AECOM

GO Transit

Rail Service Expansion from Oshawa to Bowmanville and New Rail Maintenance Facility in Whitby
Air Quality Assessment Report

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Revision Log

Revision #	Revised By	Date	Issue / Revision Description

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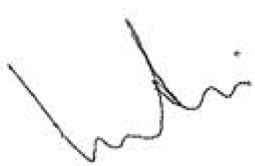
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Executive Summary

AECOM was retained by GO Transit to prepare an Air Impact Assessment for the proposed GO Transit rail expansion of the Lakeshore East operations from Whitby to Clarington, Ontario to accommodate increased ridership demand along this corridor.

The proposed project would provide new GO Transit commuter rail service between Oshawa and Bowmanville. It would require the construction of four (4) new GO Transit rail stations, one (1) new layover facility and one (1) new maintenance facility along the existing Canadian National Railway (CNR) and Canadian Pacific Railway (CPR) rail corridors.

The purpose of the Air Impact Assessment is to predict the potential air quality impacts of the GO Transit expansion in Durham Region. The objective of the report is to provide a comparison of the air quality impacts resulting from the proposed expansion to an established future baseline and evaluate how the proposed expansion may potentially affect air quality in the study area. The pollutants of concern are nitrogen oxides (NO_x), carbon monoxide (CO), sulphur dioxide (SO_2) and particulate matter (PM). Select VOC emissions were also assessed and include acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde.

Local air quality impacts were determined by comparing predicted modelled concentrations and ambient levels at representative sensitive receptors of CO, NO_x, SO_2, PM and VOCs to established standards or guidelines. Regional air quality impacts were determined by estimating and comparing the differences in air pollutant emissions from the total transportation mix, using an emission inventory approach. All analysis was performed for the years 2015 and 2031 based on the future no-build and future build scenarios.

Ambient data for TSP and PM_{10} are not readily available. Background values for TSP and PM_{10} were calculated using MOE approved ratios ($PM_{2.5}$ / PM_{10} = 0.54 and $PM_{2.5}$ / TSP = 0.3). In addition, all station models investigating PM assumed that TSP and PM_{10} emissions are that of $PM_{2.5}$. This is considered to be a conservative estimate for dispersed TSP levels, since it is expected that the larger particles in TSP should settle quicker than the smaller fraction of PM_{10} or PM2.5 and the vast majority of combustion emissions are $PM_{2.5.}$

As discussed in Section 2 “Approach and Methodology” of this report, the Base Case for this specific project was assessed using ambient air concentrations for the pollutants of interest and were extracted from Ontario Ministry of Environment and the Federal National Air Pollution Surveillance (NAPS) program. This data was used to represent the current base year. The background contaminant concentration levels may include emissions resulting from current traffic levels. The modelled point of impingement (POI) adds local traffic values to this background contaminant concentration resulting in a highly conservative analysis.

Future traffic maps, plans and reports were reviewed to build the road networks and links around the proposed GO stations. Sensitive receptor locations were evaluated and extracted from secondary sources and a field investigation. Using the traffic information, representative emissions rates were developed for vehicular flow using MOBILE 6.2.

The collected data and generated vehicular emission rates were used in an air dispersion model, CAL3QHCR. 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 required for the model include, a base map of road network, the location of receptors and road segments, vehicle exhaust emission factors (i.e., g/VmT) for the road segments, the overall peak hourly traffic flow in each area, traffic signal timing used to calculate idle times and length of traffic queuing; and one year (2000) of meteorological data.

The CAL3QHCR model was run using urban settings as outlined in the US EPA document Guideline on Air Quality Models (40 CFR Part 51, Appendix W). The gaseous contaminants such as CO, SO_2, NO_x and VOCs were modelled using the CO option, while the particulate contaminants used the PM option. Presented results are based on a 1 hr, 8 hr, 24 hr and annual averaging time to facilitate comparison to the applicable guidelines. The maximum concentration predicted by CAL3QHCR is considered 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 frequently less (not peak).

For the highest impacted receptor, the main findings of the air quality assessment are outlined below:
The local effects of the two future build scenarios are limited to receptors close to the GO stations. The modelled impact and concentration levels greatly decrease with increasing distance from the GO stations and the main arterial roads feeding into these stations. The modelling results comparing the current impact and the future build 2015 scenario are shown in Table E- 1. For all four stations, the future build scenario is seen to result in an decreased predicted concentration at the highest impacted receptor for NOx, and VOCs. The modelling results for the two future no-build and future build scenario are shown in Table E- 2 and Table E- 3. For all four stations, the future build scenario is seen to result in an increased predicted concentration at the highest impacted receptor

Table E- 1 - Difference in Maximum Predicted Concentrations - Current vs. Future Build 2015

Pollutant	Averaging Time (Hours)	Percentage Increase around Thornton Station (%)	Percentage Increase around Ritson Station (%)	Percentage Increase around Courtice Station (%)	Percentage Increase around Martin Station (%)
NOx	1	-3	-21	-23	-11
	24	-2	-14	-15	-7
CO	1	5	-10	13	-1
	24	3	-6	8	-1
SO_2	24	1	1	5	1
$PM_{2.5}$	24	-5	2	5	1
Acetaldehyde	24	0	-2	0	0
Acrolein	24	0	-4	-5	-5
Benzene	24	-2	-17	-4	-6
1,3-Butadiene	24	-6	-29	-6	-17
Formaldehyde	24	0	-2	0	-1

Table E- 2 – Difference in Maximum Predicted Concentrations (2015) - Future Build vs. No Build

Pollutant	Averaging Time (Hours)	Percentage Increase around Thornton Station (%)	Percentage Increase around Ritson Station (%)	Percentage Increase around Courtice Station (%)	Percentage Increase around Martin Station (%)
NOx	1	9	3	21	8
	24	5	2	12	5
CO	1	19	6	37	12
	24	10	4	21	6
SO_2	24	1	0	5	1
$PM_{2.5}$	24	0	0	7	2
Acetaldehyde	24	1	1	2	1
Acrolein	24	1	5	0	0
Benzene	24	15	5	17	12
1,3-Butadiene	24	25	5	33	12
Formaldehyde	24	1	1	2	1

Table E- 3 – Difference in Maximum Predicted Concentrations (2031) - Future Build vs. No Build

Pollutant	Averaging Time (Hours)	Percentage Increase around Thornton Station (%)	Percentage Increase around Ritson Station (%)	Percentage Increase around Courtice Station (%)	Percentage Increase around Martin Station (%)
NOx	1	6	4	30	5
	24	3	2	17	3
CO	1	24	10	49	7
	24	13	6	30	4
SO_2	24	1	1	7	1
$PM_{2.5}$	24	1	1	11	5
Acetaldehyde	24	1	1	3	1
Acrolein	24	1	0	5	0
Benzene	24	15	9	26	5
1,3-Butadiene	24	18	15	36	9
Formaldehyde	24	1	1	2	0

Although there is a local increase in air pollutants from the specific GO Transit stations, the overall impact will decrease due to commuters using GO Transit and reducing vehicle use on a regional level. The reduction in annual emissions is shown in Table E- 4 along with mobile emission inventories for Ontario and Canada.

Table E- 4 -Regional Impacts, Change in Annual Mobile Emissions Due to Future Build

	Project 2031 GO Train				Project 2031 Vehicle Traffic Removed						
Contaminant	Thornton	Ritson	Courtice	Martin	Thornton	Ritson	Courtice	Martin	**Project (2031) Total Emissions**	**Ontario 2007**	**Canada 2007**
	Tonnes/year	**Tonnes/year**	**Tonnes/year**	**Tonnes/year**	**Tonnes/year**	**Tonnes/year**	**Tonnes/year**	**Tonnes/year**	**kTonnes/year**	**kTonnes/year**	**kTonnes/year**
Composite VOC*	-6.80E-7	5.94E-8	6.08E-8	6.08E-8	-60.9	-61.7	-117.1	-56.9	-0.297	161	553.828
Composite CO	0.000	1.151	1.141	1.141	-2,062.2	-2,118.9	-2,843.8	-2,047.2	-9.069	2,067	6852.157
Composite NO_x	-4.321	0.899	0.881	0.881	-120.3	-123.9	-220.5	-148.4	-0.615	310.812	1209.463
$PM_{2.5}$	-0.154	0.014	0.014	0.014	-7.8	-8.0	-10.0	-10.0	-0.036	16.464	64.885

*For road vehicles, "Composite VOC" is as defined by the EPA code Mobile 6.2C. For trains,"Compsosite VOC" is defined as total Benzo(a)Pyrene.

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1. Introduction

AECOM was retained by GO Transit to prepare an Air Impact Assessment for the proposed GO Transit rail expansion of the Lakeshore East operations from Whitby to Clarington, Ontario to accommodate increased ridership demand along this corridor. The proposed project would provide new GO Transit commuter rail service between Oshawa and Bowmanville. It would require the construction of four (4) new GO Transit rail stations, one (1) new layover facility and one (1) new maintenance facility along the existing Canadian National Railway (CNR) and Canadian Pacific Railway (CPR) rail corridors.

The purpose of the Air Impact Assessment is to predict the potential air quality impacts as they relate to the proposed undertaking within the study area. The objective of the report is to provide a comparison of the emissions of air quality contaminants estimated to result from the proposed expansion to an established future baseline, and evaluate how the proposed expansion may potentially affect air quality in the study area.

2. Approach and Methodology

The air quality study consisted of an assessment to address the air quality impacts of the proposed GO Transit rail expansion project in Durham Region. The impacts studied are broadly defined in terms of local and regional air quality impacts.

Local air quality impacts were assessed by estimating contaminant concentrations at representative sensitive receptors within the study area and comparing them to applicable regulatory limits. Within the study area, a comparison was completed between background contaminant concentration levels and anticipated contaminant concentration levels resulting from the project, including future traffic volumes. Ambient concentrations and current traffic volumes were used to represent the current base year. The scenarios analyzed include the future build and future no-build for the years 2015 and 2031.

Regional air quality impacts were assessed by estimating and comparing the differences in air pollutant emissions from the total transportation mix for the year 2015 and 2031 based on the future no-build and future-build scenarios. An emission inventory approach was thus used to determine the regional air quality impacts.

The study assessed impacts from transportation emissions such as nitrogen oxides (NO_x), carbon monoxide (CO), sulphur dioxide (SO_2) and particulate matter (PM). Select VOC emissions were also assessed as directed by the MOE. They include acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde.

Ambient data for TSP and PM_{10} are not readily available. Background values for TSP and PM_{10} were calculated using MOE approved ratios ($PM_{2.5}$ / PM_{10} = 0.54 and $PM_{2.5}$ / TSP = 0.3). In addition, all station models investigating PM assumed that TSP and PM_{10} emissions are that of $PM_{2.5}$. This is considered to be a conservative estimate for dispersed TSP levels, since it is expected that the larger particles in TSP should settle quicker than the smaller fraction of PM_{10} or PM2.5 and the vast majority of combustion emissions are $PM_{2.5.}$

Emission and dispersion models included MOBILE6.2 and US EPA CAL3QHCR. Further model input details are described in the corresponding section.

2.1. Relevant Guidelines

The maximum predicted concentrations at the sensitive receptors in this study were compared with the corresponding standards, criteria, and guidelines:

- Ontario Regulation 419/05 Air Pollution – Local Air Quality Regulation, Schedule 3;
- MOE Ambient Air Quality Criteria; and
- Proposed Canada Wide Standards (CCME).

A summary of standards proposed for the Air Quality Assessment is shown below in Table 1. Where multiple sources of standards are available, the most stringent values are shown. The MOE interim 24-hour reference level for PM_{10} was added for comparison.

Table 1 Summary of Applicable Guidelines and Standards

Contaminant	Source	Averaging Time	Value (µg/m^3)
NOx	Reg. 419/05 Schedule 3	1 hr	400
	Reg. 419/05 Schedule 3	24 hr	200
CO	Reg. 419/05 Schedule 3	1 hr	36,200
	Reg. 419/05 Schedule 3	8 hr	15,700
SO_2	Reg. 419/05 Schedule 3	1	690
	Reg. 419/05 Schedule 3	24	275
PM - TSP	Reg. 419/05 Schedule 3	24 hr	120
PM_{10}	MOE Interim Reference Level	24 hr	50
$PM_{2.5}$	Canada Wide Standard (CCME)	24 hr	30
Acetaldehyde	Reg. 419/05 Schedule 3	24 hr	500
Acrolein	Reg. 419/05 Schedule 3	24 hr	0.4
Benzene	N/A	N/A	N/A
1,3-Butadiene	N/A	N/A	N/A
Formaldehyde	Reg. 419/05 Schedule 3	24 hr	65

AAQCs are acceptable effects-based levels in ambient air. Limits are set based on the "limiting effect" and are the lowest concentrations at which an adverse effect may be experienced. Effects considered may be health, odour, vegetation, soiling, visibility, corrosion or others and limits have variable averaging times appropriate for the effect that they are intended to protect against. AAQCs are used for assessing general air quality and the potential for causing an adverse effect. They are set at levels below which adverse health and/or environmental effects are not expected. If a contaminant has more than one AAQC, all must be used for assessment purposes as each represents a different type of effect linked to a particular averaging period.

The Canadian Council of Ministers of the Environment (CCME) has developed Canada-wide Standards for a variety of contaminants. These standards are developed jointly by various provincial jurisdictions based on scientific and risk-based approach. Standards are presented to the Ministers along with a timetable for implementation and monitoring and public reporting programs. Ministers are responsible for implementing the standards within their own jurisdictions and promote consistency across the country. Applicable standards include the Canada Wide Standard for $PM_{2.5}$ (particles smaller than 2.5 µm in diameter), which was established for the year 2010. This standard is based on the 98th percentile ambient measurement (24-hour), annually averaged over three years.

2.2. Study Area

The proposed expansion route generally follows existing east-to-west CNR and CPR rail lines. It is bounded by Brock Street in Whitby at the western limit and Bragg Road in Bowmanville at the eastern limit. Eastbound GO trains are to operate within the existing CNR rail corridor until Thickson Road South. Between Thickson Road South and Thornton

Road South, a new rail bridge crossing will be erected over Highway 401. The GO rail line would then merge onto and continue east along the existing CPR rail corridor until terminating at the proposed Bowmanville GO station at Martin Road. Westbound GO trains will follow the same route but in the opposite direction.

The spatial extent of the study area was selected to encompass potential project air quality impacts. It includes the layer of air near the earth's surface, known as the troposphere, which extends from the surface to approximately 10 km in altitude. The study area follows the proposed GO Rail route and infrastructure. It is bounded by 500m in each direction north and south of the rail corridor in order to encompass Highway 401 and capture emission, accumulation and dispersion of air contaminants.

The study area limits and the proposed GO Rail route and infrastructure locations are depicted in the Project Overview Plan in Appendix A. Proposed track layouts are also included in Appendix A.

To facilitate the analysis, the study area was divided into three (3) zones. Each zone represents a distinct blend of CPR, CNR, CNR passenger (VIA) and GO Transit rail service within each time frame. The zones are described in Table 2.

Table 2 - Rail Service Zone Definitions

Zone	Stations	Description of Zone
Zone 1	Thornton Rd (Oshawa West)	East of Brock Street and West of the proposed Hwy 401 crossing
Zone 2	Ritson Rd. (Oshawa Central)	East of proposed Hwy 401 crossing and West of proposed Central Oshawa station
Zone 3	Courtice Rd (Clarington) Martin Rd (Bowmanville)	East of the proposed Central Oshawa station and West of Bragg Road

2.3. Existing Ambient Air Quality

A general estimate of the baseline ambient air quality was made using publicly available historical air quality data from ambient air quality monitoring stations within Ontario. Data utilized was the latest publicly available at the time of the study commencement. It was assumed that the historic ambient air quality will be the same for both the future build and future no-build scenarios in 2015 and 2031. This is a conservative estimate as there are numerous federal, provincial, and municipal initiatives which are currently being implemented to reduce the levels of ambient air pollutants. For vehicle emissions in particular, it is anticipated that due to more stringent vehicle emission limits the on road emissions will decrease despite increasing traffic. In addition, ambient monitoring data[1] typically shows decreasing concentrations for $PM_{2.5}$, NO_x, SO_2 and CO over the past several years.

Hourly and annual ambient concentrations of air quality pollutants ($PM_{2.5}$, NO_x, SO_2 and CO) were obtained from the Toronto West monitoring station (Table 3). The Toronto West station has shown considerably higher ambient results due to its proximity to high density traffic corridors.

Ambient monitoring data for air quality pollutants was extracted as follows for ($PM_{2.5}$, NO_x, SO_2 and CO):

- 1 and 24 hour ambient concentrations for the contaminant were obtained from the 90^{th} percentile of hourly measurements from the Toronto West station (average value).

[1] *MOE, 2008, "Air Quality in Ontario, 2007 Report", Monitoring & Reporting Section, Environmental Monitoring and Reporting Branch MOE Document: 6930e, http://www.ene.gov.on.ca/publications/6930e.pdf*

- The annual ambient concentrations for the contaminant consisted of the maximum annual average of the hourly measurements from the Toronto West station
- As TSP and PM_{10} are not monitored, MOE approved ratios ($PM_{2.5}$ / PM_{10} = 0.54 and $PM_{2.5}$ / TSP = 0.3) were used to estimate ambient concentrations.

Table 3 - Toronto West Monitoring Station Information

	Toronto West Information
Station Name:	Toronto West
NAPS Number	N/A
Address:	125 Resources Rd.
Latitude:	43.709444
Longitude:	-79.5435
Station Type:	Urban
Height of Air Intake:	8 m
Elevation ASL:	141 m
Pollutants Measured:	O_3, $PM_{2.5}$, NO_2, CO, SO_2

Most of the data was extracted from the annual MOE publication "Air Quality in Ontario" (http://www.airqualityontario.com/history/). Data from 2003 – 2007 was used.

Ambient air monitoring for VOCs is less common and the available monitoring stations were not close to the study area as compared to stations monitoring NO_x, CO, SO_2 and PM. The MOE's Hamilton Downtown monitoring station(Table 4) was chosen for ambient background Benzene and 1,3-Butadiene concentrations. Data in the form of 24 hour averages was provided to AECOM for 45 days of 2008.

Table 4 - Hamilton Downtown Monitoring Station Information

	Hamilton Downtown Information
Station Name:	Hamilton Downtown
NAPS Number:	60512
Address:	Elgin St./Kelly St.
Latitude:	43.257778
Longitude:	-79.861667
Station Type:	Urban
Height of Air Intake:	4 m
Elevation ASL:	90 m
Pollutants Measured:	Benzene, 1,3-Butadiene

Additional VOC data was obtained from the Windsor West monitoring station (Table 5). Data for acetaldehyde, acrolein and formaldehyde was provided as an annual average for the years 2000-2004. For each contaminant, the average of 90^{th} percentile values was used as the 24 hr background contaminant value. The highest annual average was selected to be the annual background contaminant value.

Table 5 – Windsor West Monitoring Station Information

	Windsor West Information
Station Name:	Windsor West
NAPS Number:	60211
Address:	College Ave./South St
Latitude:	42.292889
Longitude:	--83.073139
Station Type:	Urban
Height of Air Intake:	4 m
Elevation ASL:	180 m
Pollutants Measured:	Acetaldehyde, Acrolein, Formaldehyde

The monitoring stations at which these values were obtained are located in areas that are more urban and industrial than the location of many of the proposed GO stations, and hence may have higher contaminant concentrations than the area of interest. Furthermore, the background contaminant concentration levels already include emissions resulting from current traffic levels. The modelled point of impingement (POI) adds local traffic values to this background contaminant concentration and this double accounting of traffic emissions results in a highly conservative analysis.

Table 6 – Ambient Air Quality 24 hr Concentrations Used in Air Dispersion Modelling

Contaminant	90^{th} Percentile Concentration $\mu g/m^3$
NOx	162
CO	673
SO_2	13.8
$PM_{2.5}$	18.6
PM_{10}	34.44
PM_{TSP}	62
Acetaldehyde	2.62
Acrolein	0.19
Benzene	1.88
1,3-Butadiene	0.09
Formaldehyde	4.45

Table 6 shows the ambient concentration values used as the background concentration. The ambient concentration for NO_x (24 hour), acrolein, and $PM_{2.5}$, represent 50% or more of the contribution to the relevant standard or guideline.

2.4. Modelling Scenarios

For each station five (5) scenarios were investigated:

- Current (2009)
- Future No Build (2015)
- Future No Build (2031)
- Future Build (2015)
- Future Build (2031)

3. Data Collection and Analysis

3.1. Maintenance Facility

For the purposes of this study, it has been determined that the air quality impact of the proposed maintenance facility will be negligible in comparison to the four proposed stations. There are a few reasons for coming to this conclusion with the main one being the planned location of the facility. The facility is to be built in a highly industrialized area with the nearest sensitive receptor being approximately a kilometre away; a distance far greater than the 300m to 500m boundary within which the impacts on receptors are analyzed that is typically employed for this type of study. In comparison, each of the four train stations modeled have receptors within 10m to 50m of arterial roadways which are the main sources of emissions. Given that air impacts from an emission source decrease greatly with distance from the source, air quality at any sensitive receptor will not be greatly impacted by this facility.

In addition to the much greater distance to any sensitive receptor, another factor that will cause emissions from this facility to have a far smaller effect on air quality than the proposed stations is the actual level of emissions. As has been noted previously, the main source of emissions in this project is the increase in traffic on the arterial roads surrounding the stations rather than the trains themselves. The amount of traffic expected to travel to this facility is significantly less than the thousands of commuters travelling to the stations each day.

3.2. Roadway Links, Traffic and Fleet Composition

3.2.1. Thornton Station

For the study, the road network consisted of all of the on-property roads and the adjacent main arterial roads onto which the proposed station traffic exits.

Traffic data for the current, future build and future no build scenario was available from the draft "*GO Station Traffic Impact Study Proposed Oshawa West GO station",* prepared in 2009 by AECOM (See Appendix I). No traffic prediction data is available for the year 2031. Instead, traffic predictions from the study timeframe of 2015 were extrapolated using a conservative GDP growth estimate of 2.5 to quantify the traffic volumes for both on-property and arterial traffic in both future scenarios for the year 2031. The default MOBILE6.2 fleet composition was used for all scenarios.

3.2.2. Ritson Station

For the study, the road network consisted of all of the on-property roads and the adjacent main arterial roads onto which the proposed station traffic exits.

Traffic data for the current, future build and future no build scenario was available from the draft "*GO Station Traffic Impact Study Proposed Central Oshawa GO Station",* prepared in 2009 by AECOM (See Appendix I). No traffic prediction data is available for the year 2031. Instead, traffic predictions from the study timeframe of 2015 were extrapolated using a conservative GDP growth estimate of 2.5 to quantify the traffic volumes for both on-property and arterial traffic in both future scenarios for the year 2031. .The default MOBILE6.2 fleet composition was used for all scenarios.

3.2.3. Courtice Station

For the study, the road network consisted of all of the on-property roads and the adjacent main arterial roads onto which the proposed station traffic exits.

Traffic data for the current, future build and future no build scenario was available from the draft "GO Station Traffic Impact Study Proposed Courtice GO Station", prepared in 2009 by AECOM (See Appendix I). No traffic prediction data is available for the year 2031. Instead, traffic predictions from the above noted study for the study timeframe of 2015 were extrapolated using a conservative GDP growth estimate of 2.5 to quantify the traffic volumes for both on-property and arterial traffic in both future scenarios for the year 2031. The default MOBILE6.2 fleet composition was used for all scenarios.

3.2.4. Martin Station

For the study, the road network consisted of all of the on-property roads and the adjacent main arterial roads onto which the proposed station traffic exits.

Traffic data for the current, future build and future no build scenario was available from the draft "*GO Station Traffic Impact Study Proposed Bowmanville GO Station",* prepared in 2009 by AECOM (See Appendix I). No traffic prediction data is available for the year 2031. Instead, traffic predictions from the above noted study for the study timeframe of 2015 were extrapolated using a conservative GDP growth estimate of 2.5 to quantify the traffic volumes for both on-property and arterial traffic in both future scenarios for the year 2031. The default MOBILE6.2 fleet composition was used for all scenarios.

3.3. Receptor Data

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 community centers. Based on the expected emission release characteristics of the sources, the closest sensitive receptors surrounding the sources (in all directions) were identified and it was assumed that receptors further away will have lower impacts.

Data on the identification and location of the sensitive receptors, described below, was obtained from the following sources:

- Region of Durham;
- Listings of education, healthcare and day care facilities, places of worship

Details on the sensitive receptors were confirmed by field observations by AECOM personnel. Additional receptors were also identified during field observations. Locations of the receptors are provided included in Appendix B.

Table 7 through

Table 10 below lists all the sensitive receptors considered for modeling. The receptor height for all sensitive receptors was assumed to be 1.8 meters, which is considered the typical breathing height. The CAL3QHCR software uses an internal numbering system to present results. This number will be included in brackets for presented results. For example, "The Children's Place" will be denoted as "4 (4)" in the results table with the internal CAL3QHCR receptor ID in the brackets.

Table 7 – Ritson Station Receptors

Number	Name	Description	UTM Coordinate X (m)	UTM Coordinate Y (m)
1 (1)	Village Union Public School	School	671781	4861950
2 (2)	New Ark - Opportunity Learning Center	School	672151	4860757
3 (3)	Ritson Public School	School	672616	4862106
4 (4)	The Children's Place	Daycare	672683	4862049
5 (5)	Holy Cross Roman Catholic Church	Church	671997	4861698
6 (6)	New Life Seventh day Adventist Church	Church	672068	4861761
7 (7)	Church of the Good Shepherd	Church	672179	4861944
8 (8)	St John The Baptist Ukrainian Orthodox Church	Church	672352	4860834
9 (9)	Ukrainian Catholic Church of St George	Church	672372	4861053
10 (10)	Annunciation of the Virgin Mary	Church	673021	4861060
11 (11)	Hope Spiritualist Church	Church	672862	4860997
12 (12)	St James Presbyterian Church	Church	672073	4861299
13 (13)	Riston Rd Baptist Church	Church	672833	4861631

Table 8 – Martin Station Receptors

Number	Name	Description	UTM Coordinate X (m)	UTM Coordinate Y (m)
14 (1)	Church of Jesus Christ and Latter Day Saints	Church	684324	4864431
15 (2)	Kawartha Child Care Services	Day Care	684151	4863621
16 (3)	Dr. Ross Tiley Public School	School	684622	4863188
17 (4)	Saint Steven's Elementary School	School	685365	4863567
18	Leep Daycare	Day Care	684592	4863900

Table 9 – Courtice Station Receptors

Number	Name	Description	UTM Coordinate X (m)	UTM Coordinate Y (m)
15 (1)	Kawartha Child Care Services	Day Care	684151	4863621
43 (2)	Grandview Children's School/Campbell Children's School	Rehabilitation Centre/School	676053	4862181
45 (3)	Courtice Flea Market	Market	678520	4862732
46 (4)	Hope Fellowship Church	Church	678479	4862691
47 (5)		Residence	679230	4862166
48 (6)		Residence	679377	4861700
49 (7)		Residence	679577	4861139
50 (8)		Residence	679071	4860948
51 (9)		Residence	678598	4861392
52 (10)		Residence	678325	4862166

Table 10– Thornton Station Receptors

Number	Name	Description	UTM Coordinate	UTM Coordinate
			X (m)	Y (m)
53 (1)		Residence	669760	4861088
54 (2)		Residence	669459	4860996
55 (3)		Residence	669395	4861188
56 (4)		Residence	670470	4861025
57 (5)		Residence	669201	4860933
58 (6)		Residence	669130	4860859
59 (7)		Residence	668760	4860572
60 (8)		Residence	670610	4860607

4. Emission Inventory

The air quality assessment included the development of emission factors and quantification of emission rates related to train and vehicle emissions (exhaust, evaporative losses, tire wear and brake wear). Emission factors and emission rates were developed for various scenarios as summarized in the following section.

4.1. Vehicle Emission Factors from MOBILE 6.2

Mobile vehicle emissions are categorized as:

1. Exhaust emissions that are the products of fuel combustion,
2. Evaporative emissions and
3. Particulate emissions associated with brake 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 vapor losses due to the diurnal air temperature cycle and vapor 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. The default files provided with MOBILE6.2 are typical of the vehicle fleet, vehicle operating patterns and emission regulations in the United States. The MOBILE6.2 model allows the user to override the default data with site specific data in order to estimate site specific emissions; this capability has been used in the air quality assessment to estimate mobile source emissions.

This model was used to generate composite emission factors (i.e., grams of pollutant emitted per vehicle mile traveled, g/VmT) for CO, NO_x, $PM_{2.5}$, and VOC's. Emission factors were developed for the months of January and July for the future build and future no-build scenario.

The input data required to run MOBILE6.2is presented in Table 11 and Table 12 along with a summary of data sources. Details on fleet composition are presented in Section 3.1. Where default data included in MOBILE6.2are deemed appropriate for the study area, these default data have been used.

Table 11 – MOBILE6.2 Input Data

Parameter	Input	Reference
External Conditions		
Year of Evaluation	2015/2031	
Month of Evaluation	January/July	(1)
Temperature ˚C	-13/25	Environment Canada weather normal's
Humidity	65/83 %	Environment Canada weather normal's
Altitude	Low	(1)
Fuel Options		
Reid Vapour Pressure (RVP) in PSI	8.9 psi (summer)/ 14.7 psi (winter)	(2)
Diesel Sulphur Content	15 ppm (2021)	(3)
Gasoline Sulphur Content	25 ppm (2021)	(2)
Air Toxics		
Gasoline Aromatics (%)	28.4	(2)
Gasoline Olefin (%)	10.3	(2)
Gasoline Benzene (%)	0.8	(2
Vapour Pressure of gasoline at 200 F (%)	47.3 (summer) / 53.7 (winter)	(2)
Vapour Pressure of gasoline at 300 F (%)	83.3	(2)
Oxygenate Volume % of Ethanol or Ethyl Alcohol (Ethanol)	(10% volume, 20% market share in 2021)	(4)
Vehicle Activity		
Fractions of Vehicle Miles Travelled (VMT)	Appendix C	
VMT by facility, hour and speed	default	Default file for MOBILE 6.2
Starts per day	Default for all Local Roads 0 for all Arterial Roads	
Distribution of vehicle starts during day	default	Default file for MOBILE 6.2
Soak Distribution	default	Default file for MOBILE 6.2
Hot Soak activity	default	Default file for MOBILE 6.2
Diurnal Soak activity	default	Default file for MOBILE 6.2
Weekday trip length distribution	default	Default file for MOBILE 6.2
Weekend trip length distribution	default	Default file for MOBILE 6.2
Weekend use vehicle activity	default	Default file for MOBILE 6.2
Vehicle Fleet Characteristics		
Distribution of Vehicle Registrations	default	Default file for MOBILE 6.2

Parameter	Input	Reference
Diesel Fractions	default	Default file for MOBILE 6.2
Annual Mileage accumulation rates	Ontario - Created by Environment Canada	Default file for MOBILE 6.2
Vehicle Miles Travelled (VMT) fraction	default	Default file for MOBILE 6.2
Natural gas vehicles (NGV) fraction	default	Default file for MOBILE 6.2
Alternate emission factor for NGVs	default	Default file for MOBILE 6.2

(1) 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

(2) Emission of air toxics from on-highway sources in Canada: Estimated impacts of various vehicle and fuel control strategies. Environment Canada technical Report M6C-02-E, Prepared by SENES Consultants Limited and Air Improvement resource Inc.

(3) MOE Drive Clean Program

(4) http://www.ec.gc.ca/cleanair-airpur/CAOL/transport/publications/ethgas/ethgas3.htm

Table 12 – MOBILE6.2 Input Data; Vehicle Speed

Road	Class	Free Flow Speed [km/h]	Idle Speed [km/h]
Thornton			
Thornton Rd	Local	60	4
Champlain Ave/Consumers Rd, Gibb St, Kendalwood Rd	Local	50	4
Access Road-Bus	Local	32	4
Access Road-Parking Traffic	Local	32	4
Ritson Rd			
Olive Ave, Gibb St, Albany Rd, Front St, Beatty Ave, McNaughton Ave, Howard Ave	Local	50	4
Simcoe Ave, Ritson Rd	Arterial	50	4
Access Road-Bus	Local	32	4
Access Road-Parking Traffic	Local	32	4
Courtice			
Baseline Rd	Local	70	4
Courtice Rd	Arterial	80	4
Bloor St, Trulls Rd	Local	60	4
Access Road-Bus	Local	32	4
Access Road-Parking Traffic	Local	32	4
Martin Rd			
Clarington Rd, Prince William Bvld, Pethick St, Aspen Springs Dr	Local	60	4
Martin Rd, Hwy2 (King St)	Arterial	60	4
Access Road-Bus	Local	32	4
Access Road-Parking Traffic	Local	32	4

A summary of emission factors developed along with the MOBILE6.2 input/output files are provided in Appendix C.

Train volumes and emission factors were calculated in a previous submission "GO Transit Rail Service Expansion from Oshawa to Bowmanville and New Rail Maintenance Facility in Whitby Environmental Air Quality Assessment: December 4, 2009" This report has been included in Appendix K.

5. Dispersion Modelling

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 D and summarized below:

- base map of road network
- the location of receptors (Section 3.3);
- the location and length of each road/train segment;
- vehicle/train exhaust emission factors (i.e., g/VmT) for the road segments near both stations and each emission scenario as described in Section 4.1);
- 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);
- traffic signal timing used to calculate idle times and length of traffic queuing; and
- One year (2000) meteorological data set

A base map of the road network in a CAD format was provided by GO Transit. Receptor coordinates were imported into CALRoads (graphical interface for CAL3QHCR model). The base map was used to develop the location and length of road and train links and segments within CALRoads. Arterial roads were modelled for approximately 500 m beyond the intersection of interest. The definition of the train and roadway links was done on a case by case basis taking into account the on property station configuration and the impacted arterial roads directly adjacent to the proposed GO Transit stations. Commuter parking impacts were assessed where facilities are proposed. "Freeflow" links were used to define all roads and parking lots. Supplementary "queue links" were used to define intersections. Two "freeflow" links were used to define train travel. A "freeflow" link was utilized to represent composite train (i.e. traffic weighted GO, VIA, CN, CP) traffic flow through the station of interest. A supplementary "freeflow" link was utilized to account for idling GO train emissions at the station. It was assumed that VIA, CN, CP trains would not stop at the stations other than for emergency purposes.

Receptors considered in the air quality assessment include potentially sensitive receptors such as education facilities, healthcare facilities, day care facilities, places of worship and community sensitive receptors were confirmed by field observations by AECOM personnel. Additional also identified during field observations. Locations of the receptors are provided in base maps B.

Table 7 in Section 3.3 lists all the sensitive receptors considered for modeling.

The developed emission factors were input in to the CAL3QHCR dispersion model along with established peak traffic flow data for the future build and future no-build scenarios. Traffic signal data from various reports were used to calculate traffic queuing and the queue specific links in CALRoads.

One (1) year of regional meteorological data was utilized in the analysis. MOE provided upper air data was obtained from the Buffalo station, while surface data was obtained from Toronto Pearson International airport. The meteorological data spans the year 2000 and includes a sufficient timeframe to capture a wide degree of varying meteorological conditions.

The CAL3QHCR model was run using urban settings as outlined in the US EPA document Guideline on Air Quality Models (40 CFR Part 51, Appendix W) because when "the land use within a 3 km radius around the facility sources is examined… more than 50% of the area is accounted for by land use categories ranging from multi-family dwelling to commercial and industrial use." Lower coefficients resulting from the urban settings produce higher concentrations and were chosen to keep the model conservative.

The gaseous contaminants such as CO, SO_2, NO_x and VOCs were modelled using the CO option (for gaseous contaminants), while the particulate contaminants used the PM option. The settling velocity of CO and gases is typically 0, as outlined by the CAL3QHC manual. The settling velocity of PM was 2.75 cm/s.

The model was run according to MOE requirements to produce contour plots of ground level concentrations of NO_x, CO and PM encompassing the nearest sensitive receptors to the GO Transit stations. A unit dispersion method was used for VOCs (See Section 5.3). Since the MOE standards are based on different averaging times for each of the contaminants, the results were converted following the ADMGO[2] (see Equation 5.0). CO POI values were based on a 1hr averaging time and scaling factors were used to obtain 24hr and annual values to facilitate comparison to the applicable guidelines. PM POI values were based on a 24 hr averaging time and scaling factors were used to obtain 1hr and annual values to facilitate comparison to the applicable guidelines.

$$
\begin{aligned}
C_{24hr} &= C_t \times \left(\frac{t_1}{t_o}\right)^n \\
&= C_{60\min} \times \left(\frac{60\min}{24hr \times 60\frac{\min}{hr}}\right)^{0.28} \\
&= C_{60\min} \times 0.41
\end{aligned}
\qquad \text{Eqn 5.0}
$$

5.1. Tier 1 Modelling

The maximum concentration predicted by CAL3QHCR is considered very conservative as the maximum emission factors and peak traffic flow are used for all hours of the one-year modeling period (Tier 1 CAL3QHCR modelling) when in reality the actual emission factors and traffic flow are less at non-peak times. The maximum impacted receptor was used in assessing all contaminants for this project.

5.2. Tier 2 Modelling

In order to assess how the conservative POI values would be resulting from Tier 1 modelling, Tier 2 modelling incorporating time of day traffic flows was performed using CAL3QHCR for a single station (Ritson Rd). Where possible, measured time of day traffic flows provided by the Region of Durham were utilized (Appendix J). In cases where such data was not available, a non-dimensional profile was used based on measured traffic flows. This profile is illustrated in Figure 1. This profile illustrates that a significant portion of the day features traffic flows less than 50% of the peak.

[2] *"Air Dispersion Modelling Guideline for Ontario v2.0, March 2009"*

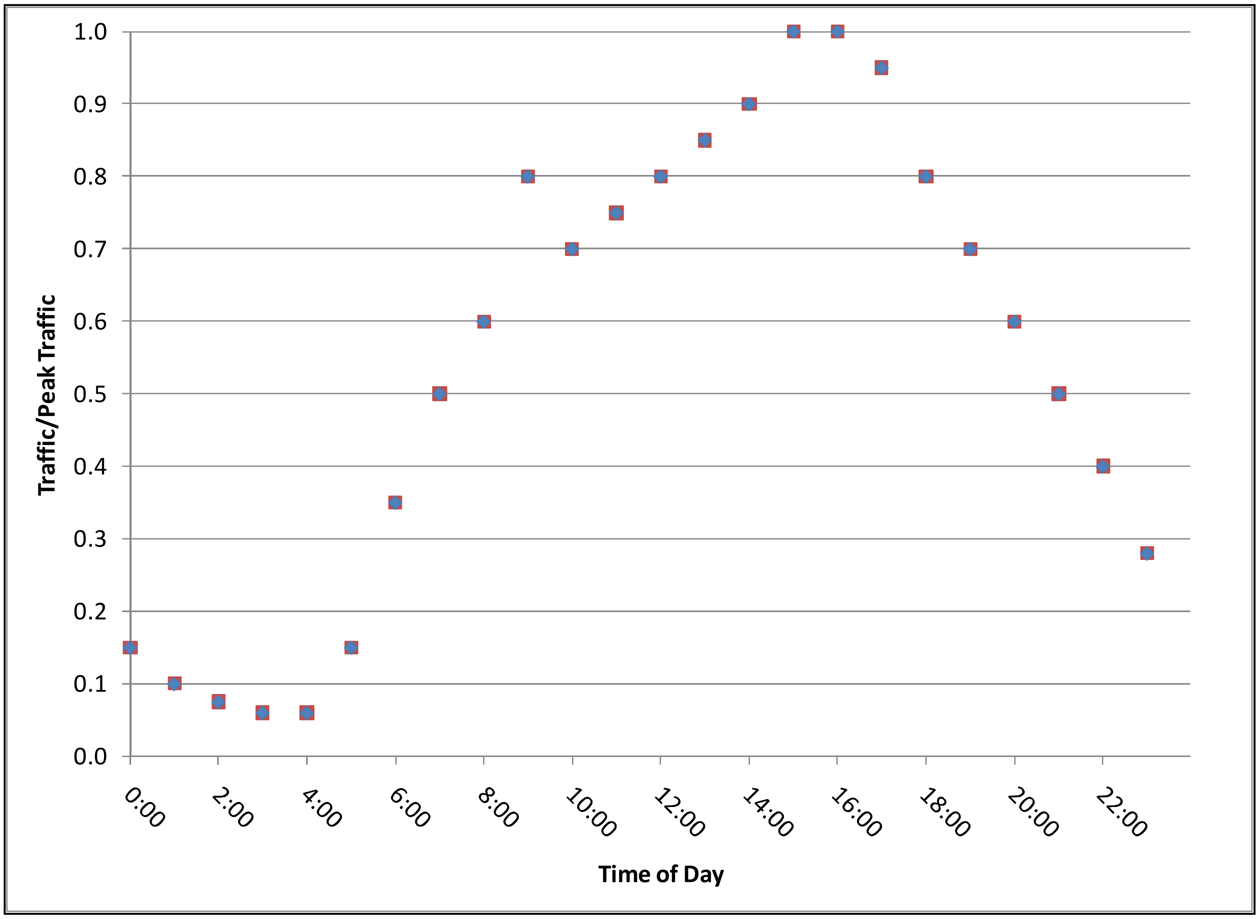

Figure 1: Non-dimensional Time of Day Traffic Flows

5.3. Unit Dispersion Modelling

A unit dispersion modelling approach was adapted for modelling gaseous contaminants. The current, future no-build and future build models (2015 and 2031) were modified by changing all of the emission rates to a 'unit' value. Emission rates for all free flow links were changed to 500 grams/vehicle miles travelled and all queue links were changed to 500 grams/hour. These emission rates were selected in order to avoid round off and precision errors in the CAL3QHCR software. The CAL3QHCR model has the ability to output the contaminant contribution for each traffic link for each receptor. Assuming a linear relationship between emission rate and contaminant concentration, the contribution for each traffic link can then be scaled by the unit model. For example, if the free flow link actually has an emission rate of 50 grams/vehicle miles travelled, then the link should produce a concentration that is 10% of the unit model (50 / 500). All other parameters of the link remain the same such as lane widths, traffic volume, height etc. Once all of the link contributions are added together, they represent the overall contaminant concentration at the receptor.

6. Assessment of Results

The maximum air quality concentration within the study area was simulated by adding the maximum concentrations predicted by dispersion modelling at a given receptor to the established background concentration. This approach provides a very conservative assessment of the maximum air quality concentration since the selected background for urban areas already includes impacts from roadways. The contaminant concentrations were also evaluated between the future no-build and future build scenario to determine the actual impact. The maximum air quality concentration results are summarized in the following sections.

In general, the contribution of vehicle emissions is minor relative to the current background for most pollutants especially for future emission scenarios. Vehicle emissions for these pollutants of interest are predicted to decline due to future improvements to fuel standards and emission controls. The policy assumptions considered by USEPA in the development of the model (MOBILE6.2) used to estimate current and future vehicle emissions are detailed in the model documentation.

Sections 6.1 through 6.4 will present the current and Future Build 2015 scenarios. Results for the Future Build 2031 scenario can be found in Appendix E, while results for the Future No Build 2015 and Future No Build 2031 scenarios can be found in Appendices F&G respectively

6.1. Maximum Modelling Concentrations

6.1.1. Thornton

For the area around the Thornton Station, the maximum impact occurred at receptor number 57 for the Current scenario (Table 13) and receptor number 55 for the Future Build 2015 scenario (Table 14). For all contaminants except CO, the background levels represent a large portion of the total concentration. All contaminants are below their respective standards or guidelines. Contaminants that are at or exceed 50% of the standard or guideline are NO_x, PM and acrolein. Sample contour plot figures for the Thornton Station are provided in Appendix H.

Table 13 - Thornton - Maximum Predicted Concentrations -- Current

Pollutant	Modelled	Background	Total	Air Quality Threshold	Percentage of Threshold	Impact at Receptor ID
	ug/m^3	ug/m^3	ug/m^3	ug/m^3	%	
1-Hour Averaging Period						
NOx	54.71	194.10	248.81	400	62.2%	5
NO2	54.71	80.40	135.11	400	33.8%	5
CO	388.5	738.0	1,126.52	36,200	3.1%	5
SO2	0.4	14.3	14.69	690	2.1%	5
PM2.5	12.1	20.2	32.30	-	-	1
PM10	22.4	37.4	59.81	-	-	1
PM TSP	40.3	67.3	107.67	-	-	1
Acetaldehyde	0.217	-	0.22	500	0.0%	5
Acrolein	0.032	-	0.03	-	-	5
Benzene	2.14	-	2.14	-	-	5
1,3-Butadiene	0.21	-	0.21	-	-	5
Formaldehyde	0.33	-	0.33	-	-	5
24-Hour Average Period						
NOx	22.47	161.80	184.27	200	92.1%	5
NO2	22.47	70.20	92.67	200	46.3%	5
CO	159.6	673.4	832.97	-	-	5
SO2	0.2	13.8	13.96	275	5.1%	5
PM2.5	3.20	18.60	21.80	30	72.7%	1
PM10	5.93	34.44	40.37	50	80.7%	1
PM TSP	10.67	62.00	72.67	120	60.6%	1
Acetaldehyde	0.089	2.62	2.71	500	0.5%	5
Acrolein	0.013	0.19	0.20	0.40	50.8%	5
Benzene	0.88	1.88	2.76	-	-	5
1,3-Butadiene	0.08	0.09	0.17	-	-	5
Formaldehyde	0.14	4.45	4.59	65	7.1%	5
Annual Averaging Period						
NOx	4.49	113.00	117.49	-	-	5
NO2	4.49	53.00	57.49	-	-	5
CO	31.91	627.00	658.91	-	-	5
SO2	0.03	8.00	8.03	55	14.6%	5
PM2.5	0.64	10.00	10.64	-	-	1
PM10	1.19	18.52	19.70	-	-	1
PM TSP	2.13	33.33	35.47	-	-	1
Acetaldehyde	0.02	1.67	1.69	-	-	5
Acrolein	0.003	0.11	0.11	-	-	5
Benzene	0.18	0.91	1.09	-	-	5
1,3-Butadiene	0.02	0.05	0.07	-	-	5
Formaldehyde	0.03	2.61	2.64	-	-	5

Table 14 -Thornton - Maximum Predicted Concentrations 2015 - Future Build Scenario

Pollutant	Modelled	Background	Total	Air Quality Threshold	Percentage of Threshold	Impact at Receptor ID
	ug/m^3	ug/m^3	ug/m^3	ug/m^3	%	
1-Hour Averaging Period						
NOx	47.43	194.10	241.53	400	60.4%	3
NO2	47.43	80.40	127.83	400	32.0%	3
CO	448.3	738.0	1,186.25	36,200	3.3%	3
SO2	0.6	14.3	14.90	690	2.2%	3
PM2.5	7.6	20.2	27.80	-	-	7
PM10	14.1	37.4	51.48	-	-	7
PM TSP	25.3	67.3	92.67	-	-	7
Acetaldehyde	0.203	-	0.20	500	0.0%	3
Acrolein	0.030	-	0.03	-	-	3
Benzene	2.03	-	2.03	-	-	3
1,3-Butadiene	0.16	-	0.16	-	-	3
Formaldehyde	0.29	-	0.29	-	-	3
24-Hour Average Period						
NOx	19.48	161.80	181.28	200	90.6%	3
NO2	19.48	70.20	89.68	200	44.8%	3
CO	184.1	673.4	857.50	-	-	3
SO2	0.2	13.8	14.05	275	5.1%	3
PM2.5	2.06	18.60	20.66	30	68.9%	7
PM10	3.81	34.44	38.26	50	76.5%	7
PM TSP	6.87	62.00	68.87	120	57.4%	7
Acetaldehyde	0.083	2.62	2.70	500	0.5%	3
Acrolein	0.012	0.19	0.20	0.40	50.6%	3
Benzene	0.83	1.88	2.71	-	-	3
1,3-Butadiene	0.07	0.09	0.16	-	-	3
Formaldehyde	0.12	4.45	4.57	65	7.0%	3
Annual Averaging Period						
NOx	3.90	113.00	116.90	-	-	3
NO2	3.90	53.00	56.90	-	-	3
CO	36.82	627.00	663.82	-	-	3
SO2	0.05	8.00	8.05	55	14.6%	3
PM2.5	0.41	10.00	10.41	-	-	7
PM10	0.76	18.52	19.28	-	-	7
PM TSP	1.37	33.33	34.71	-	-	7
Acetaldehyde	0.02	1.67	1.69	-	-	3
Acrolein	0.002	0.11	0.11	-	-	3
Benzene	0.17	0.91	1.08	-	-	3
1,3-Butadiene	0.01	0.05	0.06	-	-	3
Formaldehyde	0.02	2.61	2.63	-	-	3

Ritson

As discussed in Sections 5.1 and 5.2, both Tier 1 and Tier 2 modelling was conducted for the Ritson Station. While all 5 scenarios were investigated using Tier 1 modelling techniques, only the Current and Future Build (2015) scenarios were investigated using Tier 2 modelling techniques.

6.1.1.1 Ritson; Tier 1 Modelling

For the area around the Ritson Station, the maximum impact occurred at receptor number 4 for both the Current scenario (Table 15) and Future Build 2015 scenario (Table 16). For all contaminants except CO, the background levels represent a large portion of the total concentration. All contaminants except for NO_x are below their respective standards or guidelines. NO_x is seen to exceed both the 1 hour and 24 hour standards. Background values for NO_x, are seen to be at least 45% of the Air Quality Threshold for 1 hour and 24 hour averaging periods. Contaminants that are at or exceed 50% of the standard or guideline are NO_x, PM and acrolein. Sample contour plot figures for the Ritson Station are provided in Appendix H.

Table 15 - Ritson - Maximum Predicted Concentrations - Current Scenario

Pollutant	Modelled	Background	Total	Air Quality Threshold	Percentage of Threshold	Impact at Receptor ID
	ug/m^3	ug/m^3	ug/m^3	ug/m^3	%	
1-Hour Averaging Period						
NOx	246.16	194.10	440.26	400	110.1%	4
NO2	107.72	80.40	188.12	400	47.0%	4
CO	1,087.4	738.0	1,825.42	36,200	5.0%	4
SO2	1.9	14.3	16.22	690	2.4%	4
PM2.5	4.4	20.2	24.60	-	-	4
PM10	8.1	37.4	45.56	-	-	4
PM TSP	14.7	67.3	82.00	-	-	4
Acetaldehyde	0.599	-	0.60	500	0.1%	4
Acrolein	0.093	-	0.09	-	-	4
Benzene	5.85	-	5.85	-	-	4
1,3-Butadiene	0.53	-	0.53	-	-	4
Formaldehyde	0.93	-	0.93	-	-	4
24-Hour Average Period						
NOx	101.10	161.80	262.90	200	131.5%	4
NO2	77.37	70.20	147.57	200	73.8%	4
CO	446.6	673.4	1,120.02	-	-	4
SO2	0.8	13.8	14.59	275	5.3%	4
PM2.5	2.05	18.60	20.65	30	68.8%	4
PM10	3.80	34.44	38.24	50	76.5%	4
PM TSP	6.83	62.00	68.83	120	57.4%	4
Acetaldehyde	0.246	2.62	2.87	500	0.6%	4
Acrolein	0.038	0.19	0.23	0.40	57.0%	4
Benzene	2.40	1.88	4.28	-	-	4
1,3-Butadiene	0.22	0.09	0.31	-	-	4
Formaldehyde	0.38	4.45	4.83	65	7.4%	4
Annual Averaging Period						
NOx	20.22	113.00	133.22	-	-	4
NO2	15.47	53.00	68.47	-	-	4
CO	89.32	627.00	716.32	-	-	4
SO2	0.16	8.00	8.16	55	14.8%	4
PM2.5	0.41	10.00	10.41	-	-	4
PM10	0.76	18.52	19.28	-	-	4
PM TSP	1.37	33.33	34.70	-	-	4
Acetaldehyde	0.05	1.67	1.72	-	-	4
Acrolein	0.008	0.11	0.12	-	-	4
Benzene	0.48	0.91	1.39	-	-	4
1,3-Butadiene	0.04	0.05	0.09	-	-	4
Formaldehyde	0.08	2.61	2.69	-	-	4

Table 16 - Ritson - Maximum Predicted Concentrations 2015 - Future Build Scenario

Pollutant	Modelled	Background	Total	Air Quality Threshold	Percentage of Threshold	Impact at Receptor ID
	ug/m^3	ug/m^3	ug/m^3	ug/m^3	%	
1-Hour Averaging Period						
NOx	155.16	194.10	349.26	400	87.3%	4
NO2	98.62	80.40	179.02	400	44.8%	4
CO	910.7	738.0	1,648.69	36,200	4.6%	4
SO2	2.2	14.3	16.46	690	2.4%	4
PM2.5	5.0	20.2	25.20	-	-	4
PM10	9.3	37.4	46.67	-	-	4
PM TSP	16.7	67.3	84.00	-	-	4
Acetaldehyde	0.428	-	0.43	500	0.1%	4
Acrolein	0.064	-	0.06	-	-	4
Benzene	4.11	-	4.11	-	-	4
1,3-Butadiene	0.31	-	0.31	-	-	4
Formaldehyde	0.63	-	0.63	-	-	4
24-Hour Average Period						
NOx	63.73	161.80	225.53	200	112.8%	4
NO2	63.73	70.20	133.93	200	67.0%	4
CO	374.0	673.4	1,047.43	-	-	4
SO2	0.9	13.8	14.69	275	5.3%	4
PM2.5	2.45	18.60	21.05	30	70.2%	4
PM10	4.54	34.44	38.98	50	78.0%	4
PM TSP	8.17	62.00	70.17	120	58.5%	4
Acetaldehyde	0.176	2.62	2.80	500	0.6%	4
Acrolein	0.026	0.19	0.22	0.40	54.1%	4
Benzene	1.69	1.88	3.57	-	-	4
1,3-Butadiene	0.13	0.09	0.22	-	-	4
Formaldehyde	0.26	4.45	4.71	65	7.2%	4
Annual Averaging Period						
NOx	12.75	113.00	125.75	-	-	4
NO2	12.75	53.00	65.75	-	-	4
CO	74.81	627.00	701.81	-	-	4
SO2	0.18	8.00	8.18	55	14.9%	4
PM2.5	0.49	10.00	10.49	-	-	4
PM10	0.91	18.52	19.43	-	-	4
PM TSP	1.63	33.33	34.97	-	-	4
Acetaldehyde	0.04	1.67	1.71	-	-	4
Acrolein	0.005	0.11	0.12	-	-	4
Benzene	0.34	0.91	1.25	-	-	4
1,3-Butadiene	0.03	0.05	0.08	-	-	4
Formaldehyde	0.05	2.61	2.66	-	-	4

6.1.1.2 Ritson Tier 2 Modelling

For both Current and Future build (2015) scenarios, Tier 2 modelling techniques are seen to reduce the predicted maximum POI concentration by at least 20% for almost all contaminants.

Table 17 – Maximum Predicted 1 Hour Concentrations – Current Scenario

Pollutant	Tier 1 Modelled (µg/m^3)	Tier 2 Modelled (µg/m^3)	% Modelled Tier 1
NO_x	246.2	198.1	80
NO_2	107.7	102.9	96
CO	1,087.4	802.4	74
SO_2	1.9	1.61	84
$PM_{2.5}$	4.4	3.7	84
PM_{10}	8.15	6.85	84
PM_{TSP}	14.7	12.3	84
Acetaldehyde	0.6	0.44	73
Acrolein	0.093	0.07	73
Benzene	5.85	4.13	71
1,3-Butadiene	0.53	0.38	71
Formaldehyde	0.93	0.68	73

Table 18 – Maximum Predicted 1 Hour Concentrations 2015 - Future build Scenario

Pollutant	Tier 1 Modelled (µg/m^3)	Tier 2 Modelled (µg/m^3)	% Modelled Tier 1
NO_x	155.16	124.94	81
NO_2	98.62	95.59	97
CO	910.7	686.84	75
SO_2	2.2	1.80	84
$PM_{2.5}$	5.0	4.5	90
PM_{10}	9.25	8.3	90
PM_{TSP}	16.7	15	90
Acetaldehyde	0.428	0.32	75
Acrolein	0.064	0.05	75
Benzene	4.11	2.98	72
1,3-Butadiene	0.31	0.23	74
Formaldehyde	0.63	0.47	75

6.1.2. Courtice

For the area around the Courtice Station, the maximum impact occurred at receptor number 48 for both the Current scenario (Table 19) and Future Build 2015 scenario (Table 20). For all contaminants except CO, the background levels represent a large portion of the total concentration. All contaminants except for NO_x, are below their respective standards or guidelines. NO_x is seen to exceed the 24 hour standards. Background values for NO_x, are seen to be at least 48% of the Air Quality Threshold for 1 hour and 24 hour averaging periods. Contaminants that are at or exceed 50% of the standard or guideline are NO_x, PM and acrolein. Sample contour plot figures for the Courtice Station are provided in Appendix H.

Table 19 - Courtice - Maximum Predicted Concentrations - Current Scenario

Pollutant	Modelled	Background	Total	Air Quality Threshold	Percentage of Threshold	Impact at Receptor ID
	ug/m^3	ug/m^3	ug/m^3	ug/m^3	%	
1-Hour Averaging Period						
NOx	195.14	194.10	389.24	400	97.3%	6
NO2	102.61	80.40	183.01	400	45.8%	6
CO	677.6	738.0	1,415.62	36,200	3.9%	6
SO2	1.5	14.3	15.84	690	2.3%	6
PM2.5	3.3	20.2	23.50	-	-	6
PM10	6.1	37.4	43.52	-	-	6
PM TSP	11.0	67.3	78.33	-	-	6
Acetaldehyde	0.243	-	0.24	500	0.0%	6
Acrolein	0.038	-	0.04	-	-	6
Benzene	2.29	-	2.29	-	-	6
1,3-Butadiene	0.21	-	0.21	-	-	6
Formaldehyde	0.37	-	0.37	-	-	6
24-Hour Average Period						
NOx	80.15	161.80	241.95	200	121.0%	6
NO2	75.27	70.20	145.47	200	72.7%	6
CO	278.3	673.4	951.71	-	-	6
SO2	0.6	13.8	14.43	275	5.2%	6
PM2.5	1.40	18.60	20.00	30	66.7%	6
PM10	2.59	34.44	37.04	50	74.1%	6
PM TSP	4.67	62.00	66.67	120	55.6%	6
Acetaldehyde	0.100	2.62	2.72	500	0.5%	6
Acrolein	0.016	0.19	0.21	0.40	51.4%	6
Benzene	0.94	1.88	2.82	-	-	6
1,3-Butadiene	0.08	0.09	0.17	-	-	6
Formaldehyde	0.15	4.45	4.60	65	7.1%	6
Annual Averaging Period						
NOx	16.03	113.00	129.03	-	-	6
NO2	15.05	53.00	68.05	-	-	6
CO	55.66	627.00	682.66	-	-	6
SO2	0.13	8.00	8.13	55	14.8%	6
PM2.5	0.28	10.00	10.28	-	-	6
PM10	0.52	18.52	19.04	-	-	6
PM TSP	0.93	33.33	34.27	-	-	6
Acetaldehyde	0.02	1.67	1.69	-	-	6
Acrolein	0.003	0.11	0.11	-	-	6
Benzene	0.19	0.91	1.10	-	-	6
1,3-Butadiene	0.02	0.05	0.07	-	-	6
Formaldehyde	0.03	2.61	2.64	-	-	6

Table 20 - Courtice - Maximum Predicted Concentrations 2015 - Future Build Scenario

Pollutant	Modelled	Background	Total	Air Quality Threshold	Percentage of Threshold	Impact at Receptor ID
	ug/m^3	ug/m^3	ug/m^3	ug/m^3	%	
1-Hour Averaging Period						
NOx	105.12	194.10	299.22	400	74.8%	6
NO2	93.61	80.40	174.01	400	43.5%	6
CO	861.4	738.0	1,599.42	36,200	4.4%	6
SO2	3.4	14.3	17.66	690	2.6%	6
PM2.5	5.4	20.2	25.60	-	-	6
PM10	10.0	37.4	47.41	-	-	6
PM TSP	18.0	67.3	85.33	-	-	6
Acetaldehyde	0.241	-	0.24	500	0.0%	6
Acrolein	0.036	-	0.04	-	-	6
Benzene	2.00	-	2.00	-	-	6
1,3-Butadiene	0.16	-	0.16	-	-	6
Formaldehyde	0.36	-	0.36	-	-	6
24-Hour Average Period						
NOx	43.18	161.80	204.98	200	102.5%	6
NO2	43.18	70.20	113.38	200	56.7%	6
CO	353.8	673.4	1,027.20	-	-	6
SO2	1.4	13.8	15.18	275	5.5%	6
PM2.5	2.45	18.60	21.05	30	70.2%	6
PM10	4.54	34.44	38.98	50	78.0%	6
PM TSP	8.17	62.00	70.17	120	58.5%	6
Acetaldehyde	0.099	2.62	2.72	500	0.5%	6
Acrolein	0.015	0.19	0.20	0.40	51.1%	6
Benzene	0.82	1.88	2.70	-	-	6
1,3-Butadiene	0.07	0.09	0.16	-	-	6
Formaldehyde	0.15	4.45	4.60	65	7.1%	6
Annual Averaging Period						
NOx	8.64	113.00	121.64	-	-	6
NO2	8.64	53.00	61.64	-	-	6
CO	70.76	627.00	697.76	-	-	6
SO2	0.28	8.00	8.28	55	15.0%	6
PM2.5	0.49	10.00	10.49	-	-	6
PM10	0.91	18.52	19.43	-	-	6
PM TSP	1.63	33.33	34.97	-	-	6
Acetaldehyde	0.02	1.67	1.69	-	-	6
Acrolein	0.003	0.11	0.11	-	-	6
Benzene	0.16	0.91	1.07	-	-	6
1,3-Butadiene	0.01	0.05	0.06	-	-	6
Formaldehyde	0.03	2.61	2.64	-	-	6

6.1.3. Martin

For the area around the Martin Station, the maximum impact occurred at receptor number 14 for both the Current scenario (Table 21) and Future Build 2015 scenario (Table 22). For all contaminants except CO, the background levels represent a large portion of the total concentration. All contaminants except for NO_x, are below their respective standards or guidelines. NO_x is seen to exceed both 24 hour standards. Background values for NO_x, are seen to be at least 45% of the Air Quality Threshold for 1 hour and 24 hour averaging periods. Contaminants that are at or exceed 50% of the standard or guideline are NO_x, PM and acrolein. Sample contour plot figures for the Martin Station are provided in Appendix H.

Table 21 - Martin - Maximum Predicted Concentrations - Current Scenario

Pollutant	Modelled	Background	Total	Air Quality Threshold	Percentage of Threshold	Impact at Receptor ID
	ug/m^3	ug/m^3	ug/m^3	ug/m^3	%	
1-Hour Averaging Period						
NOx	127.11	194.10	321.21	400	80.3%	1
NO2	95.81	80.40	176.21	400	44.1%	1
CO	504.6	738.0	1,242.63	36,200	3.4%	1
SO2	1.0	14.3	15.31	690	2.2%	1
PM2.5	2.3	20.2	22.50	-	-	1
PM10	4.3	37.4	41.67	-	-	1
PM TSP	7.7	67.3	75.00	-	-	1
Acetaldehyde	0.253	-	0.25	500	0.1%	1
Acrolein	0.039	-	0.04	-	-	1
Benzene	2.50	-	2.50	-	-	1
1,3-Butadiene	0.22	-	0.22	-	-	1
Formaldehyde	0.39	-	0.39	-	-	1
24-Hour Average Period						
NOx	52.21	161.80	214.01	200	107.0%	1
NO2	52.21	70.20	122.41	200	61.2%	1
CO	207.3	673.4	880.66	-	-	1
SO2	0.4	13.8	14.22	275	5.2%	1
PM2.5	0.78	18.60	19.38	30	64.6%	1
PM10	1.44	34.44	35.89	50	71.8%	1
PM TSP	2.60	62.00	64.60	120	53.8%	1
Acetaldehyde	0.104	2.62	2.72	500	0.5%	1
Acrolein	0.016	0.19	0.21	0.40	51.5%	1
Benzene	1.03	1.88	2.91	-	-	1
1,3-Butadiene	0.09	0.09	0.18	-	-	1
Formaldehyde	0.16	4.45	4.61	65	7.1%	1
Annual Averaging Period						
NOx	10.44	113.00	123.44	-	-	1
NO2	10.44	53.00	63.44	-	-	1
CO	41.45	627.00	668.45	-	-	1
SO2	0.08	8.00	8.08	55	14.7%	1
PM2.5	0.16	10.00	10.16	-	-	1
PM10	0.29	18.52	18.81	-	-	1
PM TSP	0.52	33.33	33.85	-	-	1
Acetaldehyde	0.02	1.67	1.69	-	-	1
Acrolein	0.003	0.11	0.11	-	-	1
Benzene	0.21	0.91	1.12	-	-	1
1,3-Butadiene	0.02	0.05	0.07	-	-	1
Formaldehyde	0.03	2.61	2.64	-	-	1

Table 22 - Martin - Maximum Predicted Concentrations 2015 - Future Build Scenario

Pollutant	Modelled	Background	Total	Air Quality Threshold	Percentage of Threshold	Impact at Receptor ID
	ug/m^3	ug/m^3	ug/m^3	ug/m^3	%	
1-Hour Averaging Period						
NOx	92.43	194.10	286.53	400	71.6%	1
NO2	92.34	80.40	172.74	400	43.2%	1
CO	486.6	738.0	1,224.63	36,200	3.4%	1
SO2	1.3	14.3	15.61	690	2.3%	1
PM2.5	2.6	20.2	22.80	-	-	1
PM10	4.8	37.4	42.22	-	-	1
PM TSP	8.7	67.3	76.00	-	-	1
Acetaldehyde	0.213	-	0.21	500	0.0%	1
Acrolein	0.032	-	0.03	-	-	1
Benzene	2.07	-	2.07	-	-	1
1,3-Butadiene	0.15	-	0.15	-	-	1
Formaldehyde	0.32	-	0.32	-	-	1
24-Hour Average Period						
NOx	37.96	161.80	199.76	200	99.9%	1
NO2	37.96	70.20	108.16	200	54.1%	1
CO	199.9	673.4	873.27	-	-	1
SO2	0.5	13.8	14.34	275	5.2%	1
PM2.5	0.93	18.60	19.53	30	65.1%	1
PM10	1.72	34.44	36.17	50	72.3%	1
PM TSP	3.10	62.00	65.10	120	54.3%	1
Acetaldehyde	0.087	2.62	2.71	500	0.5%	1
Acrolein	0.013	0.19	0.20	0.40	50.8%	1
Benzene	0.85	1.88	2.73	-	-	1
1,3-Butadiene	0.06	0.09	0.15	-	-	1
Formaldehyde	0.13	4.45	4.58	65	7.0%	1
Annual Averaging Period						
NOx	7.59	113.00	120.59	-	-	1
NO2	7.59	53.00	60.59	-	-	1
CO	39.97	627.00	666.97	-	-	1
SO2	0.11	8.00	8.11	55	14.7%	1
PM2.5	0.19	10.00	10.19	-	-	1
PM10	0.34	18.52	18.86	-	-	1
PM TSP	0.62	33.33	33.95	-	-	1
Acetaldehyde	0.02	1.67	1.69	-	-	1
Acrolein	0.003	0.11	0.11	-	-	1
Benzene	0.17	0.91	1.08	-	-	1
1,3-Butadiene	0.01	0.05	0.06	-	-	1
Formaldehyde	0.03	2.61	2.64	-	-	1

6.2. Train Impact – Ritson Station

In order to assess the contribution of train traffic to the POI value at the most sensitive receptor, models were run with only the train free flow links using the techniques discussed in section 5. Using the techniques discussed in section 5.3, the train traffic is seen to have insignificant contribution (compared to the local vehicle traffic) to overall gaseous concentrations at the most sensitive receptor (Figure 2). Using the PM option as discussed in section 5, train traffic is seen to contribute to overall PM concentrations at the most sensitive receptor (Figure 3).

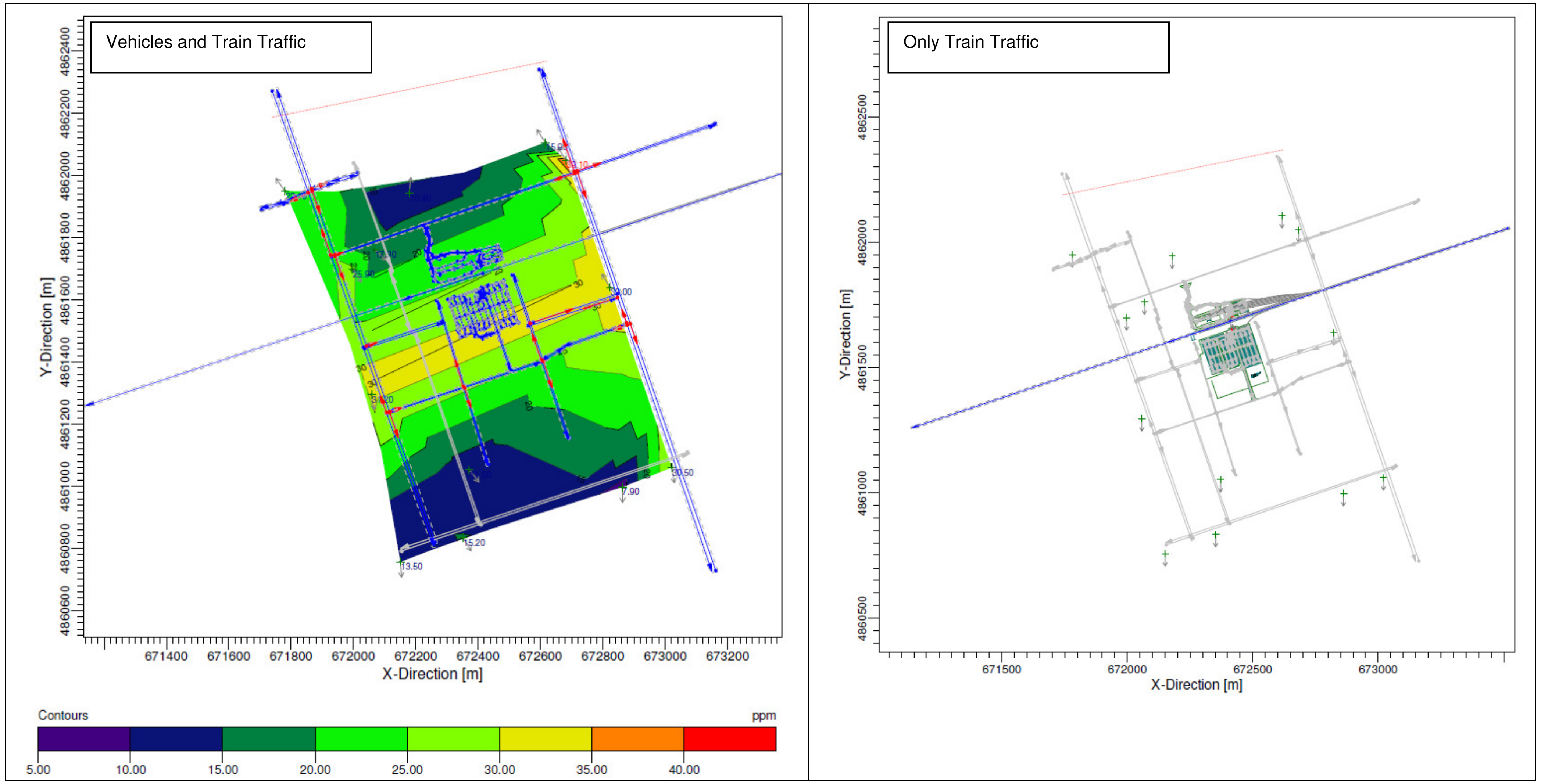

Figure 2 - Train Only Comparison Future Build 2015 - Unit Scalar

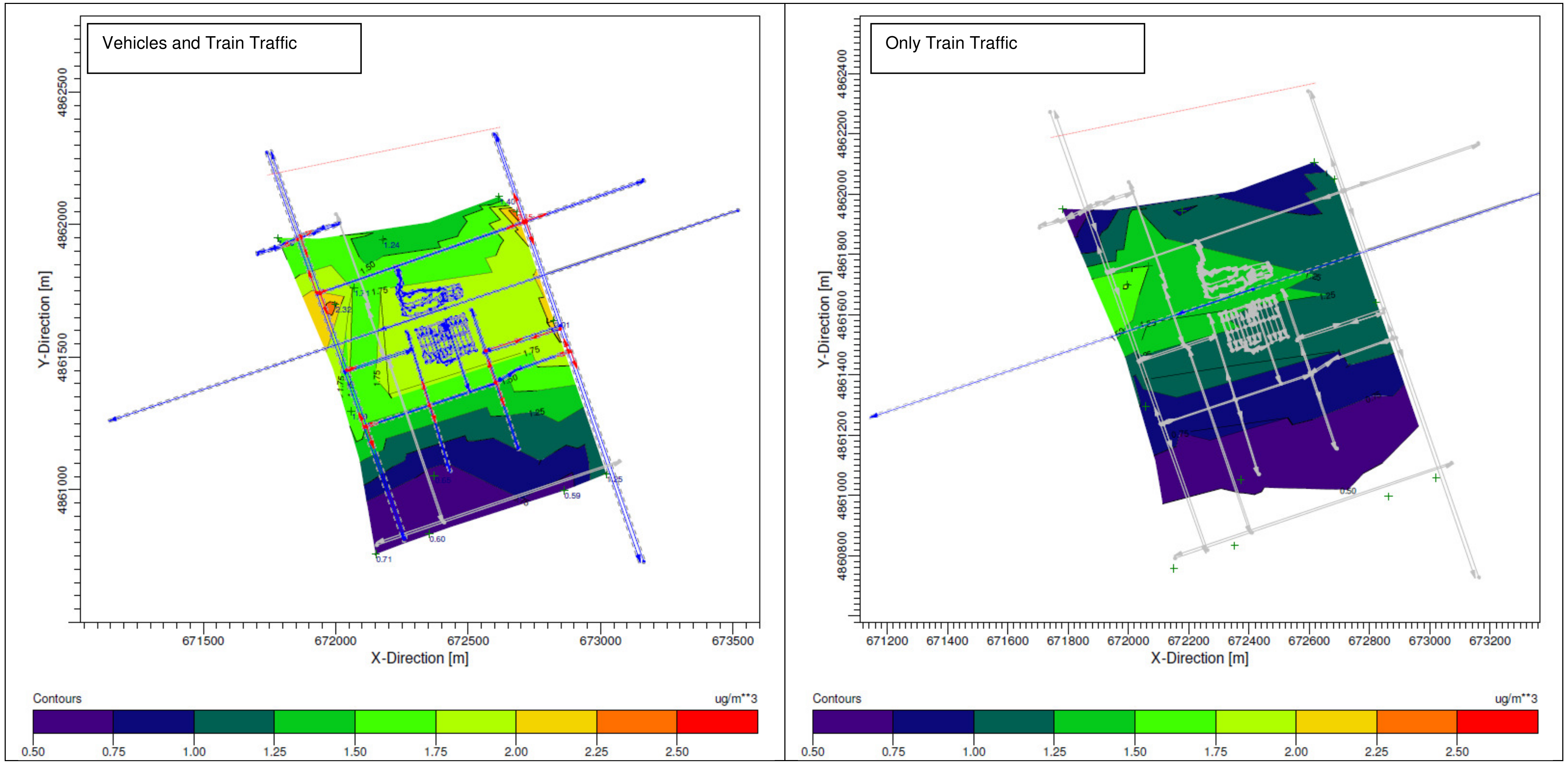

Figure 3 - Train Only Comparison Future Build 2015 - PM

6.3. Regional Impacts

Regional impacts were determined by assessing the overall change in vehicles use, due to the GO Transit expansion and changes in locomotive emissions regulations. Although there is a local increase in air pollutants from the specific GO stations, the overall impact decreases from commuters using the trains and reducing vehicle use on a regional level. Using ridership data developed for the four GO stations, the annual reduction in vehicular emissions is shown in Table 23. When compared to the mobile emission inventories for Ontario and Canada the regional decreases are small. Mobile emission inventories for Ontario and Canada are provided by the NPRI. It is worth noting that anticipated locomotive emissions regulations do not affect CO emission rates. In addition, GO train traffic volumes at Thornton station do not change during the period of study; thus there will be no change to the overall CO regional impact as a result of activities at Thornton Station.

Table 23 – Regional Impacts, Change in Annual Mobile Emissions Due to Future Build

Contaminant	Project 2031 GO Train				Project 2031 Vehicle Traffic Removed				Project (2031) Total Emissions	Ontario 2007	Canada 2007
	Thornton	Ritson	Courtice	Martin	Thornton	Ritson	Courtice	Martin			
	Tonnes/year	Tonnes/year	Tonnes/year	Tonnes/year	Tonnes/year	Tonnes/year	Tonnes/year	Tonnes/year	kTonnes/year	kTonnes/year	kTonnes/year
Composite VOC*	-6.80E-7	5.94E-8	6.08E-8	6.08E-8	-60.9	-61.7	-117.1	-56.9	-0.297	161	553.828
Composite CO	0.000	1.151	1.141	1.141	-2,062.2	-2,118.9	-2,843.8	-2,047.2	-9.069	2,067	6852.157
Composite NO_x	-4.321	0.899	0.881	0.881	-120.3	-123.9	-220.5	-148.4	-0.615	310.812	1209.463
$PM_{2.5}$	-0.154	0.014	0.014	0.014	-7.8	-8.0	-10.0	-10.0	-0.036	16.464	64.885

*For road vehicles, "Composite VOC" is as defined by the EPA code Mobile 6.2C. For trains,"Compsosite VOC" is defined as total Benzo(a)Pyrene.

7. Conclusions and Recommendations

The impacts to air quality have been investigated for the proposed GO Transit Project. The air quality assessment reviewed current standards and guidelines for air contaminants of CO, NO_x, SO_2, PM and VOCs. Ambient air concentrations were taken from local monitoring stations. Scenarios were developed for the future build and future no build scenarios. Emission factors for CO, NO_x, SO_2, PM and VOCs, using MOBILE 6.2, were developed for several road types and fleets. A conservative air dispersion model using CAL3QHCR was developed using all of the information collected. For the highest impacted receptors, the main findings of the air quality assessment are outlined below:

- All contaminants with the exception of NO_x are below their respective standard, guideline or interim reference level around all Go Transit stations
- In many cases, the ambient concentrations make up a large percentage of the total concentrations
- The ambient acrolein background level is already 50% of the standard. The future no-build to future build scenarios will only increase the acrolein levels by up to 12%. The future build scenario should contribute to reducing the ambient concentration of acrolein on a regional basis, but this impact has not been quantified.
- Comparing the future no-build and future build scenarios, most of the contaminants will not increase by a level greater than 10% and no contaminant will increase more than 19%.

The local effects of the future build are limited to receptors closest to the proposed stations. The modelled impact and concentration levels greatly decrease with increasing distance from the stations. Although there is an increase in local impacts, contaminant levels on a regional level will decrease due to commuters using the transit expansion. Furthermore the Future Build 2015 scenario will result in a decrease in the local concentrations of many contaminants such as NO_x and Benzene.

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