average Speed	8 to 80 km/hr based on assumed average travel speeds in the area

Emission factors in grams of pollutant emitted per vehicle mile travelled (g/VMT) for vehicle speeds for the above listed vehicle speeds and vehicle distributions were obtained from MOVES3 and applied to the appropriate emission sources used in the dispersion model. Appendix D summarizes the emission factors obtained from MOVES.

4.2 Road Dust Emissions

In addition to exhaust, tire wear, brake and evaporative emissions, the re-entrainment of road dust is considered a source of PM_{10} and $PM_{2.5}$ from vehicles travelling over paved roads. Emissions resulting from travel on paved roads were quantified using the US EPA AP-42 Chapter 13.2.1 calculation methodology.

The quantity of particulate emissions from resuspension of loose material on the road surface due to vehicles travelling on the Project roadways were calculated using the equation suggested in AP-42, Section 13.2 (US EPA, 2011):

$$E = K\times (sL)^{0.91}\times(w)^{1.02}$$

Where:

E= particulate emission factor (g/VMT)

sL = road surface silt loading (g/m^2):

AADT < 500: 0.6 g/m^2

AADT between 500 – 5,000: 0.2 g/m^2

AADT between 5,000 – 10,000: 0.06 g/m^2

AADT > 10,000: 0.03 g/m^2

W = average weight (tons) of the vehicles traveling the road:

Passenger cars: 1.8 tons

Medium Trucks: 10 tons

Heavy Trucks: 20 tons

K = particle size multiplier of 0.25 (g/VMT) for $PM_{2.5}$ and 1 (g/VMT) for PM_{10}.

The particulate resuspension emission factors were calculated from the above equation and aggregated with the emission factors generated from MOVES for $PM_{2.5}$ and PM_{10}.

The MOVES output emission factors and detailed road dust emissions calculations are presented in Appendix D.

4.3 Greenhouse Gas Emissions

The estimation of GHG emissions for the Project follows the same methodology described for air contaminant emissions, using MOVES to predict CO_2, CH_4 and N_2O emission factors with the same model inputs for the Baseline (2016) and Future No Build/Build (2031) scenarios. These emission factors were then used to calculate total CO_2e emissions in 2016 and 2031 both with and without implementation of the Project. The total emissions for each scenario were based on each modelled emission source's emission factor (g/VMT) and the predicted annual vehicle miles travelled (based on the length and ADT of each source). The detailed GHG emissions calculations are also provided in Appendix D and are summarized in Table 4.2.

Table 4.2: Project GHG Emissions

Annual GHG Emissions (t CO_2e / year)		
Baseline 2016	**Future 2031**	
	No Build	**Build**
9,890	8,606	7,247

The 2031 Future Build scenario represents a reduction in GHG emissions of 27% compared to the Baseline scenario and 16% compared to the Future No Build scenario. Due to expected improvements in engine technology and cleaner fuels, overall CO_2e emissions per vehicle mile travelled are lower in the future. GHG emissions are lower in the Future Build versus No Build scenario due to improvements related to road geometry resulting in an overall increase in average travel speeds in the Study Area.

5 Air Dispersion Modelling Methodology

Dispersion modelling of CoPC from vehicle traffic travel on local roads was performed for the following assessment scenarios:

- 2016 – Baseline Conditions (existing conditions)
- 2031 – Future No Build (future conditions without the Project)
- 2031 – Future Build (future conditions with the Project)

5.1 Dispersion Model Used

The US EPA AERMOD model Version 22112 was used to predict air quality concentrations at the special receptor locations for all emission scenarios.

AERMOD is a steady-state plume model that 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. Vertical profiles of wind speed wind direction, turbulence temperature, and temperature gradient are estimated using available meteorological observations. AERMOD accounts for the vertical inhomogeneity of the Planetary Boundary Layer (PBL). This is accomplished by "averaging" the parameters of the actual Stable Boundary Layer into "effective" parameters of an equivalent homogeneous PBL. With these effective parameters, AERMOD accounts for the inhomogeneity of the PBL, in an averaged sense.

Parameters that directly influence the dispersion of pollutants include wind speed and direction, atmospheric stability, and mixing layer depths. High concentrations from low elevated sources, elevated sources with building or topography effects, or virtual sources are typically due to stable atmospheric stability conditions with light winds.

The dispersion model was used to predict maximum 1-hour, 8-hour, 24-hour, and annual average ground level concentrations (GLCs) for each CoPC at the selected receptors for the assessed scenario. The predicted Project Alone concentrations were added to their corresponding background concentrations to estimate cumulative air quality levels at the special and gridded receptors. For CoPC with other averaging periods (i.e., half-hour), the predicted 1-hour concentrations were converted to the appropriate averaging period using the MECP recommended conversion factor per the ADMGO (MECP, 2017).

A total of 21 sources (road segments) were input into the model for the Baseline and Future No Build scenarios and 29 sources for the Future Build scenario. Detailed source data for each scenario is included in Appendix E. The sources were determined based on the preferred alignment plan presented in Appendix A and available traffic volumes provided by the project design team presented in Appendix C. Emission estimates from MOVES and the re-suspended road dust calculations were assigned to each source depending on the predicted vehicle distribution and average travel speed.

5.2 Meteorological Data Sources

The local meteorology of the region must be characterized to evaluate the short-term atmospheric dispersion and transport of emissions released by the Project activities. The data required to predict dispersion and transport includes wind speed and direction, temperature, atmospheric stability, and mixing layer depth. Wind and temperature data are readily available from meteorological stations, but atmospheric stability and mixing layer depth are calculated from additional raw meteorological data including upper air soundings, cloud cover and opaque sky cover.

A 5-year (2017-2021) site-specific meteorological data set preprocessed by the MECP (MECP, 2023) using AERMET version 22112, was used as input to the dispersion model. The site-specific meteorological dataset uses upper air data from Buffalo NY, and surface data from NAV Canada's Toronto International Airport Station.

The frequency distribution of wind speeds from the site-specific meteorological data set is shown in Figure 5.1. High wind speeds (greater than 8.8 m/s) occur infrequently, while wind speeds between 3.6 – 5.7 m/s occur the most frequently. A wind rose plot is presented in Figure 5.2. Wind roses are an efficient and convenient means of presenting wind data. The length of the radial barbs gives the total percent frequency of winds blowing from the indicated direction, while portions of the barbs of different widths indicate the frequency associated with each wind speed category. Winds blow most frequently from the northwest, westerly, and southeasterly directions.

Figure 5.1: Wind Class Frequency Distribution (Toronto International Airport Station 2017-2021)

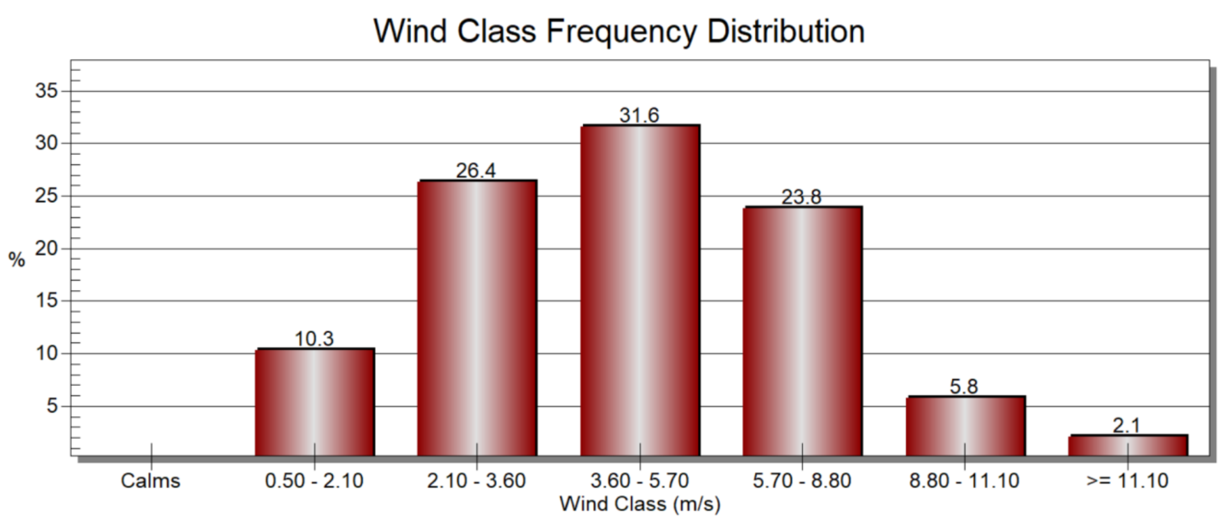
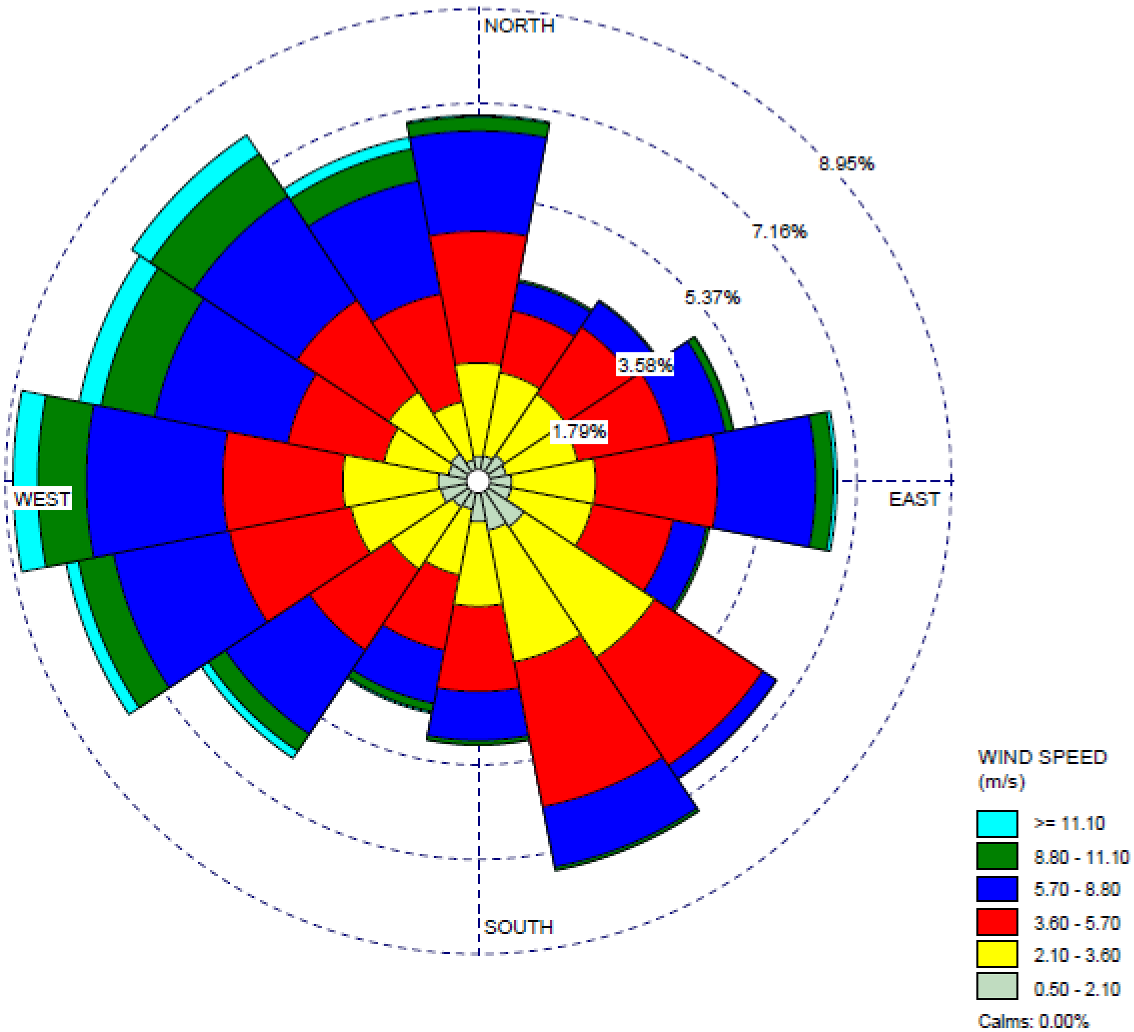


Figure 5.2: Wind Rose Plot (Toronto International Airport Station 2017-2021)



5.3 Building Downwash

Wind dependent building/obstacle dimensions are an input to AERMOD for use in the building wake and building downwash calculations for point source emissions. As all emissions sources were modelled as line volume and volume sources, building downwash data was not required.

5.4 Topographic Data

The Canadian Digital Elevation Model (CDEM) file cdem_dem_030M_tif available from the MECP's website (MECP, 2022) was used in the assessment.

5.5 Averaging Periods

AERMOD is capable of predicting concentrations for a variety of averaging times of 1-hour and greater than 1-hour. For this Project, the models were run for 1-hour, 24-hour, and annual averaging times to give results that can be directly compared to the relevant objectives for each CoPC. For objectives with other averaging periods, predicted concentrations from the nearest averaging period were converted using the conversion methodology recommended by MECP (MECP, 2017).

For comparison with the 1-hour NO_2 CAAQS, the 98th percentile of the predicted 1-hour NO_2 concentrations at the sensitive receptor where the maximum predicted GLC occurs was calculated for each of the five years in the meteorological data set. The 98th percentile concentrations were then averaged over 3-year periods and the maximum of these averages was compared with the CAAQS.

5.6 Receptors

The MTO Guide recommends that the local air quality impacts be studied within a distance of 500 m from a transportation facility in all directions, and at both sensitive (residences) and critical receptors (hospitals, retirement homes, childcare centres, etc.). The choice of a 500 m limit is based on empirical evidence for heavily travelled large highways, which clearly indicates that the concentrations of road-related pollutants drop to within 10% of their background pollution levels over this distance (MTO, 2020).

The locations of the representative sensitive and critical receptors used to assess compliance with the air quality criteria and standards are listed in Table 3.5 and are shown in a receptor map in Appendix B.

5.7 Conversion of Nitrogen Oxides to Nitrogen Dioxide

Nitrogen oxides (NOx) from fuel combustion processes are comprised mainly of nitrous oxide (NO) and nitrogen dioxide (NO_2). Only NO_2 has ambient air quality criteria. In combustion emissions, typically most of the NOx emissions are NO and only a small percentage are NO_2. Once in the ambient air, NO is irreversibly oxidized by ground level ozone (O_3) to produce nitrogen dioxide (NO_2) as follows:

$$NO + O_3 \rightarrow NO_2 + O_2$$

According to the OLM method, the conversion of NO to NO_2 is limited by the ambient concentration of ozone (O_3) in the atmosphere. If it is assumed that 10% (by volume) of the NO_X emissions released from each source is NO_2 then the remaining 90% may be converted to NO_2 (U.S. EPA 2015) as follows:

- If 90% of the NO_X concentration is less than the ambient O_3 concentration, then

$$[NO_2] = [NO_X] \text{ (complete conversion).}$$

- If 90% of the NO_X concentration is greater than the ambient O_3 concentration, then

$$[NO_2] = 10\% [NO_X] + [O_3] \text{ (limited conversion).}$$

In the application of the OLM, the above relationships assume that all concentrations are expressed in parts per billion (ppb).

The use of the OLM approach in AERMOD requires the specification of an in-stack ratio (ISR) of NO_2/NO_X. U.S. EPA guidance (U.S. EPA, 2014) notes that in-stack ratios used with the OLM option can be justified based on the specific application. As the NO_X emissions from the Project are associated with vehicular tailpipe emissions, a site specific ISR was determined from a review of the NO_x and NO_2 outputs from MOVES. For the 2016 scenario, the average NO_2/NO_X ISR is 0.1. Therefore, a NO_2/NO_X ISR of 0.2 was conservatively used as an input for the Baseline scenario. The MOVES output for 2031 has an average NO_2/NO_x ISR of 0.4. Therefore, a NO_2/NO_X ISR of 0.5 was conservatively used as an input for the Future No Build and Future Build scenario.

The OLM method was implemented in the AERMOD model to predict hourly average NO_2 concentrations using the predicted hourly average NO_X concentrations and seasonal hourly background ozone values from the Brampton station (provided in Appendix E).

5.8 Emission Source Data

The operation emission sources were modelled following the protocols and procedures outlined in the MECP's ADMGO (MECP, 2017). Emissions from on-road vehicle traffic were modelled as line volume and volume sources with parameters determined based on the recommended approach by the US EPA Haul Road Workgroup Final Report (US EPA, 2012). Hourly and daily emissions were estimated for these sources based on available traffic data.

A summary of the emission source parameters used in the AERMOD dispersion modelling is provided in Appendix C and D. The locations of the emission sources are shown in Appendix E.

6 Project Alone Air Dispersion Modelling Results

This section presents the results of the dispersion modelling analysis of the Baseline, Future No Build and Future Build configurations at the special receptor locations discussed in Special Receptors. A summary of the maximum predicted GLCs with comparison to the applicable AAQC and/or CAAQS is presented in Table 6.1. Tabulated model predictions for all special receptors identified in the study are included in Appendix F.

Predictions for the CoPC are presented as maximum modelled concentrations and are used for comparison to the applicable AAQC unless otherwise stated. For comparison with the 1-hour CAAQS for NO_2, the statistical methodology in the CCME CAAQS guidance (CCME, 2020) was used (i.e., the maximum of the 3-year average of the annual 98th percentile daily 1-hour maximum (or D1HM) was used).

The maximum predicted Project alone GLCs for all CoPC are below their relevant AAQC and/or CAAQS except for NO_2 and B(a)P in the Baseline scenario. The general trend in the model predictions is a decrease in maximum predicted concentrations over time due to advances in cleaner fuels and emissions control technology, which are anticipated to lower all vehicle contaminant tailpipe emissions in the future. Future predictions using MOVES3 are expected to be conservative as they do not account for the increasing proportion of electric vehicles.

Carbon Monoxide

Maximum predicted CO concentrations are well below the relevant AAQC for all scenarios. The Future No Build and Future Build scenarios predict reductions in maximum GLCs by 47% and 68%, respectively, compared to the Baseline scenario.

Nitrogen Dioxide

Maximum predicted NO_2 concentrations are below the relevant provincial AAQC for all scenarios. The maximum 1-hour NO_2 GLC is predicted to decrease by 50% in the Future No Build scenario and by 73% in the Future Build scenario compared to Baseline conditions. For the 24-hour averaging period, the maximum NO_2 GLC decreases by 75% in the Future No Build scenario and 82% for the Future Build scenario relative to Baseline.

The highest 98th percentile D1HM NO_2 concentration over the modelled receptors for the Baseline scenario is 115% and 165% of the 2020 and 2025 CAAQs, respectively, but is below the 2025 CAAQS in the Future No Build and Future Build scenarios by 76 and 43%. Annual average NO_2 concentrations are predicted to be below the CAAQS for all three scenarios.

Plots of 98th percentile D1HM NO_2 concentrations for the three scenarios are presented in Appendix G.

Particulates

Maximum predicted PM_{10} and $PM_{2.5}$ concentrations for all three scenarios are well below the AAQC and CAAQS, respectively. The maximum predicted 24-hour average PM_{10} concentrations, as a percent of the AAQC, are 18% for the Baseline scenario, 19% for the Future No Build and 14% for the Future Build scenario. Decreases in the maximum predicted 24-hour and annual average $PM_{2.5}$ concentrations are predicted for both future scenarios relative to Baseline, with the Future Build scenario being 15 – 18% lower than the Future No Build scenario.

Volatile Organic Compounds

Maximum predicted benzene, 1,3-butadiene, formaldehyde, acetaldehyde and acrolein GLCs decrease for both the Future Build and Future No Build scenarios compared to the Baseline scenario, with predicted Future Build concentrations being lower than Future No Build concentrations. The maximum predicted GLCs for the Future Build scenario are less than 3% of the relevant AAQCs for all VOCs.

Benzo(a)pyrene

The maximum predicted 24-hour and annual average B(a)P concentrations are 304% and 316% higher than the 24-hour and annual average AAQC for the Baseline scenario. The 24-hour average frequency of exceedance at the most impacted special receptor (R20) is 573 days over a 5-year period or 31% of the time. The annual average AAQC is predicted to be exceeded in all 5-years at 25 sensitive and 1 critical receptor.

For the Future No Build scenario, the maximum predicted 24-hour and annual average GLCs are 98% of the AAQC, which is a 76% reduction relative to the Baseline scenario. The maximum predicted 24-hour and annual average GLCs for the Future Build scenario are respectively 71% and 63% of the 24-hour and annual average AAQCs and are 82% and 85% lower than the Baseline scenario predictions. The maximum predicted 24-hour and annual average GLCs for the Future Build Scenario are respectively 27% and 36% lower than those for the Future No Build scenario.

B(a)P concentration plots for the three scenarios are presented in Appendix G.

Table 6.1: Project Alone Maximum Predicted Concentrations at Special Receptors

Contaminant	Averaging Period	Project Alone Maximum Predicted Concentration at Special Receptors [1] ($\mu g/m^3$)			Air Quality Criteria / Standard	Regulatory Framework	Percentage of Reference Criteria (%)		
		2016 Baseline	2031 Future No Build	2031 Future Build	($\mu g/m^3$)		2016 Baseline	2031 Future No Build	2031 Future Build
CO	1-hour	2,201	1165	705	36,200	AAQC	6%	3%	2%
	8-hour	1,229	651	394	15,700	AAQC	8%	4%	3%
NO_2	1-hour	160.1	80.3	43.3	400	AAQC	40%	20%	11%
		137.0*	62.8*	35.6*	119	2020 CAAQS	**115%**	53%	30%
					83	2025 CAAQS	**165%**	76%	43%
	24-hour	33.1	8.4	6.1	200	AAQC	17%	4%	3%
	Annual	7.46	1.79	1.15	34	2020 CAAQS	22%	5%	3%
					24	2025 CAAQS	31%	7%	5%
PM_{10}	24-hour	9.1	9.4	7.1	50	AAQC	18%	19%	14%
$PM_{2.5}$	24-hour	2.8	2.1	1.7	27	CAAQS	10%	8%	6%
	Annual	0.56	0.43	0.37	8.8	CAAQS	6%	5%	4%
Benzene	24-hour	2.9E-01	5.6E-02	4.3E-02	2.3	AAQC	13%	2%	2%
	Annual	5.8E-02	1.1E-02	7.6E-03	0.45	AAQC	13%	3%	2%
B(a)P	24-hour	2.0E-04	4.9E-05	3.6E-05	0.00005	AAQC	**404%**	98%	71%
	Annual	4.2E-05	9.8E-06	6.3E-06	0.00001	AAQC	**416%**	98%	63%
1, 3 Butadiene	24-hours	3.5E-02	8.8E-04	6.0E-04	10	AAQC	0%	0%	0%
	Annual	7.1E-03	1.7E-04	1.1E-04	2	AAQC	0%	0%	0%
Formaldehyde	24-hour	2.0E-01	5.0E-02	3.5E-02	65	AAQC	0%	0%	0%
Acetaldehyde	½-hour	1.5	3.6E-01	1.8E-01	500	AAQC	0%	0%	0%
	24-hours	1.3E-01	2.9E-02	2.0E-02	500	AAQC	0%	0%	0%
Acrolein	1-hour	1.4E-01	3.1E-02	1.5E-02	4.5	AAQC	3%	1%	0%
	24-hours	1.4E-02	3.0E-03	2.1E-03	0.4	AAQC	3%	1%	1%

Notes:

1. The maximum predicted concentration (meteorological anomalies included) is conservatively used for comparison to all Air Quality Objectives except for 1-hour NO_2 concentrations where the highest 98^{th} percentile D1HM concentration is used for comparison to the CAAQS.

2. Air Quality Criteria / Standards:

AAQC - Ambient Air Quality Criteria for Ontario

CAAQS - Canadian Ambient Air Quality Standards

For NO_2 - 2020 and 2025 CAAQS for 1-hour and annual averaging periods are converted to $\mu g/m^3$ based on 1 atm and 10 degrees C. The 1-hour and annual average 2020 CAAQS are 60 ppb and 17 ppb respectively. The 1-hour and annual average 2025 CAAQS are 42 ppb and 12 ppb, respectively.

For $PM_{2.5}$ - 2020 CAAQS for 24-hour and annual averaging periods.

Bolded values show a predicted exceedance of an AAQC or CAAQS.

7 Cumulative Effects Assessment

This section presents the assessment of background air quality and GHG emissions in order to evaluate the Project's emissions cumulatively and in relation to other existing sources of emissions in the Study Area.

7.1 Cumulative Air Quality

The maximum predicted GLCs from the Project alone air quality dispersion modelling presented in Section 6 were added to the background concentrations presented in Section 3.3.2 in order to assess the cumulative effects of the Project with existing air quality levels in the Study Area. A summary of the maximum modelled predictions including background concentrations in comparison to the applicable AAQC and/or CAAQS is presented in Table 7.1.

The maximum predicted cumulative GLCs for CO, PM_{10}, $PM_{2.5}$, 1, 3 butadiene, formaldehyde, acetaldehyde and acrolein are below their relevant AAQC or CAAQS for all averaging periods and all scenarios. NO_2, benzene and B(a)P, exceedances were predicted for some averaging periods when background concentrations were added, as discussed below.

Carbon Monoxide

Maximum predicted cumulative CO concentrations for all averaging periods are below the AAQC for all scenarios (between 19% and 50% of their respective AAQCs).

Nitrogen Dioxide

The maximum predicted cumulative 1-hour and 24-hour average NO_2 concentrations are below the provincial AAQC for all scenarios.

The maximum predicted cumulative 98th percentile D1HM NO_2 concentration for the Baseline Scenario is 213% of the 2025 CAAQS. For the Future No Build scenario, one sensitive receptor is predicted to be 124% of the hourly CAAQS with all other receptors predicted to be below the CAAQS. No exceedances of the 2025 hourly CAAQs are predicted for the Future Build scenario, with the maximum D1HM NO_2 concentration being 91% of the CAAQS.

Cumulative annual average NO_2 concentrations are predicted to be below the 2020 and 2025 CAAQS for all three scenarios.

Particulates

Maximum predicted cumulative PM_{10} and $PM_{2.5}$ concentrations for all averaging periods and scenarios are below the AAQC and CAAQS, respectively.

VOCs

Predicted cumulative concentrations of 1,3-butadiene, formaldehyde, acetaldehyde and acrolein for all averaging periods and scenarios are below their respective AAQCs.

Benzene

The maximum predicted cumulative 24-hour average benzene concentrations are below the AAQC for all scenarios.

The maximum cumulative annual average benzene concentrations are predicted to be 104%, 93%, and 92% of the AAQC for the Baseline, Future No Build and Future Build scenarios, respectively, with the background concentration alone being 91% of the AAQC.

Ambient air quality monitoring data suggests a decreasing trend in benzene concentrations in Ontario over the past decade (MECP, 2021) with a 27% decrease over the 10 years between 2009 and 2018. Based on this trend, it is likely that background benzene levels will continue to improve in the future and therefore the background concentrations used in the assessment are conservative.

Benzo(a)pyrene

The maximum predicted cumulative concentrations of B(a)P exceed the 24-hour and annual average AAQCs at all special receptor locations for all scenarios, with the background concentrations alone exceeding the 24-hour and annual average AAQCs. The maximum predicted 24-hour and annual average cumulative B(a)P concentrations for the Future Build scenario are 1% lower than the Future No Build scenario. The maximum cumulative B(a)P concentrations are predicted to decrease in the future scenarios relative to the existing scenario due to expected future reductions in vehicle emissions.

Table 7.1: Maximum Predicted Cumulative Concentrations at Special Receptors

Contaminant	Averaging Period	Background Concentration	Maximum Predicted Cumulative Concentration (Project + Background) at Special Receptors (µg/m³)			Air Quality Objective	Regulatory Framework	Percentage of Objective (%)		
		(µg/m³)	2016 Baseline	2031 Future No Build	2031 Future Build	(µg/m³)		2016 Baseline	2031 Future No Build	2031 Future Build
CO	1-hour	422.0	2,622	1,587	1,127	36,200	AAQC	7%	4%	3%
	8-hour	422.0	1,651	1,073	816	15,700	AAQC	11%	7%	5%
NO_2	1-hour	39.8	200	120	83	400	AAQC	50%	30%	21%
			177	103	75	119	2020 CAAQS	**149%**	86%	63%
						83	2025 CAAQS	**213%**	**124%**	91%
	24-hour	32.9	66	41	39	200	AAQC	33%	21%	19%
	Annual	15.1	23	17	16	34	2020 CAAQS	66%	50%	48%
						24	2025 CAAQS	94%	70%	68%
PM_{10}	24-hour	24.1	33.2	33.5	31.2	50	AAQC	66%	67%	62%
$PM_{2.5}$	24-hour	13	16	15	15	27	CAAQS	58%	56%	55%
	Annual	7.0	8	7	7	8.8	CAAQS	86%	84%	84%
Benzene	24-hour	0.81	1.1	0.9	0.8	2.3	AAQC	48%	37%	37%
	Annual	0.41	0.5	0.4	0.4	0.45	AAQC	**104%**	93%	92%
B(a)P	24-hour	0.0013	0.0015	0.0013	0.0013	0.00005	AAQC	**2933%**	**2627%**	**2600%**
	Annual	0.00023	0.00028	0.00024	0.00024	0.00001	AAQC	**2762%**	**2445%**	**2410%**
1, 3 Butadiene	24-hours	0.054	0.09	0.05	0.05	10	AAQC	1%	1%	1%
	Annual	0.024	0.03	0.02	0.02	2	AAQC	2%	1%	1%
Formaldehyde	24-hour	1.9	2.1	1.9	1.9	65	AAQC	3%	3%	3%
Acetaldehyde	½-hour	20.7	22.2	21.0	20.9	500	AAQC	4%	4%	4%
	24-hours	7.0	7.1	7.0	7.0	500	AAQC	1%	1%	1%
Acrolein	1-hour	0.073	0.21	0.10	0.09	4.5	AAQC	5%	2%	2%
	24-hours	0.030	0.04	0.03	0.03	0.4	AAQC	11%	8%	8%

Notes:

1. The maximum predicted concentration (meteorological anomalies included) is conservatively used for comparison to all Air Quality Objectives except for 1-hour NO_2 concentrations where the highest 98th percentile D1HM concentration is used for comparison to the CAAQS.
2. Air Quality Criteria / Standards:

AAQC - Ambient Air Quality Criteria for Ontario

CAAQS - Canadian Ambient Air Quality Standards

For NO2 - 2020 and 2025 CAAQS for 1-hour and annual averaging periods are converted to µg/m³ based on 1 atm and 10 degrees C. The 1-hour and annual average 2020 CAAQS are 60 ppb and 17 ppb respectively. The 1-hour and annual average 2025 CAAQS are 42 ppb and 12 ppb, respectively.

For $PM_{2.5}$ - 2020 CAAQS for 24-hour and annual averaging periods.

Bolded values show a predicted exceedance of an AAQC or CAAQS.

7.2 Greenhouse Gases

The global climate is influenced by the presence of natural and human made GHGs. Current scientific knowledge does not allow for the effects of an individual Project on climate change to be assessed, the Project is therefore assessed in terms of CO_2e produced and released to the atmosphere and how this compares with national and provincial levels/targets.

To evaluate the potential cumulative effects of GHG emissions due to the Project, estimated emissions (presented in Section 4.3) with and without implementation of the Project are compared to the existing baseline emissions in Canada and Ontario. Table 7.2 presents the GHG emissions estimates for each of the three scenarios compared to Canada and Ontario 2021 totals and 2030 emissions targets. The estimated GHG emissions from the Future Build scenario are 0.0011% of Canada's and 0.0048% of Ontario's total emissions for 2021. Further, this is 0.0016% of Canada's and 0.005% of Ontario's 2030 emission reduction targets.

A decrease in GHG emissions of 1.4 kt CO_2e per year is predicted for the Future Build scenario relative to the Future No Build scenario. This is equivalent to decreases in GHG emissions of 0.0002% of Canada's and 0.0009% of Ontario's 2021 totals respectively. The predicted future decrease in GHG emissions for the Future Build scenario are 0.0003% and 0.001% of the 2030 emissions targets for Canada and Ontario, respectively.

Table 7.2: Greenhouse Gas Estimates Compared to National and Provinvial Totals

Scenario	Project (kt CO_2e)	Canada				Ontario			
		2021 Total (kt CO_2e)	% 2021 Total	2030 Target (kt CO_2e)	% of 2030 Target	2021 Total (kt CO_2e)	% of 2021 Total	2030 Target (kt CO_2e)	% of 2030 Target
2016 Baseline	9.9	670,000	0.0015%	443,000	0.0022%	151,000	0.0065%	144,000	0.0069%
2031 Future No Build	8.6		0.0013%		0.0019%		0.0057%		0.0060%
2031 Future Build	7.2		0.0011%		0.0016%		0.0048%		0.0050%

8 Potential Impacts and Mitigation During Construction and Operation

8.1 Potential Impacts and Mitigation During Construction

During construction of the Project, dust will be the primary CoPC. Other CoPC such as NO_2 and VOCs will also be emitted from equipment used during construction. As the construction activities will be short-term and intermittent, emissions are expected to be minor provided adequate mitigation measures are implemented. The ECCC guideline “Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities” (ECCC, 2005) provides recommendations for mitigation measures to reduce construction emissions. These measures include material wetting or use of chemical suppressants to reduce dust, use of wind barriers and limiting exposed areas which may be a source of dust, and equipment washing.

It is recommended that these best management practices be followed during Project construction. With implementation of adequate mitigation measures, emissions from the construction phase and resulting adverse changes in local air quality can be controlled and reduced.

8.2 Potential Impacts and Mitigation During Operation

The air quality assessment has identified that exceedances of the 24-hour and annual average AAQC for B(a)P are predicted to occur for both the Future No-Build scenario as well as the Future Build scenario, with background levels being the major contributor to the cumulative exceedances.

While the Project contributions to exceedances are expected to be small, it is expected that with ongoing advancements of on-road vehicles to newer, lower emission or electric vehicles, the quantities of air contaminants released to the atmosphere from transportation sources will be lower in the future.

Implementation of the Project will improve the future traffic flow and reduce congestion in the local road network, and thereby reduce impacts on air quality. Other measures to minimize impacts of particulate and NOx emissions that could be considered include incorporating vegetative barriers in the landscaping design. The effectiveness of trees and plants as physical barriers for particulate or gaseous contaminant control depends on the density and height of the vegetation. In general, a vegetation barrier should be thick (approximately 6-metres or more) and have full leaf and branch coverage from the ground to the top of the canopy with no gaps in-between or underneath the vegetation. Typically, evergreen species are more effective than deciduous for this objective and the barrier should be located close to the emissions sources (US EPA, 2016).

9 Conclusions

The following are the main findings from the air quality and greenhouse gas impact assessment:

- For the Baseline scenario, maximum predicted Project Alone GLCs of all CoPC are below their applicable criteria, other than the hourly average NO_2 CAAQS and 24-hour and annual averages for the B(a)P AAQC.
- The maximum predicted Project Alone GLCs of all CoPC are below their relevant AAQC and/or CAAQS at all special receptors for the Future Build and Future No Build scenarios.
- The maximum predicted cumulative GLCs of all CoPC other than NO_2, benzene and B(a)P are below their relevant AAQC and/or CAAQS at all special receptors for all scenarios.
- Predicted cumulative 98th percentile daily 1-hour maximum concentrations of NO_2 exceed the 2025 1-hour CAAQS by 24% at one sensitive receptor in the Future No Build scenario. There are no cumulative exceedances of the NO_2 CAAQS in the Future Build scenario. Maximum predicted 1-hour and 24-hour average cumulative NO_2 concentrations are well below the provincial AAQC for all scenarios.
- The maximum predicted cumulative annual average benzene concentration is above the AAQC by 4% for the Baseline scenario. The maximum predicted cumulative 24-hour and annual average concentrations of benzene are below the AAQC for the Future No Build and Future Build scenarios and are lower than the Baseline scenario.
- Maximum predicted cumulative concentrations of B(a)P exceed the 24-hour and annual average AAQCs at all special receptor locations for all scenarios, with the background concentrations alone exceeding the 24-hour and annual average AAQCs by 2,529% and 2,347% respectively. The maximum predicted 24-hour and annual average cumulative B(a)P concentrations for the Future Build scenario are 1% lower than the Future No Build scenario. The maximum cumulative B(a)P concentrations are predicted to decrease in the Future Build and Future No Build scenarios relative to the Baseline scenario due to expected future reductions in vehicle emissions.
- Releases of GHGs from the Project are expected to be insignificant (less than 0.1%) in comparison to the 2021 Canada and Ontario totals and the 2030 emissions targets. Implementation of the Project is predicted to result in a decrease in GHG emissions of 1.4 kt CO_2e per year relative to the current road configuration.
- During Project construction, industry best management practices should be followed to minimize emissions.

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