Appendix N

Air Quality Assessment Report

Air Quality Assessment
Mayfield Road Widening
Chinguacousy Rd to Heart Lake Rd
Region of Peel

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1.0 Introduction

1.1 Background

The Regional Municipality of Peel is conducting a Schedule C Class Environmental Assessment (EA) for the widening of Mayfield Road (Regional Road 14) from Chinguacousy Road to Heart Lake Road **(Figure 1)**. Mayfield Road is an east-west arterial road, forming the boundary line between the City of Brampton and the Town of Caledon. Mayfield Road is currently two lanes between Chinguacousy Road and Hurontario Street (2.8 km) and four lanes between Hurontario Street and Heart lake Road (2.8 km). The study area includes nine traffic lights and a crossing with the Canadian Pacific (CP) Railway west of Cresthaven Road/Robertson Davies Drive. The project includes widening of the roadway to six lanes by 2031 to accommodate increasing traffic volumes.

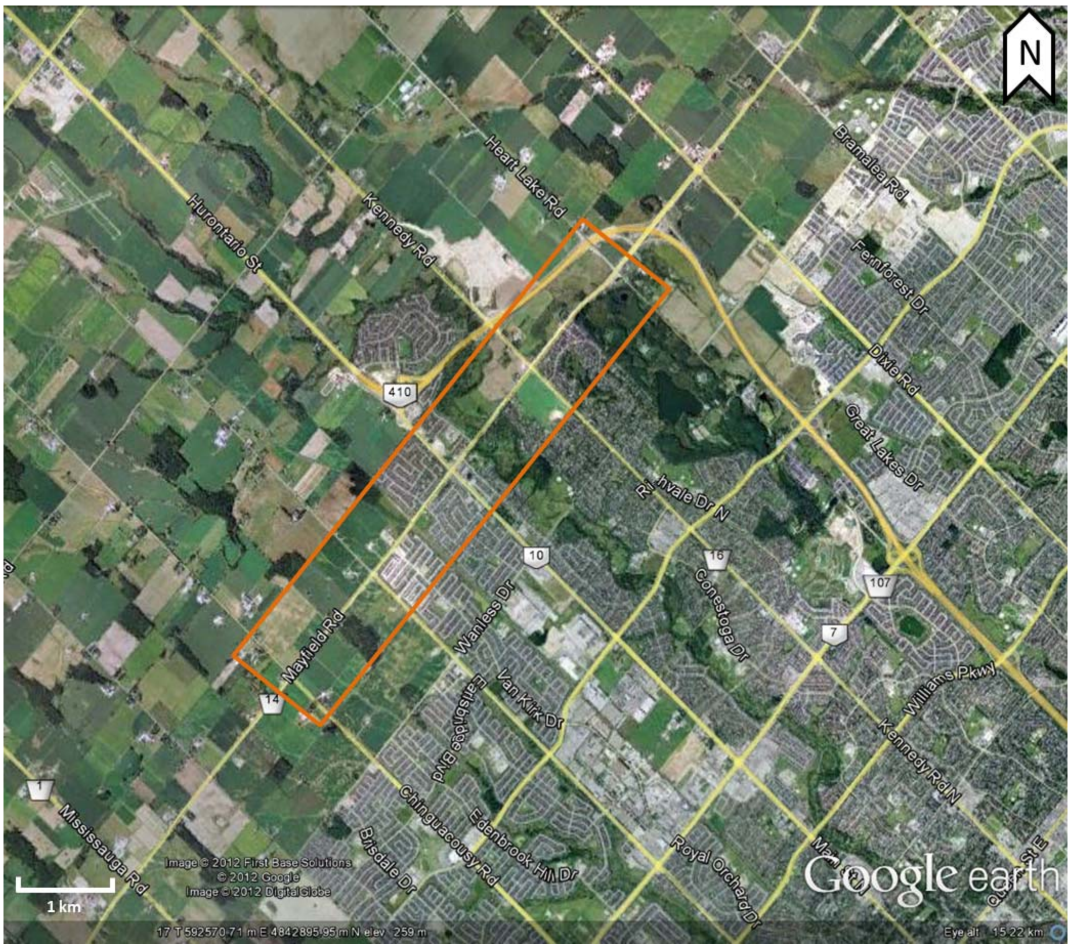


Figure 1: Study Area of Local Air Quality Assessment

1.2 Study Objectives

Novus Environmental Inc. (Novus) was retained by Genivar to conduct an air quality assessment for the widening of Mayfield Road between Chinguacousy Road and Heart Lake Road in the Region of Peel.

The objectives of this study are as follows:

- to predict the concentrations of selected contaminants resulting from traffic on the road for the future build scenario;
- to predict the combined effect of road traffic and ambient background concentrations at representative worst-case receptors; and
- to use these predictions to assess potential impacts of the project according to the applicable guidelines.

2.0 Air Quality Assessment

This study looks at the potential impacts of increased vehicular traffic due to the widening of Mayfield Road between Chinguacousy Road and Heart Lake Road. Potential impacts are assessed by predicting contaminant concentrations at sensitive land-uses adjacent to the roadway for the future build scenario. The contaminants chosen for this study are those commonly associated with motor vehicle emissions. Local meteorology, vehicle fleet distribution and characteristics, road type and traffic signals were all incorporated in this assessment.

2.1 Contaminants of Interest from Motor Vehicles

The contaminants of interest from motor vehicles have largely been determined by scientists and engineers with United States and Canadian government agencies such as the U.S. Environmental Protection Agency (EPA), the Ontario Ministry of Environment (MOE), Environment Canada (EC), Health Canada (HC), and the Ministry of Transportation Ontario (MTO). These contaminants are emitted due to fuel combustion, brake wear, tire wear, the breakdown of dust on the roadway, fuel leaks, evaporation and permeation, and refuelling leaks and spills as illustrated in **Figure 2**. Note that emissions related to refuelling leaks and spills are not applicable to motor vehicle emissions from roadway travel. Instead, these emissions contribute to the overall background levels of the applicable contaminants.

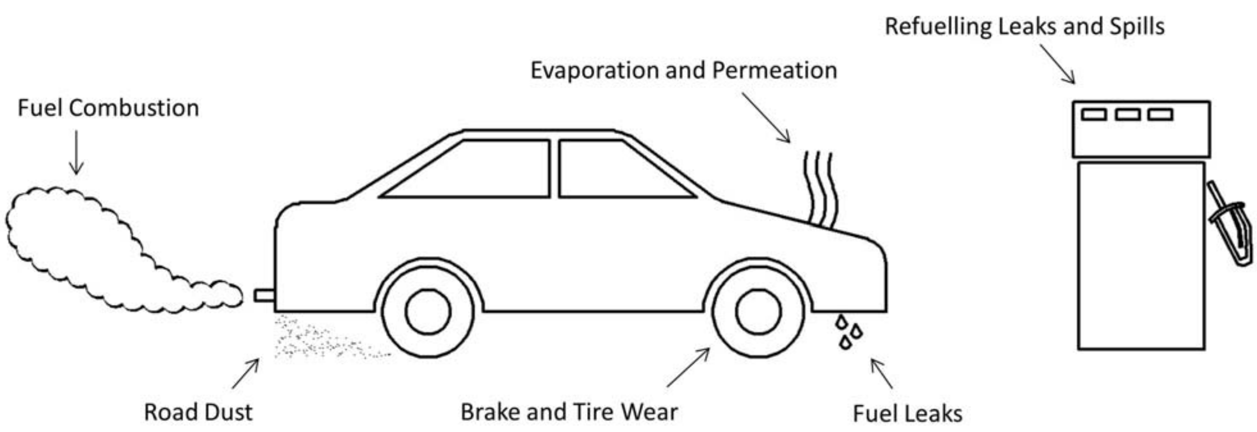


Figure 2: Motor Vehicle Emission Sources

The contaminants of interest from motor vehicles are categorized as Criteria Air Contaminants (CACs) and Volatile Organic Compounds (VOCs). The contaminants emitted during fuel combustion include all of the CACs and VOCs, and the contaminants emitted from brake wear, tire wear, and breakdown of road dust include the particulates. A summary these contaminants are provided in the following table.

Table 1: Contaminants of Interest

Criteria Air Contaminants (CACs)		Volatile Organic Compounds (VOCs)	
Name	**Symbol**	**Name**	**Symbol**
Nitrogen Dioxide	NO_2	Acetaldehyde	HCHO
Carbon Monoxide	CO	Acrolein	C_3H_4O
Fine Particulate Matter (<2.5 microns in diameter)	$PM_{2.5}$	Benzene	C_6H_6
Coarse Particulate Matter (<10 microns in diameter)	PM_{10}	1,3-Butadiene	C_4H_6
Total Suspended Particulate Matter (<44 microns in diameter)	TSP	Formaldehyde	CCHO

2.2 Applicable Guidelines

In order to assess the impact of the project, the predicted effects at sensitive receptors were compared to guidelines established by the government agencies and organizations. Relevant agencies and organizations in Canada and their applicable contaminant guidelines are:

- MOE Ambient Air Quality Criteria (AAQC)
- Health Canada/Environment Canada National Ambient Air Quality Objectives (NAAQOs)
- Canadian Council of Ministers of the Environment (CCME) Canada Wide Standards (CWSs)

Within the guidelines, the threshold value for each contaminant and its applicable averaging period was used to assess the maximum predicted effect at sensitive receptors derived from computer simulations. The applicable averaging periods for the contaminants of interest are based on 1-, 8- and 24-hour acute (short-term) exposures. The threshold values and averaging periods used in this assessment are presented in **Table 2** below. It should be noted that the CWS for $PM_{2.5}$ is not based on the maximum threshold value. Instead, it is based on the average annual 98th percentile value, averaged over 3 consecutive years.

Table 2: Applicable Contaminant Guidelines

Contaminant	Averaging Period (hrs)	Threshold Value (µg/m^3)	Source
NO_2	1	400	AAQC
	24	200	AAQC
CO	1	36,200	AAQC
	8	15,700	AAQC
$PM_{2.5}$	24	30*	AAQC (CWS)
PM_{10}	24	50	Interim AAQC
TSP	24	120	AAQC
Acetaldehyde	24	500	AAQC
Acrolein	1	4.5	MOE Environmental Registry
	24	0.4	MOE Environmental Registry
Benzene	24	2.3	MOE Environmental Registry
1,3-Butadiene	24	10	MOE Environmental Registry
Formaldehyde	24	65	AAQC

* The CWS is based on the average annual 98th percentile concentration, averaged over three consecutive years.

2.3 Background (Ambient) Conditions

2.3.1 Overview

Background (ambient) conditions are contaminant concentrations that are exclusive of emissions from the existing or proposed project infrastructure. These emissions are typically the result of trans-boundary (macro-scale), regional (meso-scale), and local (micro-scale) emission sources and result due to both primary and secondary formation. Primary contaminants are emitted directly by the source and secondary contaminants are formed by complex chemical reactions in the atmosphere. Secondary pollution is generally formed over great distances in the presence of sunlight and heat and most noticeably results in the formation of fine particulate matter ($PM_{2.5}$) and ground-level ozone (O_3), also considered smog.

In Ontario, a significant amount of smog originates from emission sources in the United States which is the major contributor during smog events, usually occurring in the summer season (MOE, 2005). During smog episodes, the U.S. contribution to $PM_{2.5}$ can be as much as 90 percent near the southwest U.S. border and approximately 50 percent in the Greater Toronto Area (GTA). The effect of U.S. air pollution on Ontario on a high $PM_{2.5}$ day and on an average $PM_{2.5}$ spring/summer day is illustrated in the following figure.

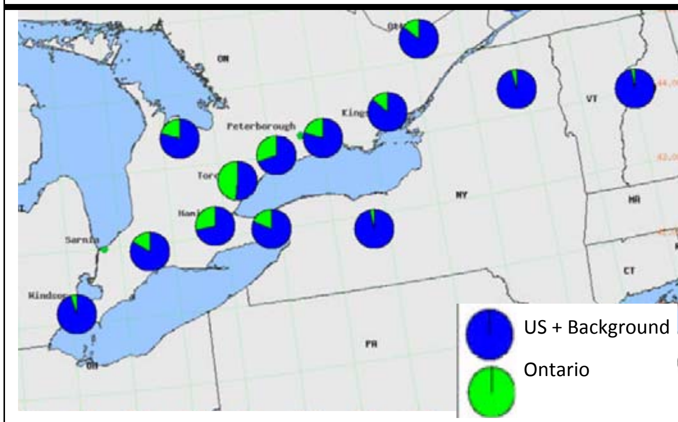
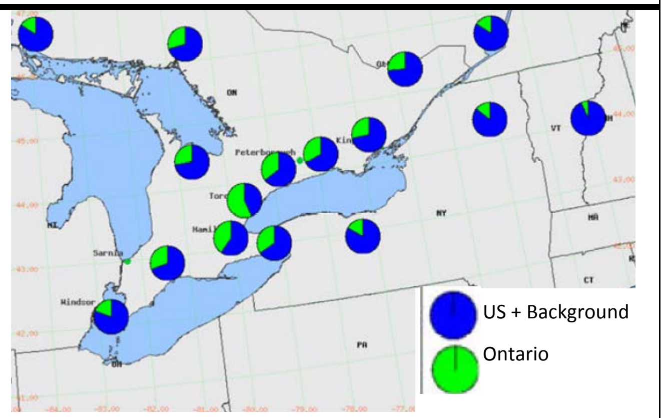
High PM$_{2.5}$ Days	Average PM$_{2.5}$ of Spring/Summer Season
	

Figure 3: Effect of Trans-boundary Air Pollution (MOE, 2005)

Air pollution is strongly influenced by weather systems (i.e., meteorology) that typically move out of central Canada into the mid-west of the U.S. then eastward to the Atlantic coast. This weather system generally produces winds with a southerly component that travel over major emission sources in the U.S. and result in the transport of pollution into Ontario. This phenomenon is demonstrated in the following figure and is based on a computer model run from the Weather Research and Forecasting (WRF) Model.

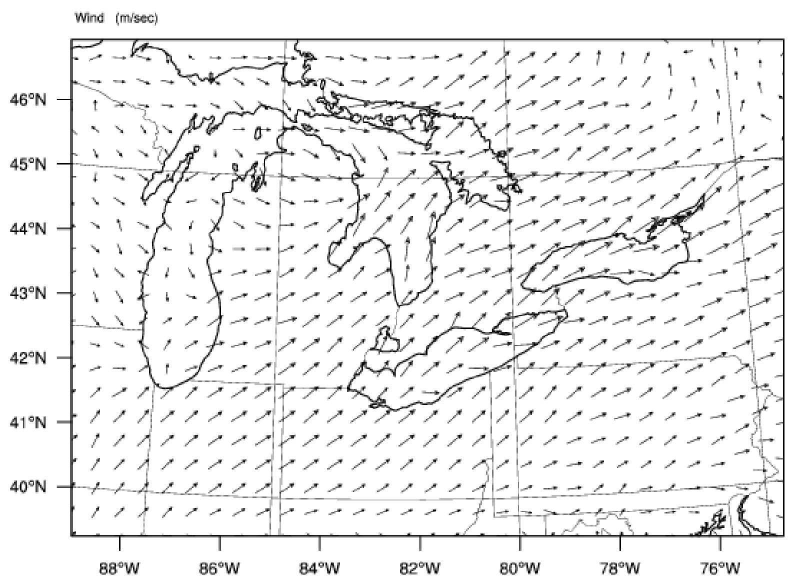


Figure 4: Typical Weather System during a Smog Episode

As discussed above, understanding the composition of background air pollution and its influences is important in determining the potential impacts of a project, considering that the majority of the combined concentrations are typically due to existing elevated ambient background levels. In this assessment, background conditions were characterized utilizing existing ambient monitoring data from MOE and NAPS (National Air Pollution Surveillance) Network stations and added to the modelled predictions in order to conservatively estimate the combined concentration.

2.3.2 Selection of Relevant Ambient Monitoring Stations

A review of MOE and NAPS ambient monitoring stations in Ontario was undertaken to identify the monitoring stations that are in relevant proximity to the study area and that would be representative of background contaminant concentrations in the study area. Two MOE (Brampton and Toronto West) and three NAPS (Brampton, Egbert and Windsor) monitoring stations were determined to be representative. The locations of the relevant ambient monitoring stations in relation to the study area are shown in **Figure 5** and their station information can be found in **Table 3**. It should be understood that the selection of the Egbert and Windsor stations is due to the fact that formaldehyde and acetaldehyde have only been recently measured at the Egbert and Windsor stations and acrolein has only been recently measured at the Windsor station. Note that the Windsor station is not shown in the figure due to its distance from the study area.

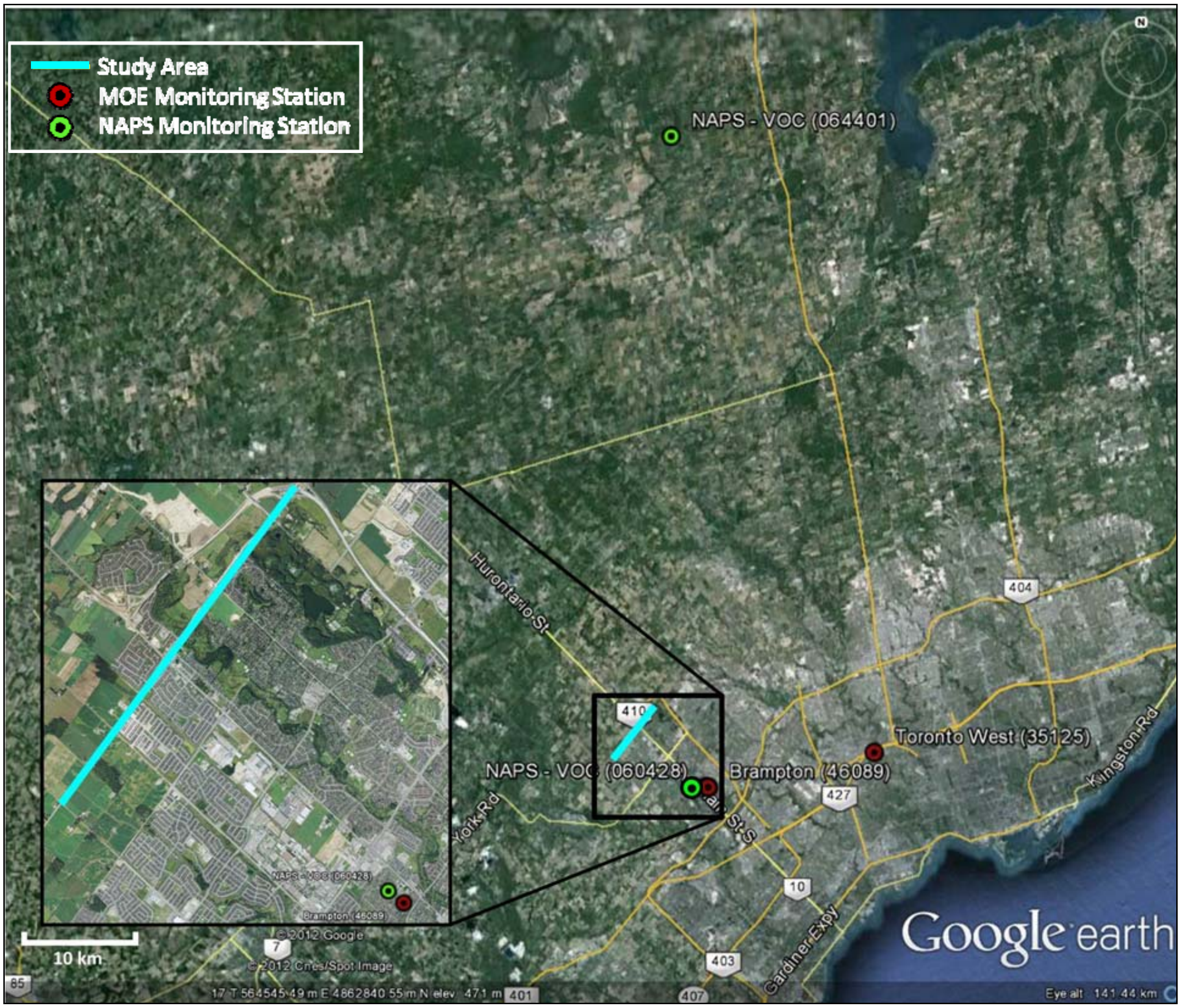


Figure 5: Relevant MOE and NAPS Monitoring Stations

Table 3: Relevant MOE and NAPS Monitoring Station Information

City/Town	Station ID	Location	Operator	Contaminants
Brampton	46089	525 Main St. N	MOE	$PM_{2.5}$ | NO_2
Toronto West	35125	125 Resources Rd.	MOE	$PM_{2.5}$ | NO_2 | CO
Brampton	60428	525 Main St. N	NAPS	Benzene | 1,3-Butadiene
Egbert	64401	Simcoe RR56/Murphy Rd.	NAPS	Formaldehyde | Acetaldehyde
Windsor	60211	College Ave./Prince Rd.	NAPS	Formaldehyde | Acetaldehyde |Acrolein

As shown in **Figure 5**, the Brampton stations are in very close proximity to the study area and therefore ambient data was first selected from these stations and then supplemented with data from the other representative stations. It was determined that $PM_{2.5}$, NO_2, benzene, and 1,3-butadiene data were available from the Brampton stations. This dataset was then supplemented with CO and acrolein data, which are only measured at the Toronto West and Windsor stations, respectively. Since the Egbert and Windsor stations both monitor formaldehyde and acetaldehyde, more detailed analysis of the data was completed in order to determine the worst-case dataset, as described further below.

A comparison of the five year datasets (Year 2005 to 2009) for the Egbert and Windsor stations was performed to determine which station would be representative of worst-case background concentrations. The station with the highest five year 90^{th} percentile value was selected to represent background concentrations in the study area. Based on the statistical summary, presented in **Table 4** and **Table 5** below, it was determined that worst-case background concentrations of formaldehyde and acetaldehyde occurred at the Egbert station.

Table 4: Comparison of Background Acetaldehyde

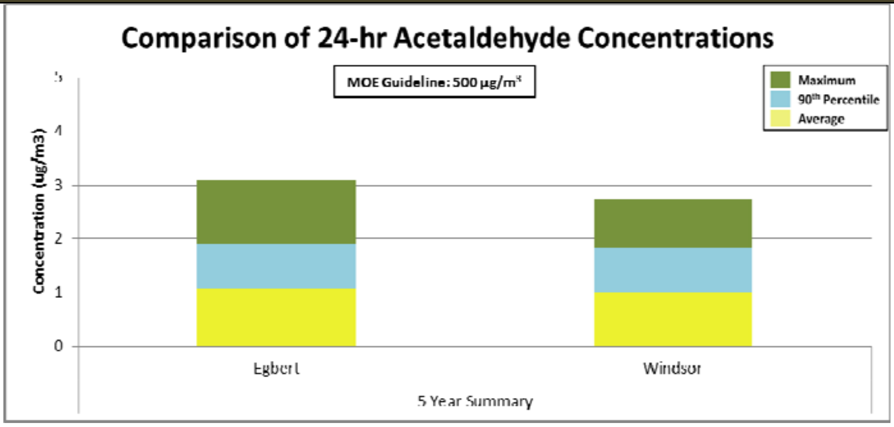
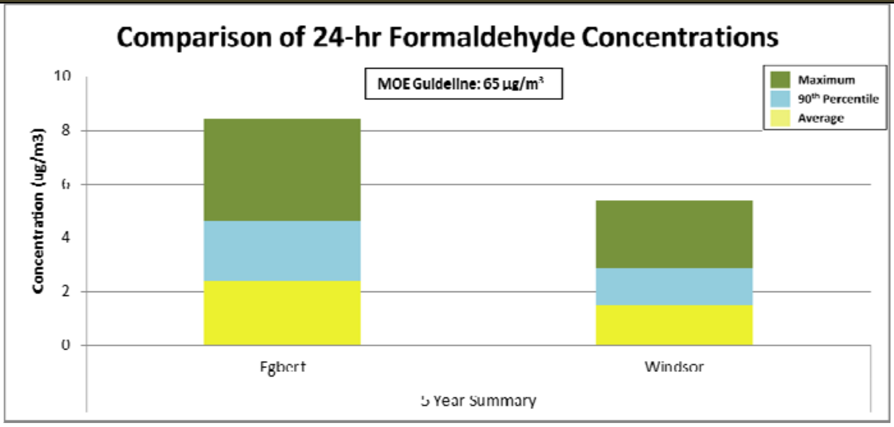
Statistical Analysis	Selection of Station
 	**Conclusion:** A review of five years of ambient monitoring data from nearby stations indicated that the highest 90^{th} percentile background concentration was measured at the Egbert Station.

Table 5: Comparison of Background Formaldehyde

<table>
<tr><th>Statistical Analysis</th><th>Selection of Station</th></tr>
<tr><td>
</td><td>Conclusion:
A review of five years of ambient monitoring data from nearby stations indicated that the highest 90th percentile background concentration was measured at the Egbert Station.</td></tr>
</table>

In summary, the following table provides a synopsis of the selected MOE and NAPS ambient monitoring stations and their corresponding contaminants used in this assessment to estimate background contaminant concentrations for the contaminants of interest.

Table 6: Selected MOE and NAPS Monitoring Stations by Contaminant

City/Town	Operator	Contaminants
Brampton	MOE	$PM_{2.5}$ | NO_2
Toronto West	MOE	CO
Brampton	NAPS	Benzene | 1,3-Butadiene
Egbert	NAPS	Formaldehyde | Acetaldehyde
Windsor	NAPS	Acrolein

2.3.3 Detailed Analysis of Selected Monitoring Stations

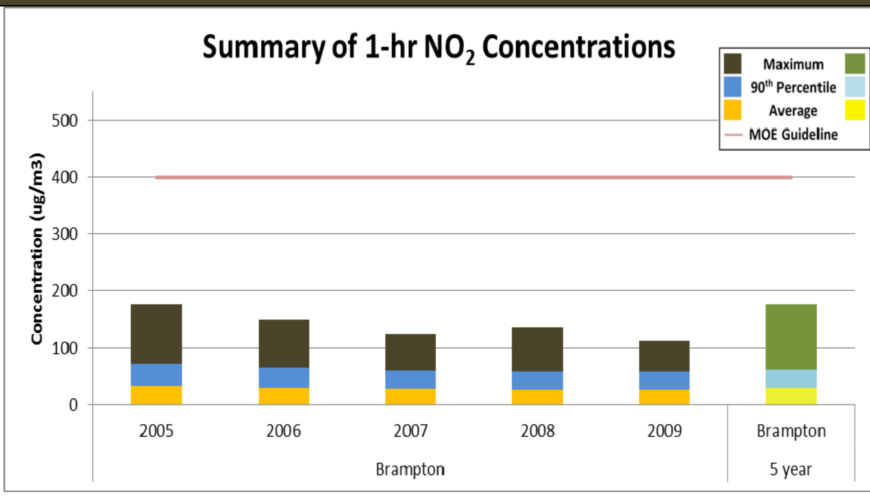
Year 2005 to 2009 hourly ambient monitoring data, the most recent 5 years publically available, from the selected stations were statistically summarized for average, 90th percentile (90 percent of the dataset are less than or equal to the 90th percentile value), and maximum concentration for the desired averaging period, 1-hour, 8-hour or 24-hour. Average concentrations represent a typical background scenario, 90th percentile concentrations represent a typical worst-case background scenario, and maximum concentrations represent a worst-case background scenario. It should be noted that the 2005 to 2009 monitoring data was selected to coincide with 2005 to 2009 meteorological data for consistency in the dispersion modelling.

From a review of the VOC dataset, it was determined that due to the lack of hourly and daily background monitoring data, 90th percentile background concentrations for each VOC in the 5 year dataset would be calculated and used to determine the combined concentration. This method was suggested by the MOE.

A detailed statistical analysis of the selected worst-case background monitoring station for each of the contaminants is presented below. Each site was summarized on a yearly basis and for the five year period. Where measurements exceeded the guideline, a frequency analysis of exceedances was performed.

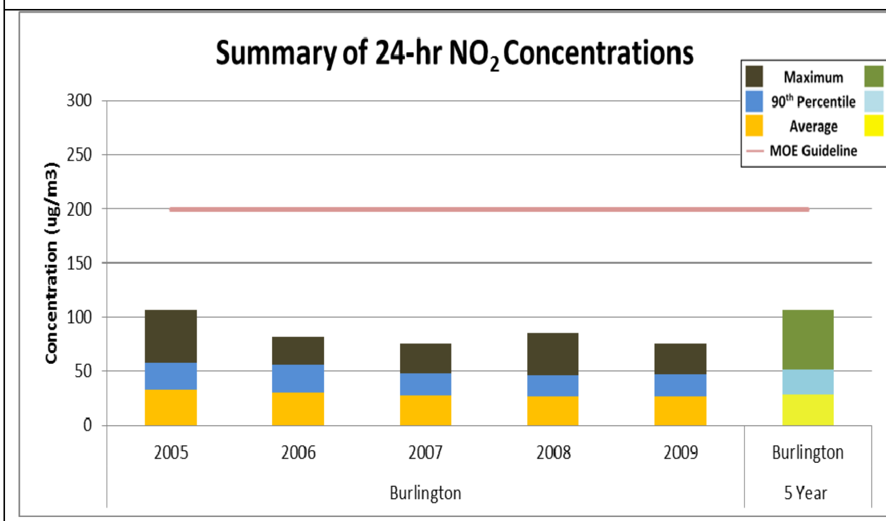
Table 7: Summary of Background NO_2

Statistical Analysis	Five Year Summary



Statistic	% of MOE Guideline
Maximum	44%
90^{th} Percentile	15%
Average	7%

Conclusion:
A review of five years of ambient monitoring data from the Brampton Station indicated that background concentrations are well below the MOE Guideline on a 1 hour basis.



Statistic	% of MOE Guideline
Maximum	53%
90^{th} Percentile	26%
Average	14%

Conclusion:
A review of five years of ambient monitoring data from the Brampton Station indicated that background concentrations are well below the MOE Guideline on a 24 hour basis.

Table 8: Summary of Background CO

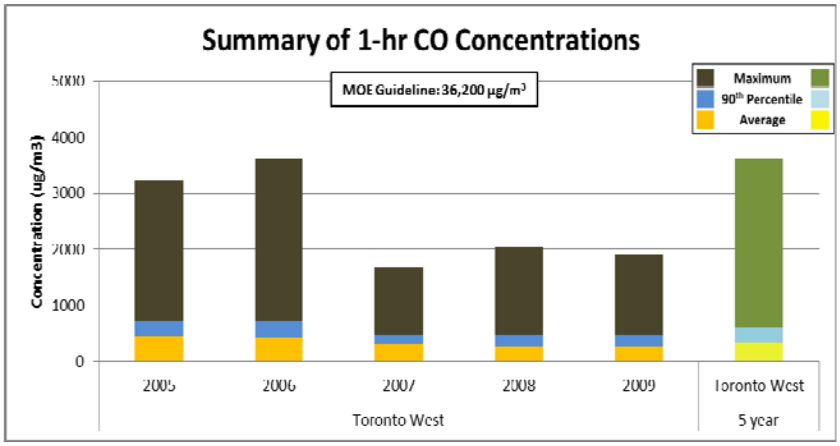
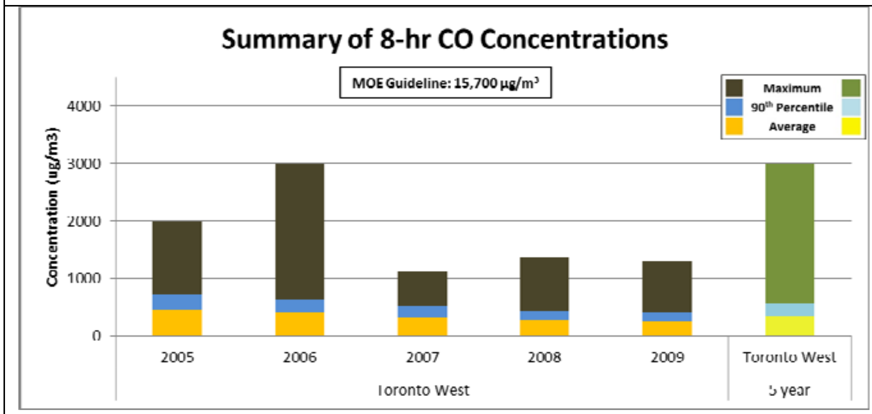
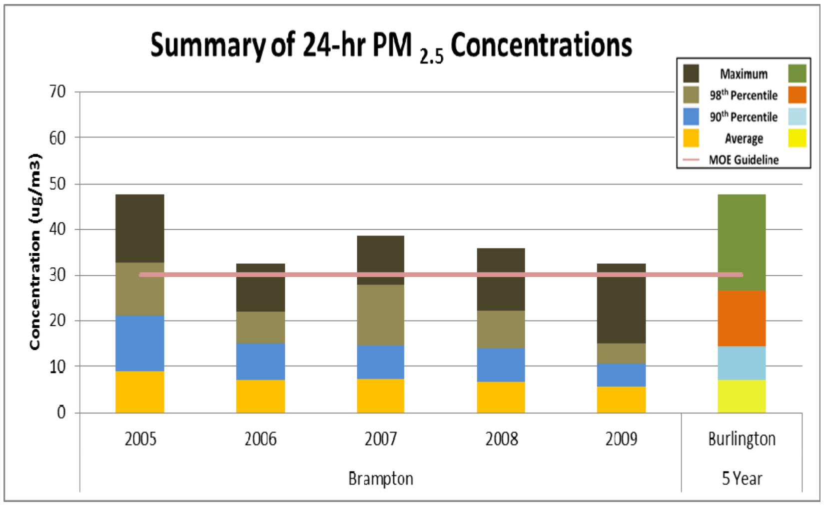
<table>
<tr><th>Statistical Analysis</th><th colspan="2">Five Year Summary</th></tr>
<tr><td rowspan="5">
</td><td>Statistic</td><td>% of MOE Guideline</td></tr>
<tr><td>Maximum</td><td>10%</td></tr>
<tr><td>90th Percentile</td><td>2%</td></tr>
<tr><td>Average</td><td>1%</td></tr>
<tr><td colspan="2">Conclusion:
A review of five years of ambient monitoring data from the Toronto West Station indicated that background concentrations are well below the MOE guideline on a 1 hour basis.</td></tr>
<tr><td rowspan="5">
</td><td>Statistic</td><td>% of MOE Guideline</td></tr>
<tr><td>Maximum</td><td>19%</td></tr>
<tr><td>90th Percentile</td><td>4%</td></tr>
<tr><td>Average</td><td>2%</td></tr>
<tr><td colspan="2">Conclusion:
A review of five years of ambient monitoring data from the Toronto West Station indicated that background concentrations are well below the MOE guideline on an 8 hour basis.</td></tr>
</table>

Table 9: Summary of Background $PM_{2.5}$

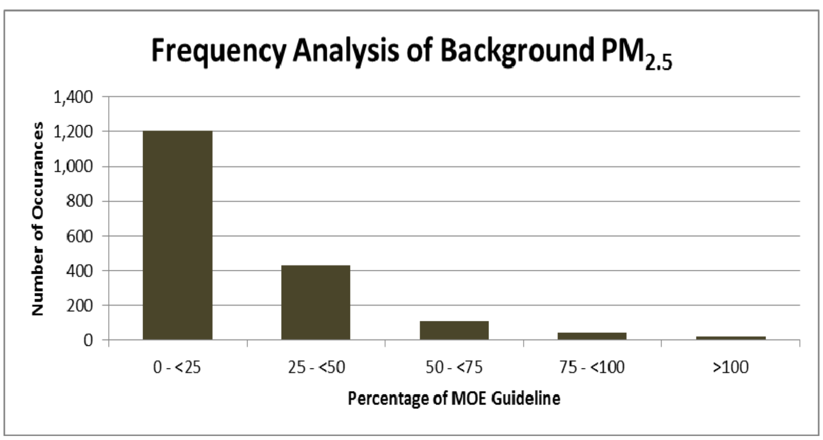
Statistical Analysis	Five Year Summary



Statistic	% of MOE Guideline
Maximum	159%
98th Percentile	89%
90th Percentile	49%
Average	24%

Conclusion:

A review of five years of ambient monitoring data from the Brampton Station indicated that the maximum background concentration exceeded the CWS on a 24 hour basis. However, the guideline for $PM_{2.5}$ is based on the 98^{th} percentile value averaged over three consecutive years. Therefore, the highest 3 year average of 27.61 µg/m^3 was below the guideline. However, frequency analysis was still conducted in order to show the number of days the background exceeded the guideline (see below).



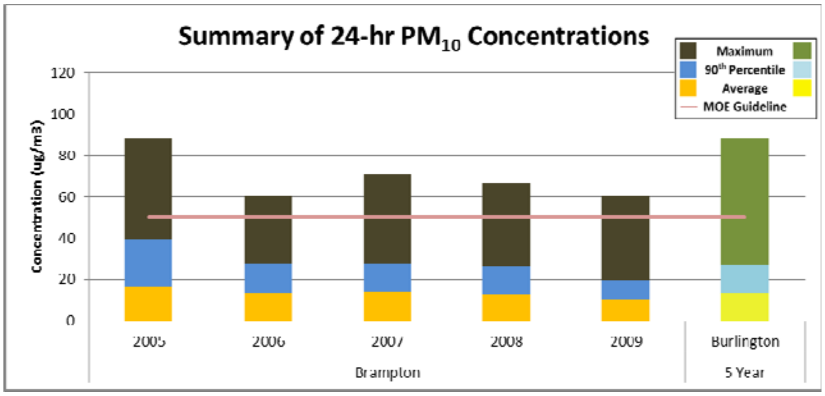
Number of Days Measured	Number of Days > MOE Guideline
1,813	21

Conclusion:

Frequency analysis determined that 24-hr concentrations exceeded the MOE guideline on an infrequent basis. Measured concentrations exceeded the guideline 21 days over the 5 year period, with 12 days occurring in 2005. This means that the background concentration exceeded the guideline 1% of the time over the 5 year period.

Table 10: Summary of Background PM_{10}

Statistical Analysis

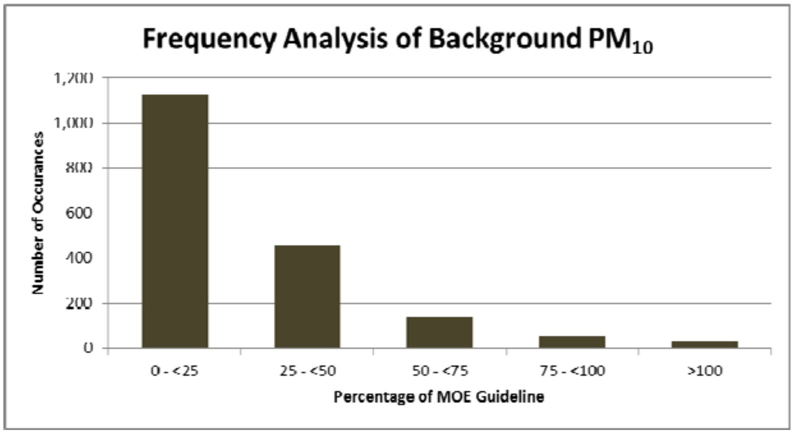


Note: PM_{10} is not monitored in Ontario; therefore, background concentrations were estimated by applying a $PM_{2.5}/PM_{10}$ ratio of 0.54. Lall et al. (2004)

Five Year Summary

Statistic	% of MOE Guideline
Maximum	176%
90th Percentile	54%
Average	27%

Conclusion:
A review of five years of PM_{10} data calculated from $PM_{2.5}$ ambient monitoring data from the Brampton Station indicated that the estimated maximum background concentration exceeded the MOE guideline on a 24 hour basis. Therefore, frequency analysis was conducted to determine the number of days the estimated background exceeded the MOE guideline (see below).

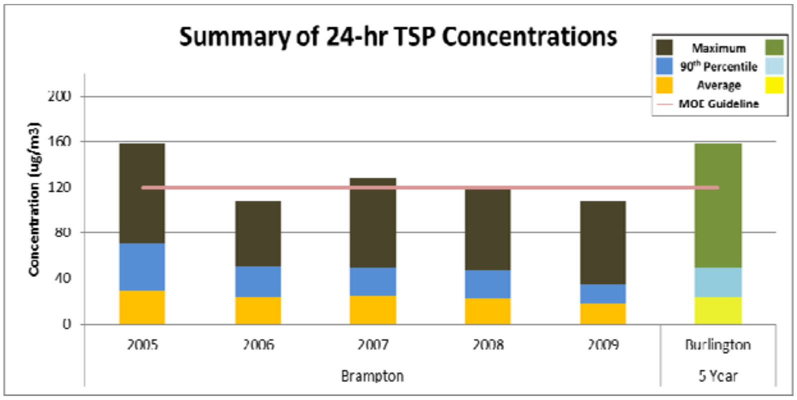


Number of Days Measured	Number of Days > MOE Guideline
1,813	33

Conclusion:
Frequency analysis determined that 24-hr concentrations exceeded the MOE guideline on an infrequent basis. Measured concentrations exceeded the MOE guideline 33 days over the 5 year period, with 18 days occurring in 2005. This means that the background concentration exceeded the MOE guideline 2% of the time over the 5 year period.

Table 11: Summary of Background TSP

Statistical Analysis



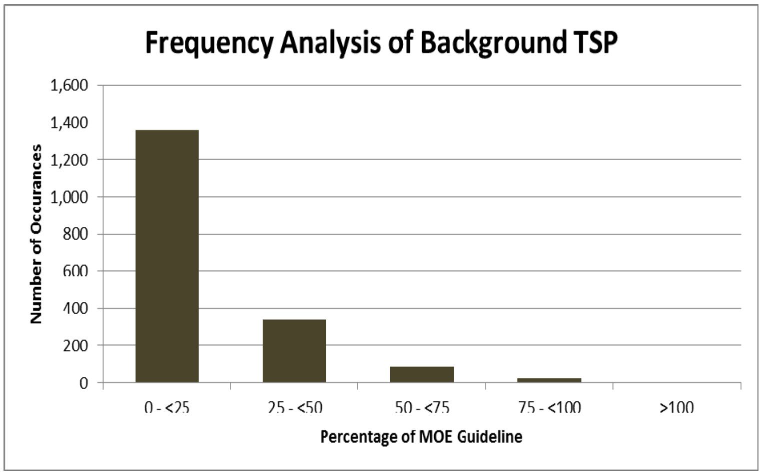
Note: TSP is not monitored in Ontario; therefore, background concentrations were estimated by applying a $PM_{2.5}$/TSP ratio of 0.3. Lall et al. (2004)

Five Year Summary

Statistic	% of MOE Guideline
Maximum	132%
90th Percentile	41%
Average	20%

Conclusion:

A review of five years of TSP data calculated from $PM_{2.5}$ ambient monitoring data from the Brampton Station indicated that the estimated maximum background concentration exceeded the MOE guideline on a 24 hour basis. Therefore, frequency analysis was conducted to determine the number of days the estimated background exceeded the guideline (see below).



Number of Days Measured	Number of Days >MOE Guideline
1,813	5

Conclusion:

Frequency analysis determined that 24-hr concentrations exceeded the MOE guideline on an infrequent basis. Measured concentrations exceeded the MOE guideline 5 days over the 5 year period, with 4 days occurring in 2005. This means that the background concentration exceeded the MOE guideline <1% of the time over the 5 year period.

Table 12: Summary of Background Acetaldehyde

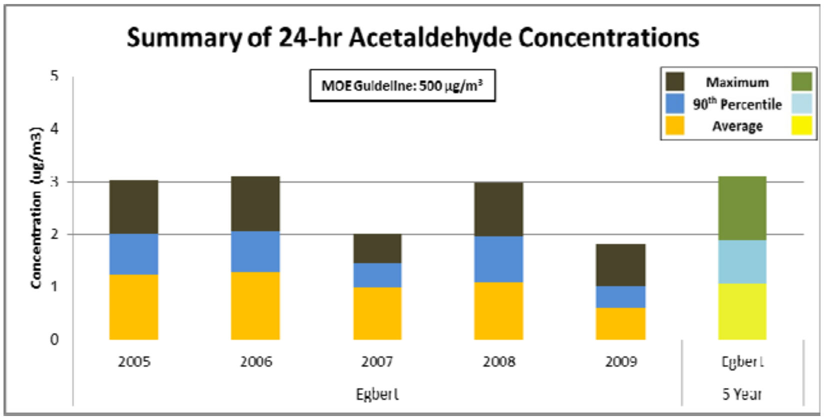
<table>
<tr><th>Statistical Analysis</th><th colspan="2">Five Year Summary</th></tr>
<tr><td rowspan="5">
</td><th>Statistic</th><th>% of MOE Guideline</th></tr>
<tr><td>Maximum</td><td><1%</td></tr>
<tr><td>90th Percentile</td><td><1%</td></tr>
<tr><td>Average</td><td><1%</td></tr>
<tr><td colspan="2">Conclusion:
A review of five years of ambient monitoring data from the Egbert Station indicated that the maximum background concentration was well below the MOE guideline.</td></tr>
</table>

Table 13: Summary of Background Acrolein

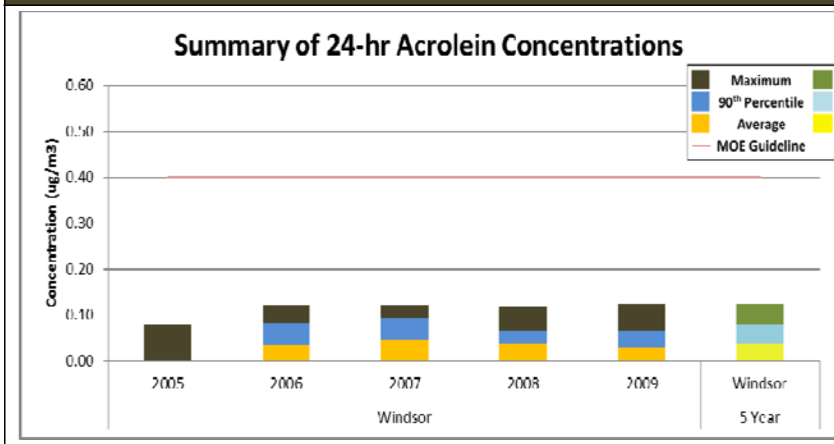
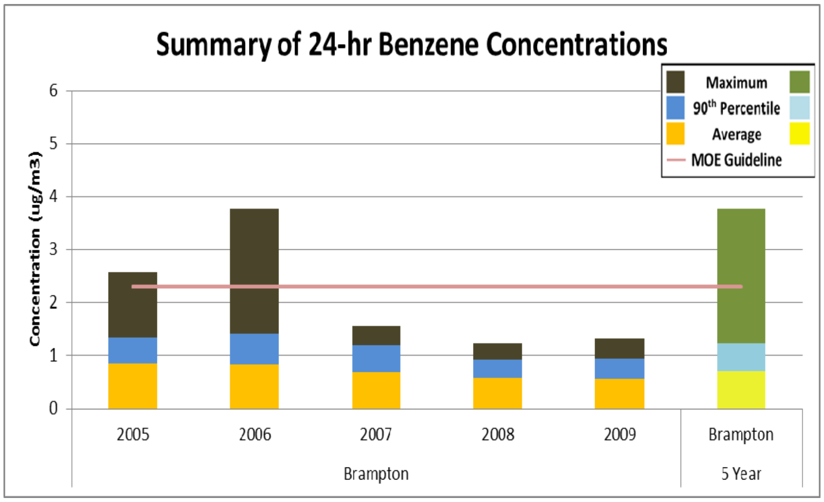
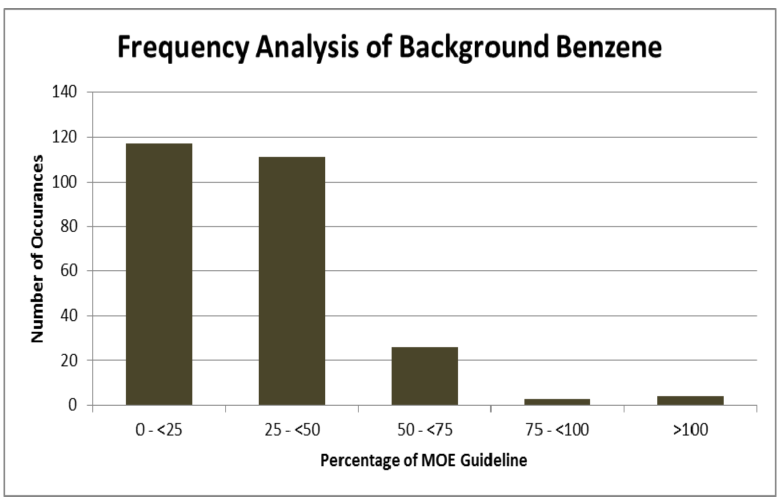
<table>
<tr><th>Statistical Analysis</th><th colspan="2">Five Year Summary</th></tr>
<tr><td rowspan="5">
</td><th>Statistic</th><th>% of MOE Guideline</th></tr>
<tr><td>Maximum</td><td>31%</td></tr>
<tr><td>90th Percentile</td><td>20%</td></tr>
<tr><td>Average</td><td>10%</td></tr>
<tr><td colspan="2">Conclusion:
A review of five years of ambient monitoring data from the Windsor Station indicated that the maximum background concentration was well below the MOE guideline.</td></tr>
</table>

Table 14: **Summary of Background Benzene**

Statistical Analysis





Five Year Summary

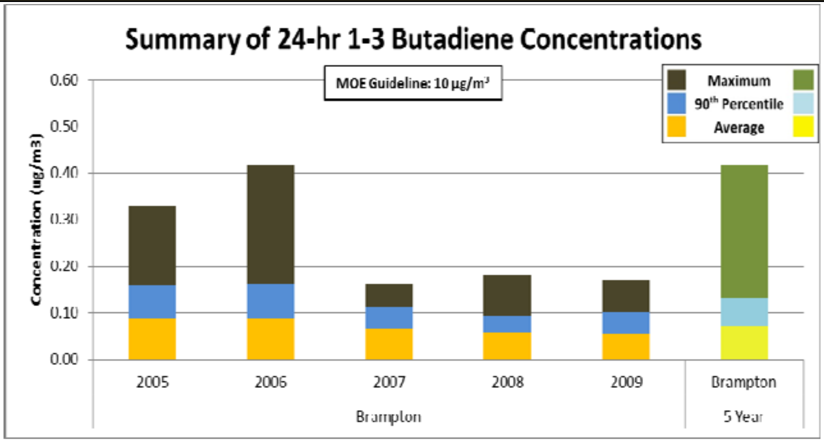
Statistic	% of MOE Guideline
Maximum	164%
90^{th} Percentile	53%
Average	31%

Conclusion:
A review of five years of ambient monitoring data from the Brampton Station indicated that the maximum background concentration exceeded the MOE guideline. Therefore, frequency analysis was conducted to determine the number of days the background exceeded the guideline (see below).

Number of Days Measured	Number of Days >MOE Guideline
261	4

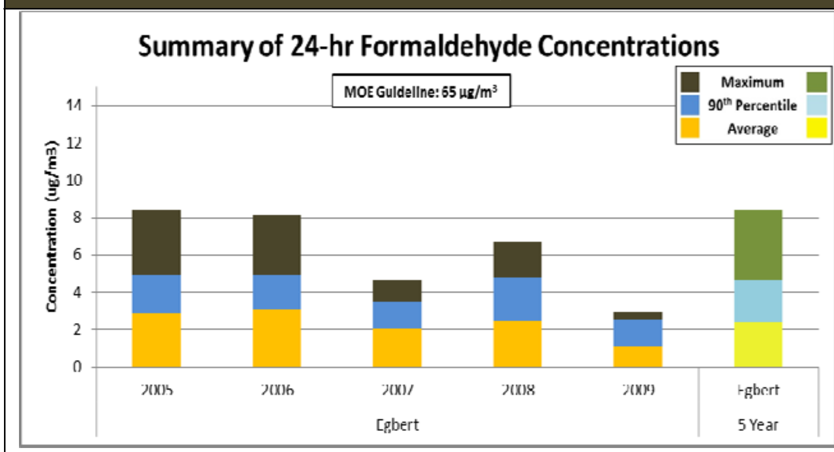
Conclusion:
Frequency analysis determined that concentrations exceeded the MOE guideline on an infrequent basis. Measured concentrations exceeded the guideline 4 days over the 5 year period, with 3 days occurring in 2005. This means that the background concentration exceeded the MOE guideline 2% of the time over the 5 year period.

Table 15: Summary of Background 1,3-Butadiene

Statistical Analysis	Five Year Summary	
	**Statistic**	**% of MOE Guideline**
	Maximum	4%
	90th Percentile	1%
	Average	<1%

Conclusion:
A review of five years of ambient monitoring data from the Brampton Station indicated that the maximum background concentration was well below the MOE guideline.

Table 16: Summary of Background Formaldehyde

Statistical Analysis	Five Year Summary	
	**Statistic**	**% of MOE Guideline**
	Maximum	13%
	90th Percentile	7%
	Average	4%

Conclusion:
A review of five years of ambient monitoring data from the Egbert Station indicated that the maximum background concentration was well below the MOE guideline.

2.3.4 Summary of Background Conditions

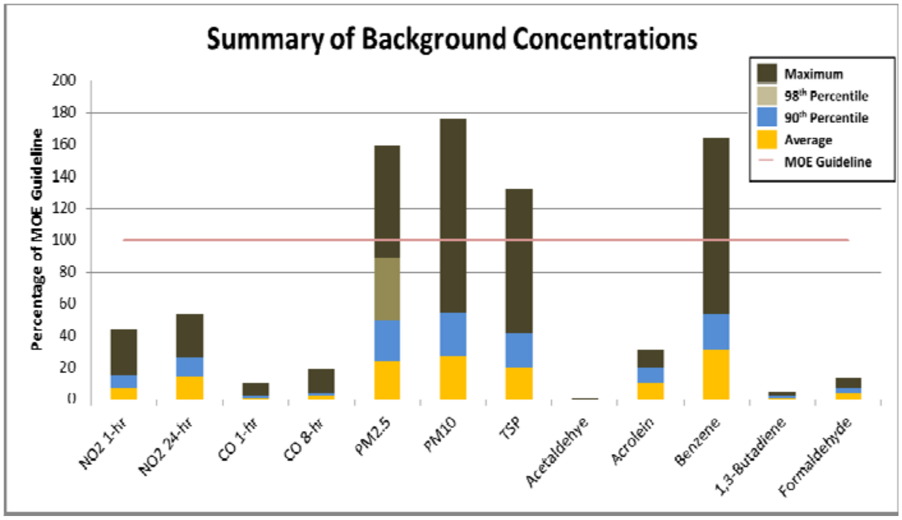
Based on a review of a Year 2005 to 2009 ambient monitoring dataset, all contaminants were below their respective MOE criteria with the exception of PM_{10}, TSP, and benzene. Benzene concentrations were based on actual measurements while PM_{10} and TSP concentrations were calculated based on their relationship to $PM_{2.5}$. It should be noted that even though the maximum concentration of $PM_{2.5}$ exceeded the CWS, the guideline for $PM_{2.5}$ is based on an average annual 98th percentile concentration, averaged over 3 consecutive years. Therefore, it was determined that the maximum rolling 98th percentile average was 27.61 µg/m^3, which is less than the guideline.

From a review of the VOC dataset, it was determined that due to the lack of hourly and daily background monitoring data, 90th percentile background concentrations for each VOC in the 5 year dataset would be calculated and used to determine the combined concentration. However, the summary of ambient monitoring data presented in this section provides the statistics for all available data. This method was suggested by the MOE.

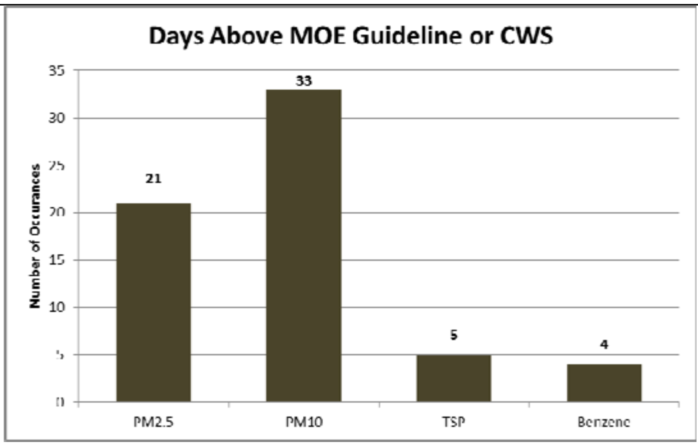
A summary of the background concentrations as a percentage of their respective MOE guidelines or CWS is presented in the following figure. Also presented is the number of days that the monitoring data was above the MOE guideline or CWS.

Table 17: **Statistical Summary of Background Concentrations**

5 Year Statistical Summary



% of Guideline	
Background:	
NO_2 (1-hr)	44%
NO_2 (24-hr)	53%
CO (1-hr)	10%
CO (8-hr)	19%
$PM_{2.5}$ *	92%
PM_{10}	176%
TSP	132%
Acetaldehyde	<1%
Acrolein	31%
Benzene	164%
1,3-Butadiene	4%
Formaldehyde	13%



Days above Guideline:	
$PM_{2.5}$	21
PM_{10}	33
TSP	5
Benzene	4

* Based on the CWS Guideline

2.4 Location of Sensitive Receptors Within The Study Area

Land uses which are defined as sensitive receptors for evaluating potential air quality effects are:

- Health care facilities;
- Senior citizens' residences or long-term care facilities;
- Child care facilities;
- Educational facilities;
- Places of worship; and
- Residential dwellings.

Forty-four sensitive receptors were selected to represent worst-case impacts surrounding the project area. The sensitive receptors are summarized in **Table 18** and their locations on mapping are identified in **Figure 6** through **Figure 9**. In addition to sensitive receptors locations, the mapping also shows the existing scenario (i.e., aerial photograph) and the future build scenario in pink and yellow. Detailed figures showing each sensitive receptor's precise location in relation to the roadway are presented in **Appendix A**. Distances in **Table 18** are measured from the Mayfield Road edge of pavement to the closest façade of the sensitive receptor.

Table 18: Representative Worst-Case Sensitive Receptors

Receptor Number	Land-Use	Distance From Roadway (m)
R1	Educational Facility	160
R2	Residential	130
R3	Residential	60
R4	Residential	55
R5	Residential	13
R6	Residential	23
R7	Residential	30
R8	Residential	30
R9	Residential	30
R10	Residential	20
R11	Residential	25
R12	Educational Facility	150
R13	Residential	15
R14	Residential	25
R15	Residential	10
R16	Residential	20
R17	Residential	65
R18	Residential	70

Receptor Number	Land-Use	Distance From Roadway (m)
R19	Residential	105
R20	Residential	15
R21	Residential	20
R22	Residential	30
R23	Educational Facility	150
R24	Residential	30
R25	Residential	20
R26	Residential	90
R27	Residential	10
R28	Residential	10
R29	Residential	10
R30	Residential	10
R31	Residential	50
R32	Residential	15
R33	Residential	85
R34	Educational Facility	150
R35	Residential	280
R36	Residential	150
R37	Residential	20
R38	Residential	15
R39	Residential	20
R40	Residential	20
R41	Residential	35
R42	Educational Facility	90
R43	Place of Worship	170
R44	Educational Facility	20

Representative worst-case impacts will be predicted by the dispersion model at the sensitive receptors closest to the roadway. This is due to the fact that contaminant concentrations disperse significantly with downwind distance from the motor vehicles resulting in reduced contaminant concentrations. At approximately 500 m from the roadway, contaminant concentrations from the motor vehicles generally become indistinguishable from background levels. The maximum predicted contaminant concentrations at the closest sensitive receptors will usually occur during weather events which produce calm to light winds (< 3 m/s). During weather events with higher wind speeds, the contaminant concentrations disperse much more quickly.

Figure 6: Sensitive Receptors R3, R35 and R37 to R41

Figure 7 : Sensitive Receptors R2, R4 to R11, R13 to R17, R19, R36 and R42 to R44

Figure 8: Sensitive Receptors R1, R12, R18, R20 to R28 and R34

Figure 9: Sensitive Receptors R29 to R33

2.5 Road Traffic Data

The following summarizes the road traffic data used in this assessment:

- AADT's were calculated from Year 2031 future build AM and PM peak hour turning counts using the equation *AADT = [AM Peak + PM Peak]*5.76, that* was provided by Genivar. The calculated AADT's used in this assessment are provided in **Table 19** and **Table 20** below.
- Default weekend and weekday hourly traffic distributions were taken from the US EPA report *"MOVES2010 Highway Vehicle – Population and Activity Data"* and are shown in **Table 21** below**.**
- The roadway was assumed to have an "Urban" hourly distribution profile.
- A 10% heavy-duty vehicle percentage was provided by Genivar.
- Light cycle timing, provided by Genivar, is shown in **Table 22** below.

Table 19: Mayfield Road Traffic Data

Section	2031 AADT's		Posted Speed Limit (km/hr)
	Eastbound	Westbound	
West of Chinguacousy Rd.	14,700	13,000	80
Chinguacousy Rd. to New Collector Road 1	16,800	16,000	80
New Collector Road 1 to New Collector Road 2	17,800	16,700	80
New Collector Road 2 to McLaughlin Rd.	18,300	17,000	80[1]
McLaughlin Rd. to Van Kirk Dr.	19,500	20,300	70
Van Kirk Dr. to Robertson Davies Dr.	21,100	21,400	70
Robertson Davies Dr. to Hurontario St. (Highway 10)	23,100	21,700	70[2]
Hurontario St. (Highway 10) to Colonel Bertram Ave.	21,600	22,300	60
Colonel Bertram Ave. to Summer Valley Dr.	22,600	23,600	60
Summer Valley Dr. to Snellview Blvd.	22,300	22,800	60
Snellville Blvd. to Kennedy Rd.	22,900	23,300	60
Kennedy Rd. to Stonegate Dr.	21,600	21,400	60
Stonegate Dr. to Heart Lake Rd.	22,100	22,100	60

Notes: 1 – Speed limit changes from 80 km/hr to 70 km/hr 100 m west of McLaughlin Rd.
2 – Speed limit chances from 70 km/hr to 60 km/hr 305m west of Hurontario St.

Table 20: Intersecting Street Traffic Data

Section	2031 AADT's		Posted Speed Limit (km/hr)
	Northbound	Southbound	
Chinguacousy Rd. North of Mayfield Rd.	1,000	1,500	70
Chinguacousy Rd. South of Mayfield Rd.	3,000	5,000	70
New Collector Road 1 North of Mayfield Rd.	1,500	1,700	50
New Collector Road 1 South of Mayfield Rd.	1,500	1,400	50
New Collector Road 2 South of Mayfield Rd.	1,400	1,300	50
McLaughlin Rd. North of Mayfield Rd.	2,400	2,400	80
McLaughlin Rd. South of Mayfield Rd.	5,200	7,300	80
Van Kirk Dr. South of Mayfield Rd.	1,800	1,400	50
Robertson Davies Dr. North of Mayfield Rd.	3,400	3,800	50
Robertson Davies Dr. South of Mayfield Rd.	1,500	1,200	50
Hurontario St. (Highway 10) North of Mayfield Rd.	14,400	14,700	70
Hurontario St. (Highway 10) South of Mayfield Rd.	13,500	16,200	70
Colonel Bertram Ave. North of Mayfield Rd.	600	800	50
Colonel Bertram Ave. South of Mayfield Rd.	1,200	1,400	50
Summer Valley Dr. North of Mayfield Rd.	1,400	1,800	40
Snellville Blvd. North of Mayfield Rd.	700	800	50
Snellville Blvd. South of Mayfield Rd.	200	300	50
Kennedy Rd. North of Mayfield Rd.	8,800	10,100	60
Kennedy Rd. South of Mayfield Rd.	8,700	9,500	60
Stonegate Dr. South of Mayfield Rd.	900	1,100	50
Heart Lake Rd. North of Mayfield Rd.	11,200	12,400	80
Heart Lake Rd. South of Mayfield Rd.	7,400	7,200	70

Table 21: Hourly Traffic Distributions

Hour	Weekday	Weekend
1	0.9%	2.2%
2	0.6%	1.4%
3	0.5%	1%
4	0.4%	0.8%
5	0.6%	0.7%
6	1.9%	1%
7	4.6%	1.9%
8	6.9%	2.6%
9	6.1%	3.8%
10	5%	4.8%
11	5.1%	5.9%
12	5.4%	6.5%
13	5.8%	7.1%
14	5.9%	7.1%
15	6.2%	7.1%
16	7.1%	7.2%
17	7.7%	7.1%
18	7.9%	6.8%
19	6%	6%
20	4.4%	5.2%
21	3.5%	4.3%
22	3.1%	3.9%
23	2.5%	3.2%
24	1.9%	2.4%

Table 22: Light Cycle Times

Location	Cycle Length (s)	Red Light Time (s)	Clearance Lost Time (s)
Eastbound on Mayfield Rd. West Chinguacousy Rd.	75	43	2
Northbound on Chinguacousy Rd. South of Mayfield Rd.	86	60	2
Southbound on Chinguacousy Rd. North of Mayfield Rd.	86	60	2
Westbound on Mayfield Rd. East of Chinguacousy Rd.	86	61	2
Northbound on New Collector Road 1 South of Mayfield Rd.	84	56	2
Southbound on New Collector Road 1 North of Mayfield Rd.	84	56	2
Northbound on New Collector Road 2 South of Mayfield Rd.	84	56	2
Eastbound on Mayfield Rd. West of McLaughlin Rd.	82	48	2
Northbound on McLaughlin Rd. South of Mayfield Rd.	82	53	2
Westbound on Mayfield Rd. East of McLaughlin Rd.	82	25	2
Southbound on McLaughlin Rd. North of Mayfield Rd.	82	53	2
Eastbound on Mayfield Rd. West of Van Kirk Dr.	62	26	2
Northbound on Van Kirk Dr. South of Mayfield Rd.	62	33	2
Westbound on Mayfield Rd. East of Van Kirk Dr.	62	26	2
Eastbound on Mayfield Rd. West of Robertson Davies Dr.	83	32	2
Northbound on Robertson Davie Dr. South of Mayfield Rd.	82	46	2
Westbound on Mayfield Rd. East of Robertson Davies Dr.	83	32	2
Southbound on Robertson Davies Dr. North of Mayfield Rd.	82	46	2
Eastbound on Mayfield Rd. West of Hurontario St.	140	96	3
Northbound on Hurontario St. South of Mayfield Rd.	143	96	3
Westbound on Mayfield Rd. East of Hurontario St.	140	95	3
Southbound on Hurontario St. North of Mayfield Rd.	140	98	3
Eastbound on Mayfield Rd. West of Colonel Bertram Rd.	85	36	3
Northbound on Colonel Bertram Rd. South of Mayfield Rd.	85	54	3
Westbound on Mayfield Rd. East of Colonel Bertram Rd.	85	22	3
Southbound on Colonel Bertram Rd. North of Mayfield Rd.	85	54	3
Eastbound on Mayfield Rd. West of Summer Valley Dr.	108	25	3
Southbound on Summer Valley Rd North of Mayfield Rd.	108	76	3
Westbound on Mayfield Rd. East of Summer Valley Dr.	108	40	3
Northbound on Snellview Blvd. South of Mayfield Rd.	139	65	2
Eastbound on Mayfield Rd. West of Kennedy Rd.	138	82	2

Location	Cycle Length (s)	Red Light Time (s)	Clearance Lost Time (s)
Northbound on Kennedy Rd. South of Mayfield Rd.	138	110	2
Westbound on Mayfield Rd. East of Kennedy Rd.	138	73	2
Southbound on Kennedy Rd. North of Mayfield Rd.	138	106	2
Eastbound on Mayfield Rd. West of Heart Lake Rd.	140	70	2
Northbound on Heart Lake Rd. South of Mayfield Rd.	140	120	3
Southbound on Heart Lake Rd. North of Mayfield Rd.	140	75	2

2.6 Assessment Approach

2.6.1 General Approach

The general assessment approach was as follows:

1) Concentrations from Mayfield Road at the representative receptors were predicted using modelling software on an hourly basis for a five-year period, using 2005-2009 meteorological data from Toronto Pearson International Airport.
2) Background concentrations for all available contaminants were determined from MOE and NAPS datasets for the most representative locations.
3) Combined concentrations were determined by adding modelled and background (i.e., ambient data) together on an hourly basis. For ambient data which was not available in hourly form (VOC's), predicted roadway concentrations were added to the 90th percentile of the aggregated data described above.
4) Maximum 1-hour, 8-hour and 24-hour predicted combined concentrations were determined for comparison with the applicable guidelines.

Computer simulations to determine project impacts were conducted using emission and dispersion models published by the U.S. Environmental Protection Agency (U.S. EPA).

2.6.2 Meteorological Data

2005-2009 hourly meteorological data was obtained from Toronto Pearson International Airport and upper air data was obtained from the Buffalo Niagara International Airport. The combined data was processed to reflect conditions at the study area using Lakes Environmental's PCRAMMET software program which prepares meteorological data for use with the CAL3QHCR model. A wind frequency diagram (wind rose) is shown in **Figure 10**. As can be seen in this figure, predominant winds are from the southwesterly through northerly directions.

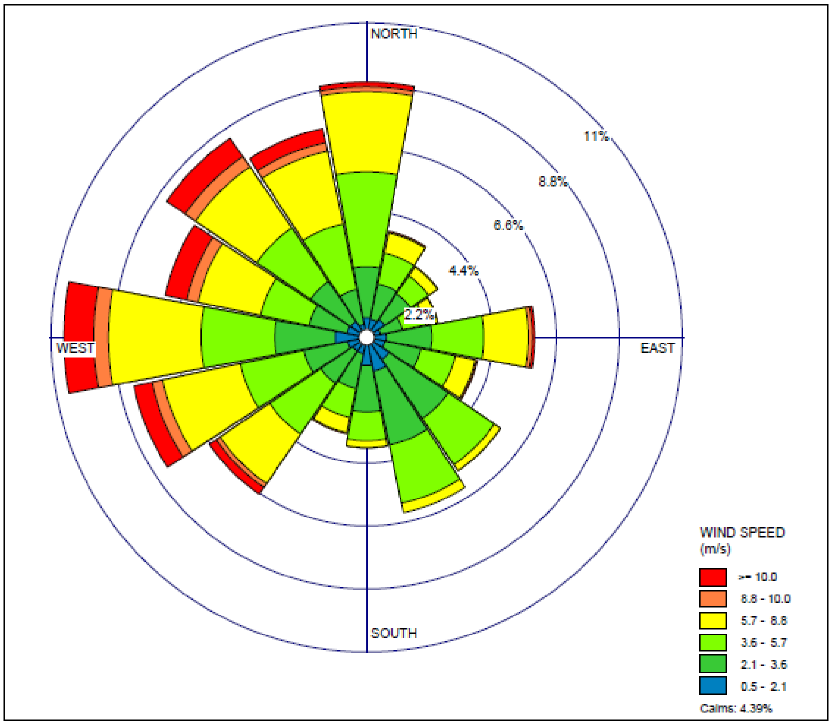


Figure 10: Wind Frequency Diagram for Toronto Pearson International Airport

2.6.3 Motor Vehicle Emission Rates

MOVES is a computer program that provides estimates of current and future emission rates from motor vehicles based on a variety of factors such as local meteorology and vehicle fleet composition. MOVES 2010a, released in August 2010, is the U.S. EPA's latest tool for estimating vehicle emissions due to the combustion of fuel, brake and tire wear, fuel evaporation, permeation and refuelling leaks. The model is based on "an analysis of millions of emission test results and considerable advances in the Agency's understanding of vehicle emissions and… accounts for changes in emissions due to proposed standards and regulations". For this project, MOVES was used to estimate vehicle emissions based on vehicle type, road type, model year, and vehicle speed.

Table 23 specifies the major inputs into MOVES and **Table 24** provides the outputted emission factors used in the dispersion model.

Table 23: MOVES Input Parameters

Parameter	Input
Scale	Custom County Domain
Meteorology	Temperature and Relative Humidity were obtained from meteorological data from Toronto Pearson International Airport for the years 2005 to 2009.
Years	2031 (Future Build)
Geographical Bounds	Custom County Domain
Fuels	Compressed Natural Gas / Diesel Fuels / Gasoline Fuels Note that MOVES assumes a default distribution for each fuel type within the vehicle class.
Source Use Types	Combination Long-haul Truck / Combination Short-haul Truck / Intercity Bus / Light Commercial Truck / Motor Home / Motorcycle / Passenger Car / Passenger Truck / Refuse Truck / School Bus / Single Unit Long-haul Truck / Single Unit Short-haul Truck / Transit Bus
Road Type	Urban Unrestricted Access
Pollutants and Processes	NO_2 / CO / $PM_{2.5}$ / PM_{10} / Acetaldehyde / Acrolein / Benzene / 1,3-Butadiene / Formaldehyde. TSP can't be directly modelled by MOVES. However, the U.S. EPA has determined, based on emissions test results, that >97% of tailpipe particulate matter is PM_{10} or less. Therefore, the PM_{10} exhaust emission rate was used for TSP.
Vehicle Age Distribution	MOVES defaults based on years selected.

Upon processing of the MOVES outputs, the highest monthly value was selected, which represents a worst-case emission rate. The emission rates used in the assessment are shown in **Table 24**.

Table 24: MOVES Output Emission Factors for 2031 (g/VMT)

Contaminant	Speed (km/hr)					
	Idle	40	50	60	70	80
NO_2	0.430	0.058	0.055	0.051	0.051	0.050
CO	13.50	3.88	3.74	3.36	3.09	3.00
$PM_{2.5}$ Total	0.192	0.031	0.027	0.023	0.020	0.018
PM_{10} Total	0.207	0.066	0.055	0.045	0.034	0.029
TSP[1]	0.207	0.066	0.055	0.045	0.034	0.029
Acetaldehyde	0.0080	0.0011	0.0010	0.0008	0.0007	0.0006
Acrolein	4.99×10^{-7}	6.30×10^{-8}	5.59×10^{-8}	4.57×10^{-8}	3.55×10^{-8}	3.10×10^{-8}
Benzene	0.0143	0.0023	0.0021	0.0017	0.0014	0.0012
1,3-Butadiene	2.42×10^{-5}	3.46×10^{-6}	3.11×10^{-6}	2.60×10^{-6}	2.09×10^{-6}	1.88×10^{-6}
Formaldehyde	0.0093	0.0011	0.0009	0.0008	0.0006	0.0006

1 – Note that TSP can't be directly modelled by MOVES. However, the U.S. EPA has determined, based on emissions test results, that >97% of tailpipe particulate matter is PM_{10} or less. Therefore, the PM_{10} exhaust emission rate was used for TSP.

2.6.4 Re-suspended Particulate Matter Emission Rates

A large portion of roadway particulate matter emissions comes from dust on the pavement which is re-suspended by vehicles travelling on the roadway. These emissions are estimated using empirically derived values presented by the U.S. EPA in their AP-42 report. The emissions factors for re-suspended $PM_{2.5}$ were estimated by using the following equation from U.S. EPA's Document AP-42 report, Chapter 13.2.1.3 and are summarized in **Table 25**:

$$E = k(sL)^{0.91} * (W)^{1.02}$$

Where: E = the particulate emission factor

K = the particulate size multiplier

sL = silt loading

W = average vehicle weight (Assumed 3 Tons based on Toyota fleet data and US EPA vehicle weight and distribution)

Table 25: Re-suspended Particulate Matter Emission Factors

Roadway AADT	K ($PM_{2.5}$/PM_{10}/TSP)	sL (g/m^2)	W (Tons)	E (g/VMT)		
				$PM_{2.5}$	PM_{10}	TSP
<500	0.25/1.0/5.24	0.6	3	0.503	2.015	10.561
500-5,000	0.25/1.0/5.24	0.2	3	0.185	0.741	3.886
5,000-10,000	0.25/1.0/5.24	0.06	3	0.061	0.247	1.299
>10,000	0.25/1.0/5.24	0.03	3	0.033	0.132	0.691

2.6.5 Air Dispersion Modelling Using CAL3QHCR

The U.S. EPA's CAL3QHCR dispersion model, based on the Gaussian plume equation, was specifically designed to predict air quality impacts from roadways using site specific meteorological data, vehicle emissions, traffic data, and signal data. The model input requirements include roadway geometry, sensitive receptor locations, meteorology, traffic volumes and motor vehicle emission rates as well as some contaminant physical properties such as settling and deposition velocities. CAL3QHCR uses this information to calculate hourly concentrations which are then used to determine 1-hour, 8-hour and 24-hour averages for the contaminants of interest at the identified sensitive receptor locations. **Table 26** provides the major inputs used in CAL3QHCR. The emission rates used in the model were the outputs from the MOVES and AP-42 models, weighted for the 10 % heavy-duty fleet percentage provided. The outputs of CAL3QHCR are presented in the results section.

Table 26: CAL3QHCR Model Input Parameters

Parameter	Input
Free-Flow Link Traffic Data	Hourly traffic distributions were applied to the AADT traffic volumes in order to input traffic volumes in vehicles/hour. Emission rates from the MOVES output were inputted in grams/VMT.
Queue Link Traffic Data	Average signal cycle length: See **Table 22** Average red time length: See **Table 22** Clearance lost time: See **Table 22** Approach traffic volume: hourly AADT values, as described above Idle emission factor: output from MOVES, in grams/hour Saturation flow rate: 1600 vehicles/hour (default value) Signal type: Actuated/Semi-Actuated Arrival type: Average Progressing
Meteorological Data	2005-2009 data from Toronto Pearson International Airport
Deposition Velocity	$PM_{2.5}$: 0.01 cm/s PM_{10}: 0.5 cm/s TSP: 0.15 cm/s NO_2: 0.1 cm/s CO: 0.03 cm/s VOC's: 0 cm/s3
Settling Velocity	$PM_{2.5}$: 0.02 cm/s PM_{10}: 0.3 cm/s TSP: 1.8 cm/s CO, NO_2, and VOC's: 0 cm/s
Surface Roughness	The average land type surrounding the project site is categorized as 'Low Intensity Residential'. The average surface roughness for all seasons of 52 cm was applied in the model.
Vehicle Emission Rate	Emission rates calculated in MOVES and AP-42 were inputted in g/VMT

3.0 Detailed Modelling Results

Presented below are the modelling results for the future build scenario, based on 5 years of meteorological data**.** For each CAC and VOC contaminant, combined concentrations are presented along with the relevant contribution due to the background and roadway. Results in this section are presented for the worst-case sensitive receptor (see **Table 27**), which was identified as the maximum combined concentration for the future build scenario. Results for all modelled receptors are provided in **Appendix A.** It should be noted that the maximum combined concentration at any sensitive receptor often occurs infrequently and actually may only occur for one hour or day over the 5 year period.

Table 27: Worst-Case Sensitive Receptor for Future Build Scenario

Contaminant	Averaging Period	Sensitive Receptor
NO_2	1-hour	R14
	24-hour	R14
CO	1-hour	100% Background
	8-hour	R43
$PM_{2.5}$	24-hour	R20
PM_{10}	24-hour	R20
TSP	24-hour	R20
Acetaldehyde	24-hour	R14
Acrolein	24-hour	R14
Benzene	24-hour	R14
1,3-Butadiene	24-hour	R14
Formaldehyde	24-hour	R14

3.1 Criteria Air Contaminants

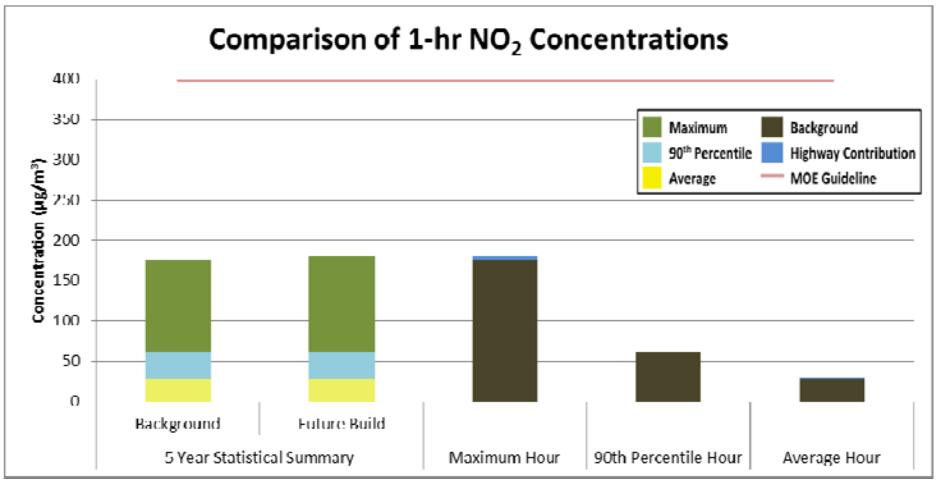
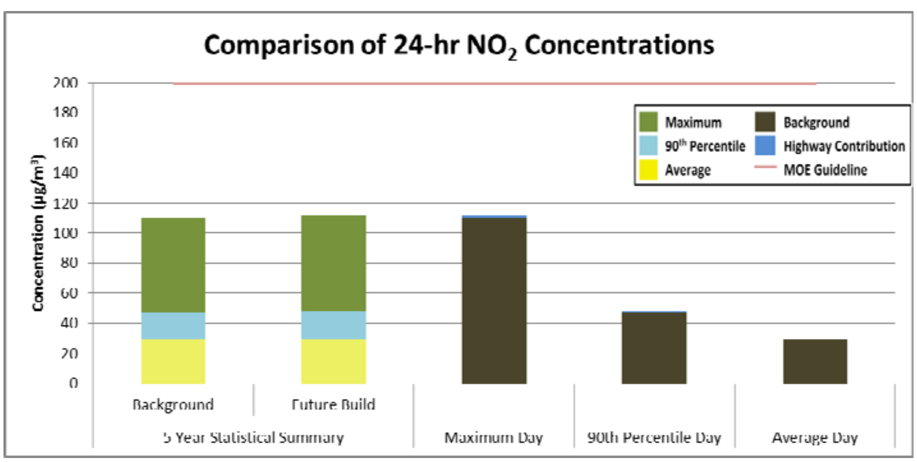
Coincidental hourly modelled roadway and background CAC concentrations were added to derive the combined concentration for each hour over a 5 year period. Statistical analysis in the form of maximum, 90th percentile, and average combined concentrations were calculated for the worst-case sensitive receptor for each contaminant and are presented below. The maximum combined concentration was then used to assess compliance with MOE guidelines or CWS. If excesses of the guideline were predicted, frequency analysis was undertaken in order to estimate the number of occurrences above the guideline. Provided below are the modelling results for the CACs: CO, NO_2, $PM_{2.5}$, PM_{10} and TSP.

3.1.1 Nitrogen Dioxide

Table 28 presents the combined concentrations for 1-hour and 24-hour NO_2 based on 5 years of meteorological data. Results shown are at the worst-case sensitive receptor for the future build scenario. The results conclude that:

- *Both the maximum 1-hour and 24-hour NO_2 combined concentrations for the future build scenario were well below their respective MOE guidelines.*

Table 28: Summary of Future Build NO_2

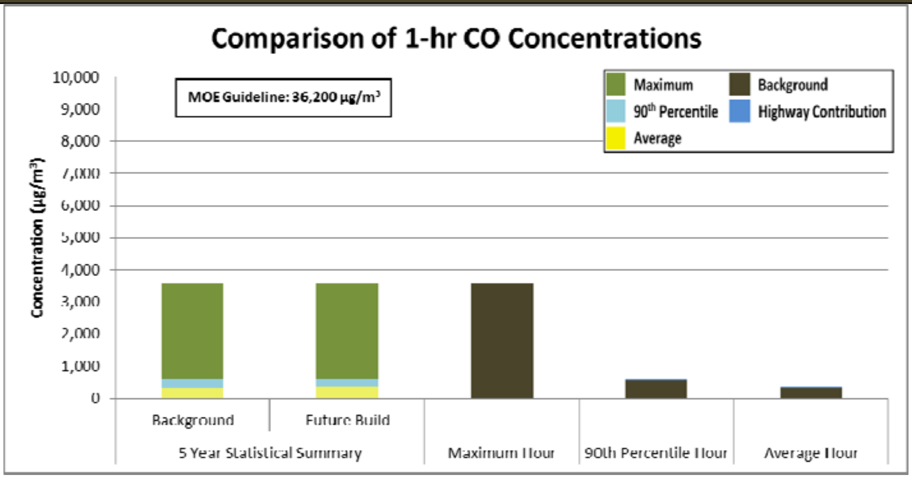
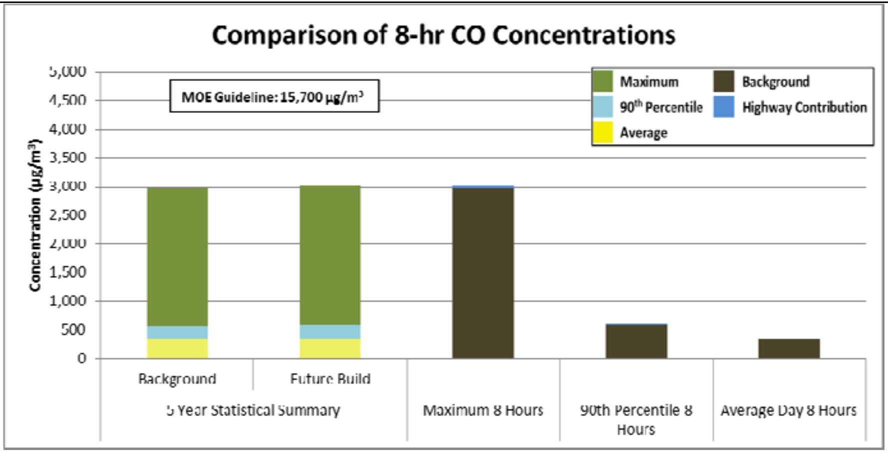
<table>
<tr><th>Statistical Analysis</th><th colspan="2">5 Year Summary of Future Build</th></tr>
<tr><td rowspan="8">
</td><td colspan="2">% of MOE Guideline:</td></tr>
<tr><td>Maximum</td><td>45%</td></tr>
<tr><td>90th Percentile</td><td>16%</td></tr>
<tr><td>Average</td><td>7%</td></tr>
<tr><td colspan="2">Roadway Contribution:</td></tr>
<tr><td>Maximum</td><td>2%</td></tr>
<tr><td>90th Percentile</td><td>2%</td></tr>
<tr><td>Average</td><td>2%</td></tr>
<tr><td rowspan="8">
</td><td colspan="2">% of MOE Guideline:</td></tr>
<tr><td>Maximum</td><td>56%</td></tr>
<tr><td>90th Percentile</td><td>24%</td></tr>
<tr><td>Average</td><td>15%</td></tr>
<tr><td colspan="2">Roadway Contribution:</td></tr>
<tr><td>Maximum</td><td>1%</td></tr>
<tr><td>90th Percentile</td><td>2%</td></tr>
<tr><td>Average</td><td>2%</td></tr>
<tr><td colspan="3">Conclusions:
• All combined concentrations were below their respective MOE guidelines.
• The contribution from the roadway to the combined concentrations was 2% or less.</td></tr>
</table>

3.1.2 Carbon Monoxide

Table 29 presents the combined concentrations for 1-hour and 8-hour CO based on 5 years of meteorological data. Results shown are at the worst-case sensitive receptor for the future build scenario. The results conclude that:

- *Both the maximum 1-hour and 8-hour CO combined concentrations for the future build scenario were well below their respective MOE guidelines.*

Table 29: Summary of Future Build CO

Statistical Analysis	5 Year Summary of Future Build	
	**% of MOE Guideline:**	
	Maximum	10%
	90th Percentile	2%
	Average	1%
	Roadway Contribution:	
	Maximum	0%
	90th Percentile	1%
	Average	2%
	**% of MOE Guideline:**	
	Maximum	19%
	90th Percentile	4%
	Average	2%
	Roadway Contribution:	
	Maximum	<1%
	90th Percentile	<1%
	Average	5%
Conclusions: • All combined concentrations were below their respective MOE guidelines. • The contribution from the roadway to the combined concentrations was 5% or less.		

3.1.3 Fine Particulate Matter ($PM_{2.5}$)

Table 30 presents the future build combined concentrations alongside the background concentrations for 24-hour $PM_{2.5}$ based on 5 years of meteorological data. The results conclude that:

- *The average annual 98th percentile 24-hour $PM_{2.5}$ combined concentration, averaged over three consecutive years for the future build scenario was below the CWS.*

Table 30: Summary of Future Build $PM_{2.5}$

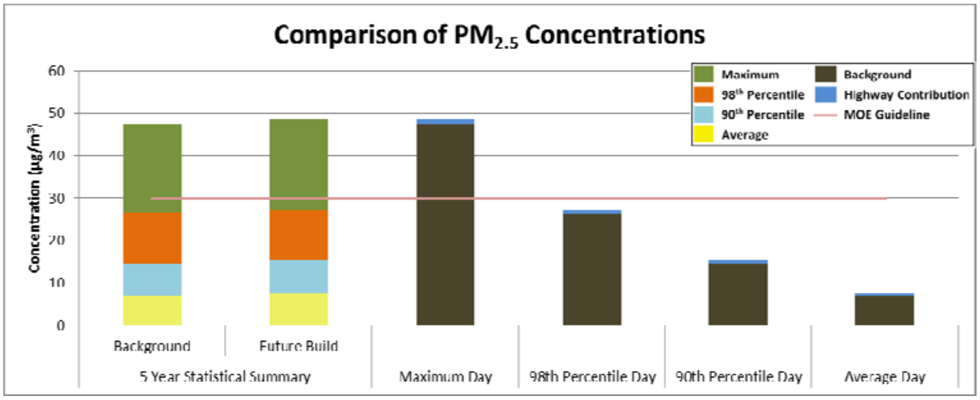
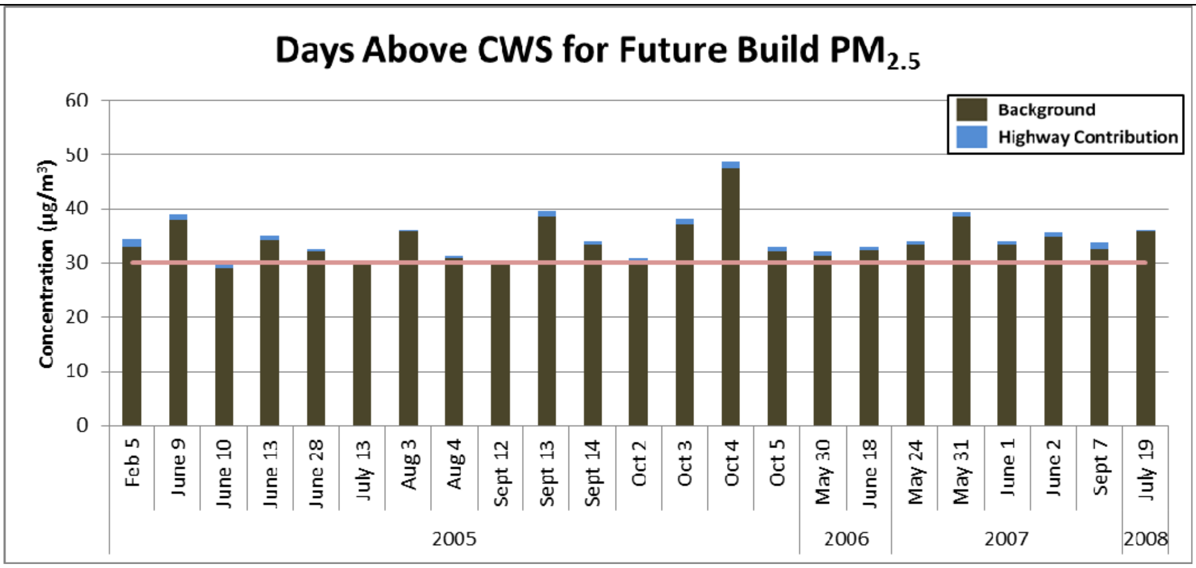
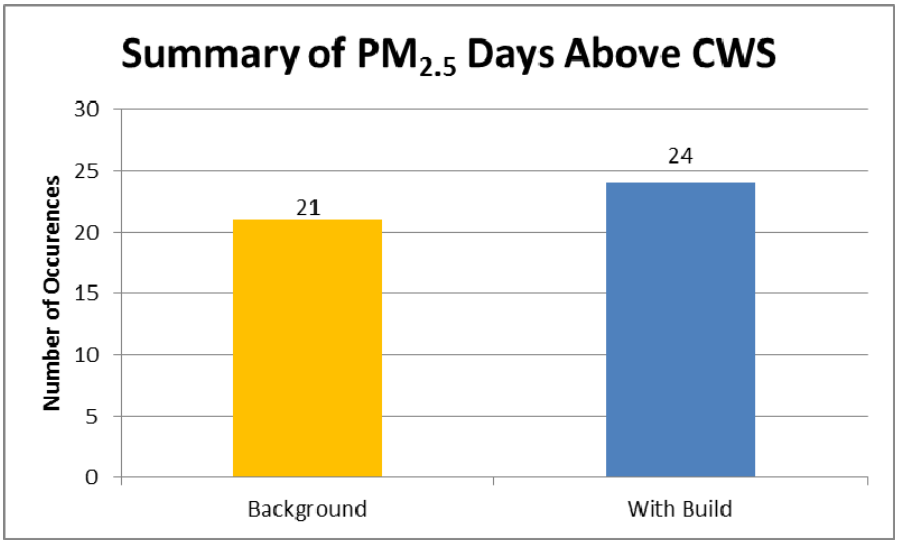
<table>
<tr><th rowspan="2">Statistical Analysis</th><th colspan="2">5 Year Summary of Future Build</th></tr>
<tr><th colspan="2">% of MOE Guideline:</th></tr>
<tr><td rowspan="9">
</td><td>Maximum</td><td>162%</td></tr>
<tr><td>98th Percentile</td><td>90%</td></tr>
<tr><td>90th Percentile</td><td>51%</td></tr>
<tr><td>Average</td><td>25%</td></tr>
<tr><th colspan="2">Roadway Contribution:</th></tr>
<tr><td>Maximum</td><td>2%</td></tr>
<tr><td>98th Percentile</td><td>3%</td></tr>
<tr><td>90th Percentile</td><td>4%</td></tr>
<tr><td>Average</td><td>6%</td></tr>
<tr><td colspan="3">Conclusions:
• The $PM_{2.5}$ results are in compliance with the CWS. The highest 3 year rolling average of the yearly 98th percentile combined concentrations was calculated to be 28.30 µg/m³ (years 2005 to 2007) or 94% of the CWS.
• The contribution from the roadway to the combined concentrations was 6% or less.
• Since there were days where elevated $PM_{2.5}$ concentrations were experienced, frequency analysis was conducted to show that elevated concentrations were not frequent over a 5 year period. This analysis is presented in Table 31.</td></tr>
</table>

Table 31: 5 Year Frequency Analysis of Future Build $PM_{2.5}$





Conclusions:

- Five additional days above the CWS are expected due to the project over a 5 year period.
- For the future build scenario the combined concentrations exceeded the CWS 1% of the time.

It should be understood that infrequent days above the guideline due to background is a common occurrence in all of Southwestern Ontario and is unavoidable due to long-range transport of contaminants from the United States.

3.1.4 Coarse Particulate Matter (PM_{10})

Table 32 presents the future build combined concentrations alongside the background concentrations for 24-hour PM_{10} based on 5 years of meteorological data. The results conclude that:

- *The maximum 24-hr PM_{10} combined concentrations for the future build scenario exceeded the MOE guideline.*

Table 32: Summary of Future Build PM_{10}

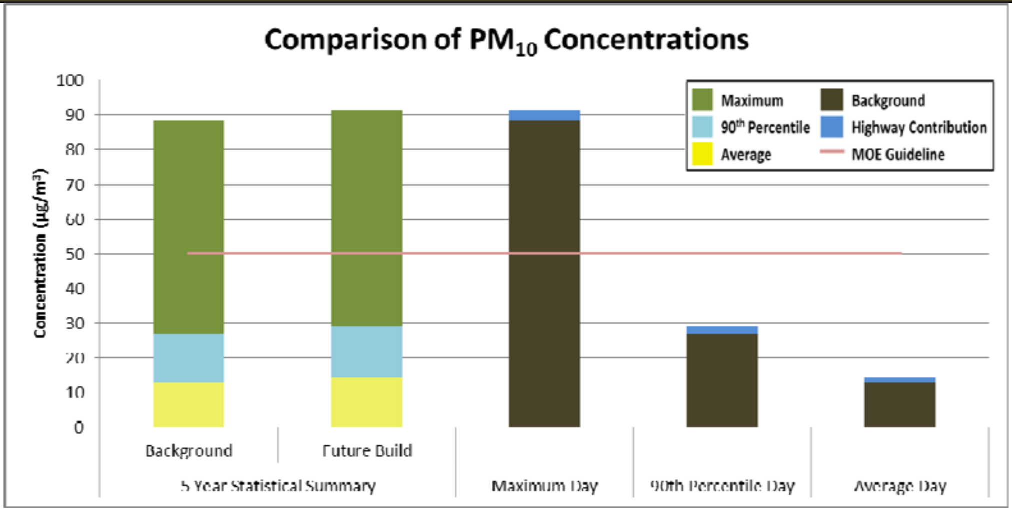
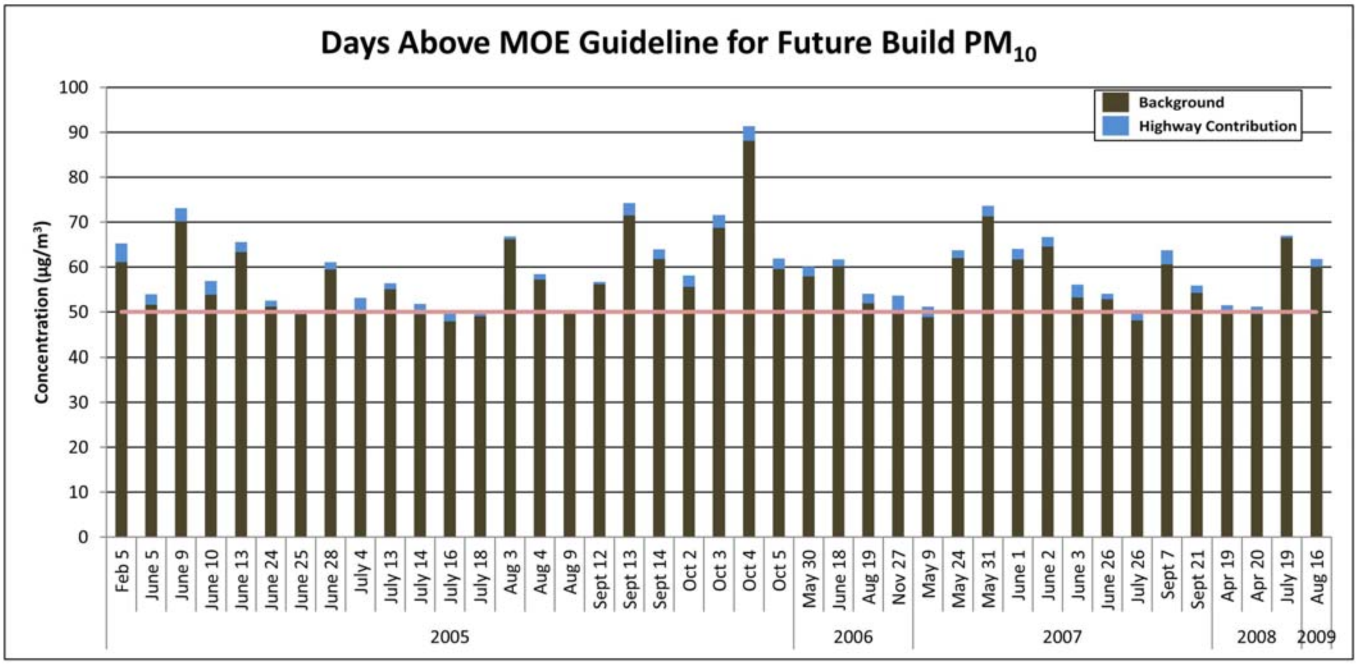
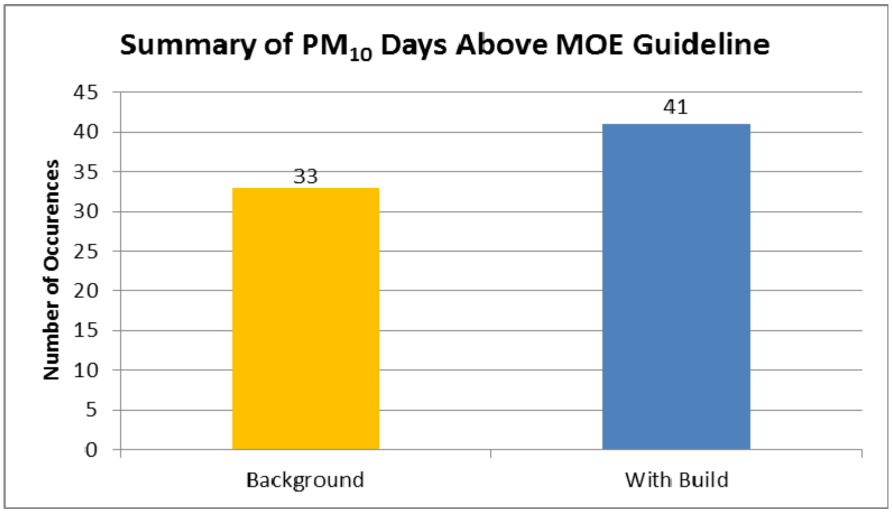
<table>
<tr><th>Statistical Analysis</th><th colspan="2">5 Year Summary of Future Build</th></tr>
<tr><td rowspan="9">
</td><td colspan="2">% of MOE Guideline:</td></tr>
<tr><td>Maximum</td><td>183%</td></tr>
<tr><td>90th Percentile</td><td>58%</td></tr>
<tr><td>Average</td><td>29%</td></tr>
<tr><td colspan="2">Roadway Contribution:</td></tr>
<tr><td>Maximum</td><td>4%</td></tr>
<tr><td>90th Percentile</td><td>7%</td></tr>
<tr><td>Average</td><td>9%</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="3">Conclusions:
• The maximum PM10 combined concentration exceeded the MOE guideline.
• The contribution from the roadway to the combined concentrations was 9% or less.
• Since there were days where PM10 concentrations were above the MOE guideline, frequency analysis was conducted to show that elevated concentrations were not frequent over a 5 year period. This analysis is presented below.</td></tr>
</table>

Table 33: 5 Year Frequency Analysis of Future Build PM_{10}





Conclusions:

- 8 additional days above the MOE guideline are expected due to the project over a 5 year period.
- For the future build scenario the combined concentrations only exceeded the MOE Guideline 1% of the time.

It should be remembered that PM_{10} background concentrations were derived based on their relationship to $PM_{2.5}$ since PM_{10} is not monitored in Ontario. Therefore, considering that there were high days of $PM_{2.5}$ it was also anticipated that there would be high days PM_{10}.

3.1.5 Total Suspended Particulate Matter (TSP)

Table 34 presents the future build combined concentrations alongside the background concentrations for 24-hour TSP based on 5 years of meteorological data. The results conclude that:

- *The maximum 24-hr TSP combined concentrations for the future build scenario exceeded the MOE guideline.*

Table 34: Summary of Future Build TSP

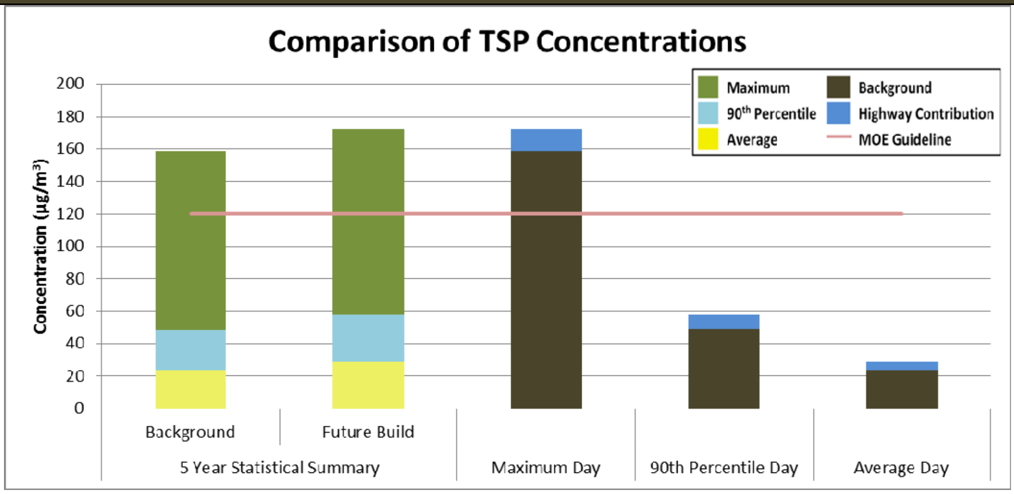
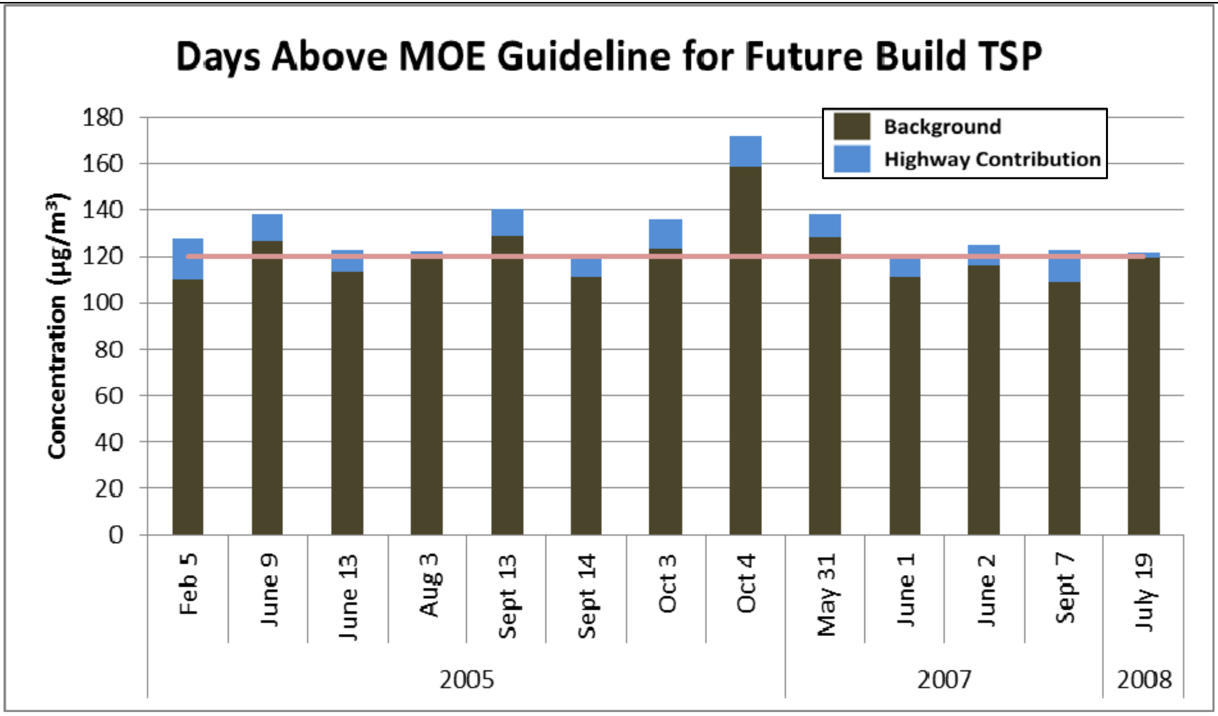
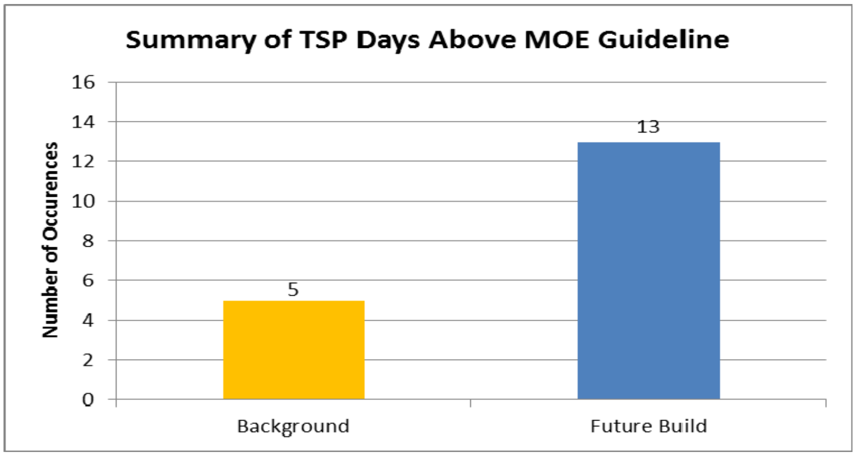
<table>
<tr><th>Statistical Analysis</th><th colspan="2">5 Year Summary of Future Build</th></tr>
<tr><td rowspan="9">
</td><td colspan="2">% of MOE Guideline:</td></tr>
<tr><td>Maximum</td><td>143%</td></tr>
<tr><td>90th Percentile</td><td>48%</td></tr>
<tr><td>Average</td><td>24%</td></tr>
<tr><td colspan="2">Roadway Contribution:</td></tr>
<tr><td>Maximum</td><td>8%</td></tr>
<tr><td>90th Percentile</td><td>15%</td></tr>
<tr><td>Average</td><td>18%</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="3">Conclusions:
• The maximum TSP combined concentration exceeded the MOE guideline.
• The contribution from the roadway to the combined concentrations was 18% or less.
• Since there were days where TSP concentrations were above the MOE guideline, frequency analysis was conducted to show that elevated concentrations were not frequent over a 5 year period. This analysis is presented below.</td></tr>
</table>

Table 35: 5 Year Frequency Analysis of Future Build TSP





Conclusions:

- 8 additional days above the MOE guideline are expected due to the project over a 5 year period.
- For the future build scenario the combined concentrations exceeded the MOE Guideline less than 1% of the time.

It should be remembered that TSP background concentrations were derived based on their relationship to $PM_{2.5}$ since TSP is not monitored in Ontario. Therefore, considering that there were elevated days of $PM_{2.5}$ it was also anticipated that there would be elevated days TSP.

3.2 Volatile Organic Compounds (VOCs)

Due to the lack of hourly and daily background monitoring data, statistical analysis (maximum, 90th percentile, and average) could not be conducted for VOCs. Instead, the 90th percentile background concentration for each VOC was calculated from available data in the 5 year dataset. The 90th percentile background concentration was then added to the modelled roadway concentrations in order to estimate a reasonable worst-case combined concentration. The combined concentration was then used to assess compliance with MOE guidelines. Provided below are the modelling results for the VOCs: acetaldehyde, acrolein, benzene, 1,3-butadiene and formaldehyde.

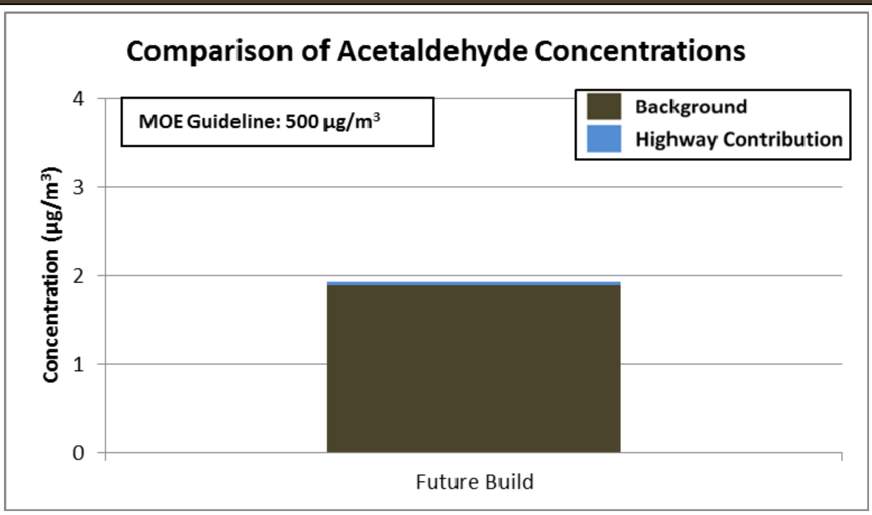
3.2.1 Acetaldehyde

Table 36 presents the combined concentrations for 24-hour acetaldehyde based on 5 years of meteorological data. Results shown are at the worst-case sensitive receptor for the future build scenario. The results conclude that:

- *The maximum 24-hour acetaldehyde combined concentrations for the future build scenario were well below their respective MOE guidelines.*

Table 36: Summary of Future Build Acetaldehyde Results

Statistical Analysis



5 Year Summary of Future Build	
% of MOE Guideline:	
Maximum	<1%
90th Percentile	<1%
Average	<1%
Roadway Contribution:	
Maximum	1%
90th Percentile	2%
Average	1%

Conclusions:

- The maximum acetaldehyde combined concentration was well below the MOE guideline.
- The contribution from the roadway to the combined concentrations was 2% or less.

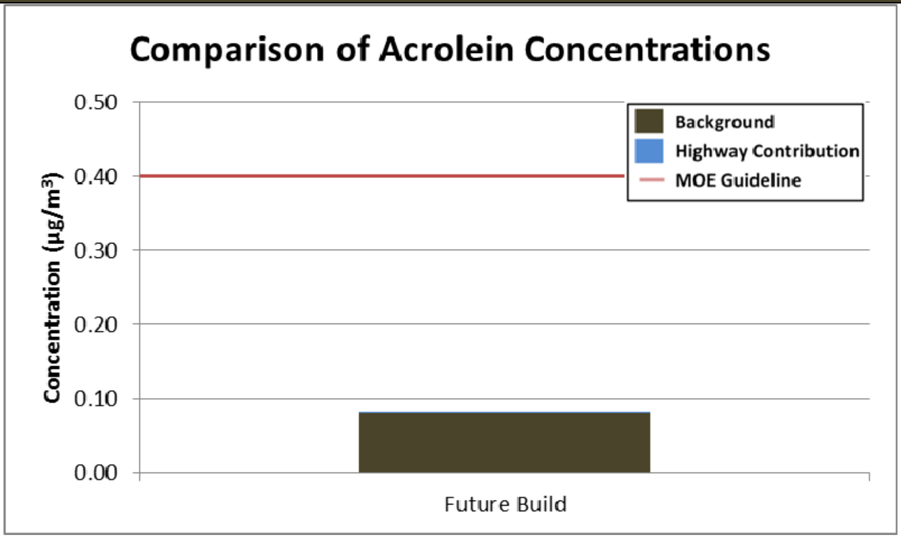
3.2.2 Acrolein

Table 37 presents the combined concentrations for 24-hour acrolein based on 5 years of meteorological data. Results shown are at the worst-case sensitive receptor for the future build scenario. The results conclude that:

- *The maximum 24-hour acrolein combined concentrations for the future build scenario were below their respective MOE guidelines.*

Table 37: Summary of Future Build Acrolein Results

Statistical Analysis



5 Year Summary of Future Build	
% of MOE Guideline:	
Maximum	21%
90th Percentile	21%
Average	20%
Roadway Contribution:	
Maximum	2%
90th Percentile	3%
Average	1%

Conclusions:

- The maximum acrolein combined concentration was below the MOE guideline.
- The contribution from the roadway to the combined concentrations was 3% or less.

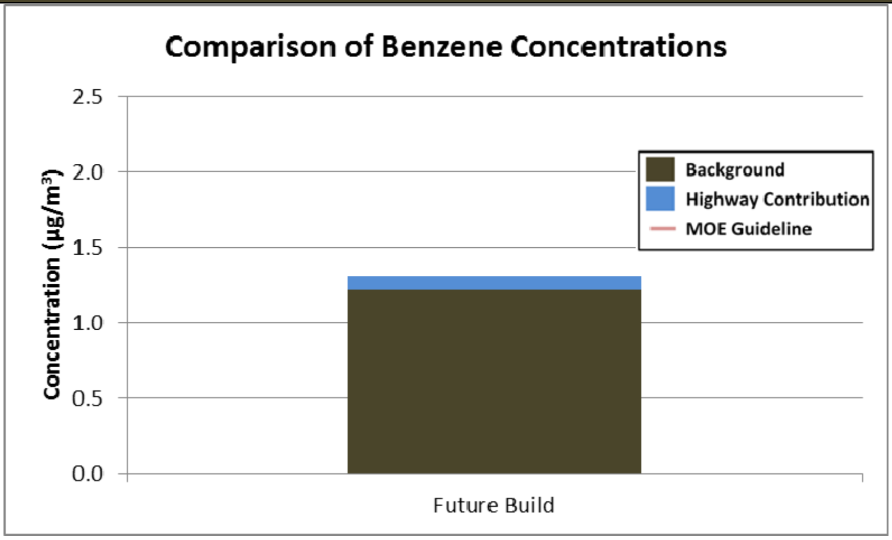
3.2.3 Benzene

Table 38 presents the combined concentrations for 24-hour benzene based on 5 years of meteorological data. Results shown are at the worst-case sensitive receptor for the future build scenario. The results conclude that:

- *The maximum 24-hour benzene combined concentrations for the future build scenario were below their respective MOE guidelines.*

Table 38: Summary of Future Build Benzene

Statistical Analysis



5 Year Summary of Future Build	
% of MOE Guideline:	
Maximum	57%
90th Percentile	55%
Average	54%
Roadway Contribution:	
Maximum	7%
90th Percentile	4%
Average	2%

Conclusions:

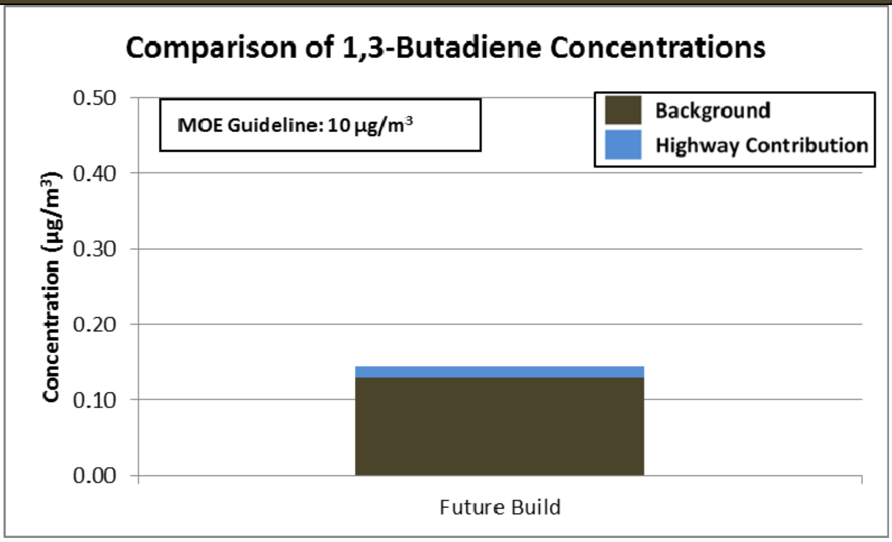
- The maximum benzene combined concentration was below the MOE guideline.
- The contribution from the roadway to the combined concentrations was 7% or less.

3.2.4 1,3-Butadiene

Table 39 presents the combined concentrations for 24-hour 1,3-butadiene based on 5 years of meteorological data. Results shown are at the worst-case sensitive receptor for the future build scenario. The results conclude that:

- *The maximum 24-hour 1,3-butadiene combined concentrations for future build scenario were well below their respective MOE guidelines.*

Table 39: Summary of Future Build 1,3-Butadiene

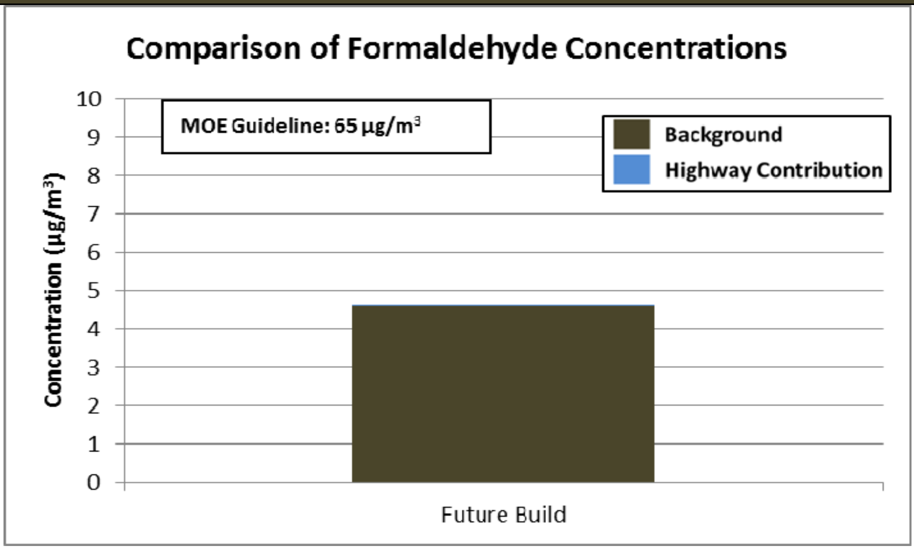
<table>
<tr><th>Statistical Analysis</th><th colspan="2">5 Year Summary of Future Build</th></tr>
<tr><td rowspan="9">
</td><td colspan="2">% of MOE Guideline:</td></tr>
<tr><td>Maximum</td><td>2%</td></tr>
<tr><td>90th Percentile</td><td>1%</td></tr>
<tr><td>Average</td><td>1%</td></tr>
<tr><td colspan="2">Roadway Contribution:</td></tr>
<tr><td>Maximum</td><td>11%</td></tr>
<tr><td>90th Percentile</td><td>6%</td></tr>
<tr><td>Average</td><td>3%</td></tr>
<tr><td colspan="2"></td></tr>
<tr><td colspan="3">Conclusions:
• The maximum 1,3-butadiene combined concentration was below the MOE guideline.
• The contribution from the roadway to the combined concentrations was 11% or less.</td></tr>
</table>

3.2.5 Formaldehyde

Table 40 presents the combined concentrations for 24-hour formaldehyde based on 5 years of meteorological data. Results shown are at the worst-case sensitive receptor for the future build scenario. The results conclude that:

- *The maximum 24-hour formaldehyde combined concentrations for the future build scenario were below their respective MOE guidelines.*

Table 40: Summary of Future Build Formaldehyde

<table>
<tr><th>Statistical Analysis</th><th colspan="2">5 Year Summary of Future Build</th></tr>
<tr><td rowspan="9">
</td><td colspan="2">% of MOE Guideline:</td></tr>
<tr><td>Maximum</td><td>7%</td></tr>
<tr><td>90th Percentile</td><td>7%</td></tr>
<tr><td>Average</td><td>7%</td></tr>
<tr><td colspan="2">Roadway Contribution:</td></tr>
<tr><td>Maximum</td><td>1%</td></tr>
<tr><td>90th Percentile</td><td>1%</td></tr>
<tr><td>Average</td><td><1%</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="3">Conclusions:
• The maximum formaldehyde combined concentration was below the MOE guideline.
• The contribution from the roadway to the combined concentrations was 1%.</td></tr>
</table>

3.3 Implications of Air Quality on Human Health

As noted in **Section 2.7**, the predicted maximum combined concentrations experienced at the worst-case sensitive receptor location along the corridor for all evaluated contaminants of concern were below their corresponding air quality guideline, with the exception of particulate matter (*i.e.*, $PM_{2.5}$, PM_{10}, and TSP). As such, for those predicted worst-case exposures that did not exceed the regulatory guideline, no potential health risks would be expected to even sensitive members of the population. As such, only the potential health risks related to particulate matter (PM) need be discussed further in this report.

PM consists of airborne particles in solid or liquid form, the size of ambient PM ranging from approximately 0.005 to 100 microns (µm) in aerodynamic diameter (WHO, 2005). PM is operationally separated into three groups: i) total suspended particulate (TSP); ii) inhalable coarse particles (PM_{10}); and, iii) fine or respirable particles ($PM_{2.5}$).

It is important to recognize that TSP contains all particles smaller than 44 microns; PM_{10} contains all particles with a mean aerodynamic diameter of 10 microns or less; and $PM_{2.5}$ contains particles equal to or smaller than 2.5 microns as well as ultrafine PM of less than 0.1 micron.

When evaluating the potential health implications arising from exceedances of the various regulatory guidelines pertaining to PM, the most relevant guideline is for the fine particulate matter size fraction (*i.e.*, $PM_{2.5}$). Fine particulate matter (*i.e.*, particulates smaller than 2.5 microns in size) largely originates from combustion processes. Particle size is a very important factor in determining the inhalability and eventual deposition of particulate matter within the respiratory tract (Health Canada, 1999). Particles between 2 and 3 µm or smaller are able to reach the alveoli in the distal parts of the lung, and therefore, have been termed respirable (Health Canada, 1999). Those particles that penetrate the lowest reaches of the lungs typically have the greatest potential for health impacts to the individual.

Epidemiological studies have indicated a positive association between particulate matter and health outcomes such as daily mortality, impaired lung function, adverse respiratory symptoms and medication use, respiratory and cardiovascular hospitalizations, frequency of reported chronic respiratory disease and restricted activity days (Environment Canada, 2000).

Time-series epidemiological studies estimate that a 10 $\mu g/m^3$ increase in mean 24-hour $PM_{2.5}$ concentration increases the relative risk for daily cardiovascular mortality by approximately 0.4% to 1.0%. Despite theoretical statistical risks ascribed to all individuals, this elevated risk from exposure is not equally distributed within a population. At present-day levels, $PM_{2.5}$ likely poses an acute threat principally to susceptible people, even if seemingly healthy, such as the elderly and those with (unrecognized) existing coronary artery or structural heart disease. Research has indicated that a 10 $\mu g/m^3$ increase during the preceding day contributes on average to the premature death of approximately one susceptible person per day in a region of 5 million people (based on annual US death rates in 2005). However, when one extrapolates this to the small impact area that may actually be exposed to these concentrations along a transportation corridor, it would be difficult to detect any increase in premature death from a statistical point-of-view.

The primary health concern with respect to particulate matter is related to chronic exposures to elevated concentrations. When focussing on $PM_{2.5}$, the regulatory benchmark (*i.e.*, Canada Wide Standard, or CWS) is 30 $\mu g/m^3$ over a 24-hour averaging time. In this case, the air quality benchmark is a risk management objective intended to provide protection for human health effects for the vast majority of the normal population. It is not intended to be considered a level at which no health impacts could occur. The CWS benchmark is calculated based on the 98^{th} percentile of ambient measurements annually, averaged over the three consecutive years. As such, the intention is to identify those circumstances where concentrations would be consistently exceeding the established benchmark, resulting in significant health impacts on individuals with the exposure area.

In the case of the current assessment, background concentrations of $PM_{2.5}$ (*i.e.*, in absence of contribution from the corridor) exceed the CWS approximately 4.2 days in a year (*i.e.*, 21 days over a five year period). These would be considered “bad air days” where regional air quality is poor, and health departments send out advisories to avoid heavy exercise outdoors, particularly if you are an individual with pre-existing health concerns. On these days, there is definitely the potential for health concerns for susceptible individuals. However, the results of the current assessment indicate that the proposed future build scenario would result in only 3 additional days over five years which would exceed the regulatory benchmark, when compared to the background conditions.

While worst-case exposures are important for evaluating the potential health impacts, and research has demonstrated any increase in ambient $PM_{2.5}$ concentrations has been shown to be statistically linked to an increase in adverse health outcomes in an overall population, the frequency of the occurrence of these elevated concentrations is also an important piece of the puzzle. While the maximum day concentration greatly exceeds the regulatory benchmark, both the 90th percentile and average days show significantly lower concentrations. Therefore, while those days that approach and exceed the risk management guideline could result in acute respiratory issues for sensitive individuals, given the typical ambient concentrations are significantly lower; the potential for chronic health concerns related to the proposed project would be low. Furthermore, the 98th percentile $PM_{2.5}$ combined concentration averaged over a 3 year period for the future build scenario was estimated to be 28.30 µg/m^3, which did not exceed the CWS benchmark of 30 µg/m^3.

4.0 Conclusions and Recommendations

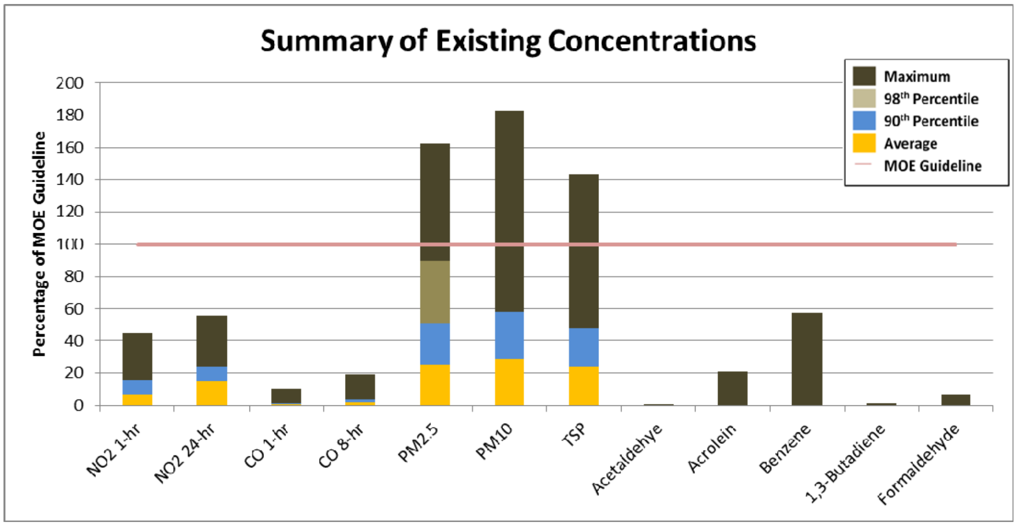
The potential air quality impacts of the proposed project have been assessed and are summarized in **Table 41** . The following conclusions and recommendations are a result of this assessment.

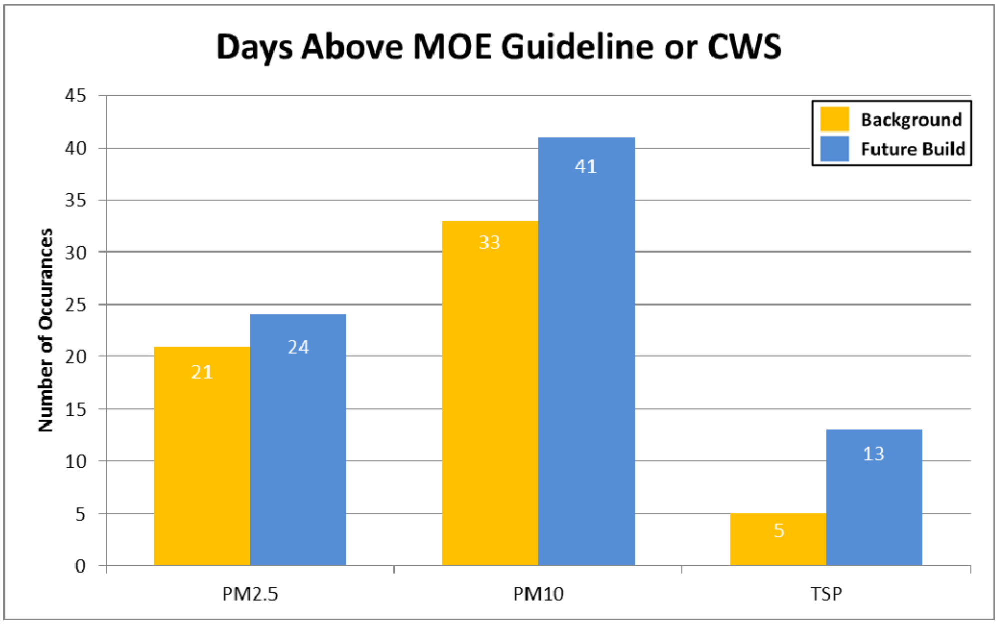
The maximum combined concentrations for the future build scenario were all below their respective MOE guidelines or CWS, with the exception of PM_{10} and TSP.

- *Frequency Analysis determined that the project exceeded both the PM_{10} and TSP guidelines 8 additional days over the 5 year period. This equates to <1% of the time.*
- *The potential for chronic health concerns would be low.*
- *Mitigation measures are not warranted, due to the fact that only 8 additional days above the guideline for PM_{10} and TSP respectively are predicted over a 5 year period.*

Table 41: Summary of Future Build Results

5 Year Statistical Summary





% of Guideline	
Future Build Scenario:	
NO_2 (1-hr)	45%
NO_2 (24-hr)	56%
CO (1-hr)	10%
CO (8-hr)	19%
$PM_{2.5}$*	162%
PM_{10}	183%
TSP	143%
Acetaldehyde	<1%
Acrolein	22%
Benzene	57%
1,3-Butadiene	2%
Formaldehyde	7%

Additional Days Above Guideline Due to Project:	
$PM_{2.5}$	3
PM_{10}	8
TSP	8

* Compliance with the CWS is based on the average annual 98th percentile concentrations, averaged over three consecutive years. The 98th percentile average concentration for the future build scenario was 28.30 µg/m³.

5.0 References

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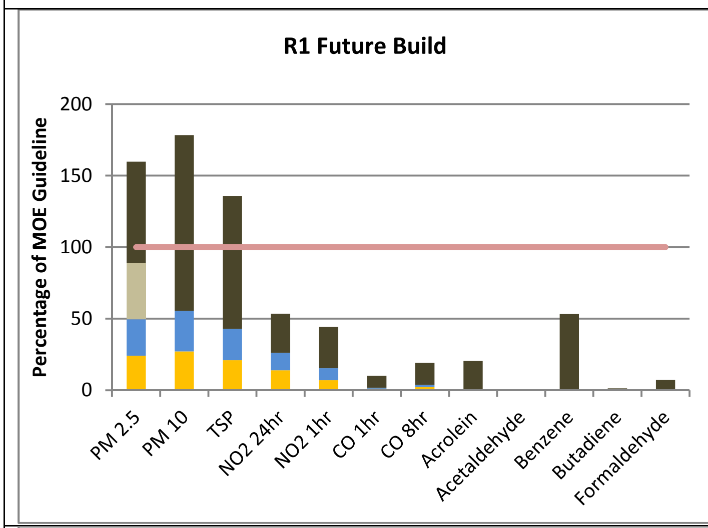
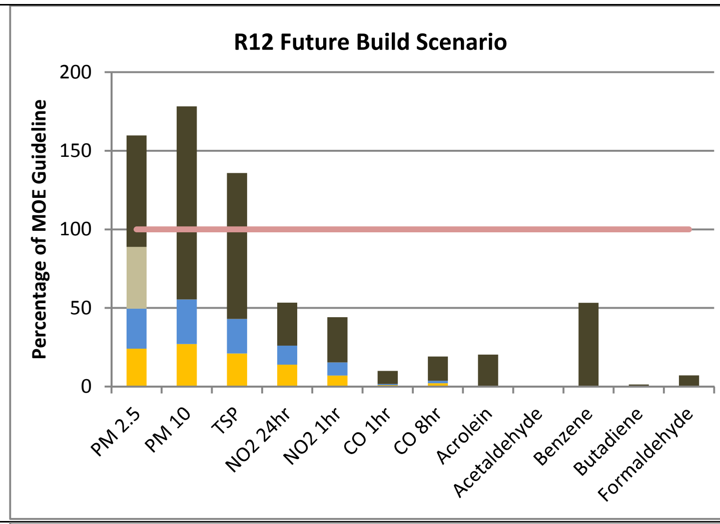
Appendix A

Individual Sensitive Receptor Results

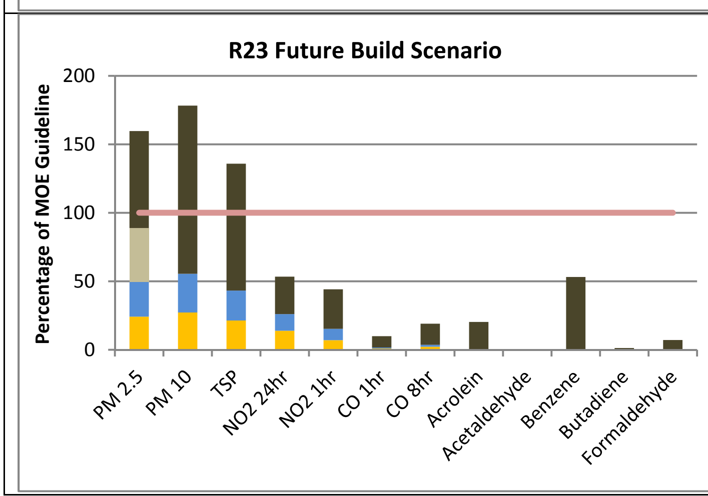
R_34
R_23
R_12
R_1



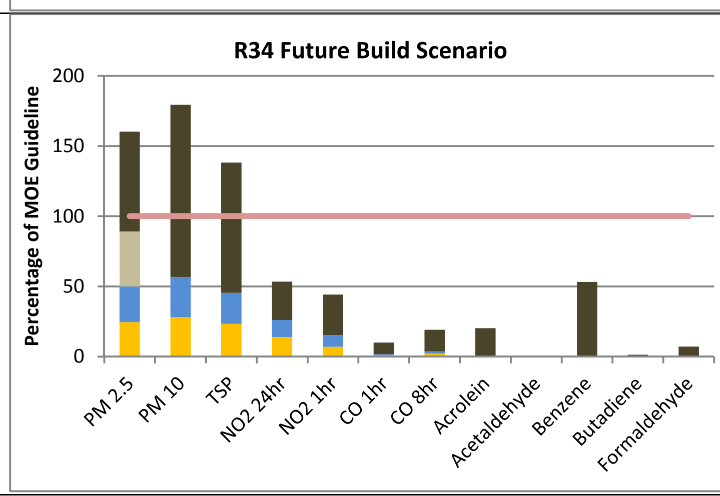
R1 Future Build
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde



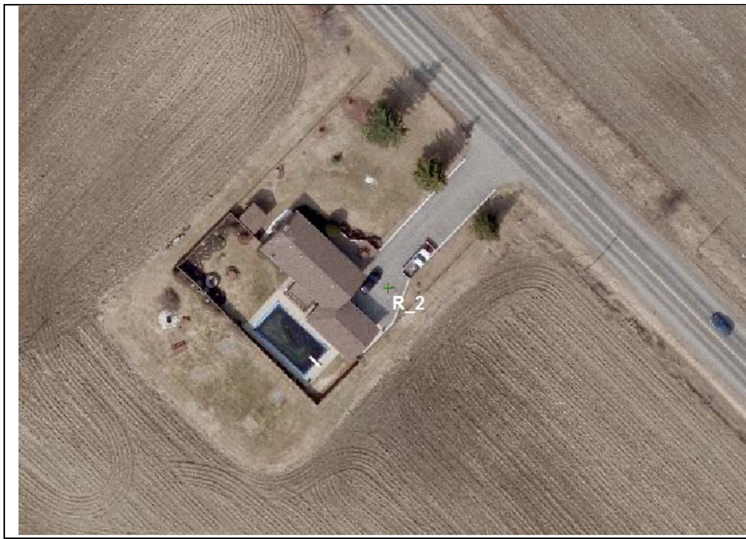
R12 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

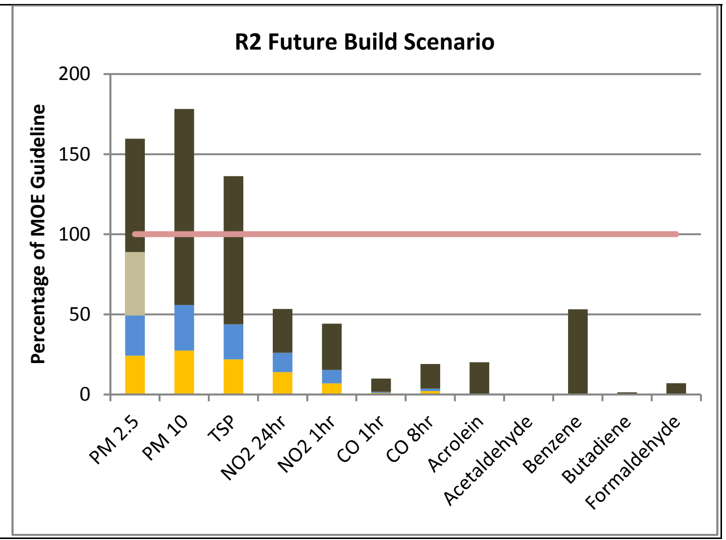


R23 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

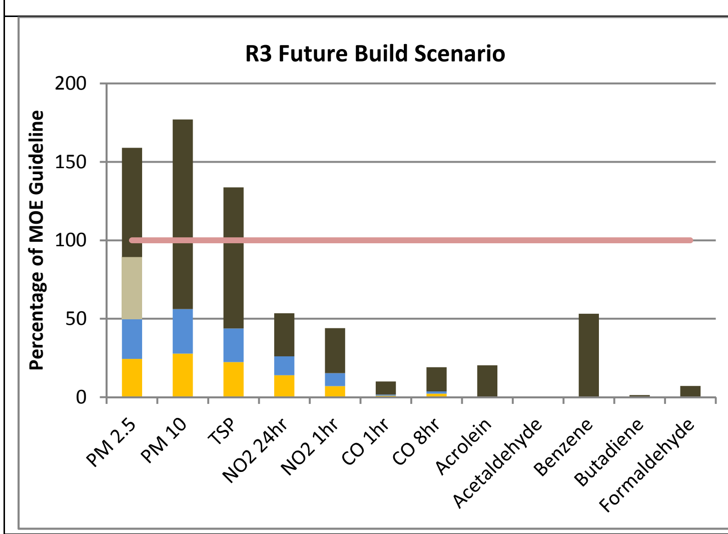


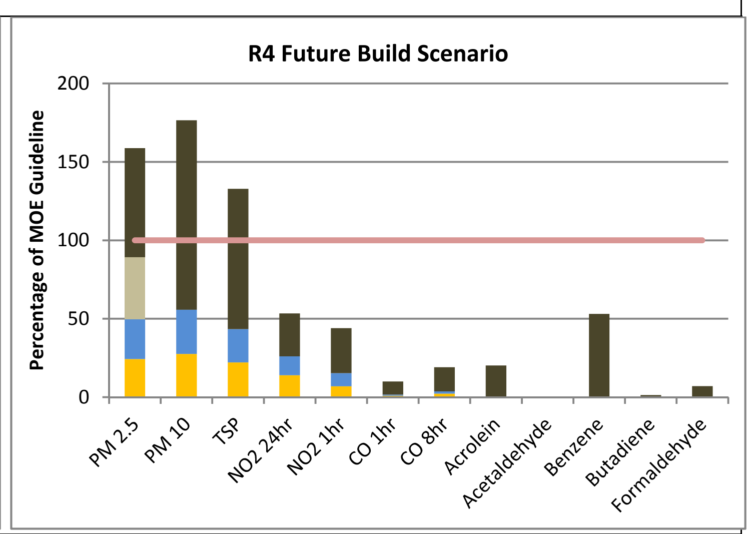
R34 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde


R_2

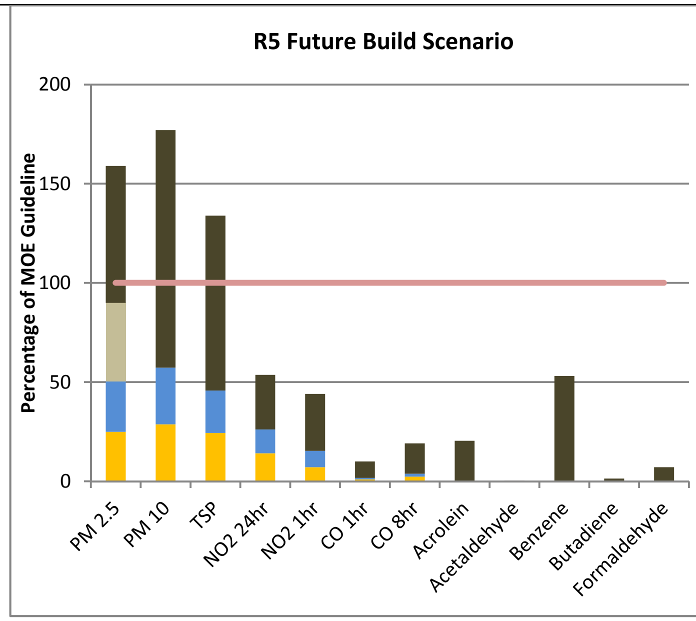

R2 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde


R_4
R_3

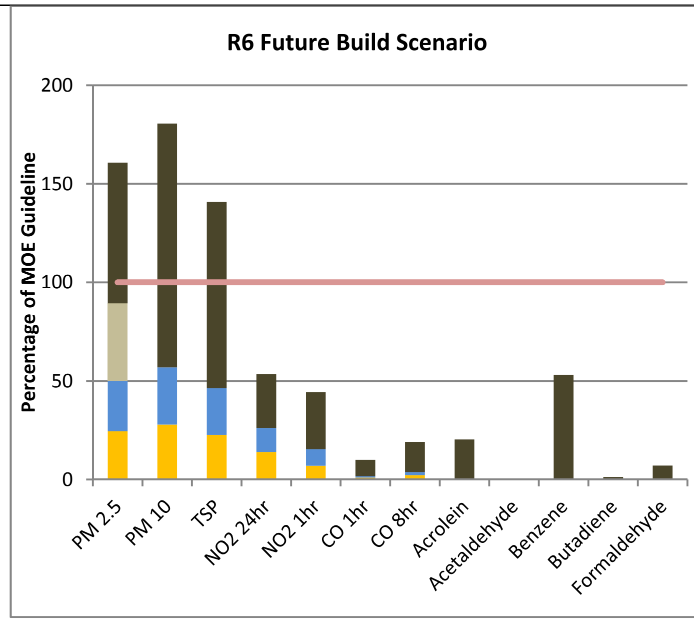

R3 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

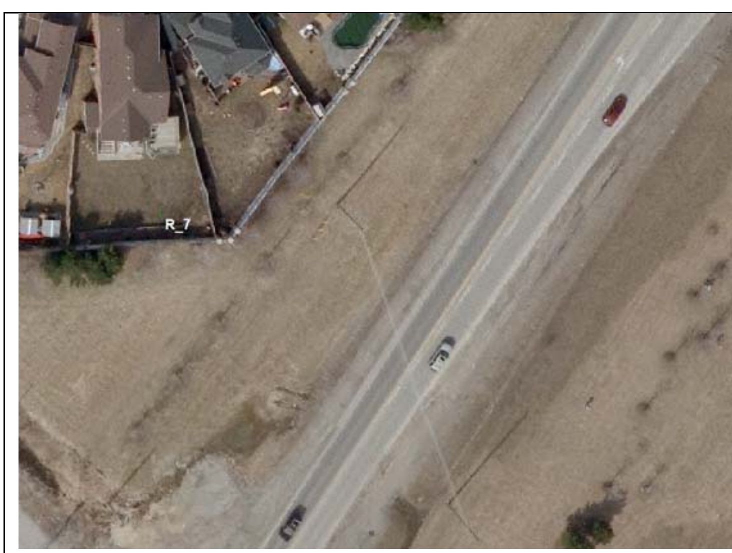

R4 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

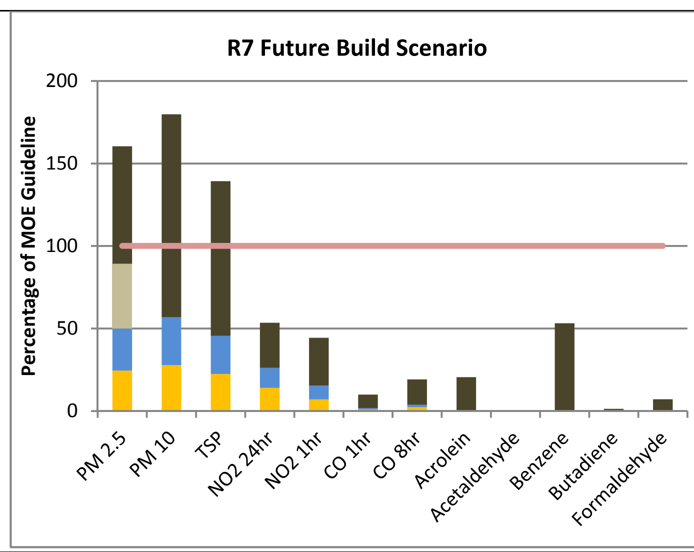

R_5


R5 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

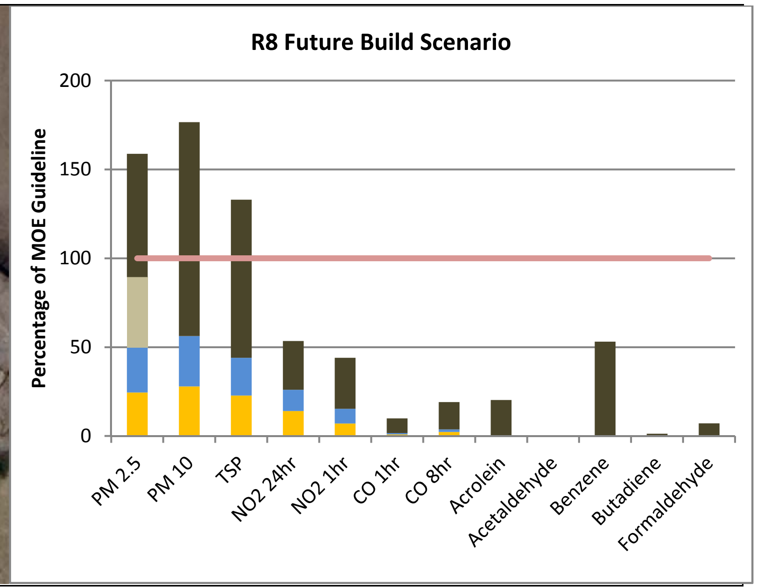

R_6

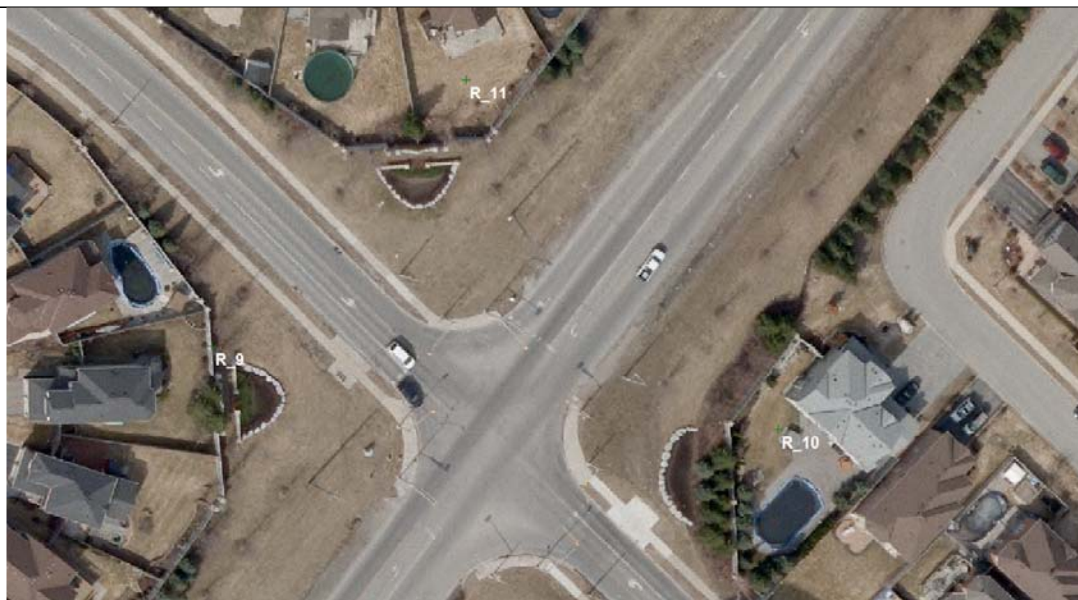

R6 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

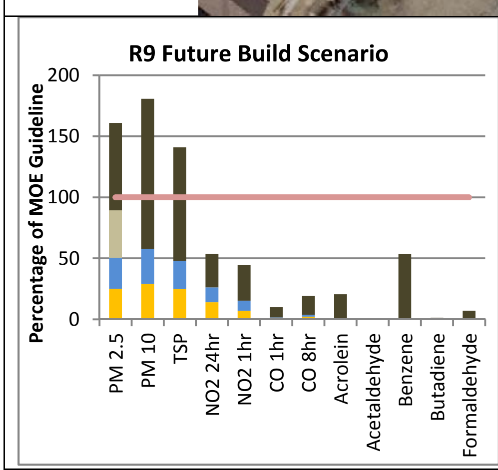

R_7

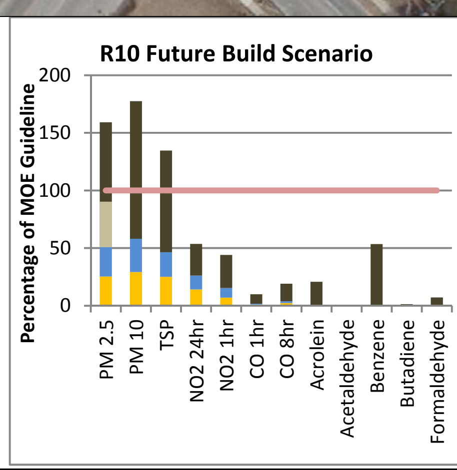

R7 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

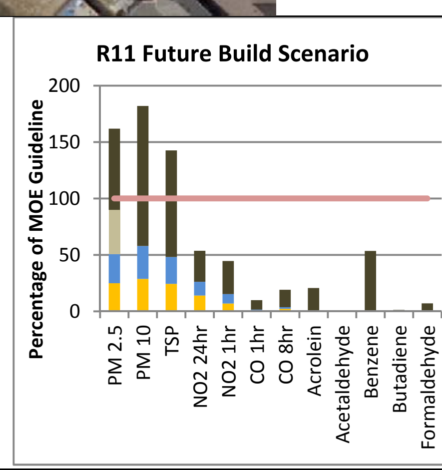

R_8


R8 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

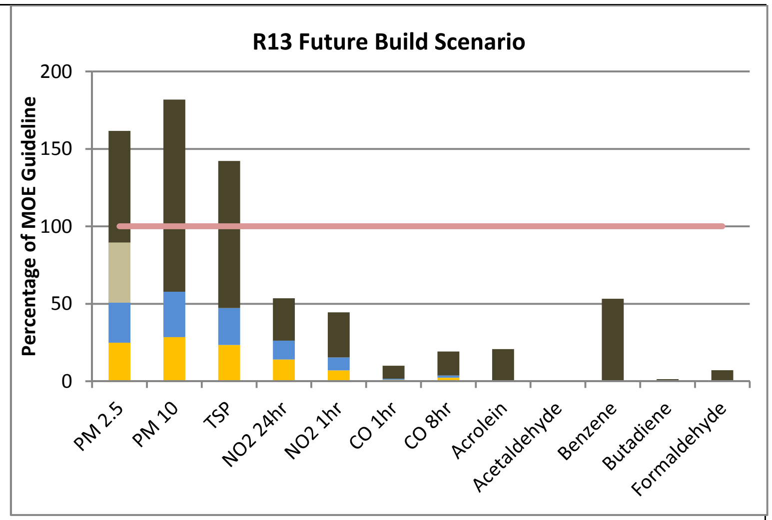

R_11
R_9
R_10

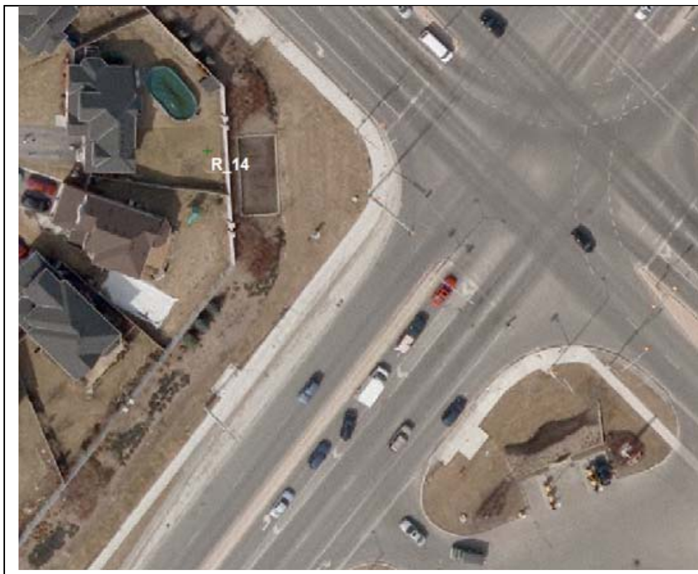

R9 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

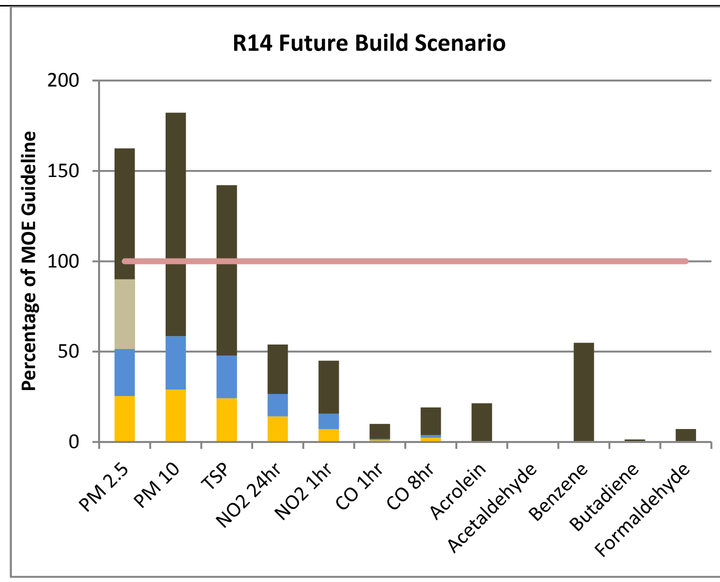

R10 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde


R11 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

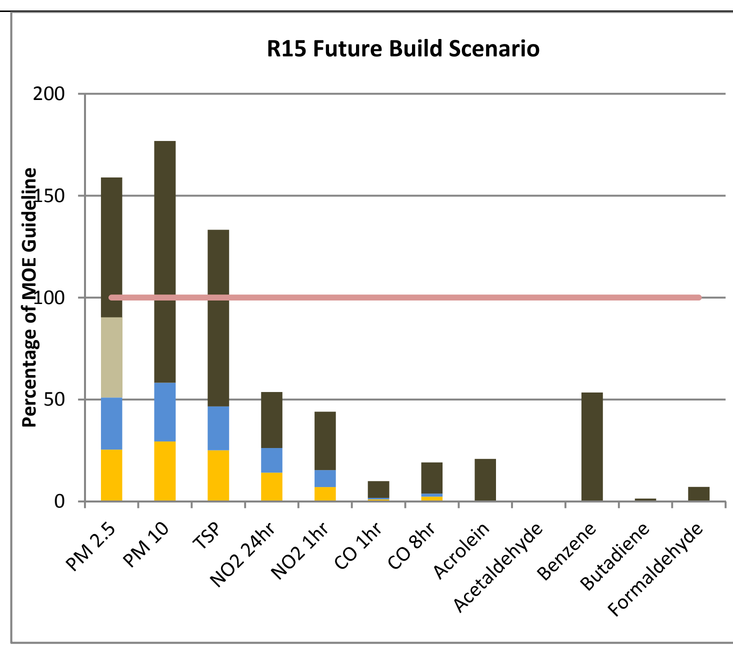

R_13

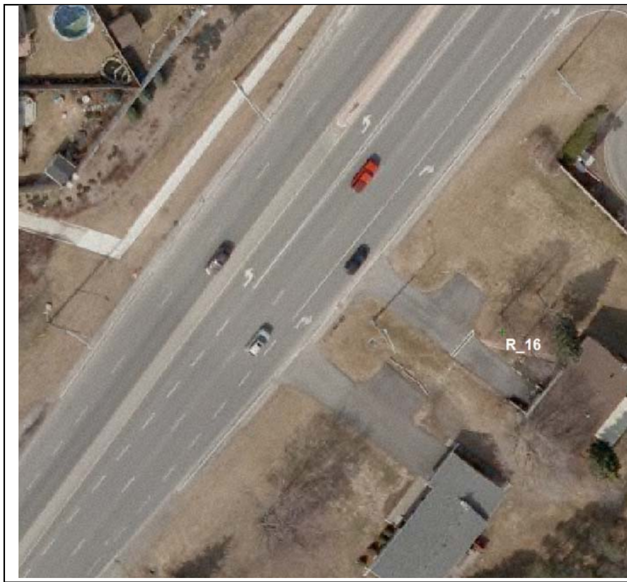

R13 Future Build Scenario
Percentage of MOE Guideline
0
50
100
150
200
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

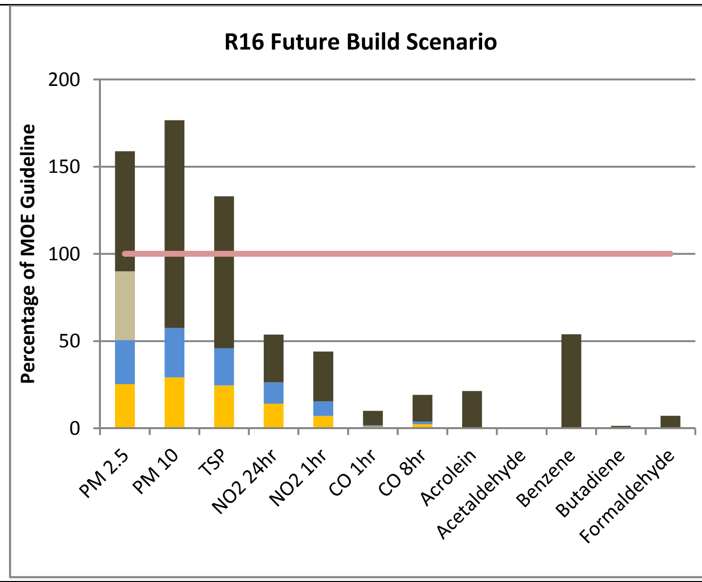

R_14

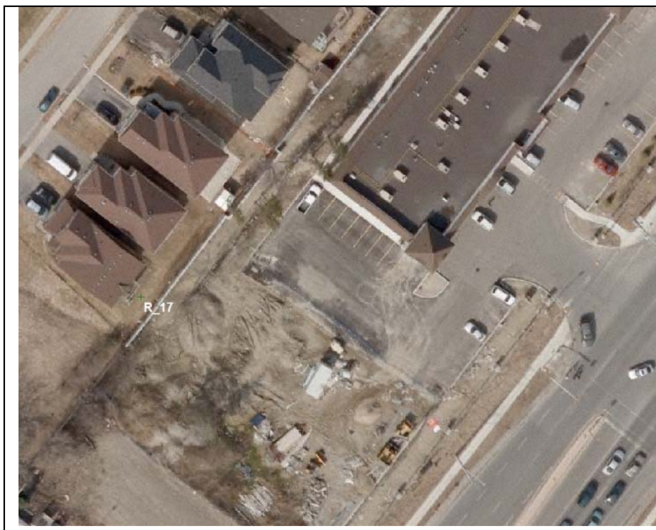

R14 Future Build Scenario
Percentage of MOE Guideline
0
50
100
150
200
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

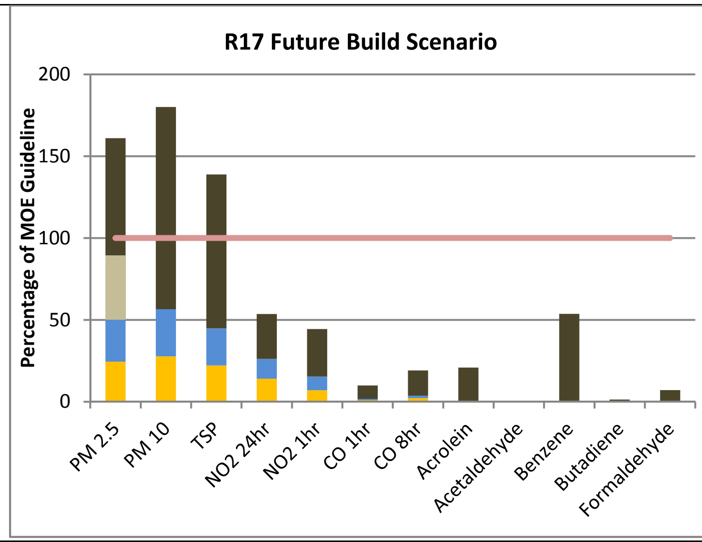

R_15

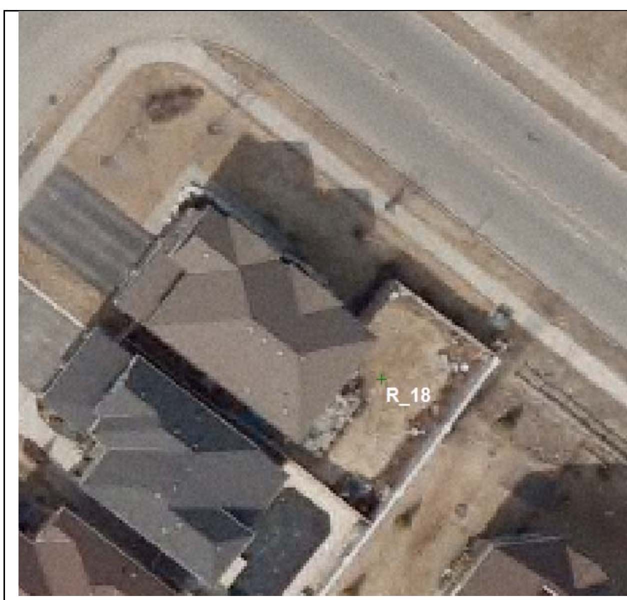

R15 Future Build Scenario
Percentage of MOE Guideline
0
50
100
150
200
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

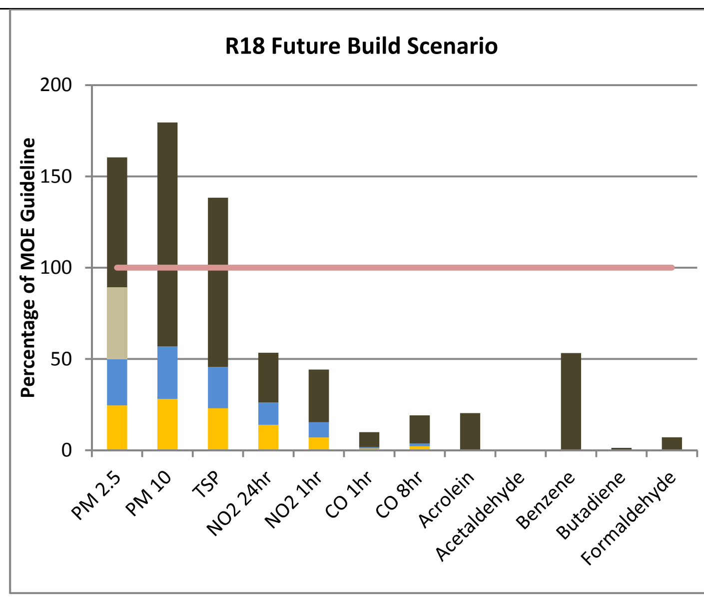

R_16

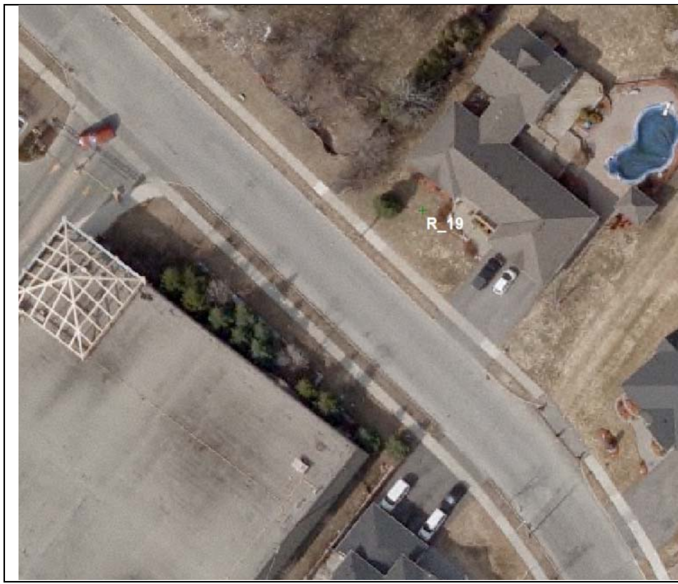

R16 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

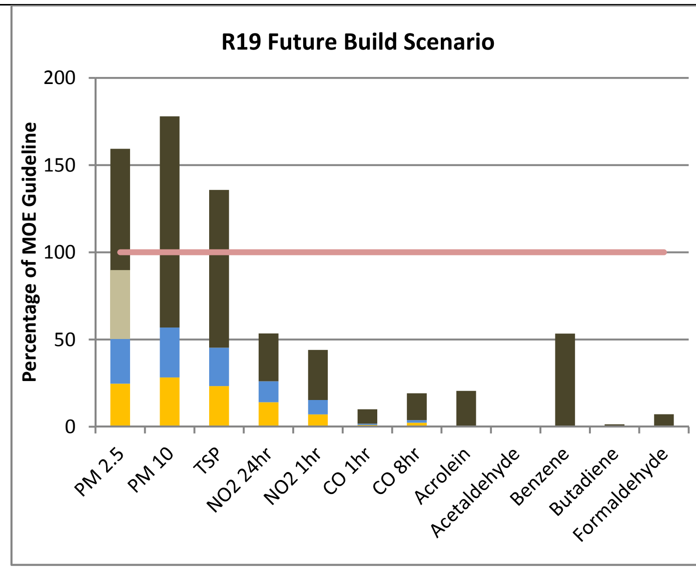

R_17

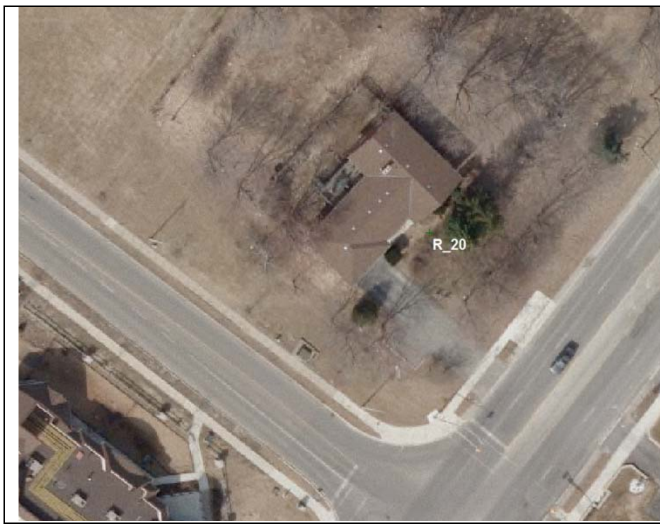

R17 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

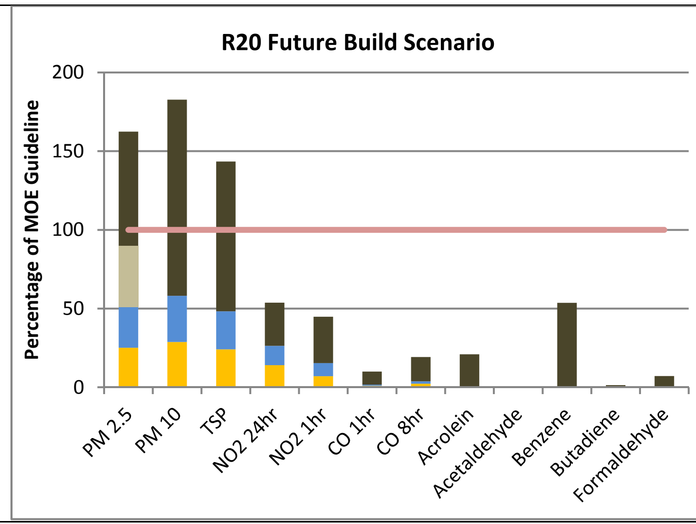

R_18

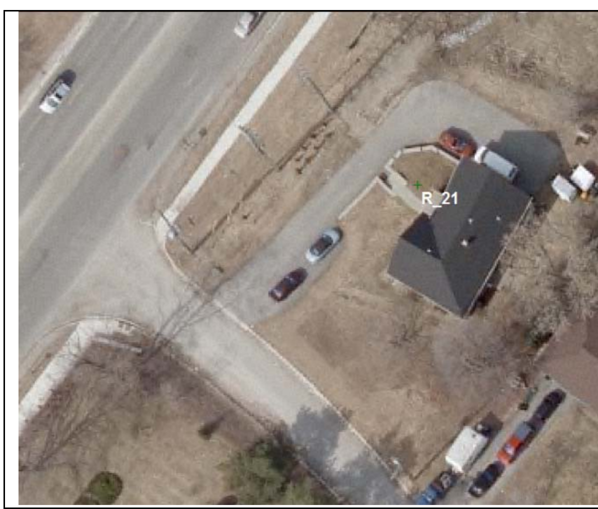

R18 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

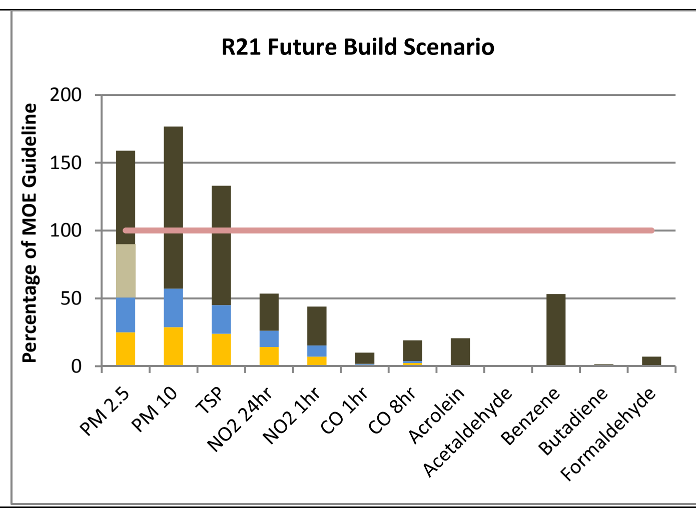

R_19

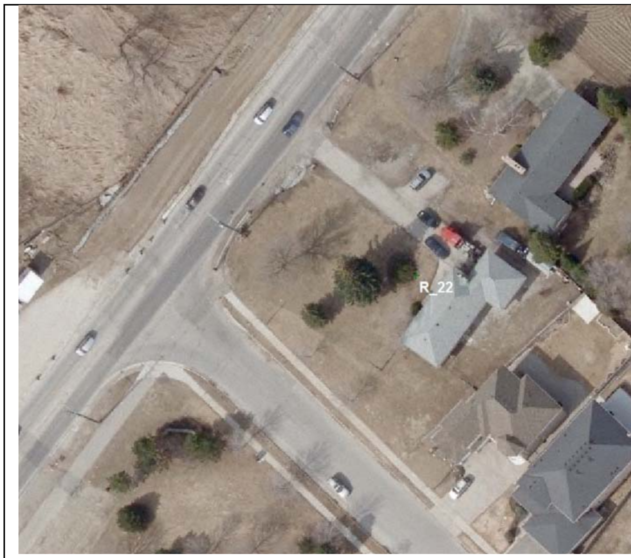

R19 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

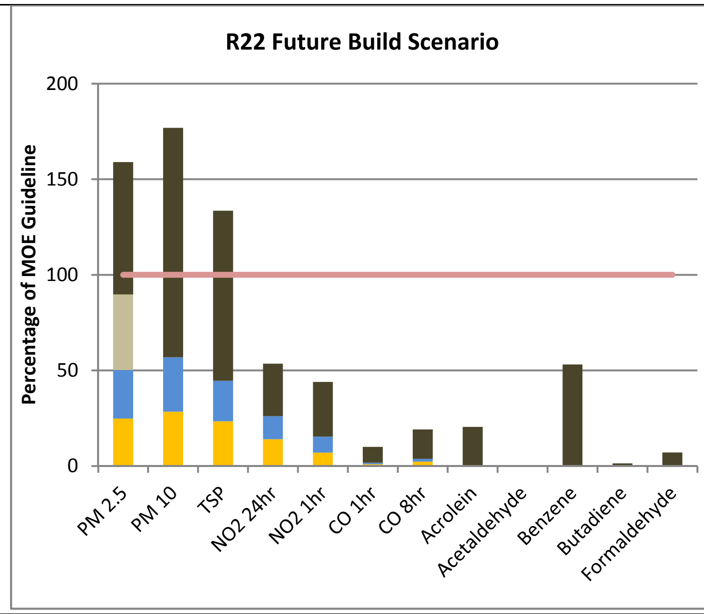

R_20

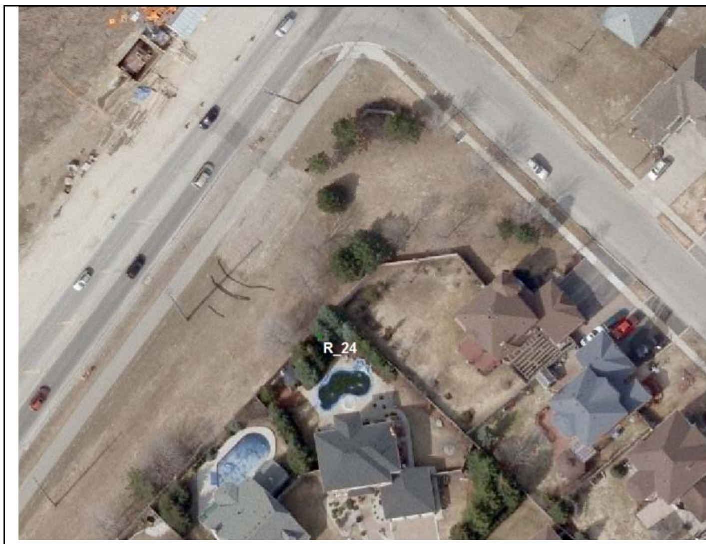

R20 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

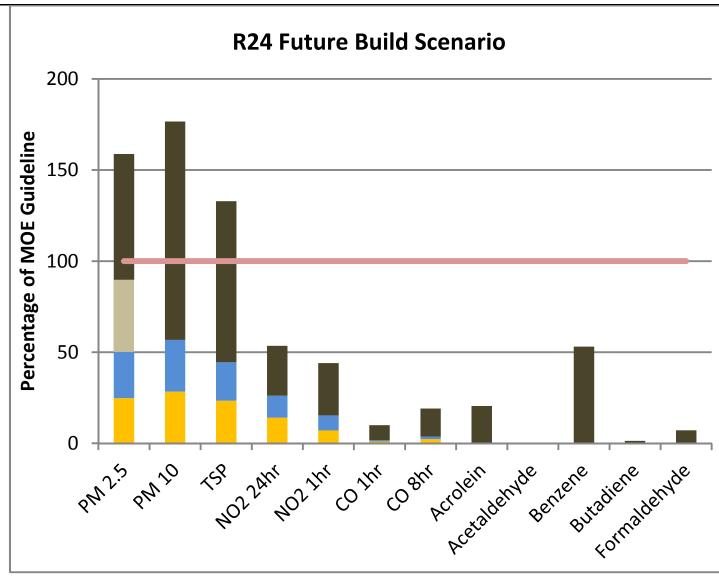

R_21


R21 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

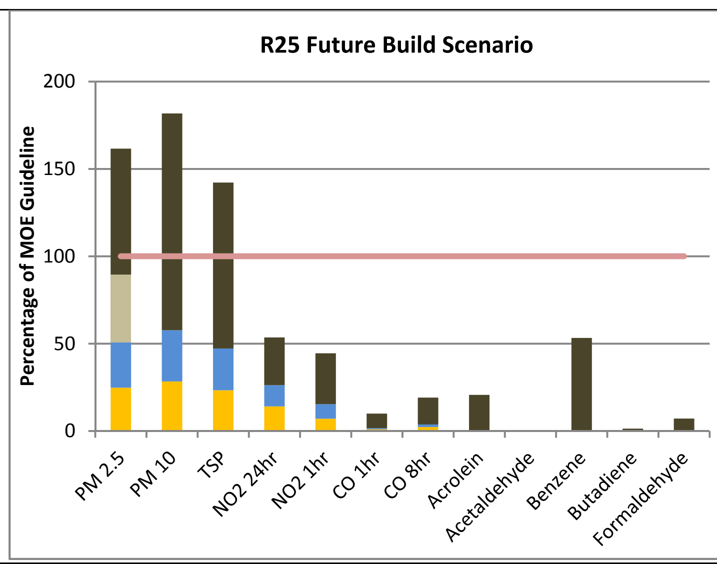

R_22


R22 Future Build Scenario
Percentage of MOE Guideline
0
50
100
150
200
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

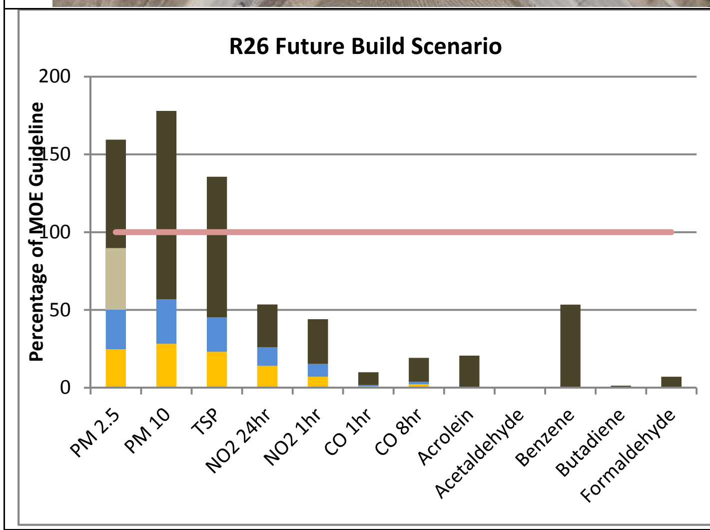

R_24


R24 Future Build Scenario
Percentage of MOE Guideline
0
50
100
150
200
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

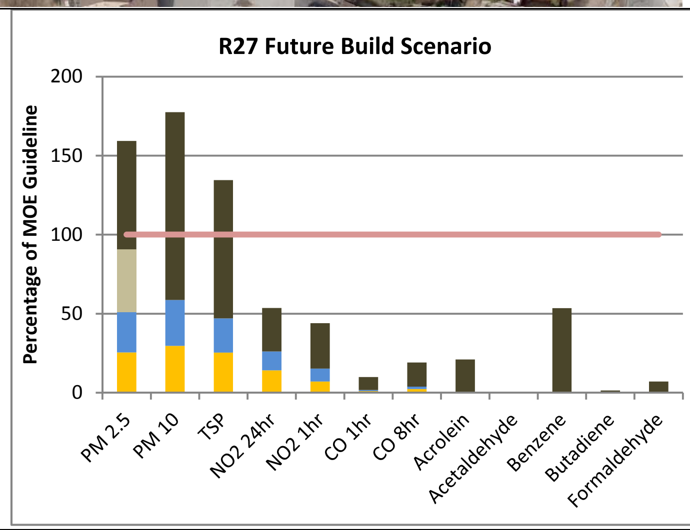

R_25


R25 Future Build Scenario
Percentage of MOE Guideline
0
50
100
150
200
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

R_27
R_26

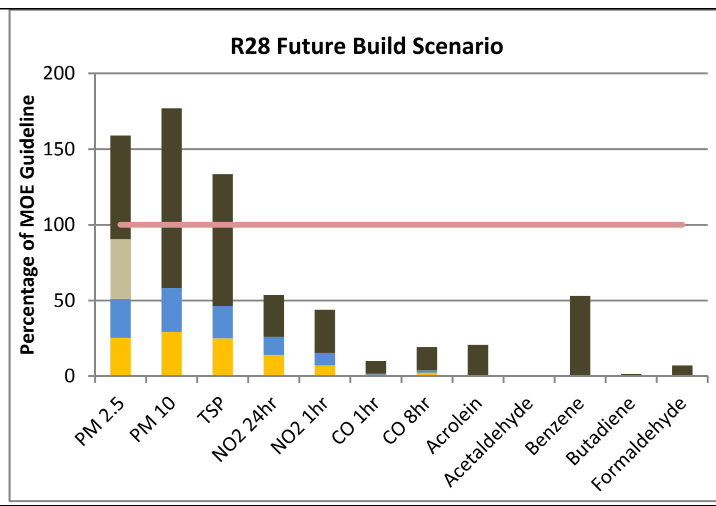


R26 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

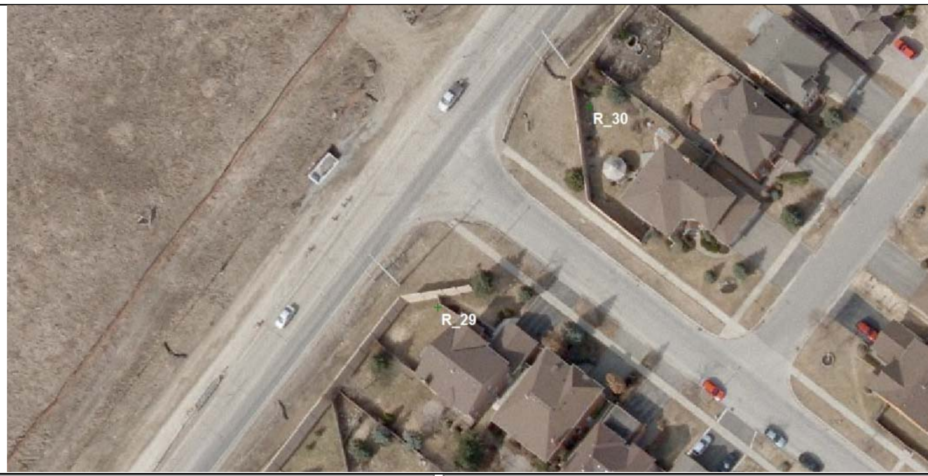


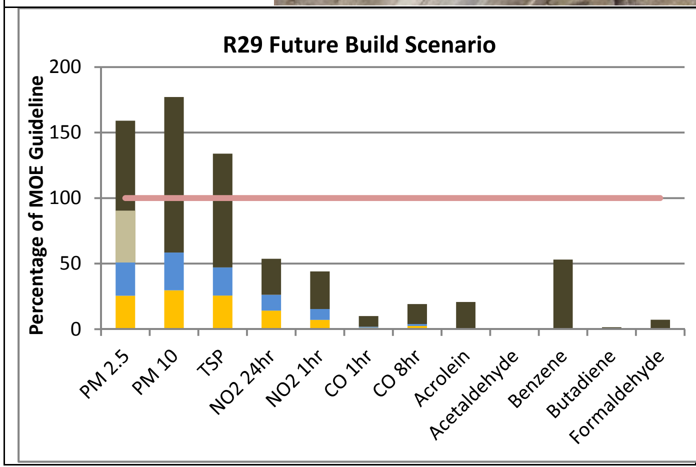
R27 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

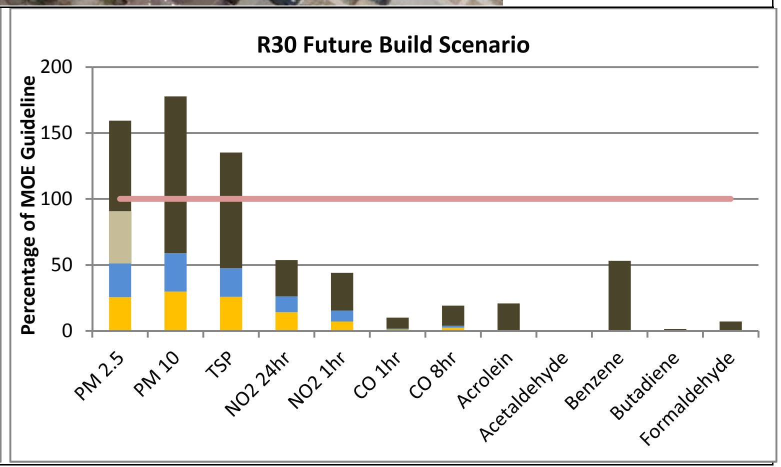
R_28



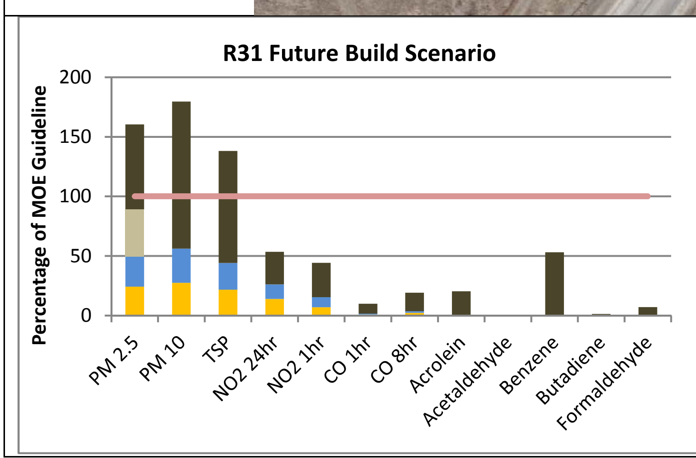
R28 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

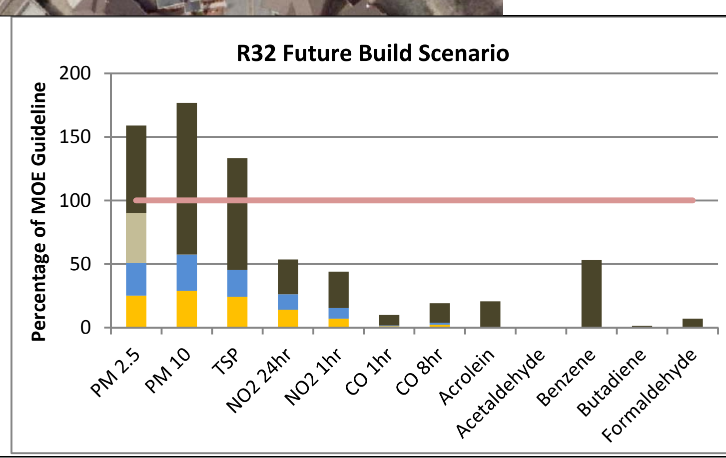

R_30
R_29

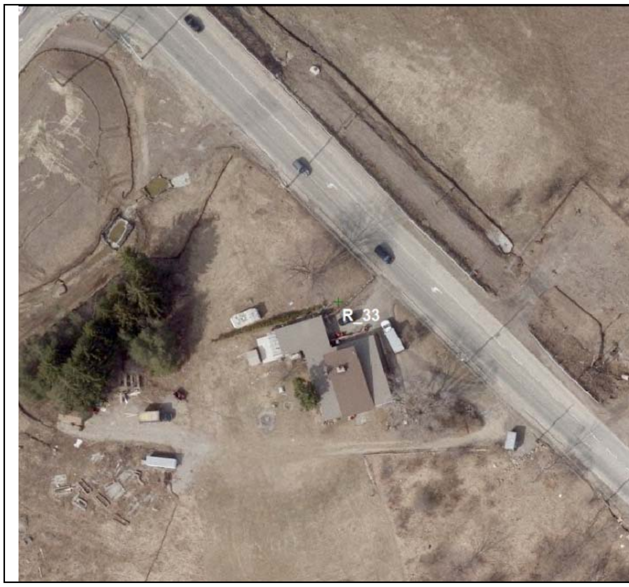

R29 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

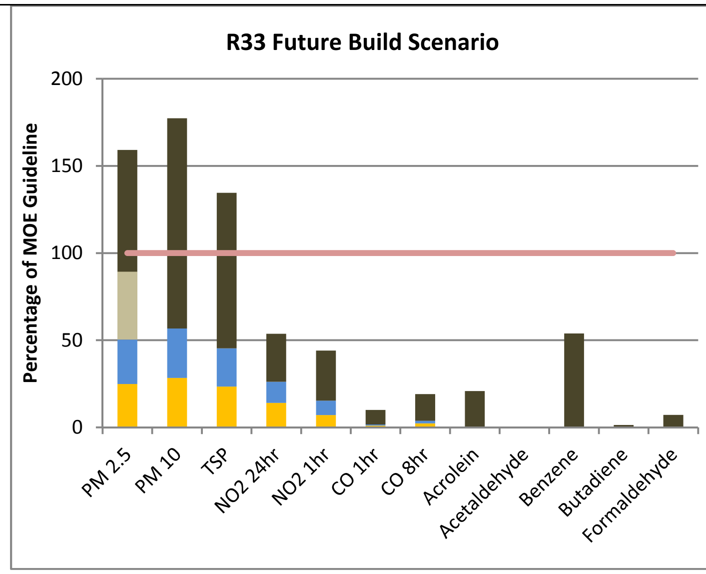

R30 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

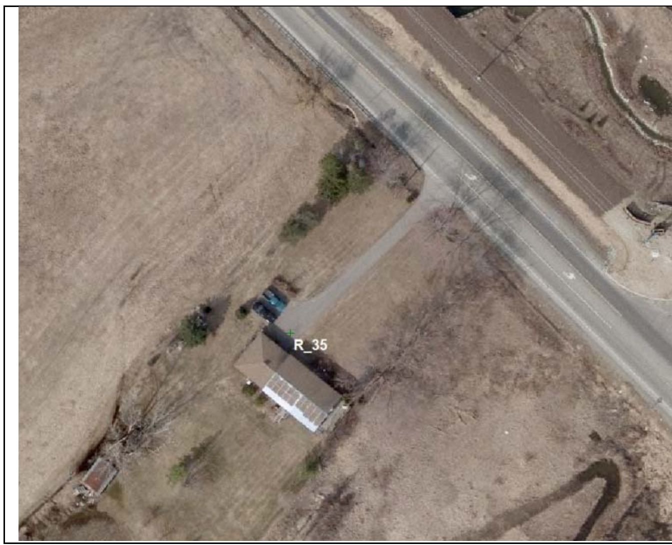

R_31
R_32

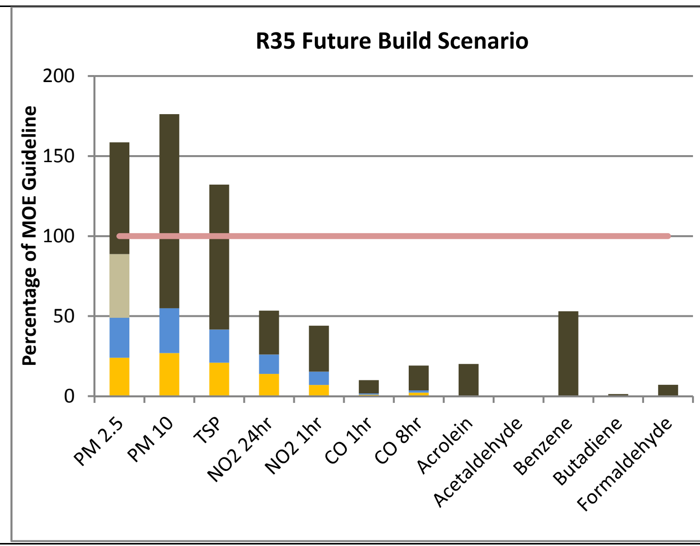

R31 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde


R32 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

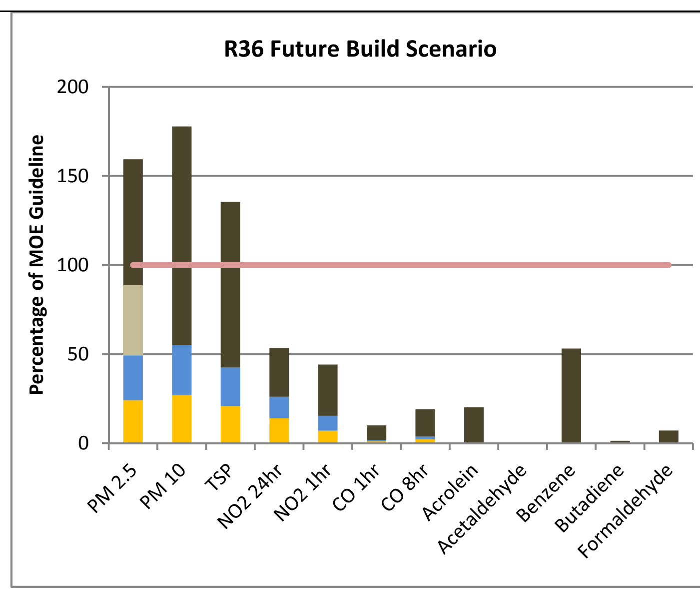

R_33

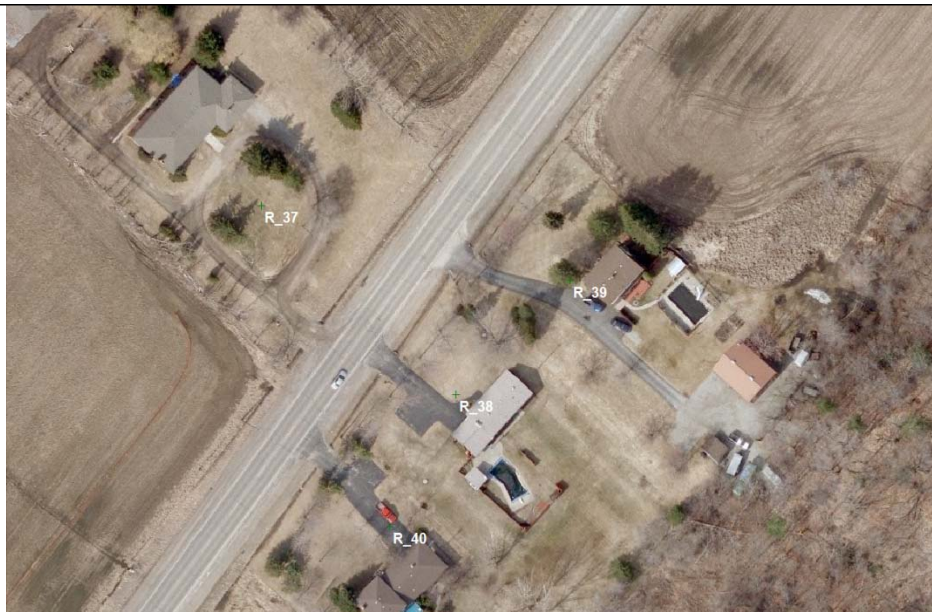

R33 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

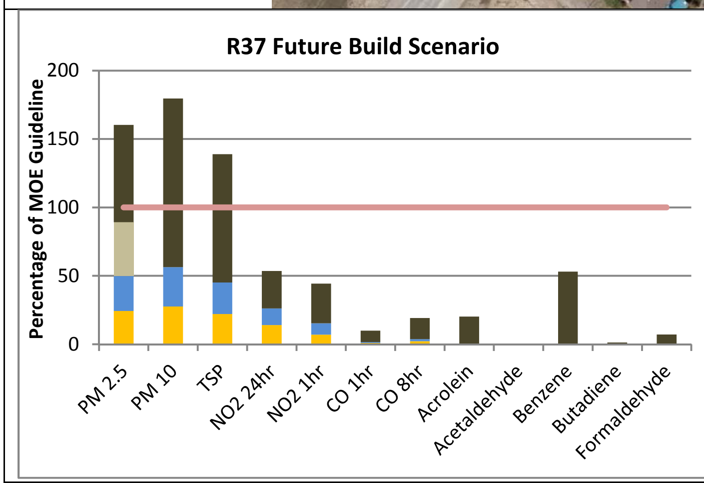

R_35

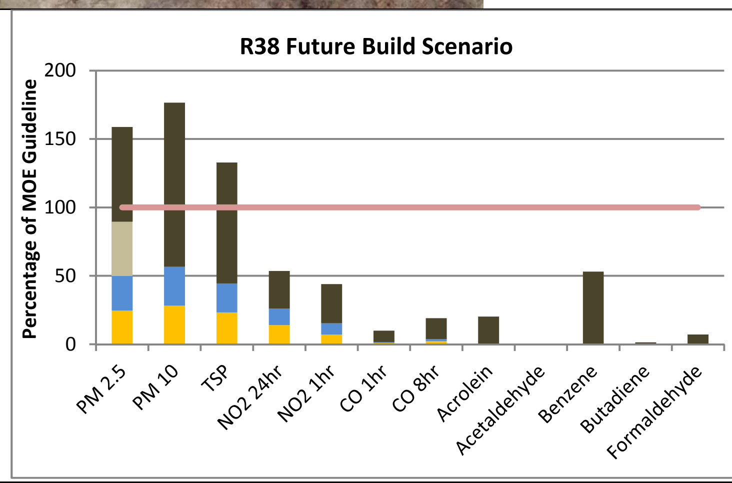

R35 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

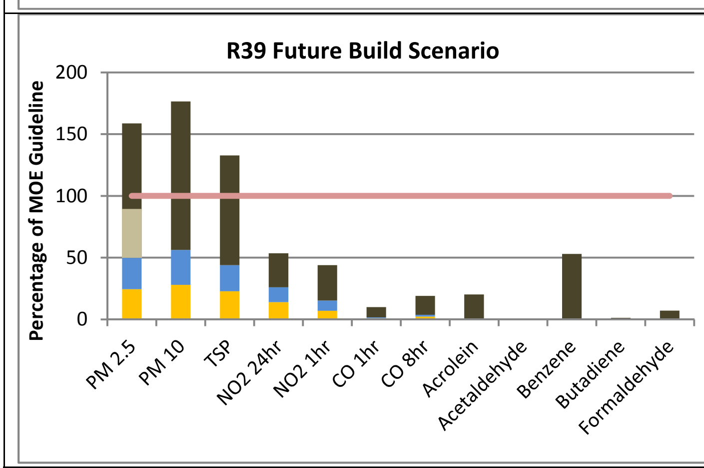

R_36

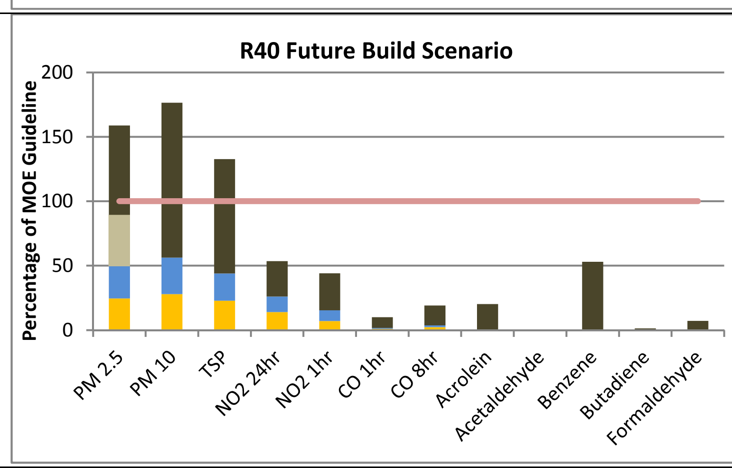

R36 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde


R_37
R_39
R_38
R_40

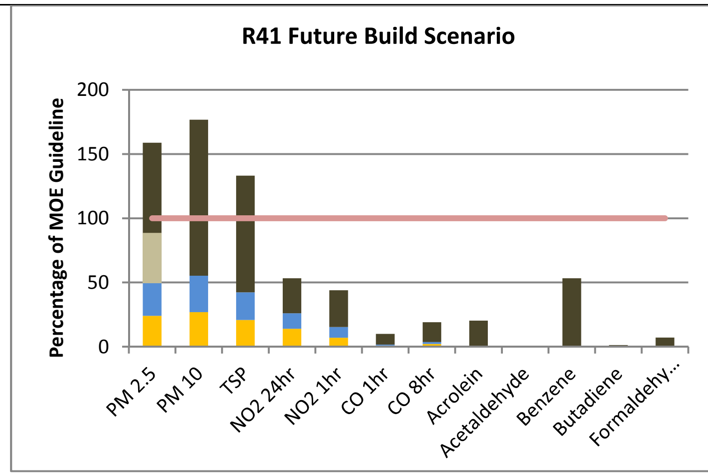

R37 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde


R38 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

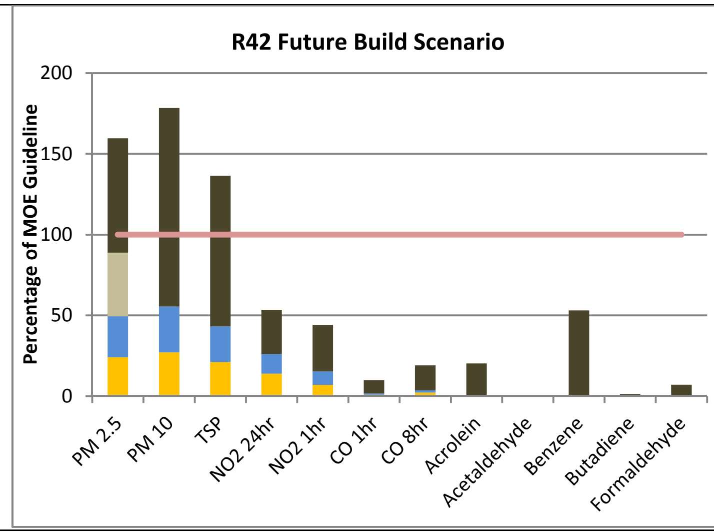

R39 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

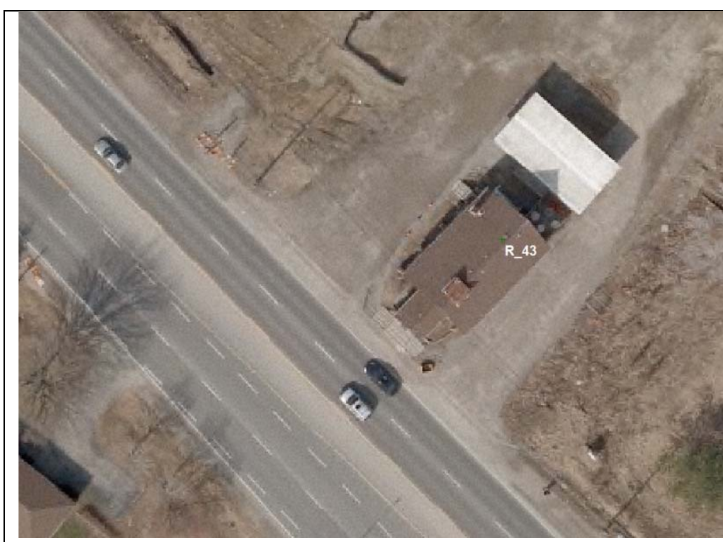

R40 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde

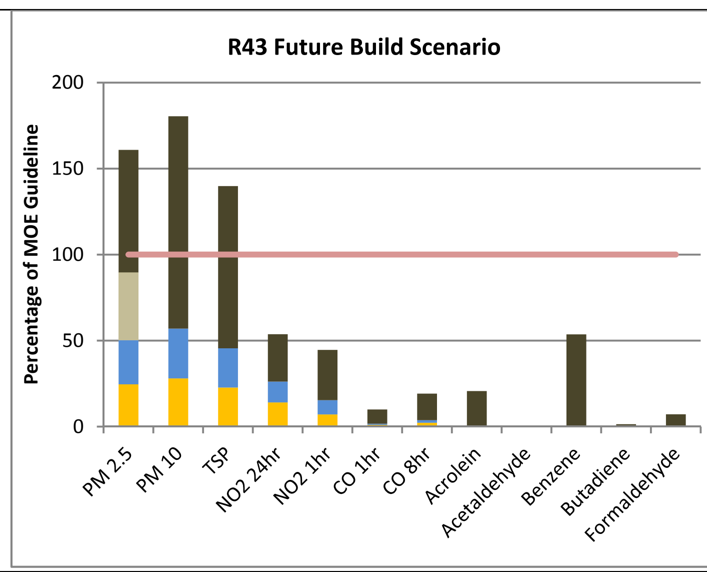

R_41

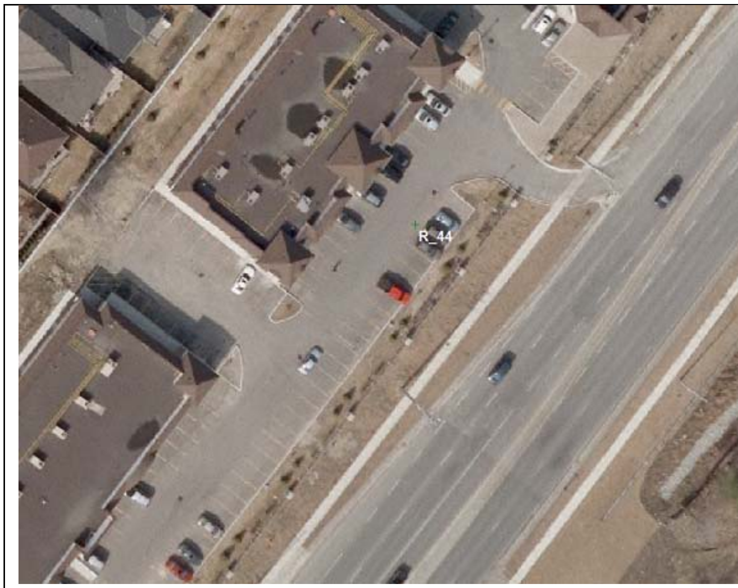

R41 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehy...

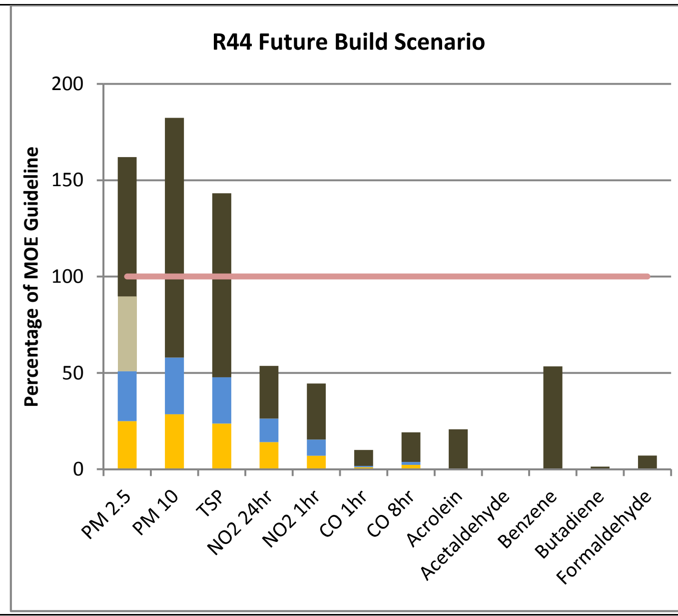

R_42


R42 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde


R_43


R43 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde


R_44


R44 Future Build Scenario
Percentage of MOE Guideline
200
150
100
50
0
PM 2.5
PM 10
TSP
NO2 24hr
NO2 1hr
CO 1hr
CO 8hr
Acrolein
Acetaldehyde
Benzene
Butadiene
Formaldehyde