yongeTOmorrow Environmental Study Report
July 2021

Appendix – yongeTOmorrow Air Quality Assessment

City of Toronto

Air Quality Assessment Yonge Street from Queen Street to Carlton/College Street

City of Toronto

SLR Project No: 241.16362.00000
July 2021

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From Queen Street to Carlton/College Street
SLR Project No: 241.16362.00000

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1. INTRODUCTION

Novus Environmental Inc. (Novus), now a part of SLR Consulting (Canada) Ltd., was retained by Steer Davies Gleave on behalf of the City of Toronto to conduct an air quality transportation assessment in Toronto, Ontario. The purpose of the assessment is to address the proposed Yonge Street roadway improvements from Queen Street to Carlton/College Street. This work is being done as part of the Municipal Class Environmental Assessment process.

1.1 PROJECT DESCRIPTION

The design and operation of Yonge Street has remained unchanged since the early 1900s – the public right-of-way on Yonge Street is 20 meters wide from Queen Street to Gerrard Street (**Figure 1**) and 26 meters from Gerrard Street to College / Carlton Street (**Figure 2**) each with four lanes of vehicular traffic (two southbound and two northbound) occupying about 13 m with the remaining 5m on each side of the road shared by public realm elements (transit stops, subway entrances, waste receptacles.) and pedestrians.

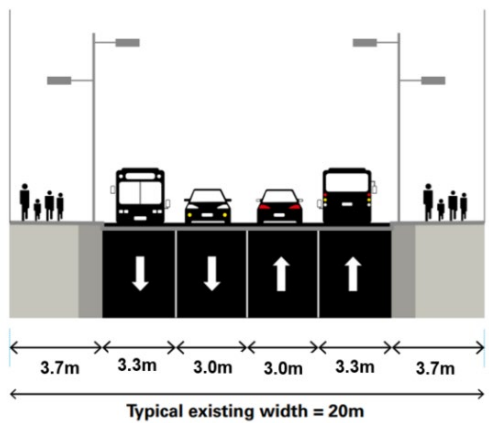


Figure 1: Typical Cross Section from Gerrard Street to Queen Street

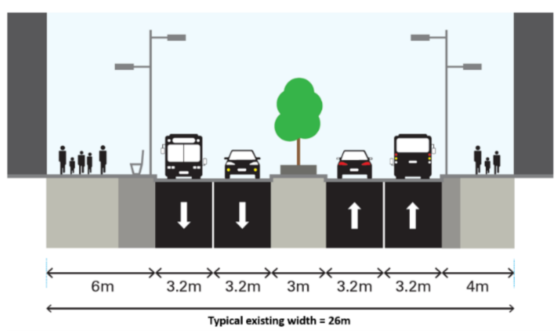


Figure 2: Typical Cross Section from College/Carlton Street to Gerrard Street

The preferred alternative (4C) reduces the road to:

- 6.6 meter wide, two lanes with mountable curbs and vehicular unit paving ;
- 2.7 meter wide furnishing, planting and café zone ;
- 4.0 meter wide (minimum) pedestrian clearway with pedestrian unit paving.

A typical cross section from Gerrard Street to Queen Street is shown in **Figure 3**.

Figure 3: Typical Cross Section from Gerrard Street to Queen Street

Thus, and by design, New Yonge Street will experience a heavy reduction in vehicle traffic – instead that traffic will be redirected to Yonge's two nearest neighbour streets: Bay and Church.

1.2 STUDY OBJECTIVES

The main objective of the study was to assess the local air quality impacts due to the proposed Yonge Street improvements. The study also includes an overview of construction impacts. To meet these objectives, the following scenarios were considered:

- 2041 Future Base (FB) – Assess the future air quality conditions at representative receptors in the absence of the project. Predicted contaminant concentrations from the existing traffic levels were combined with hourly measured ambient concentrations to determine combined impacts.
- 2041 Preferred Alterative (4C)– Assess the future air quality conditions with the proposed project in place. Predicted contaminant concentrations associated with traffic levels for the preferred alternatives were combined with hourly measured ambient concentrations to determine combined impacts.

The modelling considered vehicle emissions from Yonge Street, major intersecting roadways as well as Bay Street and Church Street. The roadway segments considered in this assessment are shown in Figure 4.

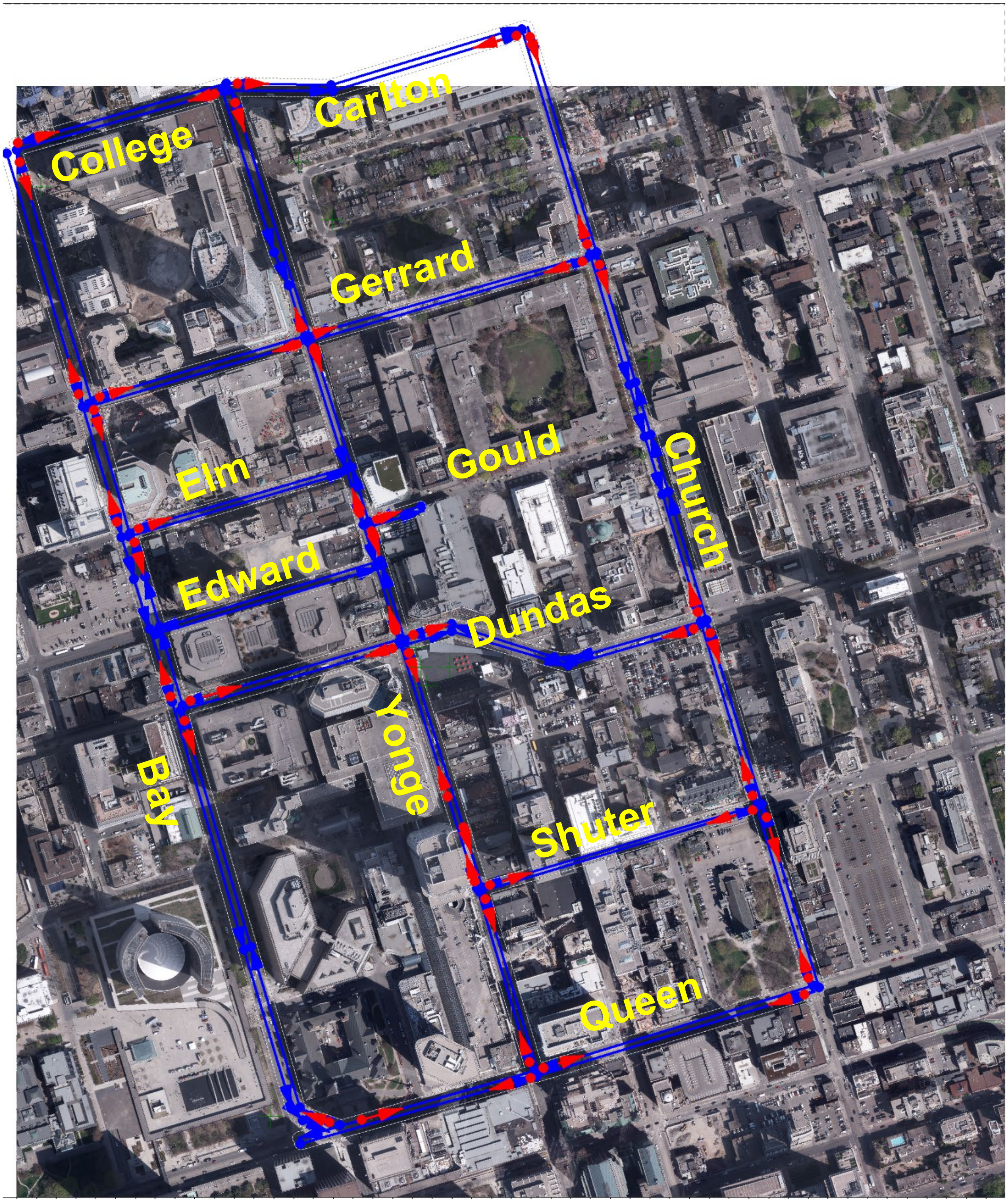


Figure 4: Modelled Road Segments in Study Area

1.3 CONTAMINANTS OF INTEREST

The contaminants of interest from vehicle emissions are based on the regularly assessed contaminants of interest for transportation assessments in Ontario, as determined by the Ministry of Transportation Ontario (MTO) and Ministry of Environment, Conservation and Parks (MECP). Motor vehicle emissions 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 MECP, Environment Canada (EC), Health Canada (HC), and the 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 5. 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. All of the selected contaminants are emitted during fuel combustion, while emissions from brake wear, tire wear, and breakdown of road dust include only the particulates. A summary of these contaminants is provided in Table 1.

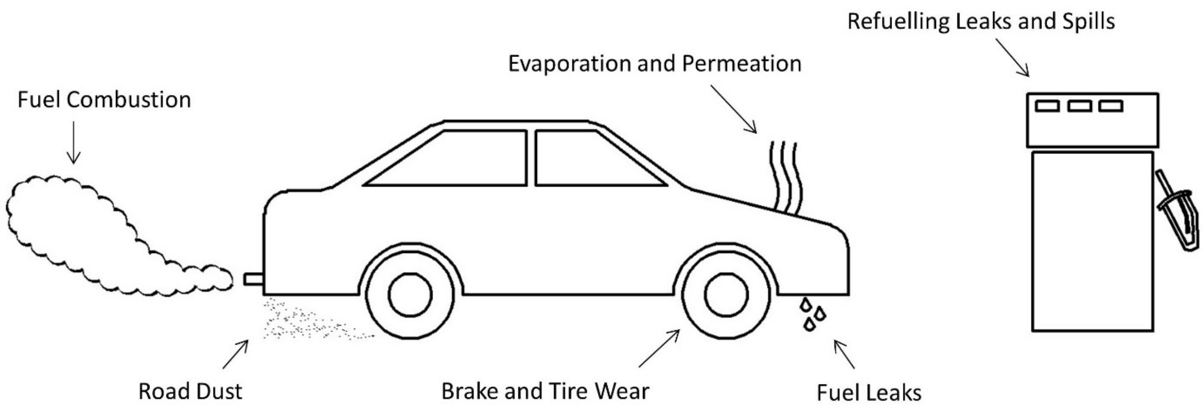


Figure 5: Typical Cross Section from Gerrard Street to Queen Street

Table 1: Contaminant of Interest

Contaminants		Volatile Organic Compounds (VOCs)	
Name	Symbol	Name	Symbol
Nitrogen Dioxide	NO_2	Acetaldehyde	C_2H_4O
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	CH_2O

1.4 APPLICABLE GUIDELINES

In order to understand the existing conditions in the study area, ambient background concentrations have been compared to guidelines established by government agencies and organizations. Relevant agencies and organizations in Ontario and Canada, and their applicable contaminant guidelines are:

- MECP Ambient Air Quality Criteria (AAQC);
- Health Canada/Environment Canada National Ambient Air Quality Objectives (NAAQOs); and
- Canadian Council of Ministers of the Environment (CCME) Canadian Ambient Air Quality Standards (CAAQS).

Within the guidelines, the threshold value for each contaminant and its applicable averaging period were used to assess the maximum predicted impact at sensitive receptors derived from computer simulations. The contaminants of interest are compared against 1-hour, 8-hour, 24-hour, and annual averaging periods. The threshold values and averaging periods used in this assessment are presented in **Table 2**. It should be noted that the CAAQS for $PM_{2.5}$ is not based on the maximum 24-hour concentration value; $PM_{2.5}$ is assessed based on the 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
	1	79 (42 ppb)[1]	CAAQS (standard is to be phased-in in 2025)
	Annual	23 (12 ppb)[2]	CAAQS (standard is to be phased-in in 2025)
CO	1	36,200	AAQC
	8	15,700	AAQC
$PM_{2.5}$	24	27[3]	CAAQS (standard is to be phased-in in 2020)
	Annual	8.8[4]	CAAQS
PM_{10}	24	50	Interim AAQC
TSP	24	120	AAQC
Acetaldehyde	24	500	AAQC
Acrolein	24	0.4	AAQC
	1	4.5	AAQC
Benzene	Annual	0.45	AAQC
	24	2.3	AAQC
1,3-Butadiene	24	10	AAQC
	Annual	2	AAQC
Formaldehyde	24	65	AAQC

[1] The 1-hour NO_2 CAAQs is based on the 3-year average of the annual 98th percentile of the NO_2 daily-maximum 1-hour average concentrations
[2] The annual CAAQs is based on the average over a single calendar year of all the 1-hour average NO_2 concentrations
[3]The 24-hr $PM_{2.5}$ CAAQS is based on the 3-year average of the annual 98th percentile of the 24-hr average concentrations
[2] The annual $PM_{2.5}$ CAAQS is based on the average of the three highest annual average values over the study period

1.5 GENERAL ASSESSMENT METHODOLOGY

The worst-case contaminant concentrations due to motor vehicle emissions from the roadways were predicted at nearby receptors using dispersion modelling software on an hourly basis for a five-year period. 2013-2017 historical meteorological data from Toronto Pearson Airport was used. Five years were modelled in order to capture the worst-case meteorological conditions. Two emission scenarios were assessed: 2041 Future Base and 2041 Preferred Alternative 4C.

Combined concentrations were determined by adding modelled and background (i.e., ambient data) concentrations together on an hourly basis. Background concentrations for all available contaminants were determined from MECP and NAPS (National Air Pollution Surveillance) stations nearest to the study area with applicable datasets.

Maximum 1-hour, 8-hour, 24-hour, and annual predicted combined concentrations were determined for comparison with the applicable guidelines using emission and dispersion models published by the U.S. Environmental Protection Agency (EPA). The worst-case predicted impacts are presented in this report; however, it is important to note that the worst-case impacts may occur infrequently and at only one receptor location.

2. BACKGROUND AMBIENT DATA

2.1 OVERVIEW

Background (ambient) conditions are measured contaminant concentrations that are independent of emissions from the proposed project infrastructure. These concentrations consist of trans-boundary (macro-scale), regional (meso-scale), and local (micro-scale) emission sources and result from 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 which usually occur in the summer season (MECP, 2005). During smog episodes, the U.S. contribution to $PM_{2.5}$ can be as much as 90 percent near the southwest Ontario-U.S. border. The effects of U.S. air pollution in Ontario on a high $PM_{2.5}$ day and on an average $PM_{2.5}$ spring/summer day are illustrated in **Figure 6.**

High $PM_{2.5}$ Days | **Average $PM_{2.5}$ of Spring/Summer Season**

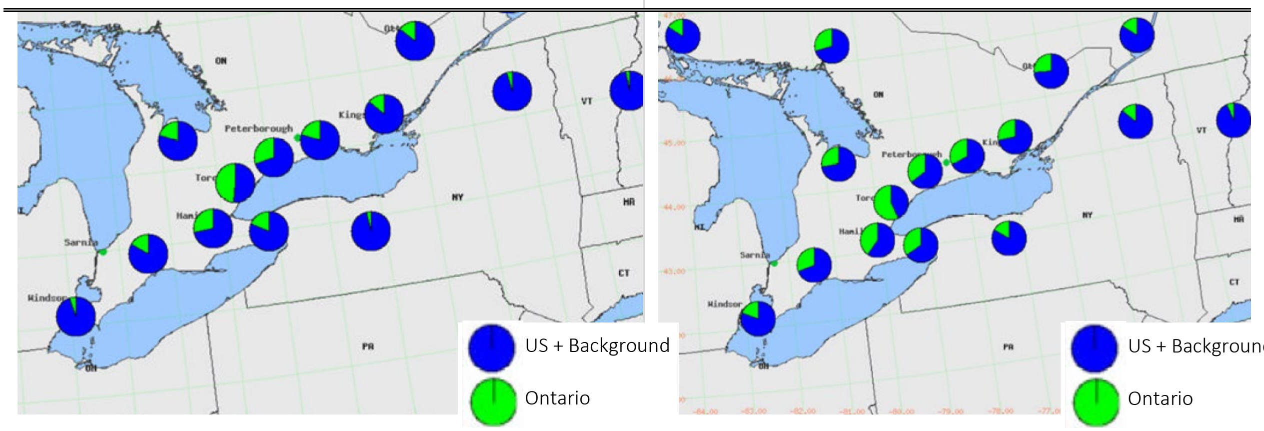


Figure 6: Effect of Trans-Boundary Air Pollution (MECP, 2005)

Air pollution is strongly influenced by weather systems (i.e., meteorology) that commonly 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 blowing from the southwest that can 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 simulation from the Weather Research and Forecasting (WRF) Model.

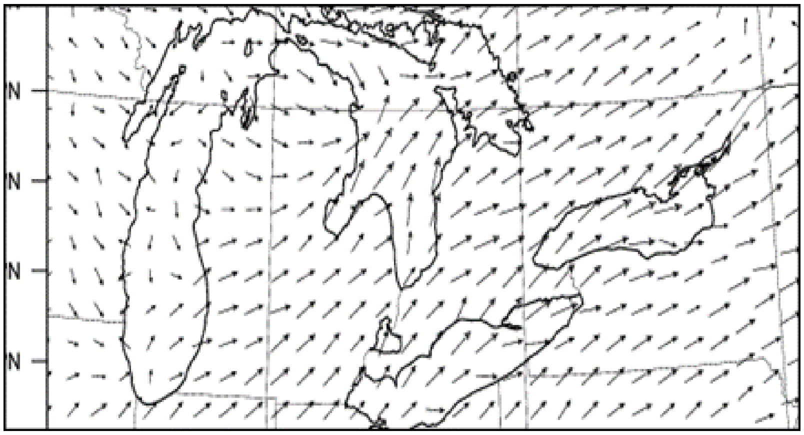


Figure 7: Typical Wind Direction during an Ontario Smog Episode

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

2.2 SELECTION OF RELEVANT AMBIENT MONITORING STATIONS

A review of MECP and NAPS ambient monitoring stations in Ontario was undertaken to identify the monitoring stations that are in relative proximity to the study area and that would be representative of background contaminant concentrations in the study area. The MECP (Toronto Downtown) station is located within 500 m of the site, and the NAPS (Toronto Downtown) station is located within 1.2 km of the site; therefore these monitoring stations were used to summarize background concentrations in the study area. Note that CO is only monitored at the Toronto West Station, therefore this station was used only to assess background CO concentrations. Also note that Windsor is the only station in Ontario at which background Acrolein, Formaldehyde, and Acetaldehyde are measured in recent years. Only these contaminants were considered from the Windsor station; the remaining contaminants from the Windsor station were not considered given the stations' distance from the study area. The locations of the relevant ambient monitoring stations in relation to the study area are shown in Figure 8. Station information is presented in Table 3.

Figure 8: Location of Ambient Monitoring Stations, Relevant to the Focus Area

Table 3: Relevant MECP and NAPS Station Information

City/Town	Station ID	Location	Operator	Contaminant
Toronto Downtown	31103	Bay St and Wellesley St. West	MECP	NO2|PM2.5
Toronto West	35125	125 Resources Rd	MECP	CO
Toronto Downtown	60427	223 College Street	NAPS	1,3-Butadiene|Benzene
Windsor West	60211	College St/Prince St	NAPS	Formaldehyde |Acetaldehyde | Acrolein

2.3 DETAILED ANALYSIS OF SELECTED WORST-CASE MONITORING STATIONS

Year 2013 to 2017 hourly ambient monitoring data from the selected stations were statistically summarized for the desired averaging periods: 1-hour, 8-hour, 24-hour, and annual. Note that for the NAPS stations (VOCs), data was unavailable for 2017, therefore, the 2016 data was used. Formaldehyde, acetaldehyde and acrolein are only measured at the Windsor station, and were not measured after 2010. Therefore 2006-2009 data was used for these VOCs.

Note that PM_{10} and TSP are not measured in Ontario; therefore, background concentrations were estimated by applying a $PM_{2.5}/PM_{10}$ ratio of 0.54 and a $PM_{2.5}$/TSP ratio of 0.3 (Lall et al., 2004). Ambient VOC data is not monitored hourly, but is typically measured every six days. To combine this dataset with the hourly modelled concentrations, each measured six-day value was applied to all hours between measurement dates, when there were 6 days between measurements. When there was greater than 6 days between measurements, the 90^{th} percentile measured value for the year in question was applied for those days in order to determine combined concentrations. This method is conservative as it applies a concentration that is higher than 90% of the measured concentrations whenever data was not available.

Table 4 shows the selected monitoring station for the various contaminants considered in the assessment.

Table 4: Selection of Background Monitoring Stations

Contaminant	Worst-Case Station	Contaminant	Worst-Case Station
CAAQ NO_2 (1-Hr)	Toronto Downtown	TSP	Toronto Downtown
CAAQ NO_2 (ann)	Toronto Downtown	1,3-Butadiene (24-hr)	Toronto Downtown
NO_2 (1-Hr)	Toronto Downtown	1,3-Butadiene (ann)	Toronto Downtown
NO_2 (24-Hr)	Toronto Downtown	Benzene (24-hr)	Toronto Downtown
CO (1-Hr)	Toronto West	Benzene (ann)	Toronto Downtown
CO (8-hr)	Toronto West	Formaldehyde	Windsor
$PM_{2.5}$ (24-hr)	Toronto Downtown	Acrolein	Windsor
$PM_{2.5}$ (ann)	Toronto Downtown	Acetaldehyde	Windsor
Pm_{10}	Toronto Downtown		

A detailed statistical analysis of the selected worst-case background monitoring station for each of the contaminants was performed and is summarized in **Figure 9**. Presented is the average, 90th percentile, and maximum concentrations as a percentage of the guideline for each contaminant from the worst-case monitoring station determined above. Maximum ambient concentrations represent a single worst-case value. The 90th percentile concentration represents a reasonably worst-case background concentration, and the average concentration represents a typical background value. The 98th percentile concentration is shown for $PM_{2.5}$, as the guideline for $PM_{2.5}$ is based on 98th percentile concentrations.

Based on a review of ambient monitoring data from 2013-2017, all background concentrations were below their respective guidelines with the exception of 24-hour PM_{10}, 24-hour TSP, and annual benzene. It should be noted that PM_{10} and TSP were calculated based on their relationship to $PM_{2.5}$. In addition, the 1-hour and annual NO_2 CAAQS standards are not met.

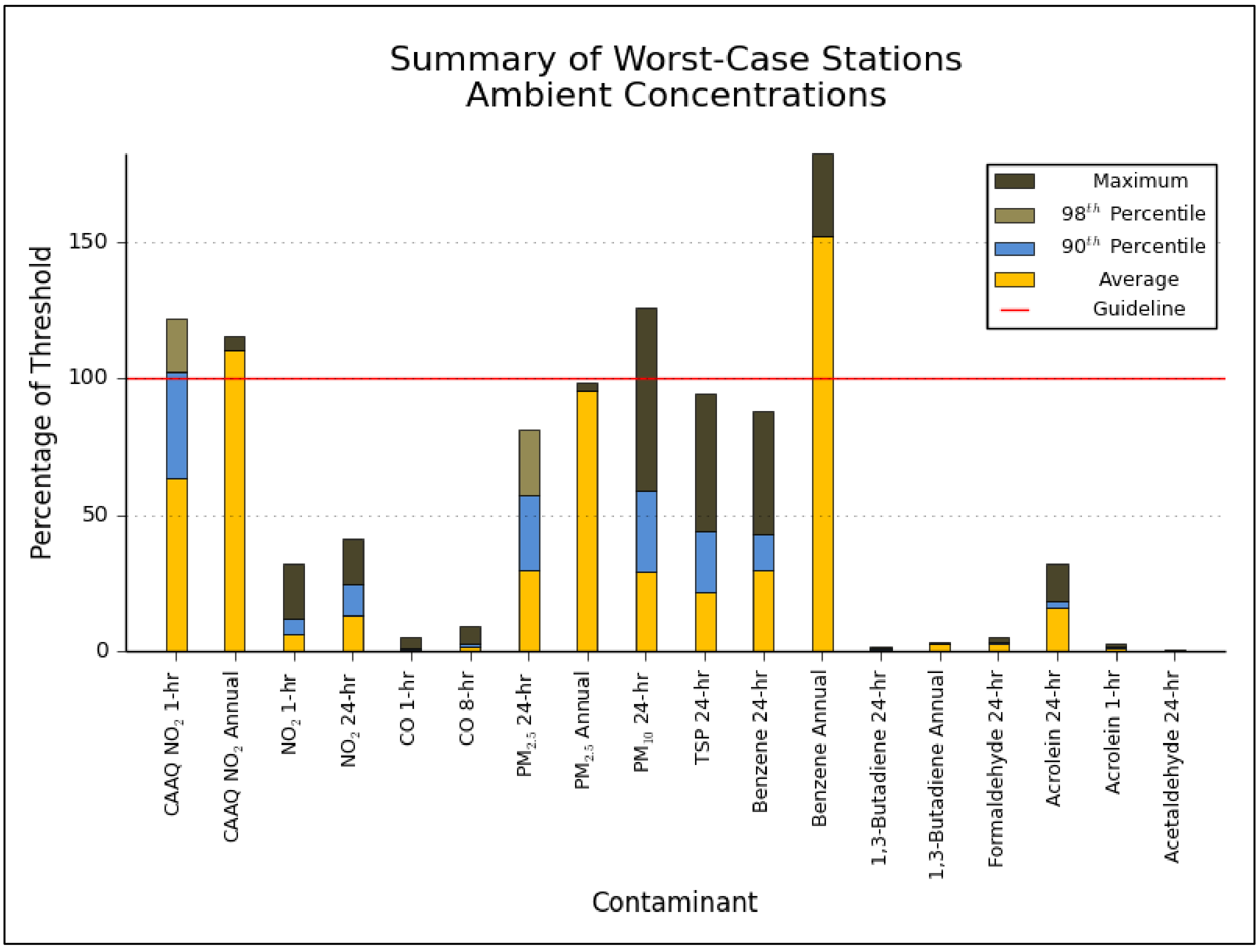


Figure 9: Worst-Case Summary of Ambient Background Concentrations

3. LOCAL AIR QUALITY ASSESSMENT

3.1 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;
- Childcare facilities;
- Educational facilities;
- Places of worship; and
- Residential dwellings.

Ten sensitive receptor locations were selected to be representative of potential impacts within the study area. Seven were selected within the main Yonge Street Corridor. Three additional sensitive receptors were placed along Bay and Church Street where traffic volumes are expected to increase slightly. The sensitive receptors considered in the air quality assessment are shown in Figure 10.

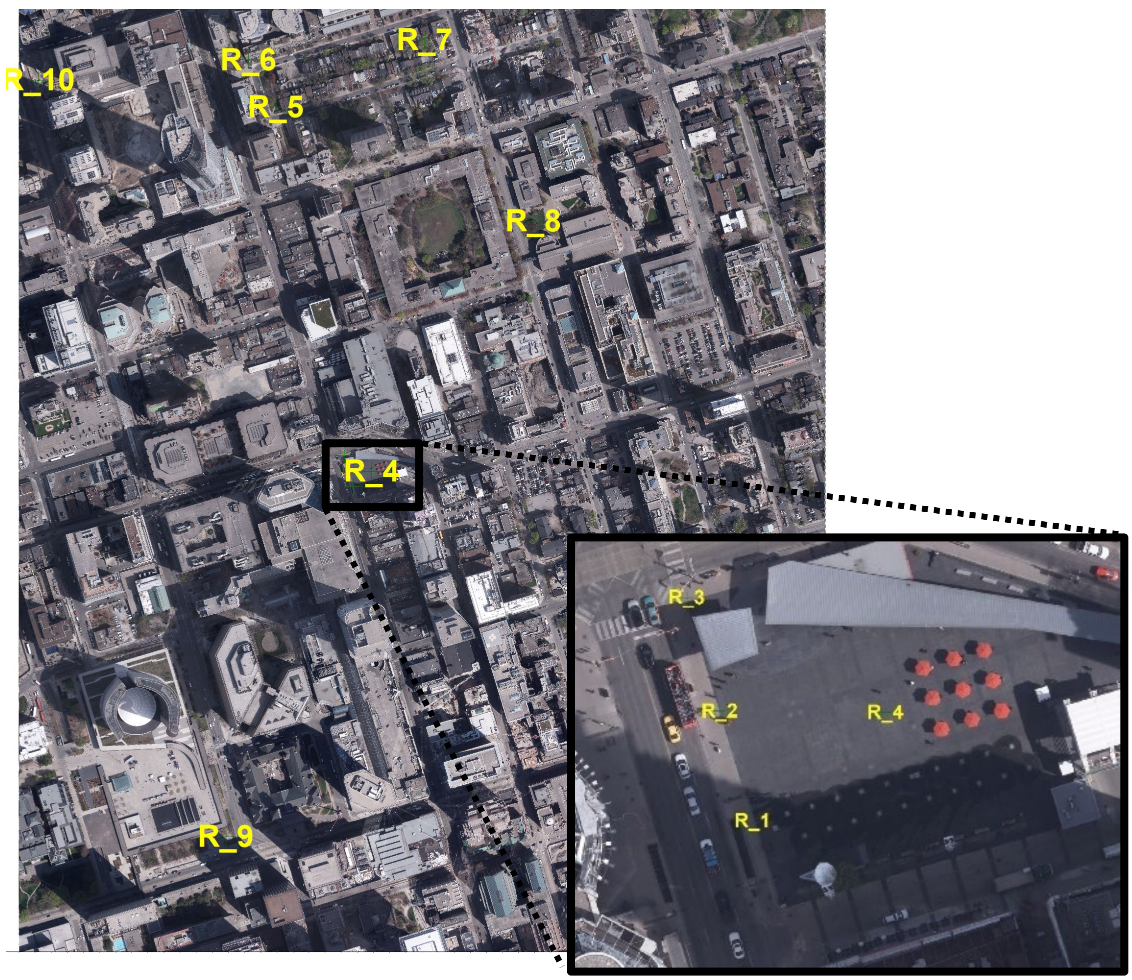


Figure 10: Sensitive Receptor Locations

3.2 ROAD TRAFFIC DATA

Traffic data was provided by Steer Davies Gleave in the form of peak PM traffic for each roadway within the study area. Annual Average Daily Traffic (AADT) volumes were derived from the PM peak flows for both the 2041 Future Base and 2041 preferred alternative 4C configurations, assuming peak hour is equal to 12% of the AADT%. The AADT volumes used in the assessment are shown in Table 5. Vehicle speeds were also provided for each roadway segment. The average speed for each segment was calculated for use in the assessment, and is shown in Table 6.

Lastly, average heavy duty vehicle percentage was determined for Bay Street, Yonge Street, and Church Street within the study area using client provided TMC Flow data. The heavy-duty vehicle percentages considered in the assessment are 4.5%, 3.44%, and 3.14% for Bay Street, Yonge Street and Church Street, respectively. Heavy and medium truck split was assumed to be 50/50. Hourly traffic volumes were not available, the therefore the US EPA standard off-network and urban weekday hourly distribution was used both scenarios. The hourly distributions are shown in Table 7.

Table 5a: Traffic Volumes (AADT – Vehicles/Day) Used in the Assessment

From ↓ On →	Bay				Yonge				Church			
	Southbound		Northbound		Southbound		Northbound		Southbound		Northbound	
	Future Base	Preferred Alternative	Future Base	Preferred Alternative	Future Base	Preferred Alternative	Future Base	Preferred Alternative	Future Base	Preferred Alternative	Future Base	Preferred Alternative
College to Gerrard	4667	4539	6764	6867	2063	242	3058	446	4325	4344	5378	5461
Gerrard to Elm	4758	4317	7017	7725	1692	0	3833	0	4208	4625	3933	4600
Elm to Gould	4700	4333	5742	6300	2017	133	4000	0	4133	4583	3933	4683
Gould to Edward	4033	3933	5742	6550	2292	1333	3733	0	4242	5000	3233	4300
Edward to Dundas	3871	4479	5621	5929	2208	0	3325	0	3908	4767	3250	4325
Dundas to Shuter	3761	3939	5564	5644	2008	0	3381	106	3642	4567	2533	4629
Shuter to Queen	4292	4283	4150	3900	1317	1204	3854	2050	3471	4229	2942	4263

Table 5b: Traffic Volumes (AADT – Vehicles/Day) Used in the Assessment

On ↓ From →	Bay to Yonge				Yonge to Church			
	Eastbound		Westbound		Eastbound		Westbound	
	Future Base	Preferred Alternative	Future Base	Preferred Alternative	Future Base	Preferred Alternative	Future Base	Preferred Alternative
College	4625	3825	6400	6092	4897	4769	5925	5386
Gerrad	3878	3722	3946	4271	4400	4842	4463	4146
Elm	892	129	1363	129	N/A	N/A	N/A	N/A
Gould	N/A	N/A	N/A	N/A	633	1317	133	117
Edward	1454	2121	1758	854	N/A	N/A	N/A	N/A
Dundas	5129	5613	6567	8004	5268	5060	6710	6987
Shuter	N/A	N/A	N/A	N/A	2382	2117	3160	3258
Queen	5342	5381	7017	6944	5558	5908	6190	5813

Table 6a: Vehicle Speed Used in the Assessment

From ↓ On →	Bay				Yonge				Church			
	Southbound		Northbound		Southbound		Northbound		Southbound		Northbound	
	Future Base	Preferred Alternative	Future Base	Preferred Alternative	Future Base	Preferred Alternative	Future Base	Preferred Alternative	Future Base	Preferred Alternative	Future Base	Preferred Alternative
College to Gerrard	30	26	22	23	15	20	15	29	32	33	32	31
Gerrard to Elm	25	25	24	25	39	0	18	0	42	41	23	18
Elm to Gould	34	34	22	26	20	12	20	0	24	24	42	39
Gould to Edward	34	32	23	24	22	26	15	0	38	41	26	24
Edward to Dundas	23	13	29	30	7	0	32	0	8	14	41	41
Dundas to Shuter	24	24	19	19	16	0	15	21	29	29	19	16
Shuter to Queen	24	26	11	10	16	30	15	25	27	34	29	31

Table 6b: Vehicle Speed Used in the Assessment

On ↓ From →	Bay to Yonge				Yonge to Church			
	Eastbound		Westbound		Eastbound		Westbound	
	Future Base	Preferred Alternative	Future Base	Preferred Alternative	Future Base	Preferred Alternative	Future Base	Preferred Alternative
College	17	17	18	17	26	27	16	15
Gerrad	18	17	23	24	25	22	20	24
Elm	22	11	21	19	N/A	N/A	N/A	N/A
Gould	N/A	N/A	N/A	N/A	7	15	22	22
Edward	21	14	22	11	N/A	N/A	N/A	N/A
Dundas	20	21	7	15	27	27	26	23
Shuter	N/A	N/A	N/A	N/A	22	26	26	27
Queen	20	21	19	18	22	22	26	25

Table 7: US EPA Off-Network, Urban, Hourly Vehicle Distribution

Hour	MON	TUE	WED	THU	FRI	SAT	SUN
1	0.9%	0.9%	0.9%	0.9%	0.9%	2.2%	2.2%
2	0.6%	0.6%	0.6%	0.6%	0.6%	1.4%	1.4%
3	0.5%	0.5%	0.5%	0.5%	0.5%	1.0%	1.0%
4	0.4%	0.4%	0.4%	0.4%	0.4%	0.8%	0.8%
5	0.6%	0.6%	0.6%	0.6%	0.6%	0.7%	0.7%
6	1.9%	1.9%	1.9%	1.9%	1.9%	1.0%	1.0%
7	4.6%	4.6%	4.6%	4.6%	4.6%	1.9%	1.9%
8	6.9%	6.9%	6.9%	6.9%	6.9%	2.6%	2.6%
9	6.1%	6.1%	6.1%	6.1%	6.1%	3.8%	3.8%
10	5.0%	5.0%	5.0%	5.0%	5.0%	4.8%	4.8%
11	5.1%	5.1%	5.1%	5.1%	5.1%	5.9%	5.9%
12	5.4%	5.4%	5.4%	5.4%	5.4%	6.5%	6.5%
13	5.8%	5.8%	5.8%	5.8%	5.8%	7.1%	7.1%
14	5.9%	5.9%	5.9%	5.9%	5.9%	7.1%	7.1%
15	6.2%	6.2%	6.2%	6.2%	6.2%	7.1%	7.1%
16	7.1%	7.1%	7.1%	7.1%	7.1%	7.2%	7.2%
17	7.7%	7.7%	7.7%	7.7%	7.7%	7.1%	7.1%
18	7.9%	7.9%	7.9%	7.9%	7.9%	6.8%	6.8%
19	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%
20	4.4%	4.4%	4.4%	4.4%	4.4%	5.2%	5.2%
21	3.5%	3.5%	3.5%	3.5%	3.5%	4.3%	4.3%
22	3.1%	3.1%	3.1%	3.1%	3.1%	3.9%	3.9%
23	2.5%	2.5%	2.5%	2.5%	2.5%	3.2%	3.2%
24	1.9%	1.9%	1.9%	1.9%	1.9%	2.4%	2.4%

3.3 MEREOLOGICAL DATA

2013-2017 hourly meteorological data was obtained from the Pearson International Airport in Toronto and upper air data was obtained from Buffalo, New York as recommended by the MECP for the study area. The combined data was processed to reflect conditions at the study area using the U.S. EPA's PCRAMMET software program which prepares meteorological data for use with the CAL3QHCR vehicle emission dispersion model. A wind frequency diagram (wind rose) is shown in **Figure 11**.

As can be seen in this figure, predominant winds are from the south-westerly through northerly directions.

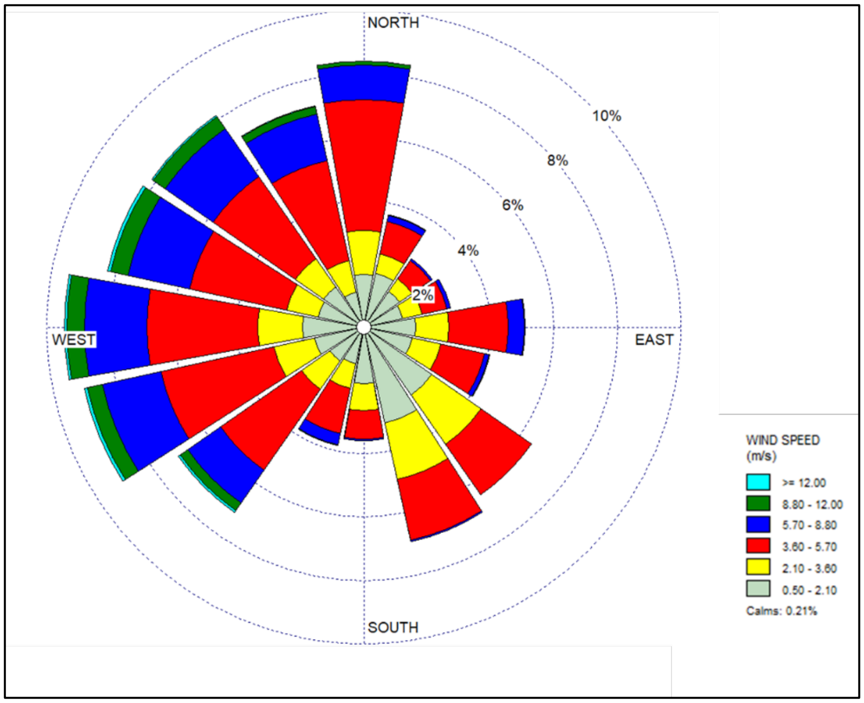


Figure 11: Wind Frequency Diagram for Toronto Pearson International Airport (2013-2017)

3.4 MOTOR VEHICLE EMISSION RATES

The U.S. EPA's Motor Vehicle Emission Simulator (MOVES) model provides estimates of current and future emission rates from motor vehicles based on a variety of factors such as local meteorology, vehicle fleet composition and speed. MOVES 2014b, released in December 2018, is the U.S. EPA's tool for estimating vehicle emissions due to the combustion of fuel, brake and tire wear, fuel evaporation, permeation, and 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. Emission rates were estimated based on the heavy-duty vehicle percentages provided by WSP. Vehicle age was based on the U.S. EPA's default distribution. **Table 8** specifies the major inputs into MOVES.

From the MOVES outputs, the highest monthly value for each contaminant was selected to represent a worst-case emission rate. The emission rates for each vehicle speed and contaminant modelled are shown in **Table 9** for the Existing and Future Build years, for a heavy/medium duty vehicle percentage of 2.25%. As shown in **Table 9**, emissions in the future year are generally predicted to decrease.

Table 8: MOVES Input Parameters

Parameter	Input
Scale	Custom County Domain
Meteorology	Temperature and Relative Humidity were obtained from meteorological data from the Environment Canada Toronto INTL A station for the years 2013 to 2017.
Years	2041 (Future Base) and 2041 (4C)
Geographical Bounds	Custom County Domain
Fuels	Compressed Natural Gas / Diesel Fuels / Gasoline Fuels
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 Arterial
Contaminants and Processes	NO_2 / CO / $PM_{2.5}$ / PM_{10} / Acetaldehyde / Acrolein / Benzene / 1,3-Butadiene / Formaldehyde/Equivalent CO_2 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 for the roadway.

Table 9: US EPA Off-Network, Urban, Hourly Vehicle Distribution

Year	Speed (Km/hr)	CO	NO_X	Benzene	1,3-Butadiene	Formaldehyde	Acetaldehyde	Acrolein	$PM_{2.5}$	PM_{10}	TSP[1]
2041	5-12	1.89	0.16	3.03E-03	7.99E-06	2.88E-03	1.02E-03	1.36E-04	3.83E-02	2.45E-01	2.45E-01
2041	13-20	1.41	0.11	1.74E-03	4.25E-06	1.57E-03	5.63E-04	7.48E-05	2.37E-02	1.47E-01	1.47E-01
2041	21-28	1.25	0.09	1.31E-03	2.91E-06	1.11E-03	4.02E-04	5.31E-05	1.83E-02	1.10E-01	1.10E-01
2041	27-36	1.11	0.08	1.09E-03	2.23E-06	8.80E-04	3.20E-04	4.21E-05	1.54E-02	9.01E-02	9.01E-02
2041	37-44	0.91	0.07	9.40E-04	1.86E-06	7.44E-04	2.72E-04	3.56E-05	1.35E-02	7.94E-02	7.94E-02

[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.

3.5 RE-SUSPENDED PARTICULATE MATTER EMISSION RATES

A large portion of highway particulate matter emissions comes from dust on the pavement which is re-suspended by vehicles travelling on the highway. 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 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 10**.

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

Where: E = the particulate emission factor
k = the particulate size multiplier
sL = silt loading
W = average vehicle weight (Assumed 3 Tons based on fleet data and U.S. EPA vehicle weight and distribution)

Table 10: 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	0.03299	0.13195	0.368

3.6 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, 24-hour and annual averages for the contaminants of interest at the identified sensitive receptor locations. Table 11 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 vehicle fleet distributions provided. The outputs of CAL3QHCR are presented in the results section.

Table 11: CAL3QHCR Model Input Parameters

Parameter	Input
Free-Flow and Queue 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 input in grams/VMT or grams per vehicle hour. Signal timings for the traffic signal were input in seconds.
Meteorological Data	2013-2017 data from Pearson Intl' Airport
Deposition Velocity	$PM_{2.5}$: 0.1 cm/s PM_{10}: 0.5 cm/s TSP: 0.15 cm/s NO_2, CO and VOCs: 0 cm/s
Settling Velocity	$PM_{2.5}$: 0.02 cm/s PM_{10}: 0.3 cm/s TSP: 1.8 cm/s CO, NO_2, and VOCs: 0 cm/s
Surface Roughness	The land type surrounding the project site is categorized as suburban. Therefore a surface roughness height of 100 cm was applied in the model.
Vehicle Emission Rate	Emission rates calculated in MOVES and AP-42 were input in g/VMT

3.7 MODELLING RESULTS

Presented below are the modelling results for the 2041 Future Base and 2041 Preferred Alternative 4C scenarios based on 5-years of meteorological data. For each 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 receptors for each contaminant and averaging period (see Table 12), which were identified as the maximum combined concentration for the 2041 Preferred Alternative 4C 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 may only occur for one hour or day over the 5-year period.

Table 12: Worst-Case Sensitive Receptors for 2041 Future Build Scenario

Contaminant	Averaging Period	Sensitive Receptor
CAAQ NO_2	1-hour	3
	Annual	3
NO_2	1-hour	3
	24-hour	3
CO	1-hour	3
	8-hour	3
$PM_{2.5}$	24-hour	3
	Annual	3
PM_{10}	24-hour	10
TSP	24-hour	10
1,3-Butadiene	24-hour	1
	Annual	1
Formaldehyde	24-hour	3
Benzene	24-hour	3
	Annual	3
Acrolein	1-hour	3
	24-hour	3
Acetaldehyde	24-hour	3

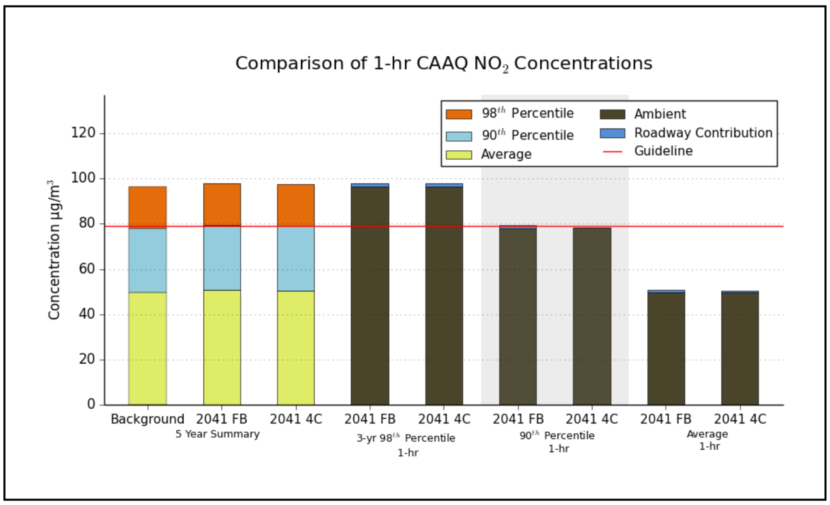
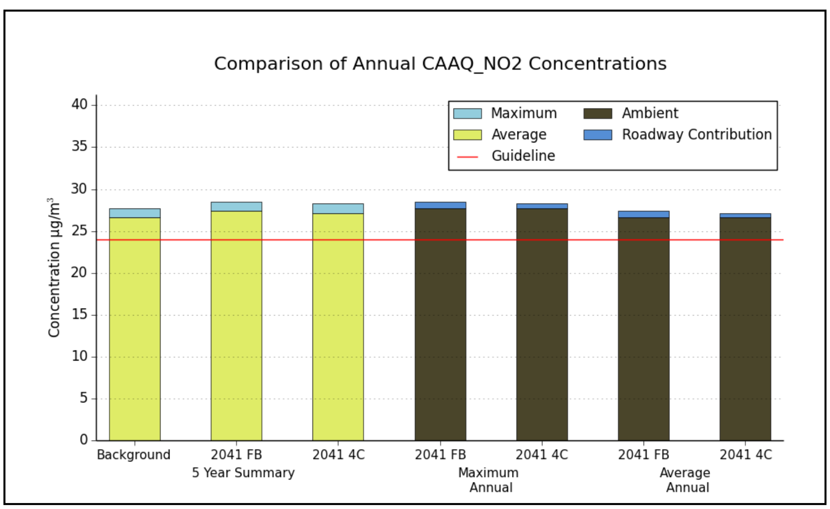
Coincidental hourly modelled roadway and background concentrations were added to derive the combined concentration for each hour over the 5-year period. Hourly combined concentrations were then used to determine contaminant concentrations based on the applicable averaging period. Statistical analysis 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 (or 3-year average annual 98th percentile concentration in the case of $PM_{2.5}$) was used to assess compliance with MECP guidelines or CAAQS. 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 contaminants of interest.

3.7.1 NITROGEN DIOXIDE CAAQS

Table 13 presents the predicted combined concentrations for the worst-case sensitive receptor for 1-hour and annual NO_2 based on 5 years of meteorological data. The results conclude that:

- *The annual 98th percentile of daily maximum 1-hour NO_2 concentration, averaged over three consecutive years exceeds the CAAQS with an 5% contribution from the roadway.*
- *The annual average concentration exceeded the guideline with a 2% contribution from the roadway.*

Table 13: Summary of Predicted NO_2 Concentrations

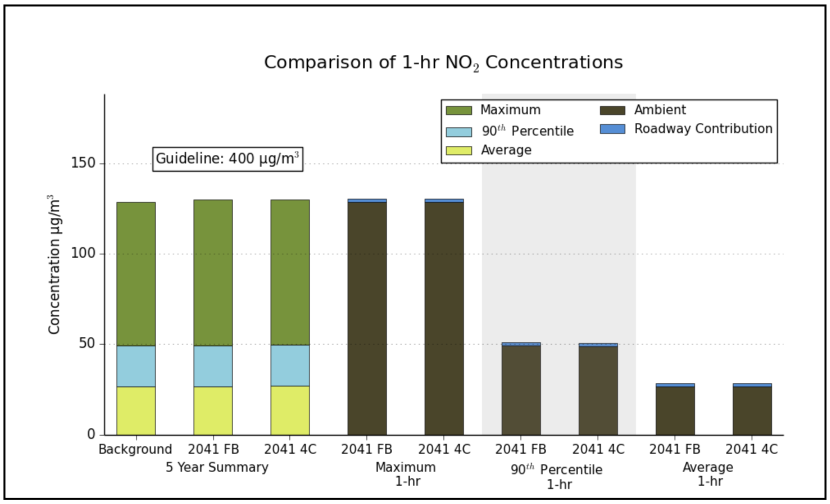
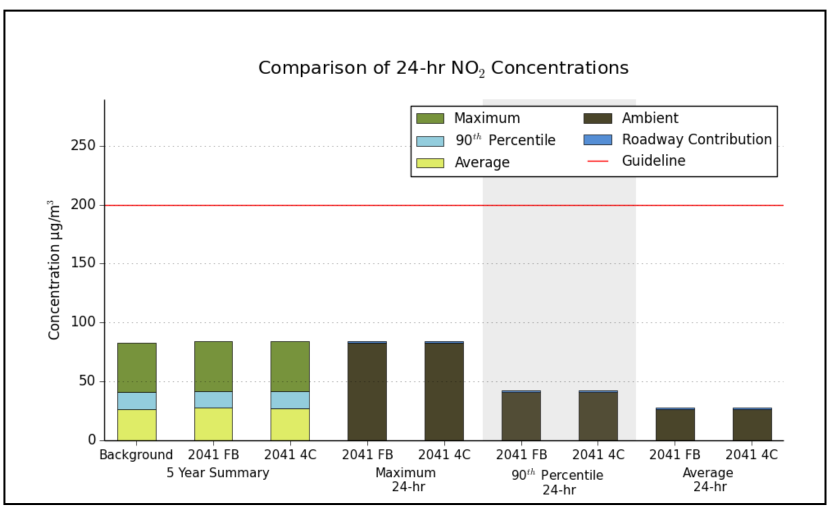
<table>
<tr><th>Statistical Analysis</th><th colspan="2">2041 4C</th></tr>
<tr><td rowspan="9">
</td><td colspan="2">% of CAAQS Guideline:</td></tr>
<tr><td>98th Percentile</td><td>124%</td></tr>
<tr><td>90th Percentile</td><td>100%</td></tr>
<tr><td>Average</td><td>64%</td></tr>
<tr><td colspan="2">Roadway Contribution:</td></tr>
<tr><td>98th Percentile</td><td>5%</td></tr>
<tr><td>90th Percentile</td><td>1%</td></tr>
<tr><td>Average</td><td>2%</td></tr>
<tr><td colspan="2">Maximum combined concentrations exceed the 1-hour CAAQ Guideline. Note that the maximum background concentrations alone exceed the CAAQ's 1-hr objective of 79 µg/m³. Also note that this objective is based on the 3-year average of the annual 98th percentile of the NO2 daily-maximum 1-hour average concentrations.</td></tr>
<tr><td rowspan="7">
</td><td colspan="2">% of CAAQs Guideline:</td></tr>
<tr><td>Maximum</td><td>118%</td></tr>
<tr><td>Average</td><td>113%</td></tr>
<tr><td colspan="2">Roadway Contribution:</td></tr>
<tr><td>Maximum</td><td>2%</td></tr>
<tr><td>Average</td><td>2%</td></tr>
<tr><td colspan="2">Maximum combined concentrations exceed the annual CAAQ Guideline. Note that the maximum background concentrations alone exceed the CAAQ's annual objective of 24 µg/m³.</td></tr>
</table>

3.7.2 NITROGEN DIOXIDE

Table 14 presents the predicted combined concentrations for the worst-case sensitive receptor for 1-hour and 24-hour NO_2 based on 5 years of meteorological data. The results conclude that:

- *Both the maximum 1-hour and 24-hour NO_2 combined concentrations were below their respective MECP guidelines.*

Table 14: Summary of Predicted NO_2 Concentrations

<table>
<tr><th>Statistical Analysis</th><th colspan="2">2041 4C</th></tr>
<tr><td rowspan="8">
</td><td colspan="2">% of MECP Guideline:</td></tr>
<tr><td>Maximum</td><td>32%</td></tr>
<tr><td>90th Percentile</td><td>12%</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>2%</td></tr>
<tr><td rowspan="8">
</td><td colspan="2">% of MECP Guideline:</td></tr>
<tr><td>Maximum</td><td>42%</td></tr>
<tr><td>90th Percentile</td><td>21%</td></tr>
<tr><td>Average</td><td>14%</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 MECP guidelines.
• The contribution from the roadway to the combined concentrations was 2% or less.</td></tr>
</table>

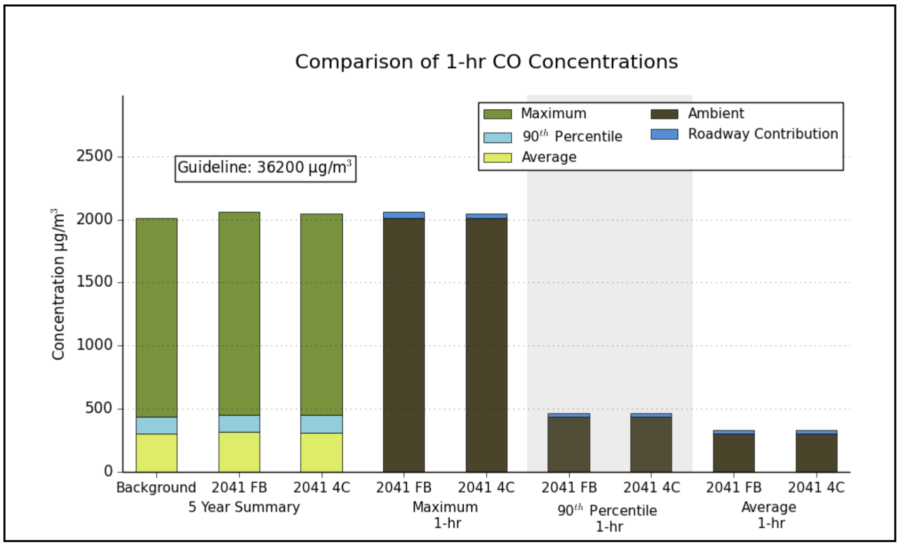
3.7.3 CARBON MONOXIDE

Table 15 presents the predicted combined concentrations for the worst-case sensitive receptor for 1-hour and 8-hour CO based on 5 years of meteorological data. The results conclude that:

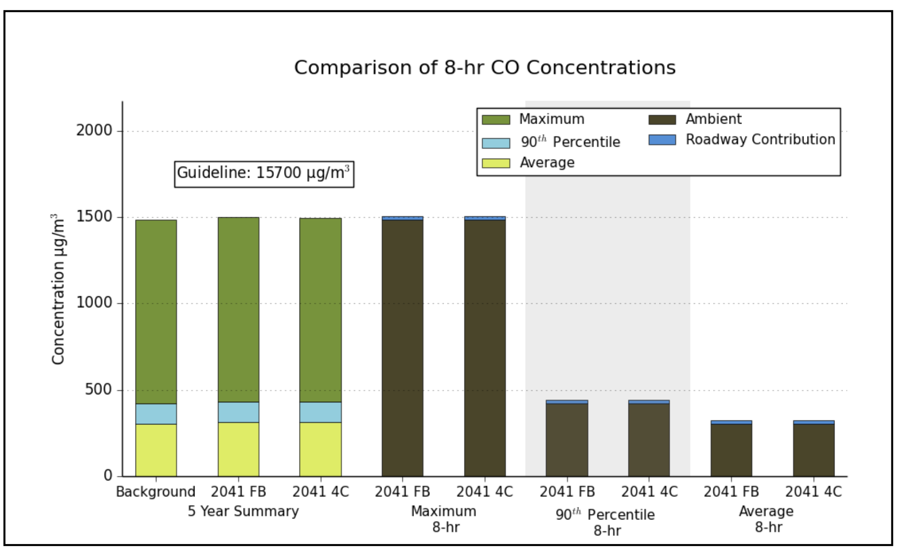
- *Both the maximum 1-hour and 8-hour CO combined concentrations were well below their respective MECP guidelines.*

Table 15: Summary of Predicted CO Concentrations

Statistical Analysis — **2041 4C**



% of MECP Guideline:	
Maximum	6%
90th Percentile	1%
Average	1%
Roadway Contribution:	
Maximum	2%
90th Percentile	3%
Average	3%



% of MECP Guideline:	
Maximum	10%
90th Percentile	3%
Average	2%
Roadway Contribution:	
Maximum	3%
90th Percentile	2%
Average	2%

Conclusions:

- All combined concentrations were below their respective MECP guidelines.
- The contribution from the roadway to the combined concentrations was 3% or less.

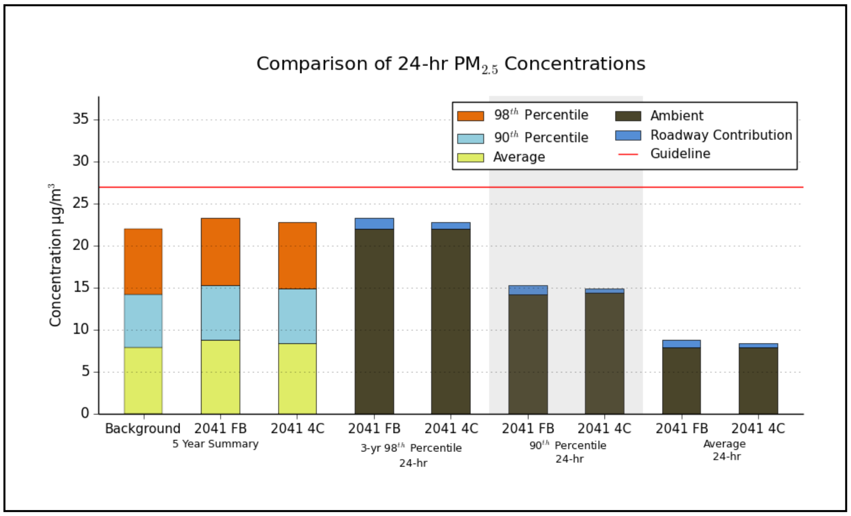
3.7.4 FINE PARTICULATE MATTER ($PM_{2.5}$)

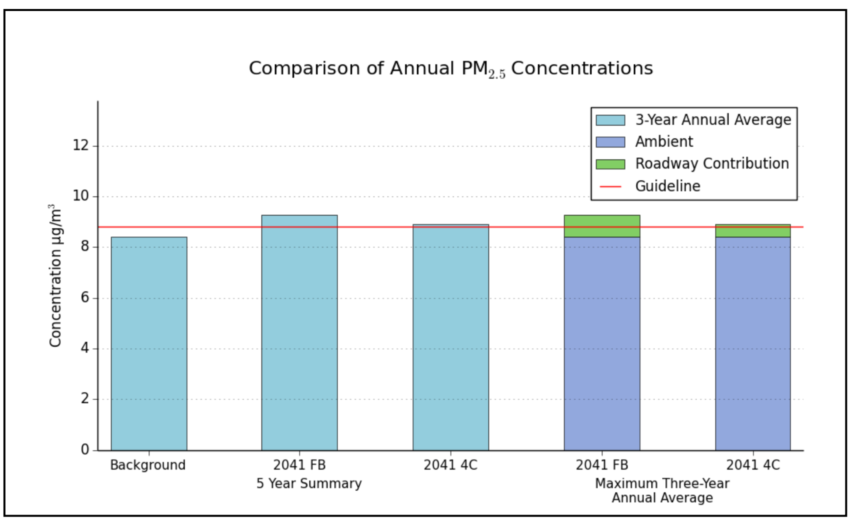
Table 16 presents the predicted combined concentrations for the worst-case sensitive receptor for 24-hour and annual $PM_{2.5}$ based on 5 years of meteorological data. The results conclude that:

- *The average annual 98th percentile 24-hour $PM_{2.5}$ combined concentration, averaged over three consecutive years was below the CAAQS.*
- *The three-year annual average concentration exceeded the guideline with a 5% contribution from the roadway.*

Table 16: Summary of Predicted $PM_{2.5}$ Concentrations

Statistical Analysis





2041 4C	
% of CAAQs Guideline:	
98th Percentile	84%
90th Percentile	55%
Average	31%
Roadway Contribution:	
98th Percentile	5%
90th Percentile	4%
Average	6%
The $PM_{2.5}$ results were below the 3-year CAAQS. The highest 3 year rolling average of the yearly 98th percentile combined concentrations was calculated to be 22.76 µg/m^3 or 84% of the CAAQS.	
% of CAAQs Guideline:	
Maximum 3-Year Annual Average	104%
Roadway Contribution:	
Maximum 3-Year Annual Average	5%
The $PM_{2.5}$ results were above the 3-year CAAQS. The maximum 3-year annual average concentration was 104% of the guideline. It should be noted that ambient concentrations alone were 98% of the guideline.	

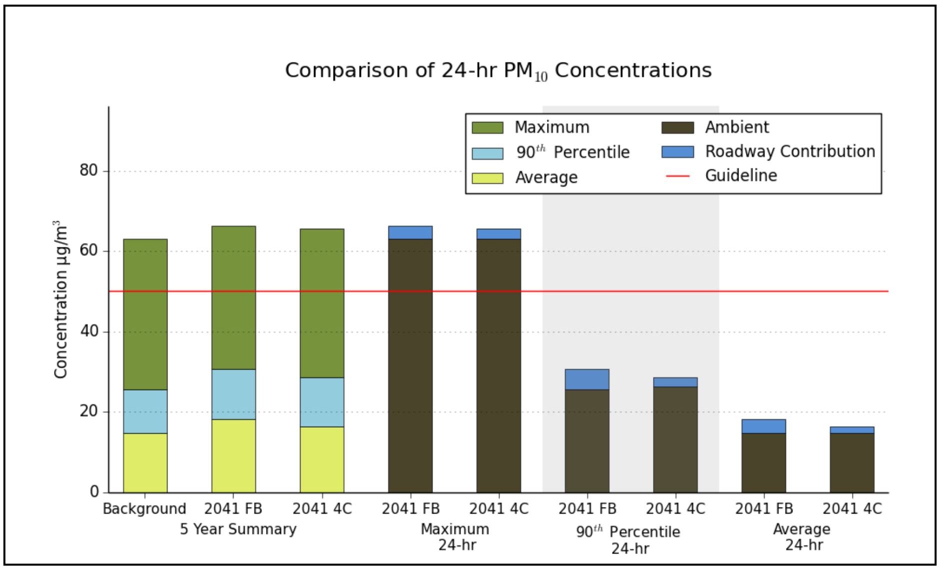
3.7.5 COARSE PARTICULATE MATTER (PM_{10})

Table 17 presents the predicted combined concentration for the worst-case sensitive receptor for 24-hour PM_{10} based on 5 years of meteorological data. The results conclude that:

- *The maximum 24-hr PM_{10} combined concentration exceeded the MECP guideline.*

Table 17: Summary of Predicted PM_{10} Concentrations

Statistical Analysis



2041 4C	
% of MECP Guideline:	
Maximum	131%
90th Percentile	57%
Average	33%
Roadway Contribution:	
Maximum	4%
90th Percentile	8%
Average	11%

Conclusions:

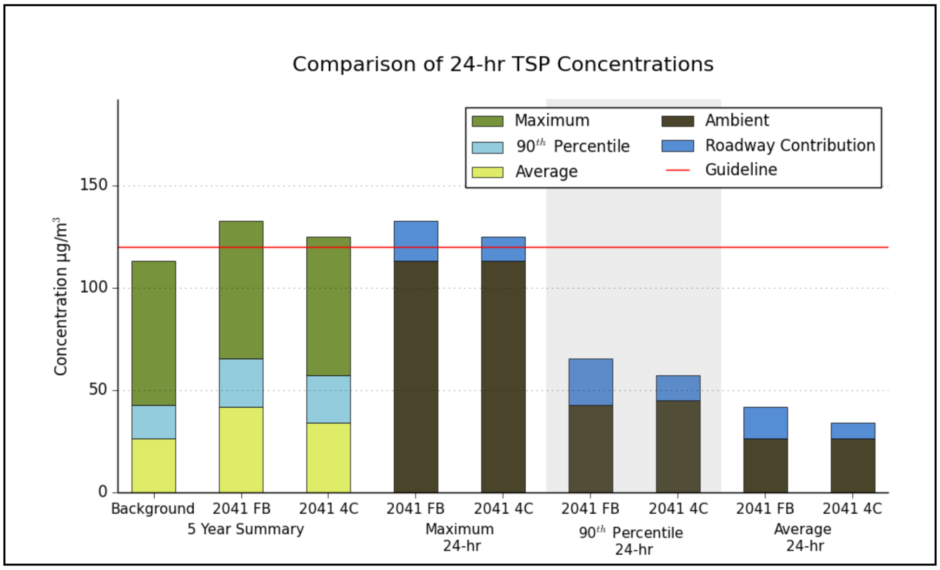
- The maximum combined concentration of PM_{10} was found to exceed the standard of 50 µg/m^3. It should be noted, however, that background concentrations alone exceeded the standard and that the roadway contribution is 4% of the maximum value.
- Frequency analysis was conducted to determine the frequency of exceedances over the 5-year period.
- A total of 15 days exceeded the guideline in the five-year period, which equates to less than 1% of the time.
- Frequency analysis showed that 3 fewer exceedances are expected due to the project over the five-year period, when comparing the 2041 Future Base and the 2041 4C scenarios.

3.7.6 TOTAL SUSPENDED PARTICULATE MATTER (TSP)

Table 18 presents the predicted combined concentration for the worst-case sensitive receptor for 24-hour TSP based on 5 years of meteorological data. The results conclude that:

- *The maximum 24-hr TSP combined concentration exceeded the MECP guideline.*

Table 18: Summary of Predicted TSP Concentrations

Statistical Analysis	2041 4C	
	**% of MECP Guideline:**	
	Maximum	104%
	90th Percentile	48%
	Average	28%
	roadway Contribution:	
	Maximum	9%
	90th Percentile	21%
	Average	23%

Conclusions:

- The TSP results show that the combined concentrations exceed the guideline. It should be noted, however, that background concentrations alone account for 94% of the standard and that the roadway contribution is 9% of the maximum value.
- Frequency analysis was conducted to determine the frequency of exceedances over the 5-year period.
- 6 day exceeded the guideline in the five-year period in, which equates to less than 1% of the time.
- Frequency analysis showed that 5 fewer exceedances are expected due to the project over the five-year period, when comparing the 2041 Future Base and the 2041 4C scenarios.

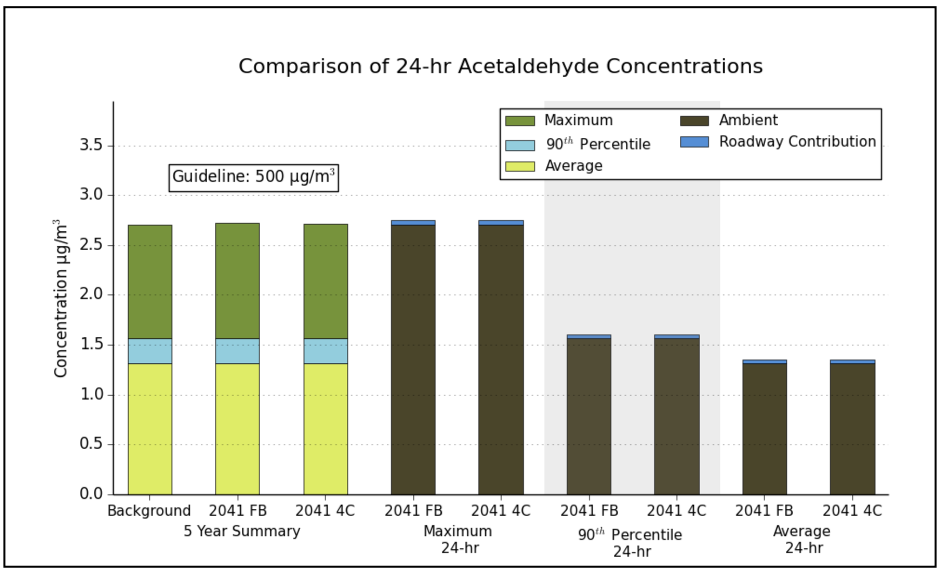
Ambient VOC concentrations are typically measured every 6 days in Ontario. In order to combine the ambient data to the modelled results, the measured concentrations were applied to the following 6 days when measurements were 6 days apart. When measurements were further than 6 days apart, the 90^{th} percentile annual value was used to represent the missing data. This background data was added to the predicted hourly roadway concentrations at each receptor to obtain results for the VOCs.

3.7.7 ACETALDEHYDE

Table 19 presents the predicted combined concentration for the worst-case sensitive receptor for 24-hour acetaldehyde based on 5 years of meteorological data. The results conclude that:

- *The maximum 24-hour acetaldehyde combined concentration was well below the respective MECP guideline.*

Table 19: Summary of Predicted Acetaldehyde Concentrations

Statistical Analysis	2041 4C	
	**% of MECP Guideline:**	
	Maximum	<1%
	90^{th} Percentile	<1%
	Average	<1%
	Roadway Contribution:	
	Maximum	<1%
	90^{th} Percentile	<1%
	Average	<1%

Conclusions:

- All combined concentrations were below the respective MECP guideline.
- The contribution from the roadway to the combined concentrations was <1%.

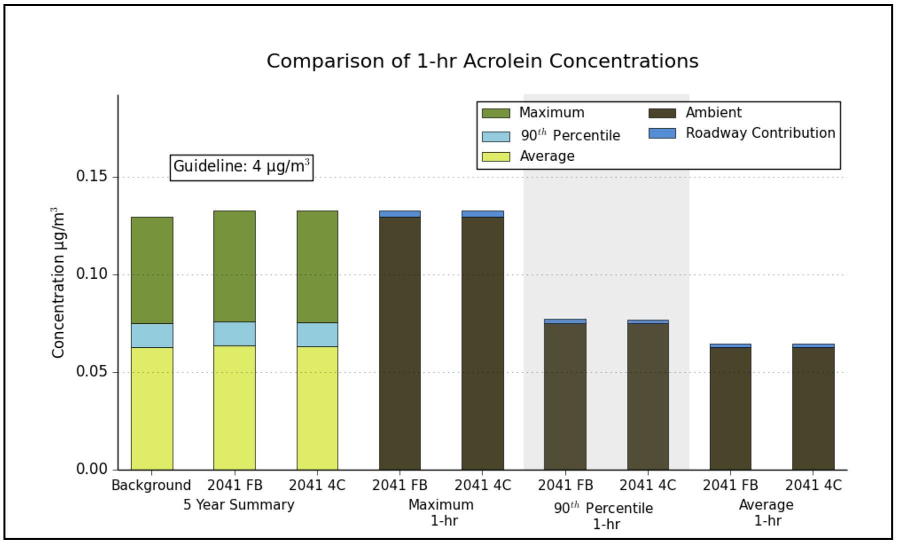
3.7.8 ACROLEIN

Table 20 presents the predicted combined concentrations for the worst-case sensitive receptor for 1-hour and 24-hour acrolein based on 5 years of meteorological data. The results conclude that:

- *The maximum 1-hour and 24-hour acrolein combined concentrations were below the respective MECP guidelines.*

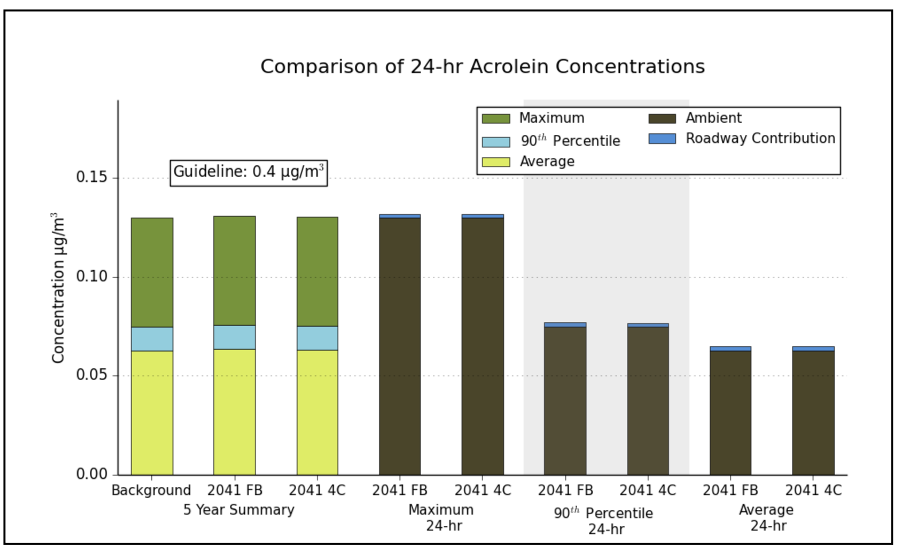
Table 20: Summary of Predicted Acrolein Concentrations

Statistical Analysis	2041 4C



% of MECP Guideline:	
Maximum	3%
90th Percentile	2%
Average	1%
Roadway Contribution:	
Maximum	2%
90th Percentile	1%
Average	1%

Conclusions:
The combined concentrations were below the respective MECP guideline. The contribution from the roadway was 2% or less.



% of MECP Guideline:	
Maximum	33%
90th Percentile	19%
Average	16%
Roadway Contribution	
Maximum	1%
90th Percentile	1%
Average	1%

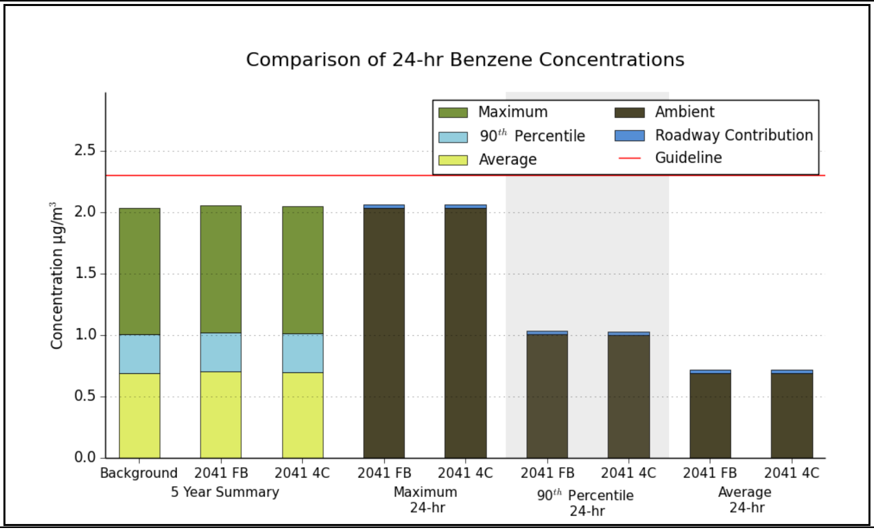
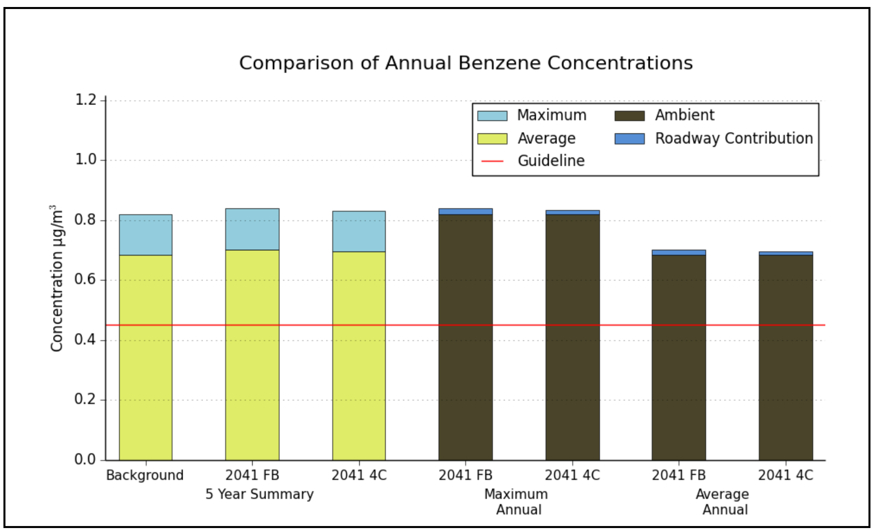
Conclusions:
The combined concentrations were below the respective MECP guideline. The contribution from the roadway was 1% or less.

3.7.9 BENZENE

Table 21 presents the predicted combined concentrations for the worst-case sensitive receptor for 24-hour and annual benzene based on 5 years of meteorological data. The results conclude that:

- *The maximum 24-hour benzene combined concentration was below the respective MECP guideline.*
- *The annual benzene concentration exceeded the guidline. The* roadway *contribution to the maximum annual average was 4%.*

Table 21: Summary of Predicted Benzene Concentrations

Statistical Analysis	2041 4C	
	**% of MECP Guideline:**	
	Maximum	89%
	90th Percentile	44%
	Average	30%
	Roadway Contribution:	
	Maximum	1%
	90th Percentile	1%
	Average	2%
	Conclusions: The combined concentrations were below the respective MECP guideline. The contribution from the roadway was 2% or less.	
	**% of MECP Guideline:**	
	Maximum	185%
	Average	155%
	Roadway Contribution:	
	Maximum	1%
	Average	2%
	Conclusions: The combined concentration exceeded the MECP guideline. It should be noted that ambient concentrations were 184% of the guideline and the roadway contribution to the maximum was 1%.	

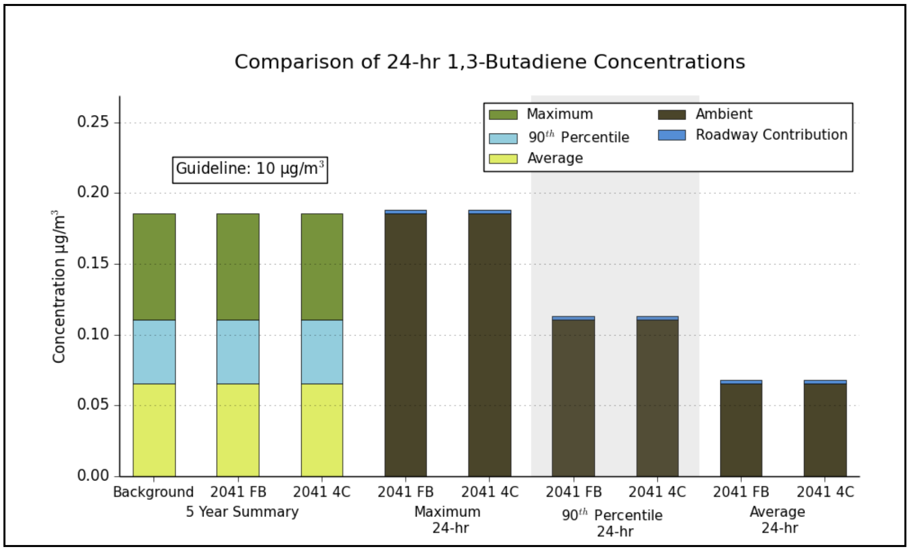
3.7.10 1,3-BUTADIENE

Table 22 presents the predicted combined concentrations for the worst-case sensitive receptor for 24-hour and annual 1,3-butadiene based on 5 years of meteorological data. The results conclude that:

- *The maximum 24-hour and annual 1,3-butadiene combined concentrations were well below the respective MECP guidelines.*

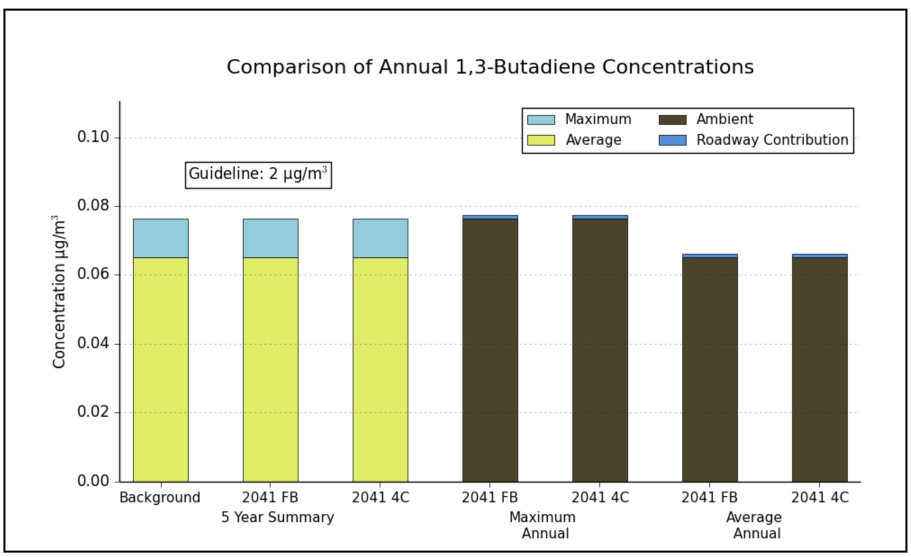
Table 22: Summary of Predicted 1,3-Butadiene Concentrations

Statistical Analysis	2041 4C	



% of MECP Guideline:	
Maximum	2%
90th Percentile	1%
Average	<1%
Roadway Contribution:	
Maximum	<1%
90th Percentile	<1%
Average	<1%

Conclusions:
The combined concentrations were below the respective MECP guideline. The contribution from the roadway was less than 1%.



% of MECP Guideline:	
Maximum	4%
Average	3%
Roadway Contribution:	
Maximum	<1%
Average	<1%

Conclusions:
The combined concentrations were below the respective MECP guideline. The contribution from the roadway was less than 1%.

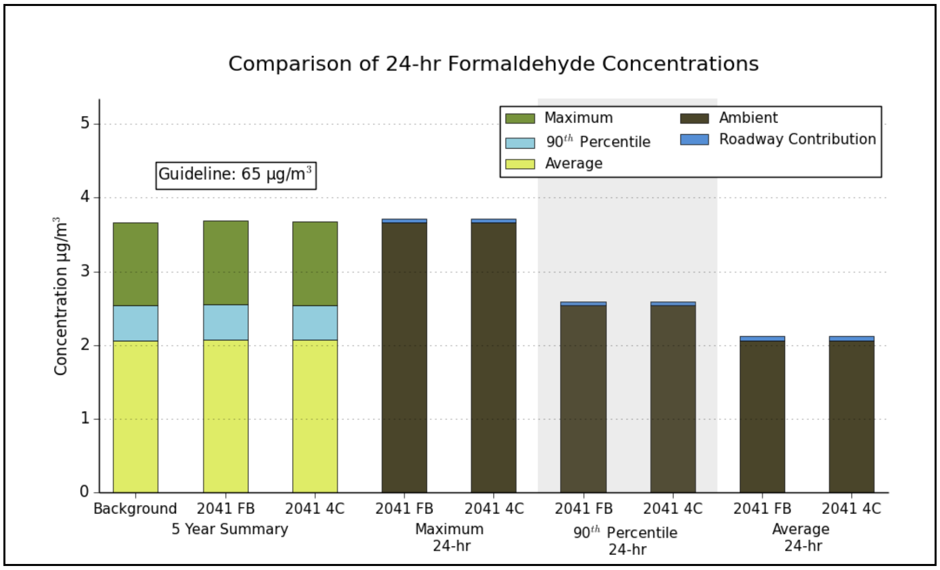
3.7.11 FORMALDEHYDE

Table 23 presents the predicted combined concentration for the worst-case sensitive receptor for 24-hour formaldehyde based on 5 years of meteorological data. The results conclude that:

- *The maximum 24-hour formaldehyde combined concentration was below the respective MECP guideline.*

Table 23: Summary of Predicted Formaldehyde Concentrations

Statistical Analysis



2041 4C	
% of MECP Guideline:	
Maximum	6%
90th Percentile	4%
Average	3%
Roadway Contribution:	
Maximum	<1%
90th Percentile	<1%
Average	<1%

Conclusions:

- All combined concentrations were below the respective MECP guideline.
- The contribution from the roadway to the combined concentration was <1%.

4. AIR QUALITY IMPACTS DURING CONSTRUCTION

During construction of the roadway, dust is the primary contaminant of concern. Other contaminants including NO_x and VOC's may be emitted from equipment used during construction activities. Due to the temporary nature of construction activities, there are no air quality criteria specific to construction activities. However, the Environment Canada "Best Practices for the Reduction of Air Emissions from Construction and Demolition Activities" document provides several mitigation measures for reducing emissions during construction activities. Mitigation techniques discussed in the document include material wetting or use of chemical suppressants to reduce dust, use of wind barriers, and limiting exposed areas which may be a source of dust and equipment washing. It is recommended that these best management practices be followed during construction of the roadway to reduce any air quality impacts that may occur.

5. CONCLUSIONS

Presented in **Table 24** is a summary of the worst-case modelling results for the 2041 preferred alternative (4C) based on 5-years of meteorological data. For each contaminant, combined concentrations are presented as a percentage of the applicable guideline.

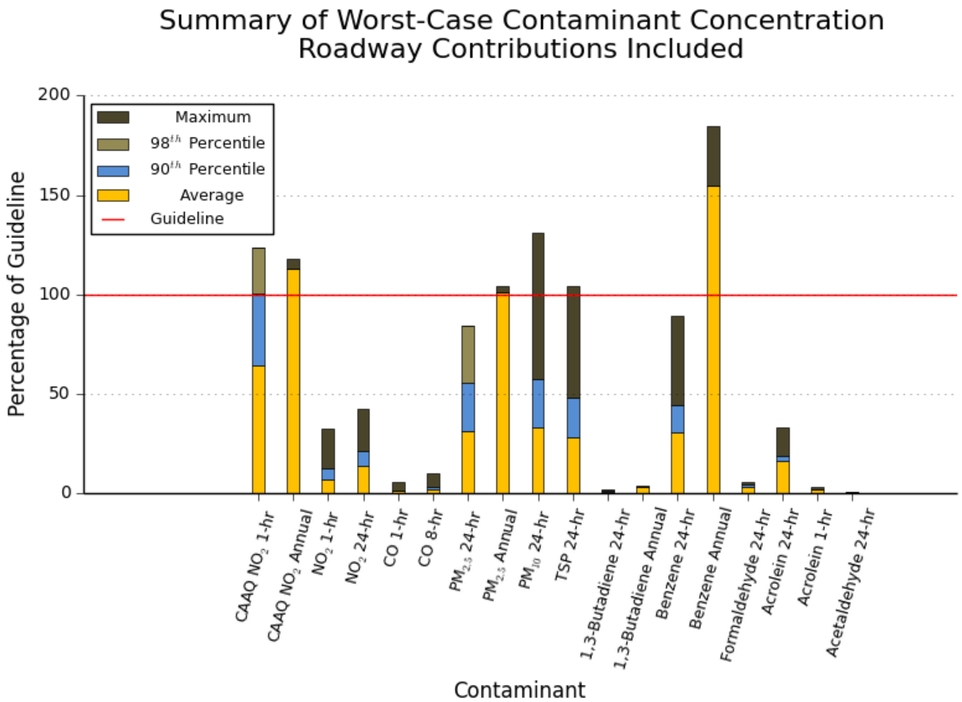
The maximum combined concentrations for the preferred alternative (4C) were all below their respective MECP guidelines or CAAQS, with the exception of the 1-hr and annual NO2 CAAQ, annual $PM_{2.5}$, 24-hr PM_{10}, 24-hr TSP and annual benzene. Note that background concentrations exceeded the guideline for many of the contaminants with the exception of the annual NO_2 CAAQS, $PM_{2.5}$ and TSP, for which background concentrations were just below the guideline. The contribution from the roadway emissions to the combined concentrations was small.

Overall, worst-case predicted concentrations are similar between the future base case and the preferred alternative, due to the overall small change in traffic volumes within the study area between the scenarios.

Mitigation measures are not warranted, due to the small number of days which are expected to exceed the guideline.

Table 24: Worst-Case Summary of Predicted Combined Contaminant Concentrations for the Preferred Alternative (4C)

5 Year Statistical Summary



Note: The $PM_{2.5}$ results are in compliance with the CAAQS. The highest 3 year rolling average of the yearly 98th percentile combined concentrations was calculated to be 22.79 µg/m^3 or 84% of the CAAQS.

% of Guideline

2041 4C	
CAAQ NO_2 (1-hr)	124%
CAAQ NO_2 (Annual)	118%
NO_2 (1-hr)	32%
NO_2 (24-hr)	42%
CO (1-hr)	6%
CO (8-hr)	10%
$PM_{2.5}$ (24-hr See Note)	84%
$PM_{2.5}$ (Annual)	101%
PM_{10}	131%
TSP	104%
Acetaldehyde	<1%
Acrolein (1-hr)	3%
Acrolein (24-hr)	33%
Benzene (24-hr)	89%
Benzene (Annual)	185%
1,3-Butadiene (24-hr)	2%
1,3-Butadiene (Annual)	4%
Formaldehyde	6%

6. REFERENCES

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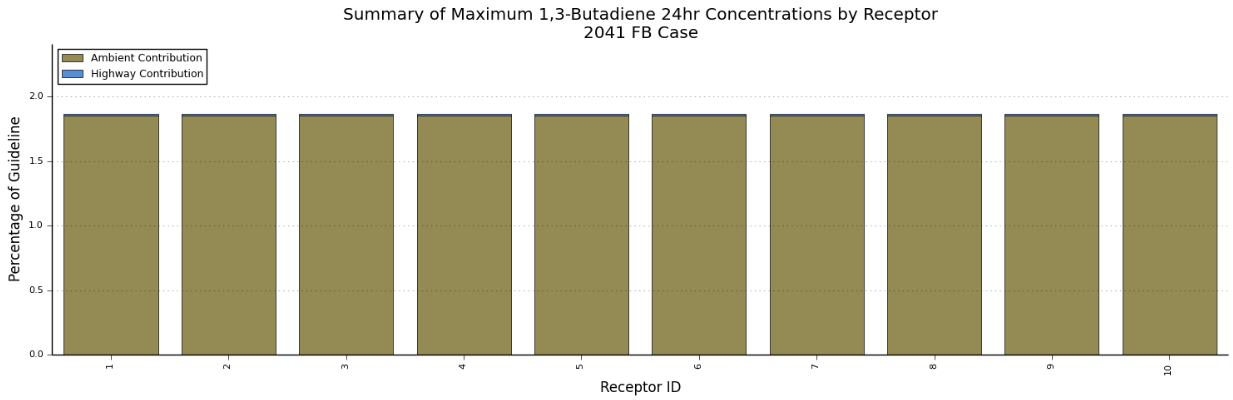
Appendix A

Results For Each Receptor


Summary of Maximum 1,3-Butadiene 24hr Concentrations by Receptor
2041 FB Case
Ambient Contribution
Highway Contribution
Percentage of Guideline
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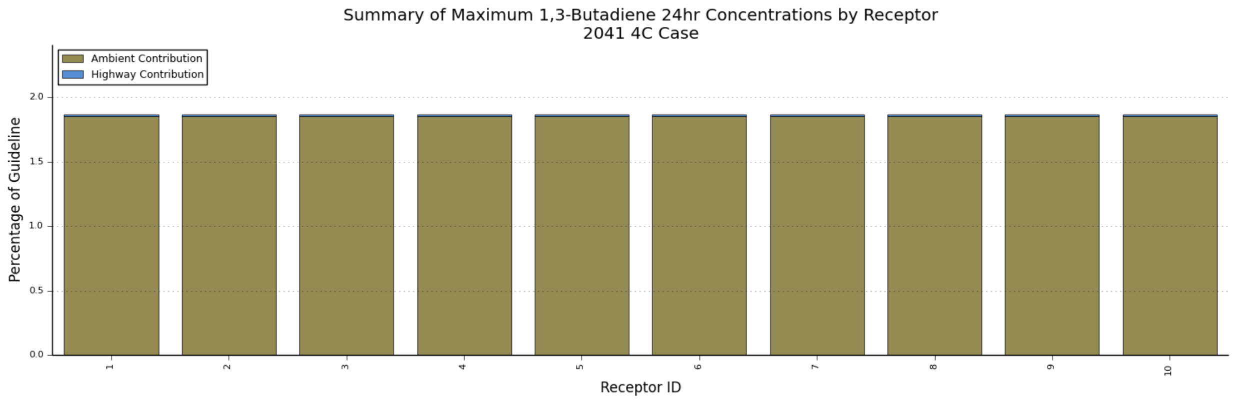
1.5
2.0
1
2
3
4
5
6
7
8
9
10
Receptor ID


Summary of Maximum 1,3-Butadiene 24hr Concentrations by Receptor
2041 4C Case
Ambient Contribution
Highway Contribution
Percentage of Guideline
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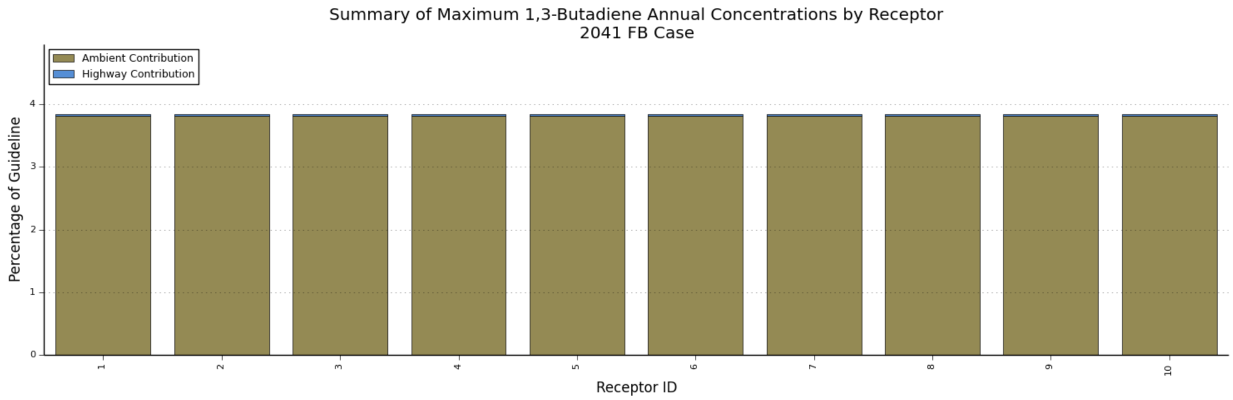
1.5
2.0
1
2
3
4
5
6
7
8
9
10
Receptor ID


Summary of Maximum 1,3-Butadiene Annual Concentrations by Receptor
2041 FB Case
Ambient Contribution
Highway Contribution
Percentage of Guideline
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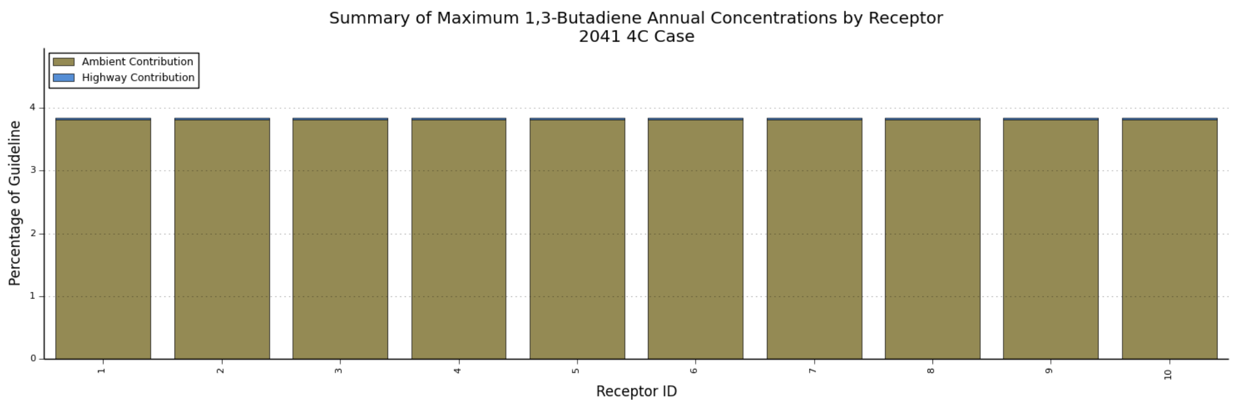
2
3
4
1
2
3
4
5
6
7
8
9
10
Receptor ID


Summary of Maximum 1,3-Butadiene Annual Concentrations by Receptor
2041 4C Case
Ambient Contribution
Highway Contribution
Percentage of Guideline
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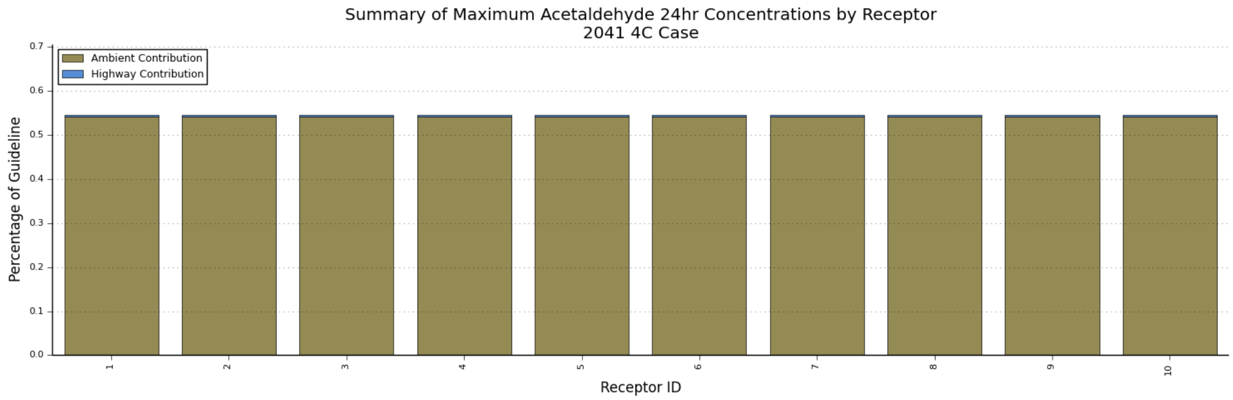
2
3
4
1
2
3
4
5
6
7
8
9
10
Receptor ID


Summary of Maximum Acetaldehyde 24hr Concentrations by Receptor
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Ambient Contribution
Highway Contribution
Percentage of Guideline
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0.2
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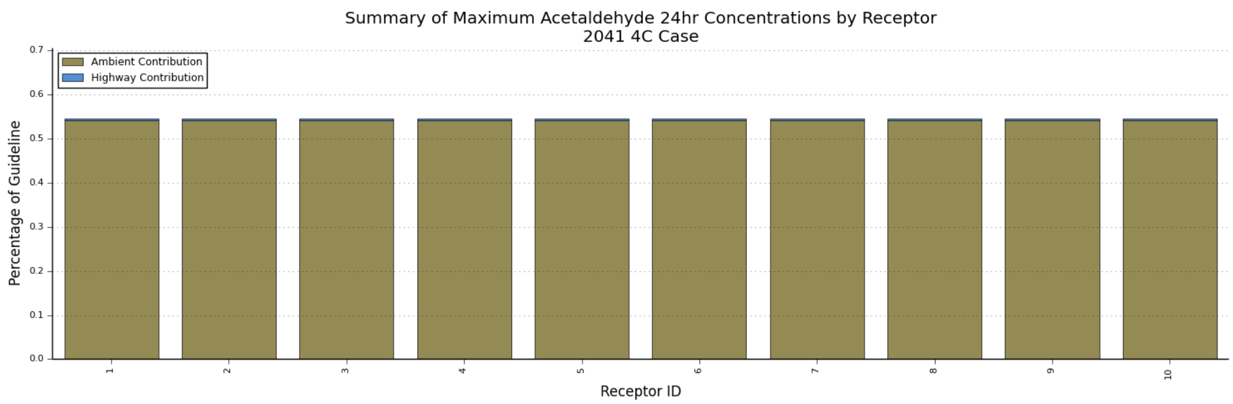
0.5
0.6
0.7
1
2
3
4
5
6
7
8
9
10
Receptor ID


Summary of Maximum Acetaldehyde 24hr Concentrations by Receptor
2041 4C Case
Ambient Contribution
Highway Contribution
Percentage of Guideline
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0.1
0.2
0.3
0.4
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0.6
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3
4
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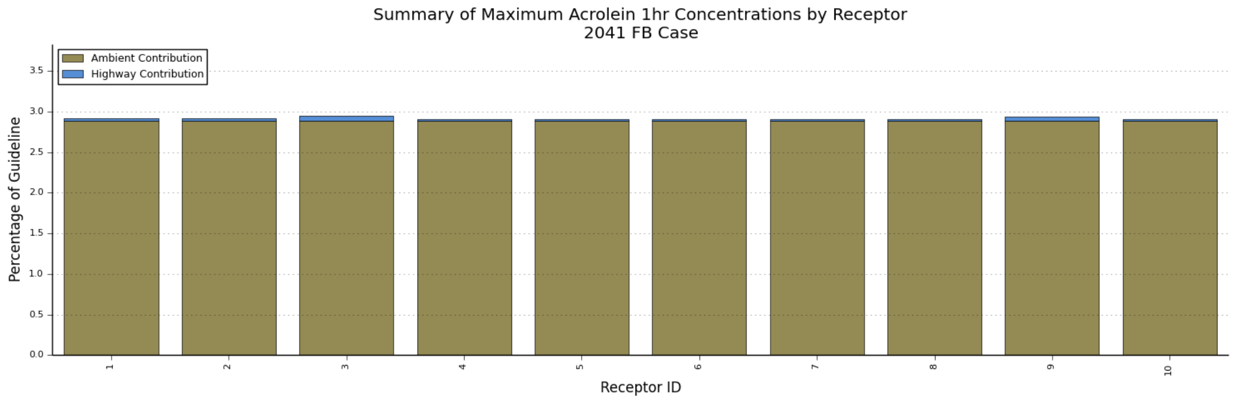
7
8
9
10
Receptor ID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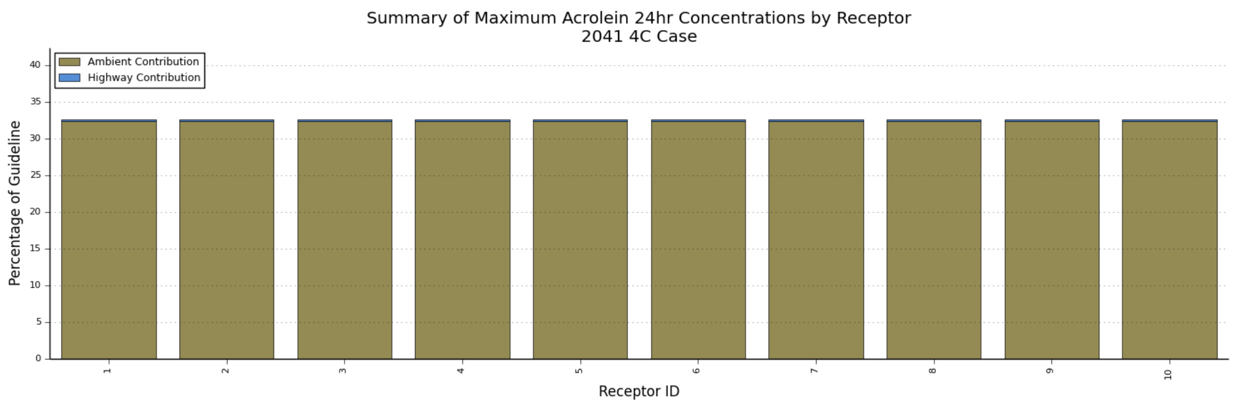
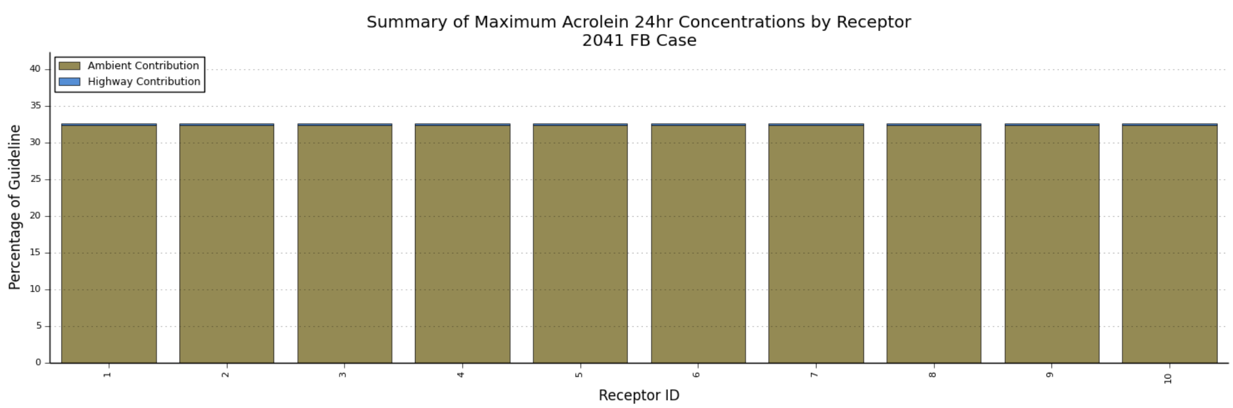
Ambient Contribution
Highway Contribution
Percentage of Guideline
Receptor ID


Summary of Maximum Acrolein 24hr Concentrations by Receptor
2041 4C Case
Ambient Contribution
Highway Contribution
Percentage of Guideline
Receptor ID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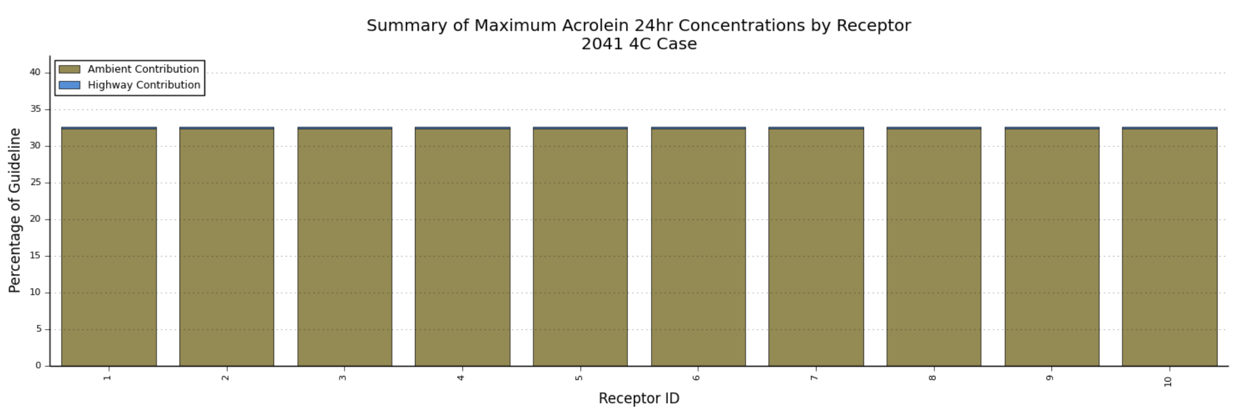
2041 FB Case
Ambient Contribution
Highway Contribution
Percentage of Guideline
Receptor ID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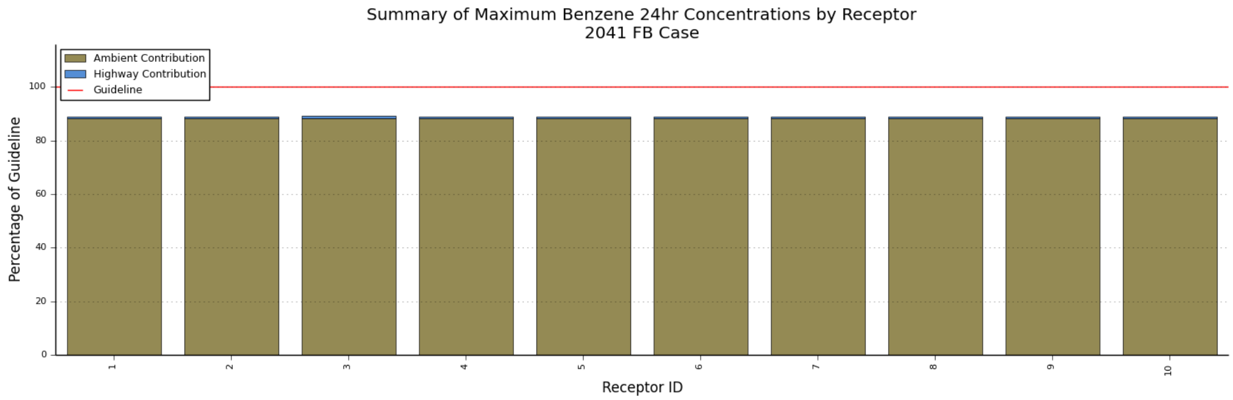
Ambient Contribution
Highway Contribution
Percentage of Guideline
Receptor ID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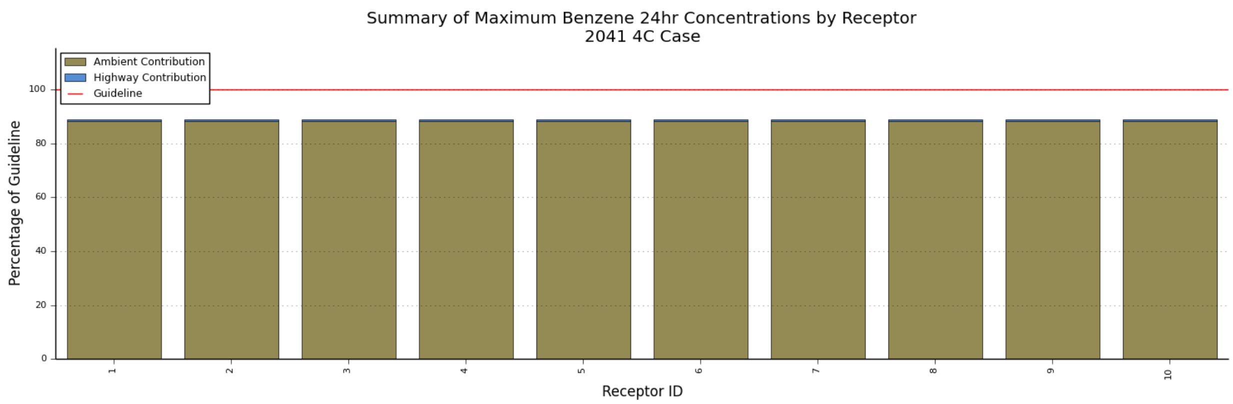
Ambient Contribution
Highway Contribution
Guideline
Percentage of Guideline
Receptor ID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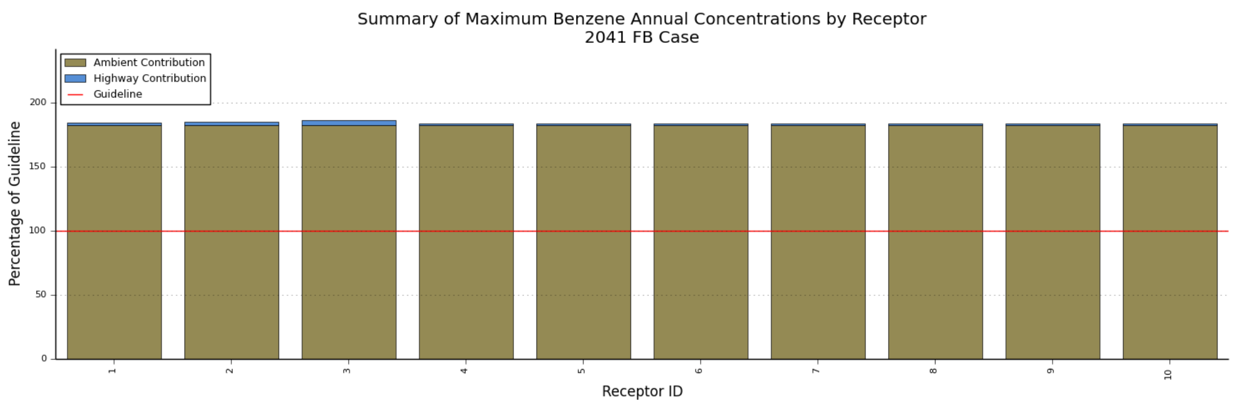
2041 4C Case
Ambient Contribution
Highway Contribution
Guideline
Percentage of Guideline
Receptor ID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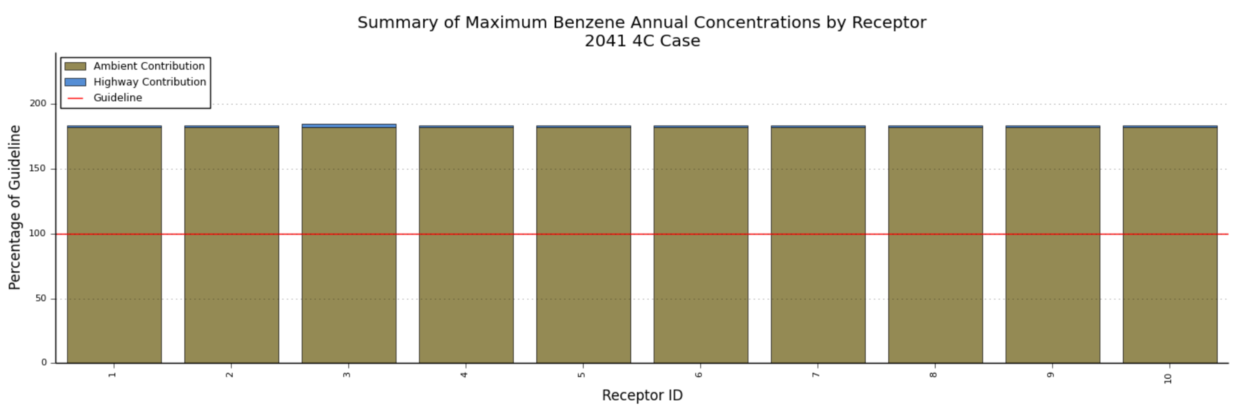
Ambient Contribution
Highway Contribution
Guideline
Percentage of Guideline
Receptor ID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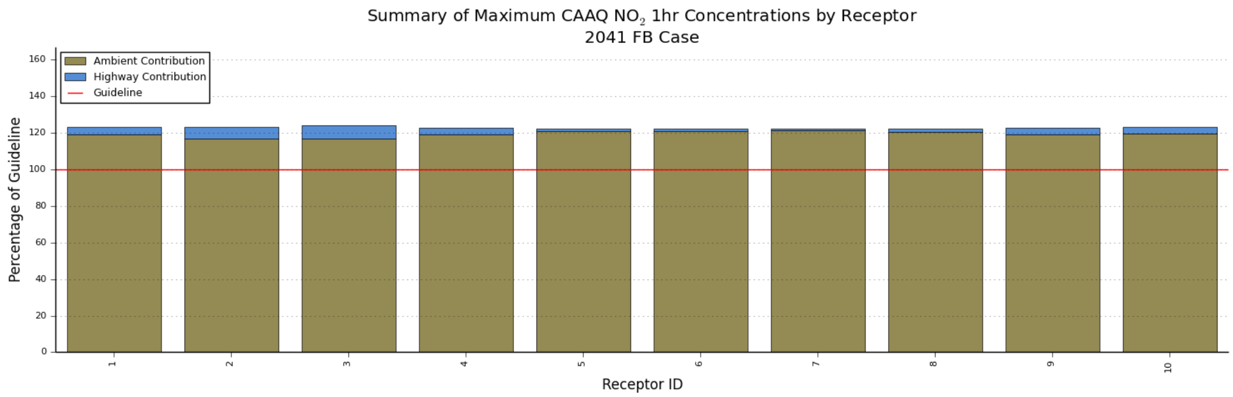
Highway Contribution
Guideline
Percentage of Guideline
Receptor ID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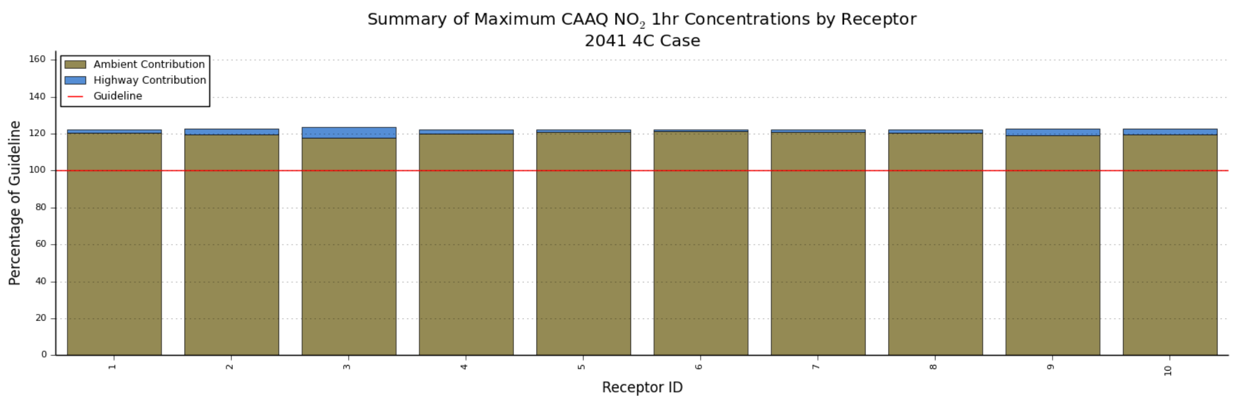
Highway Contribution
Guideline
Percentage of Guideline
Receptor ID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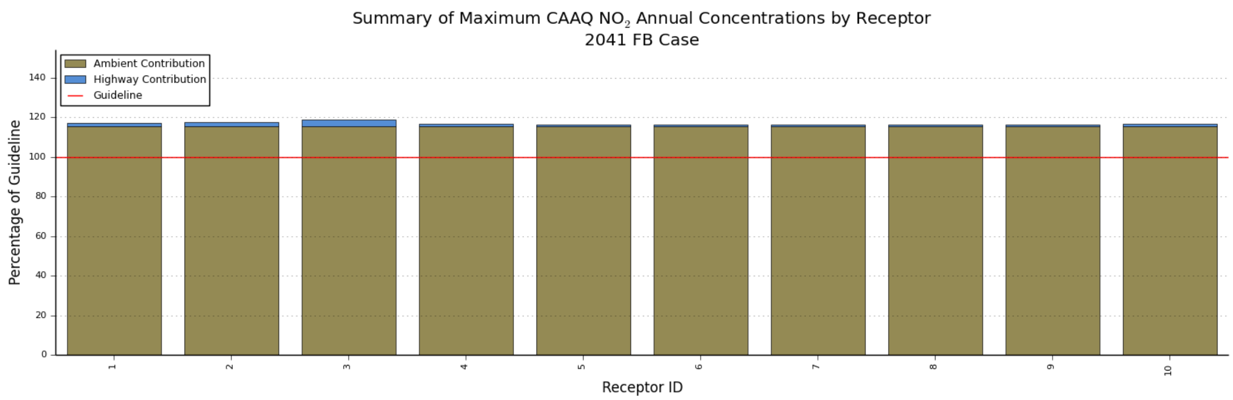
Guideline
Percentage of Guideline
Receptor ID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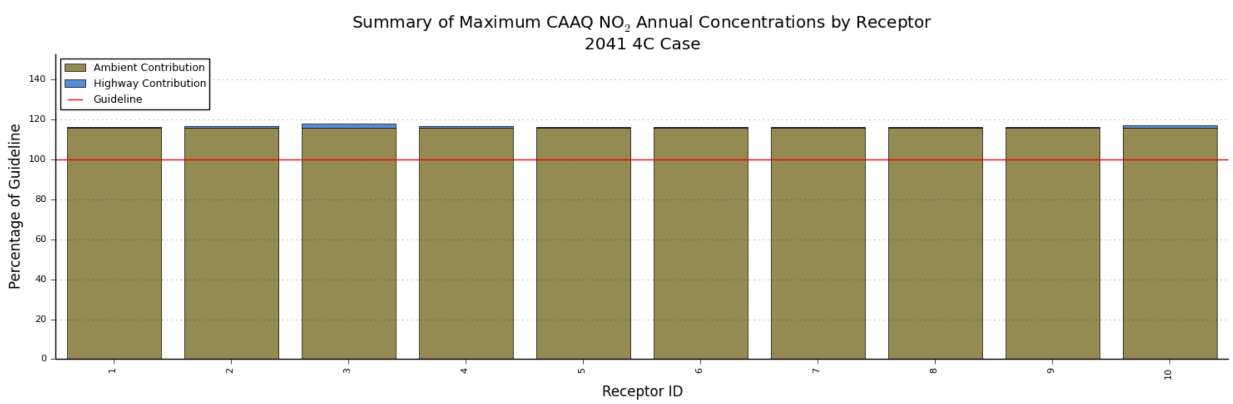
Percentage of Guideline
Receptor ID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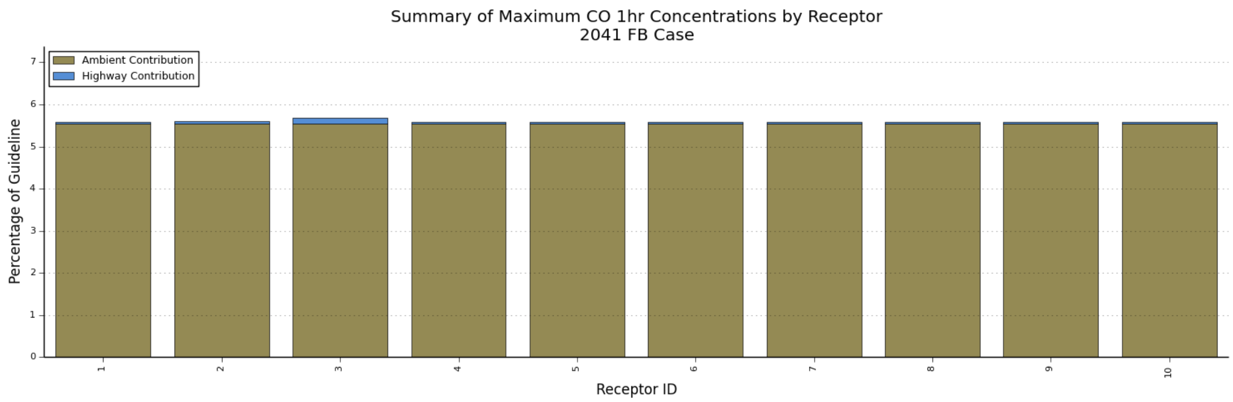
Guideline
Percentage of Guideline
Receptor ID


Summary of Maximum CO 1hr Concentrations by Receptor
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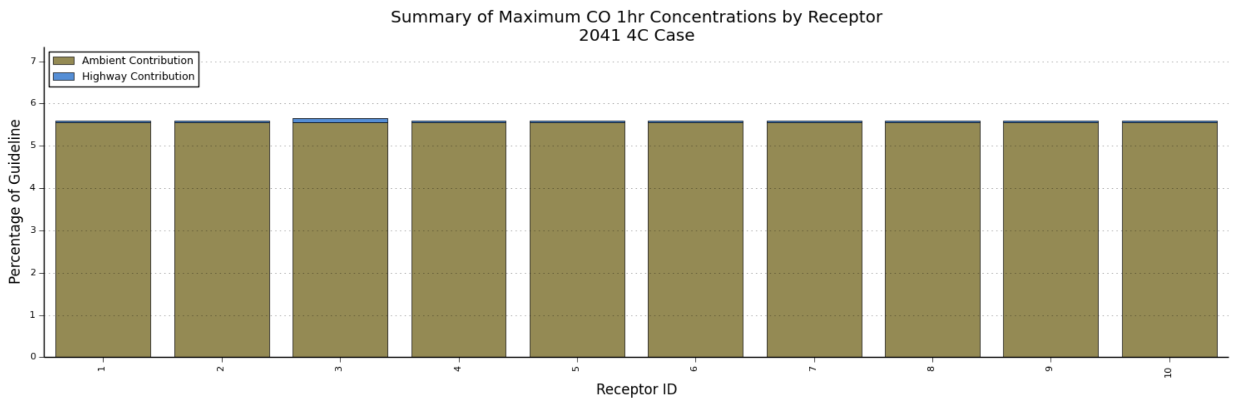
Highway Contribution
Percentage of Guideline
Receptor ID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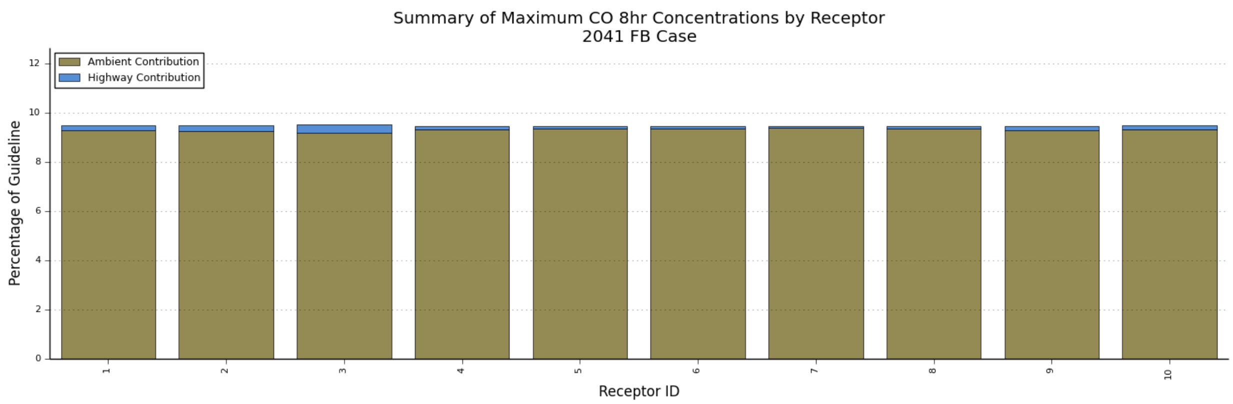
Highway Contribution
Percentage of Guideline
Receptor ID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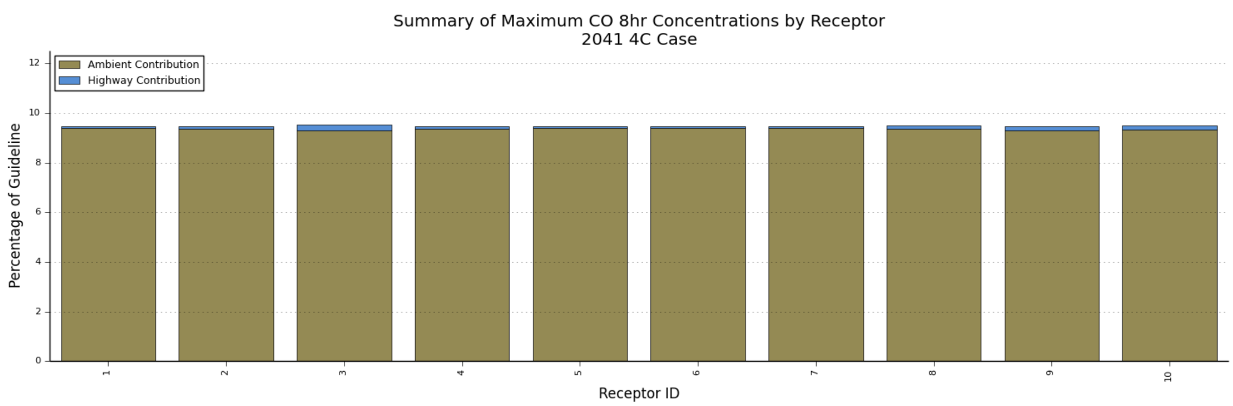
Percentage of Guideline
Receptor ID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Percentage of Guideline
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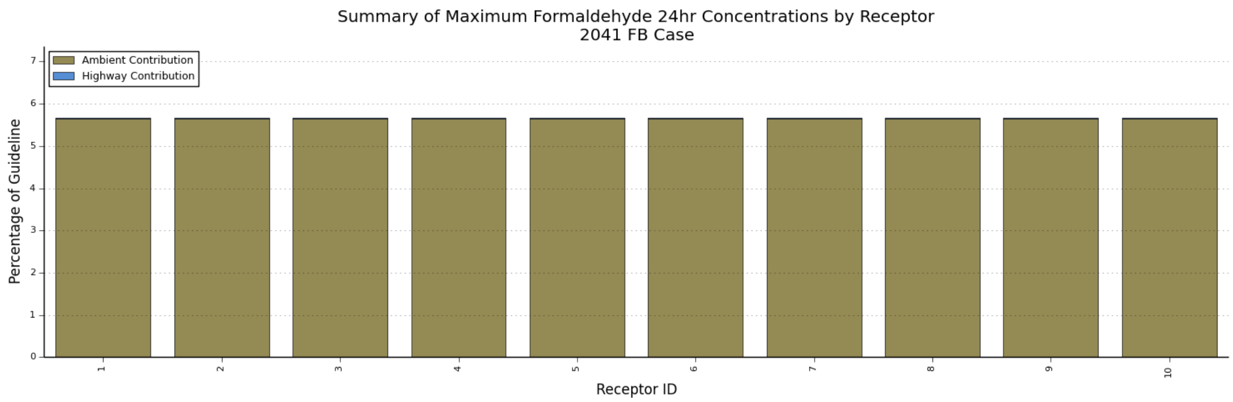
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Percentage of Guideline
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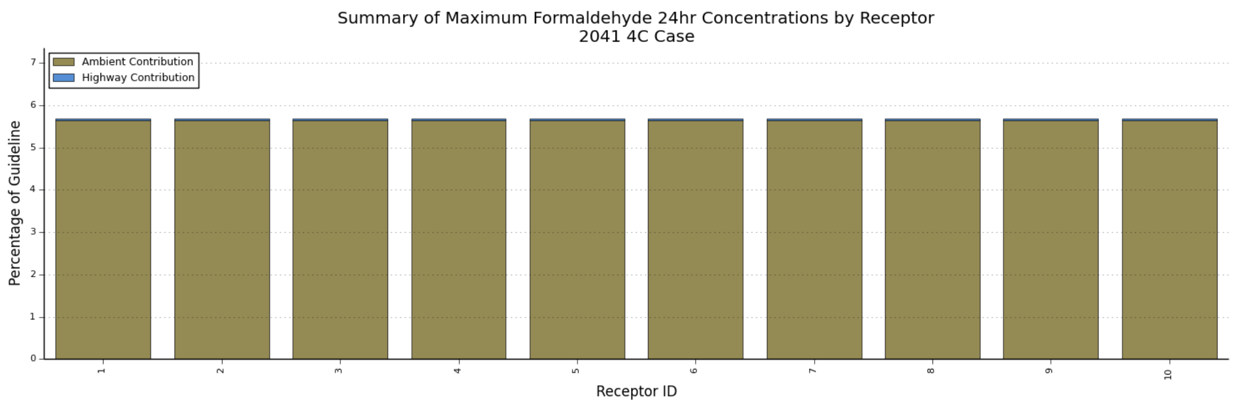
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Highway Contribution
Percentage of Guideline
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Summary of Maximum NO_2 1hr Concentrations by Receptor
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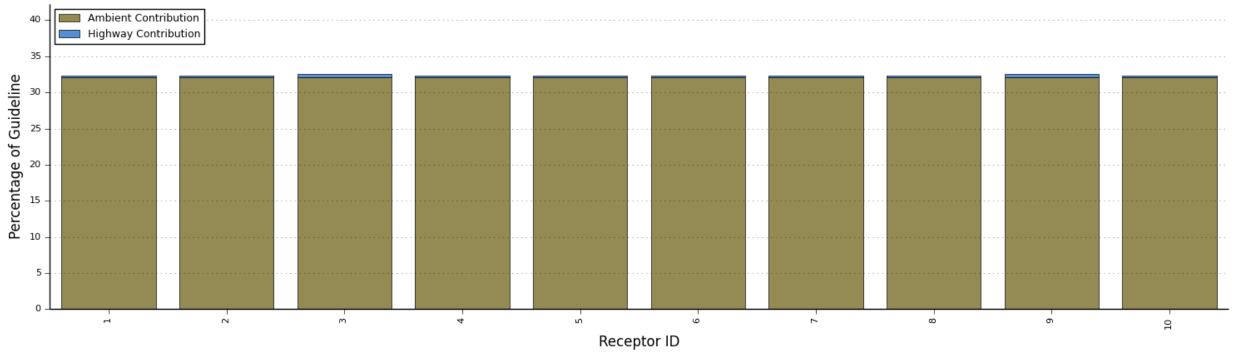
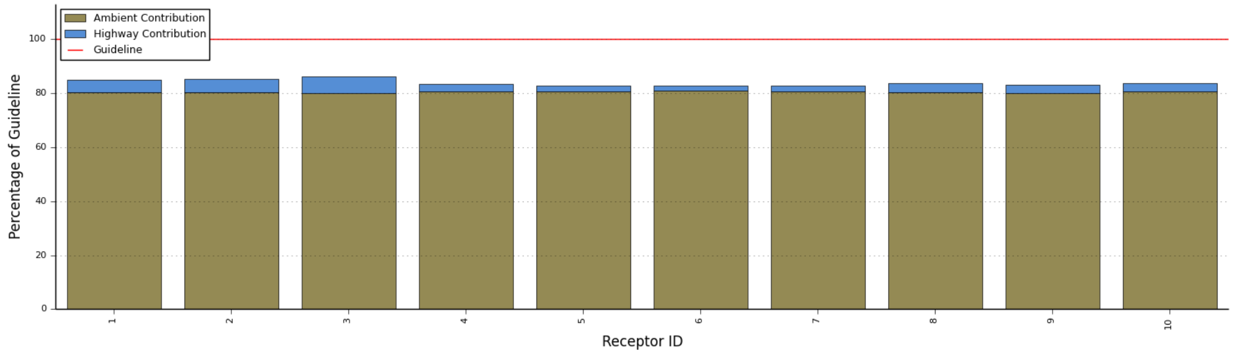


Summary of Maximum NO_2 1hr Concentrations by Receptor
2041 4C Case

Summary of Maximum NO_2 24hr Concentrations by Receptor
2041 FB Case

Summary of Maximum NO_2 24hr Concentrations by Receptor
2041 4C Case

Summary of Maximum $PM_{2.5}$ 24hr Concentrations by Receptor
2041 FB Case



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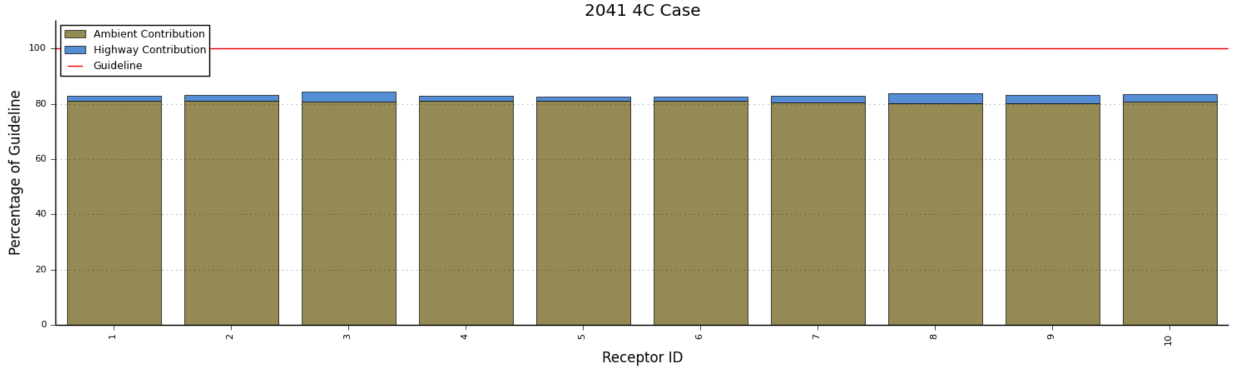
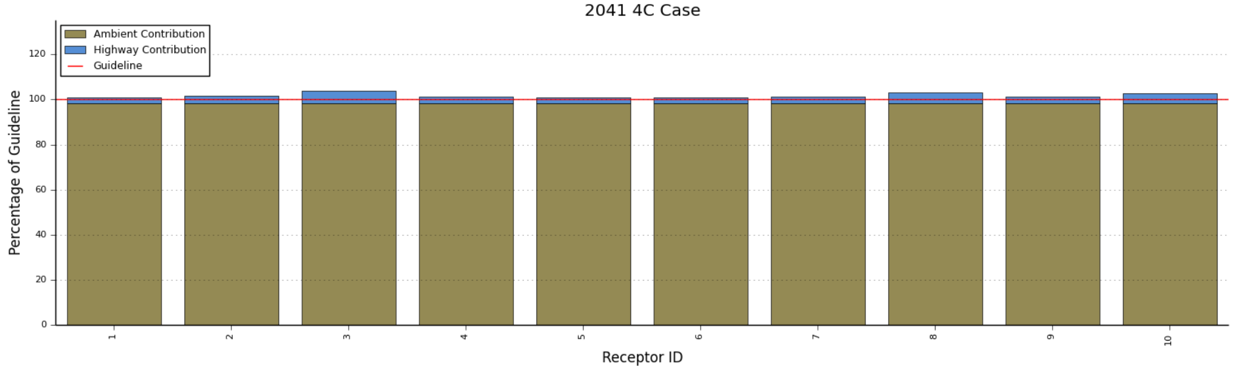
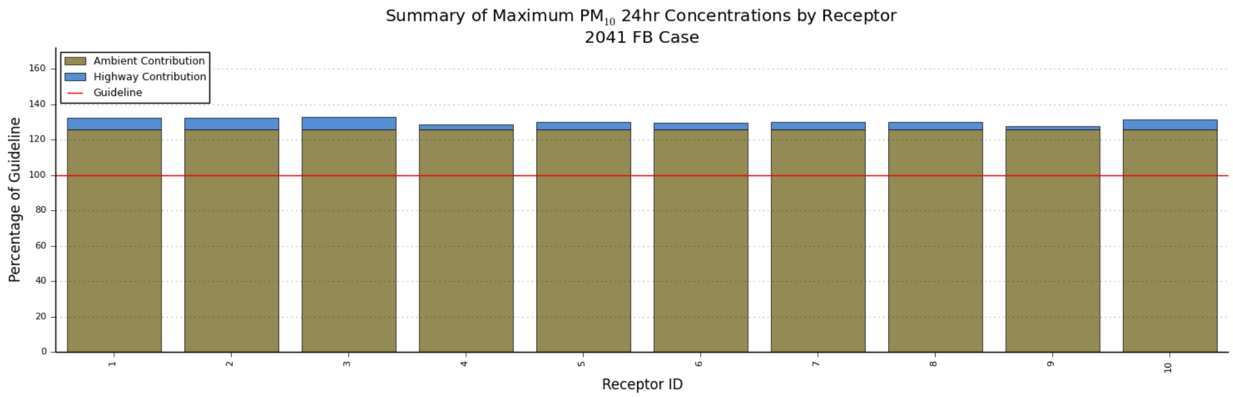


Summary of Maximum $PM_{2.5}$ Annual Concentrations by Receptor
2041 FB Case

Summary of Maximum $PM_{2.5}$ Annual Concentrations by Receptor
2041 4C Case




Summary of Maximum PM_{10} 24hr Concentrations by Receptor
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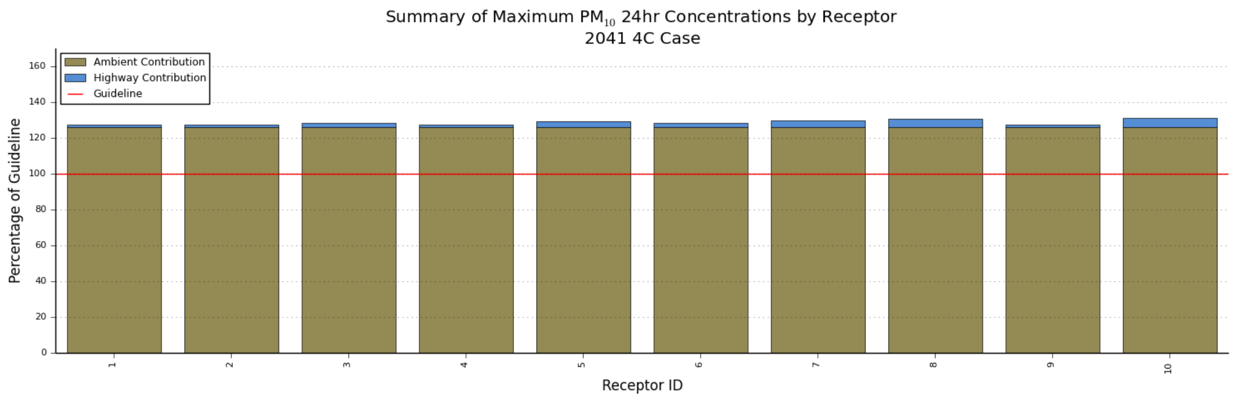
Highway Contribution
Guideline
Percentage of Guideline
Receptor ID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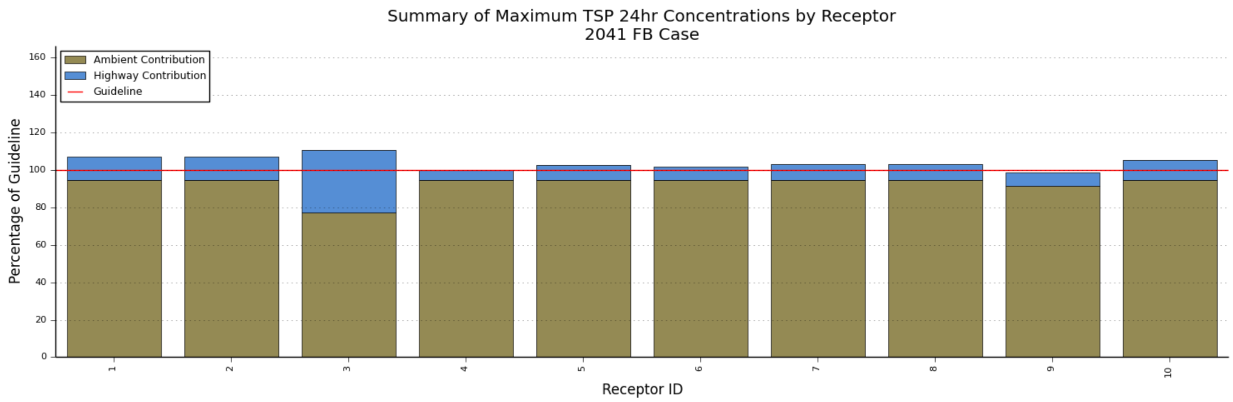
Percentage of Guideline
Receptor ID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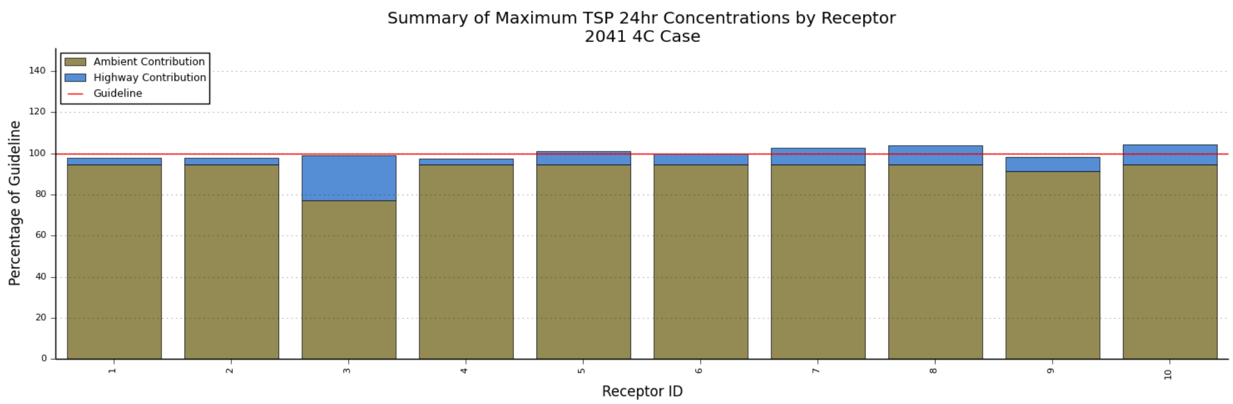
Highway Contribution
Guideline
Percentage of Guideline
Receptor ID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Percentage of Guideline
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