Teston Road Air Quality Assessment

West of Keele Street to Bathurst Street, Vaughan, York Region

Morrison Hershfield

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Making Sustainability Happen

Revision Record

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Executive Summary

SLR Consulting (Canada) Ltd., was retained by Morrison Hershfield to conduct an air quality assessment as part of the Individual Environmental Assessment (EA) process under the Ontario EA Act for upgrades and completion of Teston Road between west of Keele Street and Bathurst Street in Vaughan. The project involves the widening of Teston Road to four lanes, as well as extending the roadway between Keele Street and Dufferin Street.

The main objective of the study was to assess the local air quality impacts due to the proposed Teston Road widening and extension from West of Keele Street to Bathurst Street. The study also includes an overview of construction impacts and a screening level assessment of greenhouse gases (GHG). To meet these objectives, the following scenarios were considered:

- 2018 No Build (NB) – Assess the existing air quality conditions at representative receptors. Predicted contaminant concentrations from the existing traffic levels were combined with hourly measured ambient concentrations to determine combined impacts.
- 2041 Future Build (FB)– 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 Teston Road, and its major intersecting roadways: Keele Street, Dufferin Street, and Bathurst Street.

The maximum combined concentrations for the Future Build were below their respective MECP guidelines or CAAQS, with the exception of the 1-hr and annual NO_2 CAAQS, 24-hr PM_{10}, 24-hr TSP, 24-hr benzene and annual benzene. Note that background concentrations exceeded the guideline for all of these contaminant averaging periods as well. The overall contribution from the roadway emissions to the combined concentrations was small.

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

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1.0 Introduction

SLR Consulting (Canada) Ltd., was retained by Morrison Hershfield to conduct an air quality assessment as part of the Individual Environmental Assessment (EA) process under the Ontario EA Act for upgrades and completion of Teston Road between west of Keele Street and Bathurst Street in Vaughan. The project involves the widening of Teston Road to four lanes, as well as extending the roadway between Keele Street and Dufferin Street.

1.1 Study Objectives

The main objective of the study was to assess the local air quality impacts due to the proposed Teston Road widening and extension from West of Keele Street to Bathurst Street. The study also includes an overview of construction impacts and a screening level assessment of greenhouse gases (GHG). To meet these objectives, the following scenarios were considered:

- 2018 No Build (NB) – Assess the existing air quality conditions at representative receptors. Predicted contaminant concentrations from the existing traffic levels were combined with hourly measured ambient concentrations to determine combined impacts.
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The modelling considered vehicle emissions from Teston Road, and its major intersecting roadways: Keele Street, Dufferin Street, and Bathurst Street. The roadway segments considered in this assessment are shown in Figure 1.

1.2 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 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. 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.

Table 1: Contaminant of Interest

Criteria Air Contaminants		Volatile Organic Compounds (VOCs)		Polycyclic Aromatic Hydrocarbons (PAH)	
Name	**Symbol**	**Name**	**Symbol**	**Name**	**Symbol**
Nitrogen Dioxide	NO_2	Acetaldehyde	C_2H_4O	Benzo(a)Pyrene	$C_{20}H_{12}$
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		

1.3 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 a combined result of ambient concentration and 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 NO_2 and $PM_{2.5}$ are not based on the maximum concentration values; they are 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/m³)	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
	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
Benzo(a)Pyrene	24	0.00005	AAQC
	Annual	0.00001	AAQC

Notes:

[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 NO_2 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

[4] The annual $PM_{2.5}$ CAAQS is based on the average of the three highest annual average values over the study period

1.4 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. 2017-2021 historical meteorological data from Pearson International Airport was used. Five years were modelled in order to capture the worst-case meteorological conditions. Two emission scenarios were assessed: 2018 No Build and 2041 Future Build.

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.

2.0 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 (O3), 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 3.

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 Figure 4 and is based on a computer simulation from the Weather Research and Forecasting (WRF) Model.

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 closest MECP station is located 12km south of the site (Toronto North), second closest being Newmarket at 18km away. The closest NAPS (Toronto West) station is located within 18 km of the site; therefore, these monitoring stations were reviewed to understand background concentrations in the study area. Note that CO is only monitored at the Toronto West Station. 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 5. Station information is presented in Table 3.

Table 3: Relevant MECP and NAPS Station Information

City/Town	Station ID	Location	Operator	Contaminant
Toronto North	34020	Hendon Avenue/Young Street	MECP	NO_2 | $PM_{2.5}$
Toronto West	35125	125 Resources Road	MECP	NO_2| $PM_{2.5}$ | CO
Toronto West	60438	401W - 125 Resources Road	NAPS	Benzo (a) Pyrene
Newmarket	48006	Eagle Street & McCaffrey Road	MECP	NO_2 | $PM_{2.5}$
Windsor West	60211	College Street/Prince Street	NAPS	Formaldehyde | Acetaldehyde | Acrolein
Newmarket	65101	Eagle Street & McCaffrey Road	NAPS	1,3-Butadiene | Benzene

2.3 Detailed Analysis of Selected Worst-case Monitoring Stations

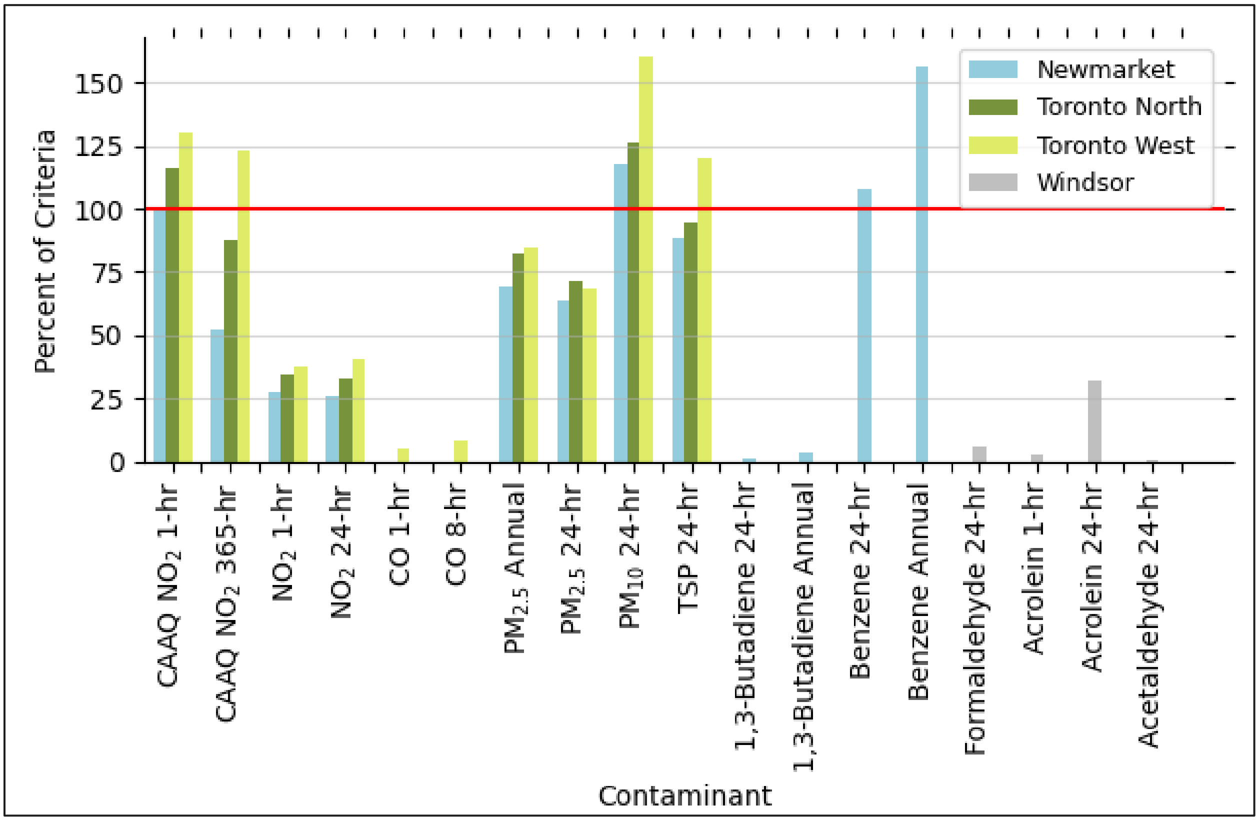
Year 2017 to 2021 hourly ambient monitoring data from the selected stations were statistically summarized for the desired averaging periods: 1-hour, 8-hour, 24-hour, and annual. Note that for the NAPS stations (VOCs) and PAHs, formaldehyde, acetaldehyde and acrolein are only measured at the Windsor station and were not measured after 2010. Therefore 2006-2010data was used for these VOCs. B(a)P is only monitored at some stations and data availability varies between NAPS stations.

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 concentrations are not monitored hourly but are 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 90th percentile measured value for the year in question was applied for those days in order to determine combined concentrations.

It was found that the available ambient Benzo(a)Pyrene data was measured at inconsistent frequencies and time intervals. Therefore, the 90th percentile value of all measured concentrations between 2016 to 2021 at the Toronto West NAPS station was used in the assessment. Since there was very little data available for 2020, six years of background data were considered for PAHs.

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

Figure 1: Selection of Worst-Case Maximum Contaminant Concentrations



Note: PM_{10} and TSP are not measured in Ontario; therefore, background concentrations were estimated from $PM_{2.5}$ concentrations

Table 4: Selection of Background Monitoring Stations

Contaminant	Worst-Case Station	Contaminant	Worst-Case Station
CAAQS NO_2 (1-Hr)	Toronto West	TSP	Toronto West
CAAQS NO_2 (ann)	Toronto West	1,3-Butadiene (24-hr)	Newmarket
NO_2 (1-Hr)	Toronto West	1,3-Butadiene (ann)	Newmarket
NO_2 (24-Hr)	Toronto West	Benzene (24-hr)	Newmarket
CO (1-Hr)	Toronto West	Benzene (ann)	Newmarket
CO (8-hr)	Toronto West	Formaldehyde	Windsor
$PM_{2.5}$ (24-hr)	Toronto North	Acrolein	Windsor
$PM_{2.5}$ (ann)	Toronto West	Acetaldehyde	Windsor
PM_{10}	Toronto West	Benzo(a)Pyrene	Toronto West

A detailed statistical analysis of the selected worst-case background monitoring station for each of the contaminants was performed and is summarized in Figure 6. 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 CAAQS NO_2 1-hour and 24-hour $PM_{2.5}$, as the guideline for these contaminants based on 98th percentile concentrations. B(a)P is not shown in this summary, as only the 90th percentile value for all available data was applied in the combined analysis. The 90th percentile 24-Hour B(a)P concentrations were 0.000125 $\mu g/m^3$ and 250 % of the applicable guidelines. Also, the 90th percentile annual average background concentration was 0.0000946 $\mu g/m^3$ and 946% of the applicable guidelines.

Based on a review of ambient monitoring data from 2017-2021, background concentrations were generally below their respective guidelines. The exceptions are B(a)P, particulate matter, benzene, as well as the 1-hour and annual NO_2 CAAQS standards. In some cases, the exceedances represent maximum concentrations and the 90th percentile and/or average concentrations are below the guideline. It should be noted that PM_{10} and TSP were calculated based on their relationship to $PM_{2.5}$.

3.0 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.

Twenty-one sensitive receptor locations were selected to be representative of potential impacts within the study area. They include proposed/existing residential houses, schools, and community centers within the closest proximity to Teston Road, and thus the most likely impacted by the roadway widening and expansion. The representative receptors include locations both north and south of Teston Road as shown in Figure 7.

3.2 Road Traffic Data

Traffic data was provided by Morrison Hershfield in the form of annual average daily traffic (AADT) values for Teston Road and the major intersecting roads within the study area for both the 2018 No Build and 2041 Future Build configurations. The AADT volumes used in the assessment are shown in Table 5. Vehicle posted speeds for Teston Road, and the arterial roads are also shown in Table 5.

Lastly, a heavy-duty vehicle percentage was also provided by Morrison Hershfield for the study area as shown in Table 6. Detailed breakdown of medium and heavy trucks on arterial roads can be found in Table 6. Hourly traffic volumes were not available for Teston road and arterial roads; therefore, the US EPA standard urban weekday hourly distribution was used for these roadways. The hourly distributions applied in this assessment are shown in Table 7.

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

Location	Direction	Posted Speed	2018 No Build AADT	2041 Future Build AADT
Along Teston				
Jane Street to Keele Street	East/West	60	6476	25760
Keele Street to Dufferin Street	East/West	60	2222[1]	27790
Dufferin Street to Bathurst Street	East/West	60	16285	23350
North/South Arterial Roads				
Keele Street	North of Teston Road	70	15234	26690
	South of Teston Rod	50	19357	20660
Dufferin Street	North of Teston Road	60	14430	21160
	South of Teston Rod	60	18553	29120
Bathurst Street	North of Teston Road	70	33838	47320
	South of Teston Rod	60	34478	40950
Notes: Between Keele Street and Dufferin Street, the No Build traffic volumes represent those between Keele Street and Rodinea Road, as there is no road connection between Rodinea Road and Dufferin Street currently. The Future Build volumes include traffic along the new roadway connection between Rodinea Road and Dufferin Street.				

Table 6: Heavy Duty Vehicle Percentages used in the Assessment

Location	Total Truck Split %	Medium Truck %	Heavy Truck %
Along Teston			
Jane Street to Keele Street	3%	1%	2%
Keele Street to Dufferin Street	9%	3%	6%
Dufferin Street to Bathurst Street	3%	1%	2%
North/South Arterial Roads			
Keele Street	6%	2%	4%
Dufferin Street	3%	1%	2%
Bathurst Street	6%	2%	4%

Table 7: Hourly Vehicle Distribution Used in the Assessment

Hour	US EPA Weekday	US EPA Weekend
1	0.9%	2.2%
2	0.6%	1.4%
3	0.5%	1.0%
4	0.4%	0.8%
5	0.6%	0.7%
6	1.9%	1.0%
7	4.6%	1.9%
8	6.9%	2.6%
9	6.1%	3.8%
10	5.0%	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	6.0%	6.0%
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%

3.3 Meteorological Data

2017-2021 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 in 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 8.

As can be seen in Figure 8, predominant winds are from the westerly through northerly directions.

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 3.0, released in December 2020, 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, fuel type, and vehicle speed. Emission rates were estimated based on the heavy-duty vehicle percentages provided by Morrison Hershfield. 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 2/1%, respectively. As shown in Table 9, emissions in the future year are generally predicted to decrease. This is due to the key assumptions of the MOVES model which predicts decreases in emissions in the future due to improved technologies and stricter regulations. The MOVES default values for vehicle fleet population, including electric vehicle fractions was considered in this assessment. Note that emission rates for 1,3-Butadiene are predicted by the MOVES model to be reduced to zero in the year 2041.

Table 8: MOVES Input Parameters

Parameter	Input
Scale	County Scale
Meteorology	Temperature and Relative Humidity were obtained from meteorological data from the Environment Canada Toronto International Airport station for the years 2017 to 2021.
Years	2018 (No Build) and 2041 (Future Build)
Geographical Bounds	County Scale
Fuels	Compressed Natural Gas / Diesel Fuels / Electricity / Ethanol (E-85) / Gasoline Fuels
Source Use Types	Combination Long-haul Truck / Combination Short-haul Truck / Other 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
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: MOVES Output Emission Factors for Roadway Vehicles (g/VMT); Idle Emission Rates are grams per vehicle hour

Year	Speed (Km/hr)	CO	NO_X	Benzene	1,3-Butadiene	Formaldehyde	Acetaldehyde	Acrolein	$PM_{2.5}$	PM_{10}	TSP[1]	B(a)P
2018	50	3.98	0.33	0.0031	0.00014	0.0016	0.00089	0.00010	0.014	0.066	0.066	0.000001541
2018	60	3.61	0.30	0.0027	0.00012	0.0014	0.00079	0.00009	0.012	0.052	0.052	0.000001374
2018	70	3.06	0.28	0.0022	0.00010	0.0012	0.00064	0.00007	0.009	0.033	0.033	0.000001207
2018	Idle	7.71	2.09	0.0303	0.00208	0.0244	0.01303	0.00168	0.099	0.109	0.109	0.000007251
2041	50	1.35	0.11	0.0011	0.00000	0.0004	0.00027	0.00002	0.010	0.061	0.061	0.000000423
2041	60	1.24	0.09	0.0010	0.00000	0.0004	0.00023	0.00002	0.008	0.048	0.048	0.000000407
2041	70	1.09	0.07	0.0009	0.00000	0.0003	0.00019	0.00002	0.005	0.030	0.030	0.000000394
2041	Idle	2.79	1.21	0.0122	0.00000	0.0051	0.00364	0.00027	0.016	0.018	0.018	0.000001115

Notes:

[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	0.691

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	2017-2021 data from Pearson International Airport
Deposition Velocity	$PM_{2.5}$: 0.1 cm/s PM_{10}: 0.5 cm/s TSP: 0.15 cm/s B(a)P, 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 B(a)P, 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 52cm 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 2018 No Build and 2041 Future Build 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 Future Build scenario. Note that 1,3-Butadiene emissions in the 2041 Future Build scenario are predicted to be zero by the MOVES model; therefore, there are no results for 1,3-Butadiene for this 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
CAAQS NO_2	1-hour	17
	Annual	14
NO_2	1-hour	17
	24-hour	17
CO	1-hour	17
	8-hour	16
$PM_{2.5}$	24-hour	14
	Annual	14
PM_{10}	24-hour	14
TSP	24-hour	14
Formaldehyde	24-hour	14
Benzene	24-hour	14
	Annual	14
Acrolein	1-hour	12
	24-hour	17
Acetaldehyde	24-hour	16
Benzo (a) Pyrene	24-hour	14
	Annual	14

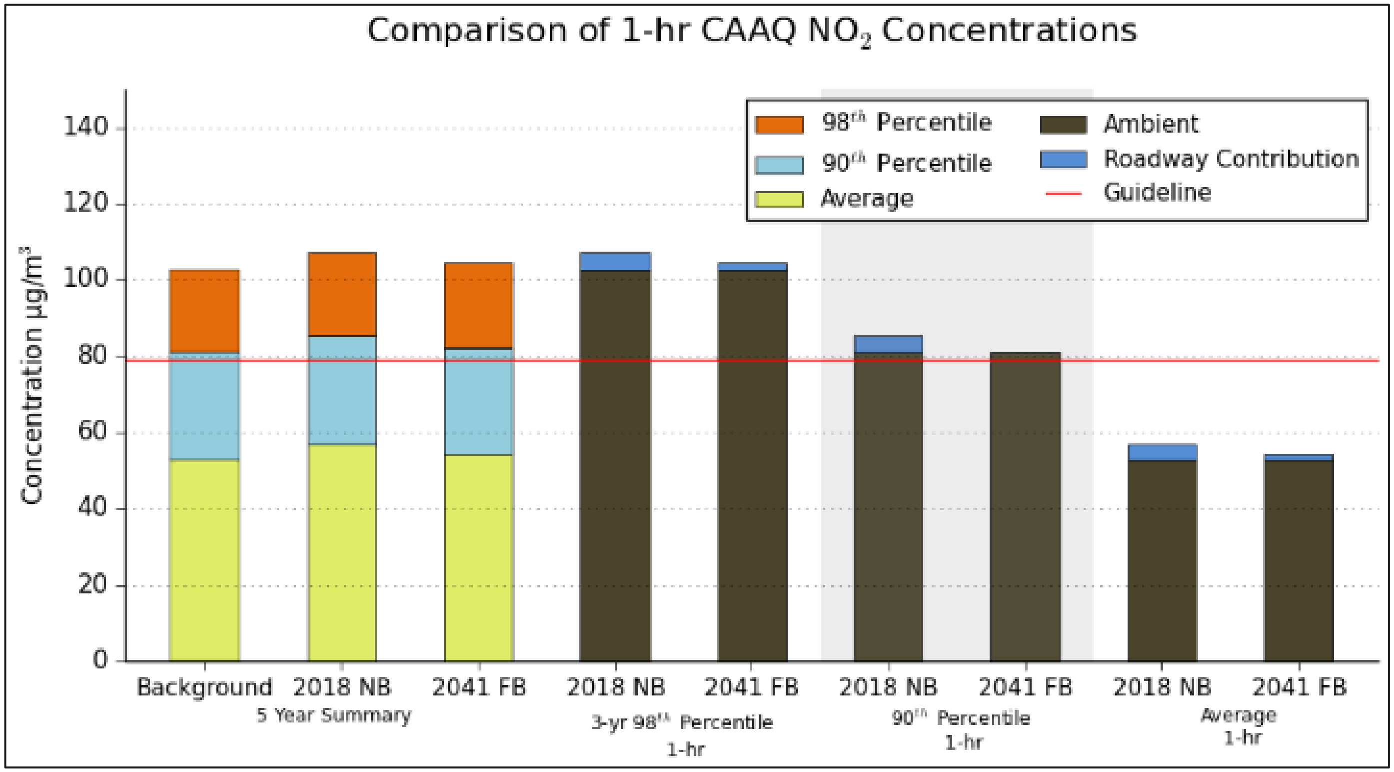
Coincidental hourly modelled roadway and background concentrations were added to derive the combined concentration for each hour over the 5-year period. Hourly combined concentrations were then used to determine contaminant concentrations based on the applicable averaging period. Statistical analysis 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 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.

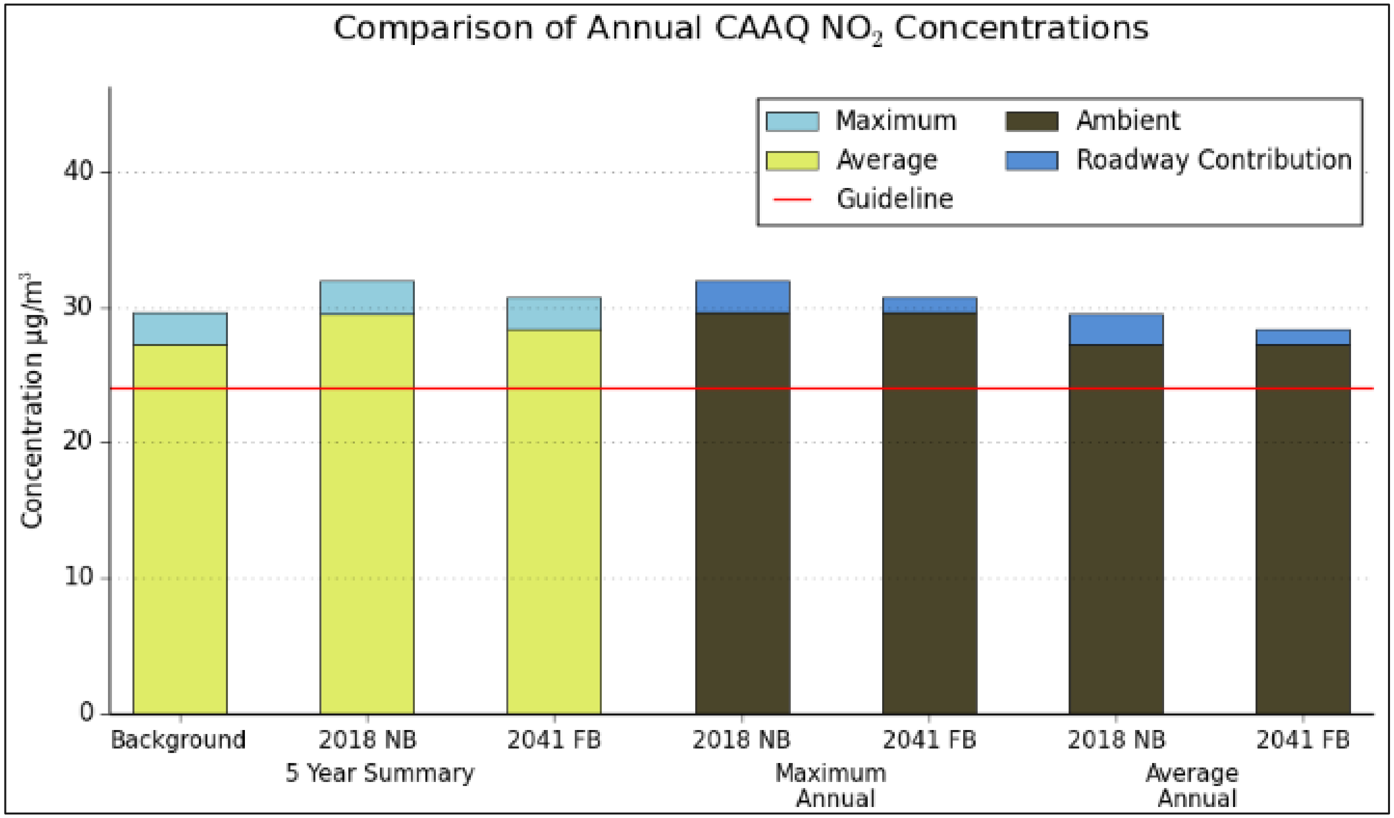
3.7.1 Nitrogen Dioxide CAAQS

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 the daily maximum 1-hour NO_2 concentration, averaged over three consecutive years exceeds the CAAQS with an 9% contribution from the roadway.
- Maximum combined concentrations exceed the 1-hour CAAQS Guideline. Note that the maximum background concentrations alone exceed the CAAQS 1-hr objective of 79 µg/m^3. Also note that this objective is based on the 3-year average of the annual 98th percentile of the NO_2 daily-maximum 1-hour average concentrations.
- Maximum combined concentrations exceed the annual CAAQS Guideline. Note that the maximum background concentrations alone exceed the CAAQS annual objective of 23 µg/m^3.

Table 13: Summary of Predicted CAAQS NO_2 Concentrations

<table>
<tr><th>Statistical Analysis</th><th colspan="2">2041 FB</th></tr>
<tr><td rowspan="9">
</td><td colspan="2">% of CAAQS Guideline:</td></tr>
<tr><td>98th Percentile</td><td>132%</td></tr>
<tr><td>90th Percentile</td><td>104%</td></tr>
<tr><td>Average</td><td>69%</td></tr>
<tr><td colspan="2">Roadway Contribution:</td></tr>
<tr><td>98th Percentile</td><td>9%</td></tr>
<tr><td>90th Percentile</td><td>2%</td></tr>
<tr><td>Average</td><td>2%</td></tr>
<tr><td colspan="2"></td></tr>
</table>

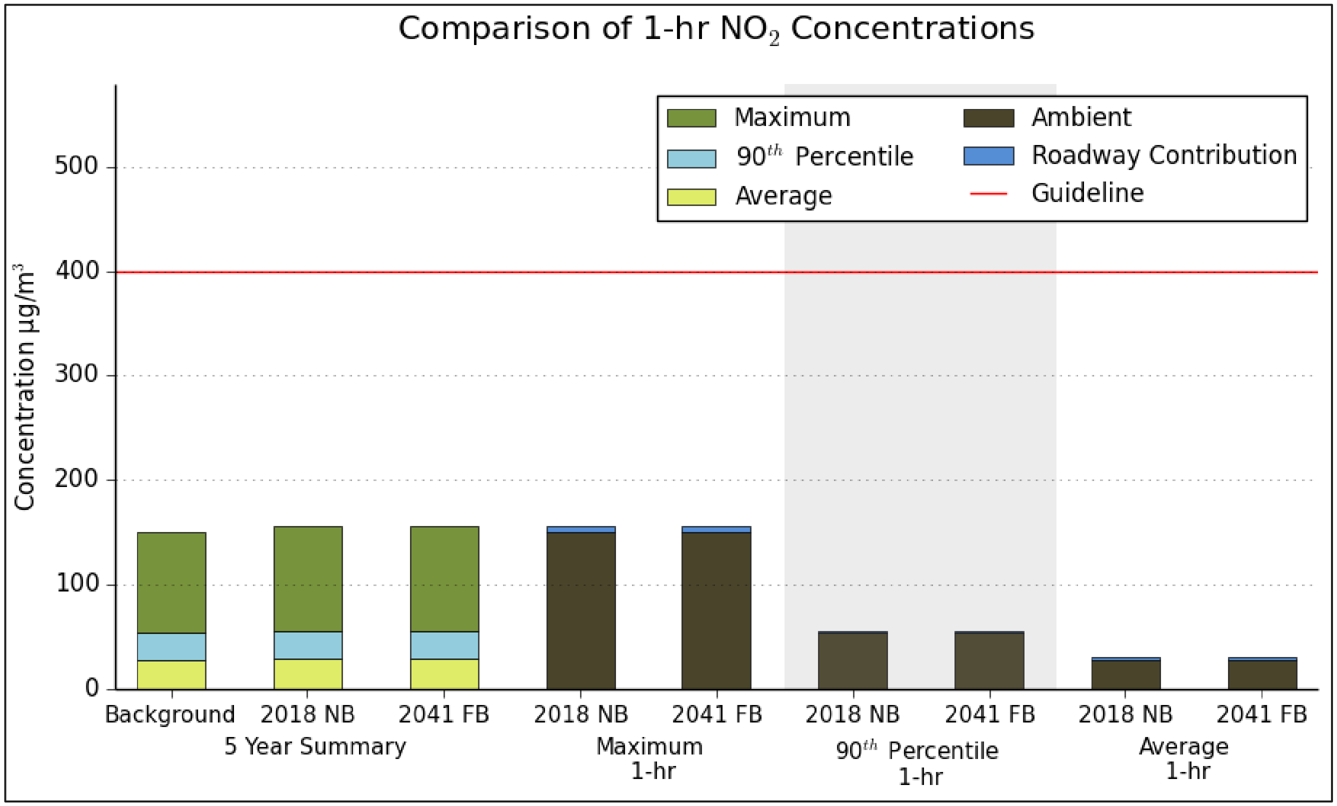
<table>
<tr><th>Statistical Analysis</th><th colspan="2">2041 FB</th></tr>
<tr><td rowspan="8">
</td><td colspan="2">% of CAAQS Guideline:</td></tr>
<tr><td>Maximum</td><td>128%</td></tr>
<tr><td>Average</td><td>118%</td></tr>
<tr><td colspan="2">Roadway Contribution:</td></tr>
<tr><td>Maximum</td><td>4%</td></tr>
<tr><td>Average</td><td>4%</td></tr>
<tr><td colspan="2">The annual average concentration exceeded the guideline with a 4% contribution from the roadway.</td></tr>
</table>

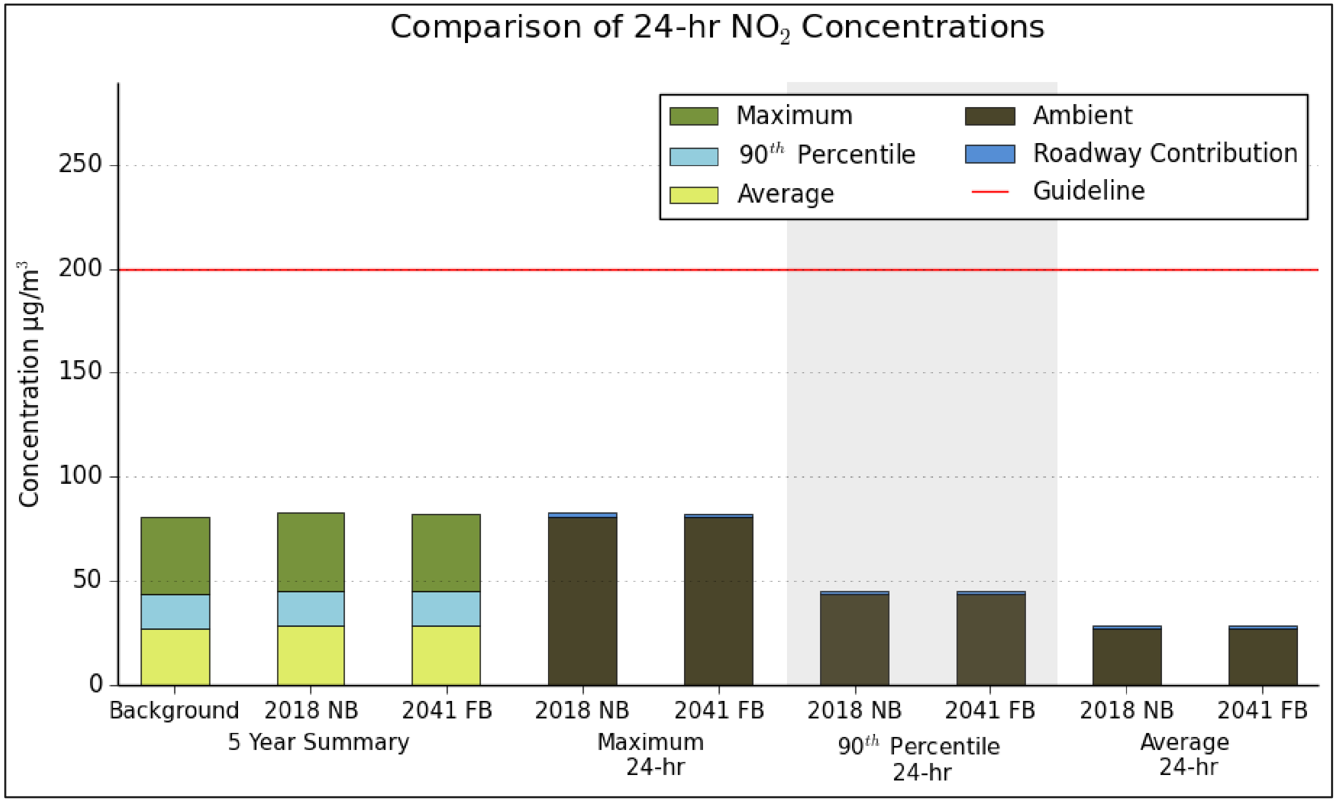
3.7.2 Nitrogen Dioxide

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 FB</th></tr>
<tr><td rowspan="9">
</td><td colspan="2">% of MECP Guideline:</td></tr>
<tr><td>Maximum</td><td>39%</td></tr>
<tr><td>90th Percentile</td><td>14%</td></tr>
<tr><td>Average</td><td>7%</td></tr>
<tr><td colspan="2">Roadway Contribution:</td></tr>
<tr><td>Maximum</td><td>3%</td></tr>
<tr><td>90th Percentile</td><td>2%</td></tr>
<tr><td>Average</td><td>4%</td></tr>
<tr><td colspan="2"></td></tr>
</table>

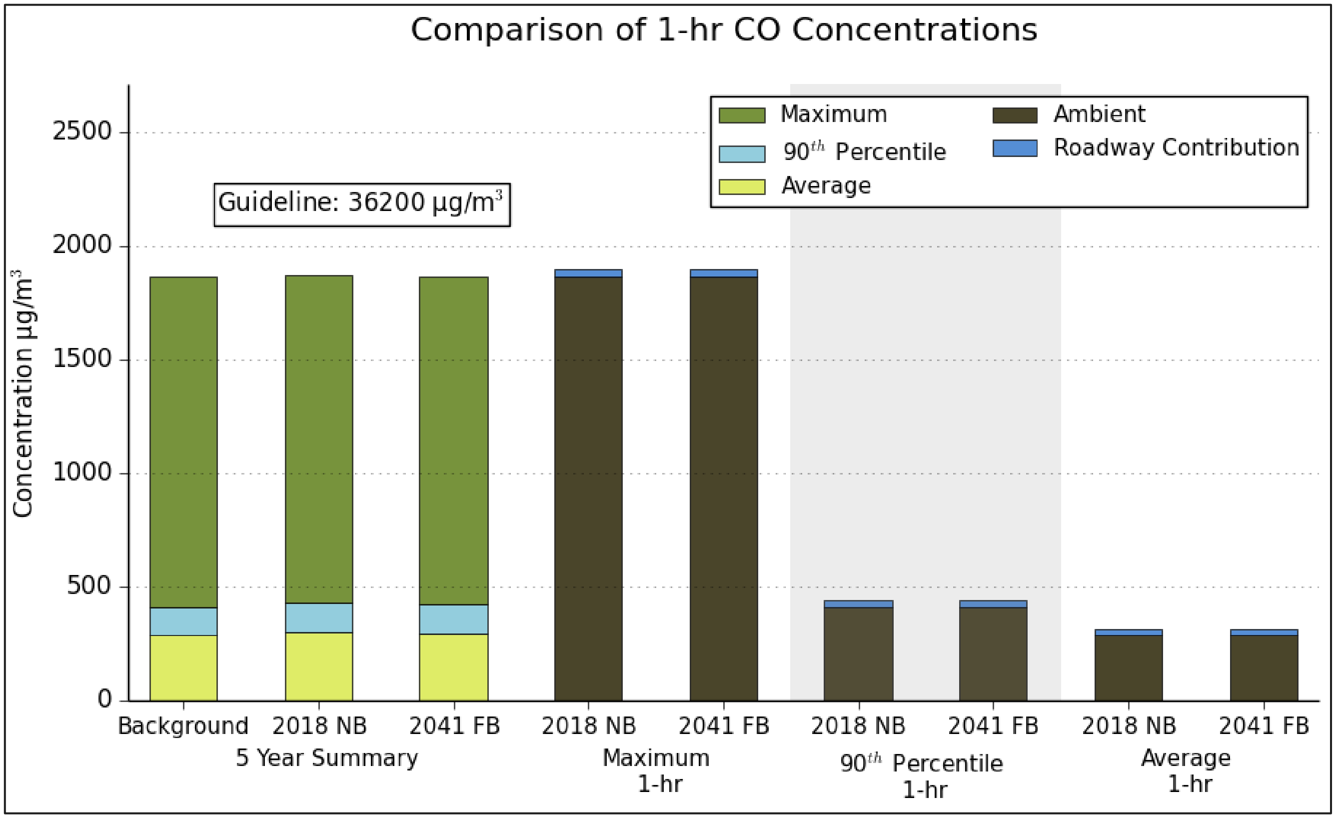
<table>
<tr><th>Statistical Analysis</th><th colspan="2">2041 FB</th></tr>
<tr><td rowspan="8">
</td><th colspan="2">% of MECP Guideline:</th></tr>
<tr><td>Maximum</td><td>41%</td></tr>
<tr><td>90th Percentile</td><td>22%</td></tr>
<tr><td>Average</td><td>14%</td></tr>
<tr><th colspan="2">Roadway Contribution:</th></tr>
<tr><td>Maximum</td><td>2%</td></tr>
<tr><td>90th Percentile</td><td>3%</td></tr>
<tr><td>Average</td><td>4%</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 3% or less of the maximum value.</td></tr>
</table>

3.7.3 Carbon Monoxide

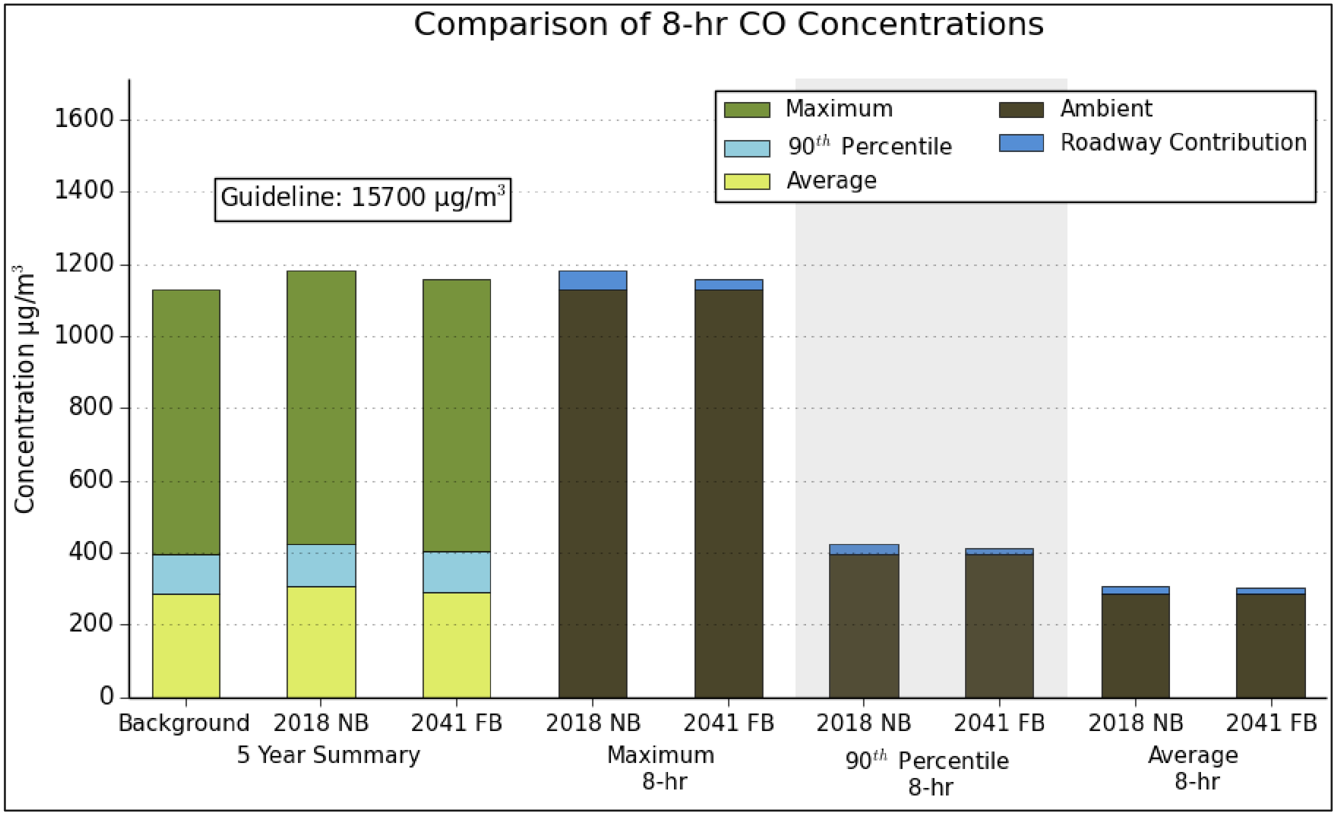
Table 15 presents the predicted combined concentrations for the worst-case sensitive receptor for 1-hour and 8-hour CO based on 5 years of meteorological data. The results conclude that:

- 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

<table>
<tr><th>Statistical Analysis</th><th colspan="2">2041 FB</th></tr>
<tr><td rowspan="9">
</td><td colspan="2">% of MECP Guideline:</td></tr>
<tr><td>Maximum</td><td>5%</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><1%</td></tr>
<tr><td>90th Percentile</td><td>3%</td></tr>
<tr><td>Average</td><td>3%</td></tr>
<tr><td colspan="2"></td></tr>
</table>

Statistical Analysis



2041 FB	
% of MECP Guideline:	
Maximum	7%
90th Percentile	3%
Average	2%
Roadway Contribution:	
Maximum	4%
90th Percentile	2%
Average	2%

Conclusions:

All combined concentrations were below their respective MECP guidelines.

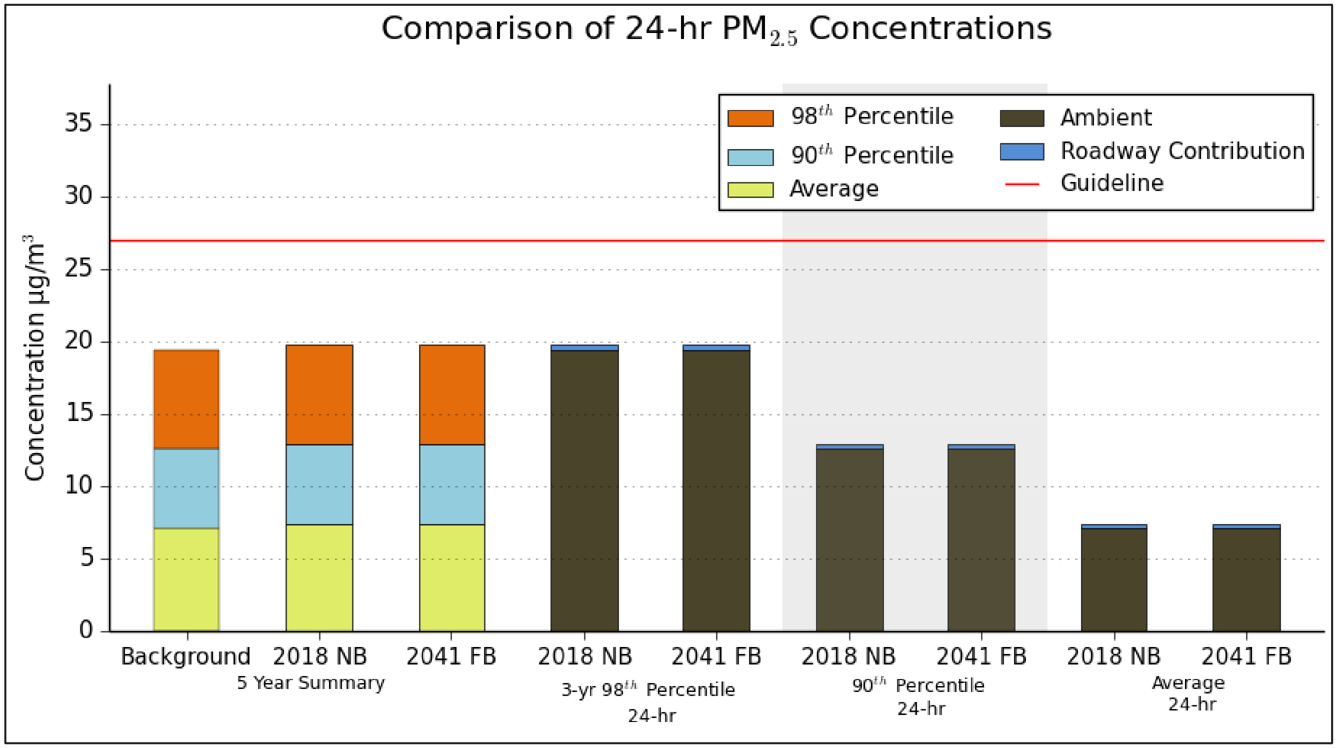
The contribution from the roadway to the combined concentrations was 4% or less of the maximum value.

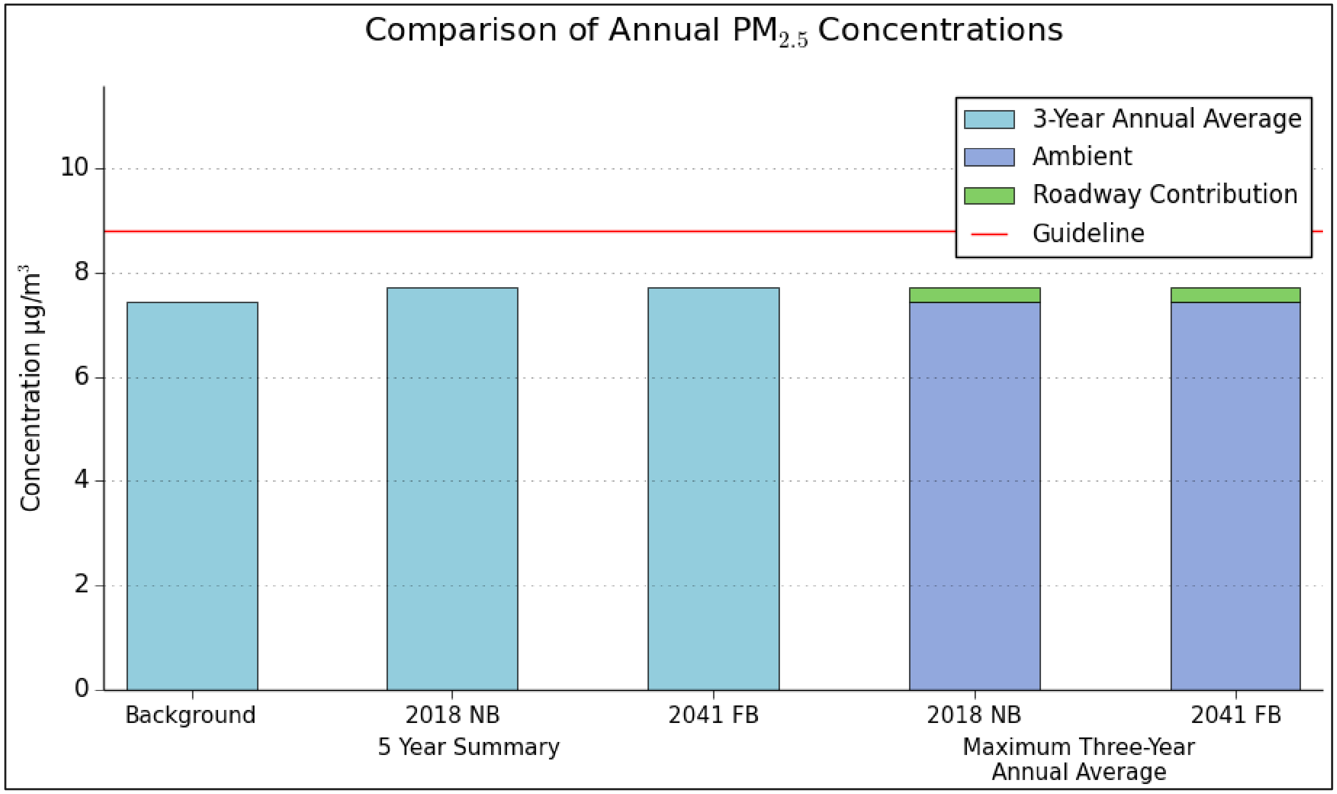
3.7.4 Fine Particulate Matter ($PM_{2.5}$)

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 $PM_{2.5}$ combined concentration Was below the CAAQS.
- 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 19.75 $\mu g/m^3$ or 73% of the CAAQS.

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

<table>
<tr><th>Statistical Analysis</th><th colspan="2">2041 FB</th></tr>
<tr><td rowspan="9">
</td><td colspan="2">% of CAAQS Guideline:</td></tr>
<tr><td>98th Percentile</td><td>73%</td></tr>
<tr><td>90th Percentile</td><td>48%</td></tr>
<tr><td>Average</td><td>27%</td></tr>
<tr><td colspan="2">Roadway Contribution:</td></tr>
<tr><td>98th Percentile</td><td>4%</td></tr>
<tr><td>90th Percentile</td><td>3%</td></tr>
<tr><td>Average</td><td>5%</td></tr>
<tr><td colspan="2"></td></tr>
</table>

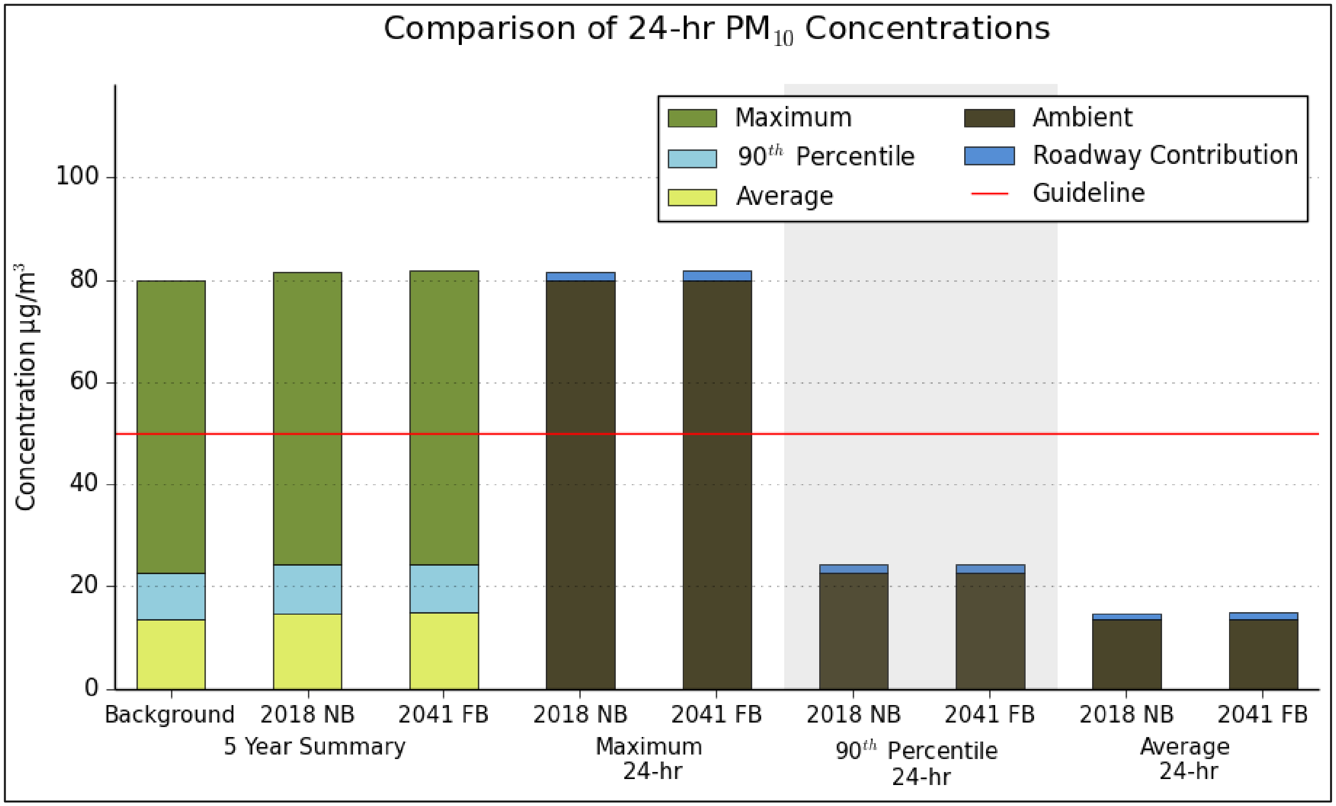
Statistical Analysis	2041 FB	
	**% of CAAQS Guideline:**	
	Maximum 3-Year Annual Average	91%
	Roadway Contribution:	
	Maximum 3-Year Annual Average	4%

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

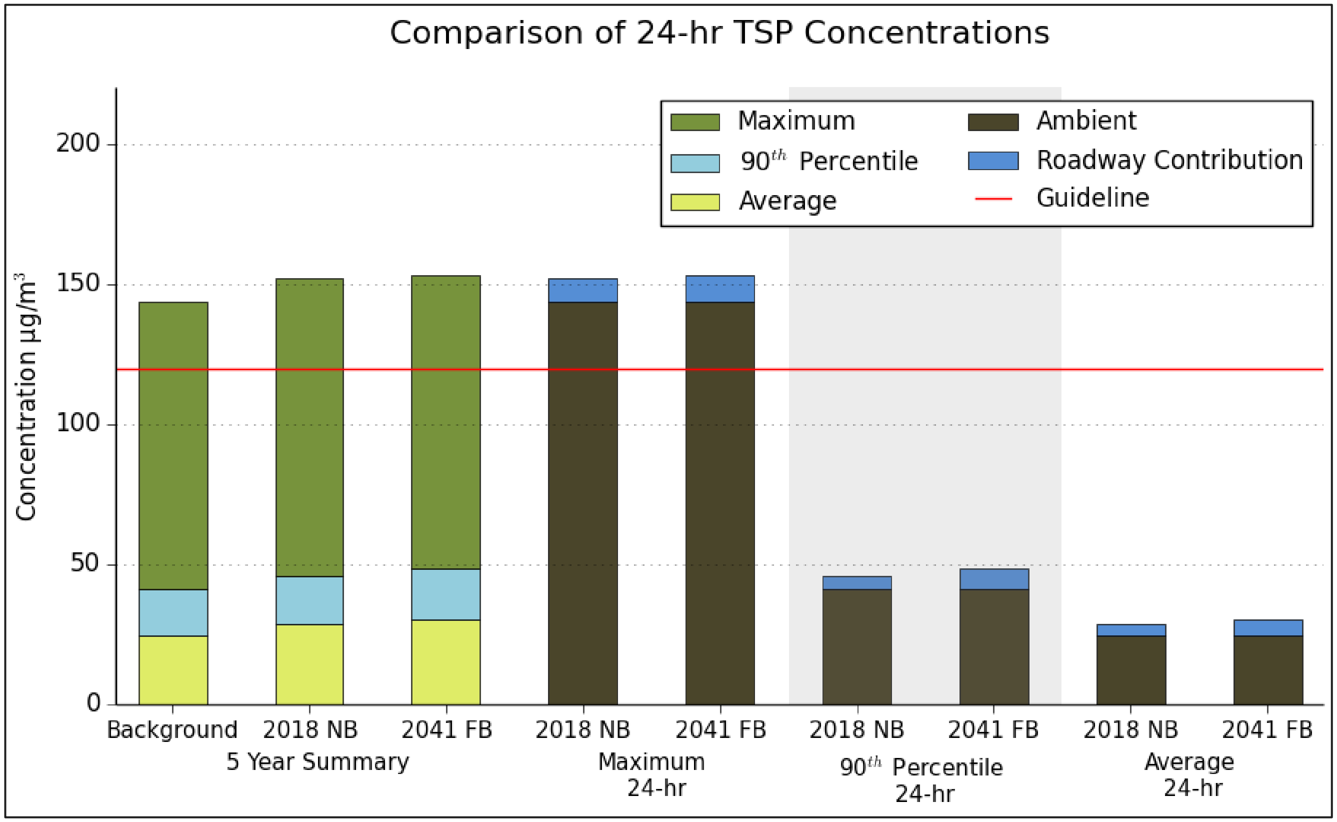
<table>
<tr><th>Statistical Analysis</th><th colspan="2">2041 FB</th></tr>
<tr><td rowspan="8">
</td><td colspan="2">% of MECP Guideline:</td></tr>
<tr><td>Maximum</td><td>164%</td></tr>
<tr><td>90th Percentile</td><td>49%</td></tr>
<tr><td>Average</td><td>30%</td></tr>
<tr><td colspan="2">Roadway Contribution:</td></tr>
<tr><td>Maximum</td><td>2%</td></tr>
<tr><td>90th Percentile</td><td>8%</td></tr>
<tr><td>Average</td><td>9%</td></tr>
<tr><td colspan="3">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 2% of the maximum value.
Frequency analysis was conducted to determine the frequency of exceedances over the 5-year period.
A total of 5 days exceeded the guideline in the five-year period, in both the Existing and Future Build scenarios, which equates to less than 1% of the time. Note that there are no additional exceedances between the Existing and Future Build scenarios.</td></tr>
</table>

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

<table>
<tr><th>Statistical Analysis</th><th colspan="2">2041 FB</th></tr>
<tr><td rowspan="8">
</td><td colspan="2">% of MECP Guideline:</td></tr>
<tr><td>Maximum</td><td>128%</td></tr>
<tr><td>90th Percentile</td><td>40%</td></tr>
<tr><td>Average</td><td>25%</td></tr>
<tr><td colspan="2">Roadway Contribution:</td></tr>
<tr><td>Maximum</td><td>6%</td></tr>
<tr><td>90th Percentile</td><td>16%</td></tr>
<tr><td>Average</td><td>19%</td></tr>
<tr><td colspan="3">Conclusions:
The TSP results show that the combined concentrations exceed the guideline. It should be noted, however, that background concentrations alone were 120% of the standard and that the roadway contribution is 6% of the maximum value.
Frequency analysis was conducted to determine the frequency of exceedances over the 5-year period.
A total of 1 day exceeded the guideline in the five-year period, in both the Existing and Future Build scenarios, which equates to less than 1% of the time. Note that there are no additional exceedances between the Existing and Future Build scenarios.</td></tr>
</table>

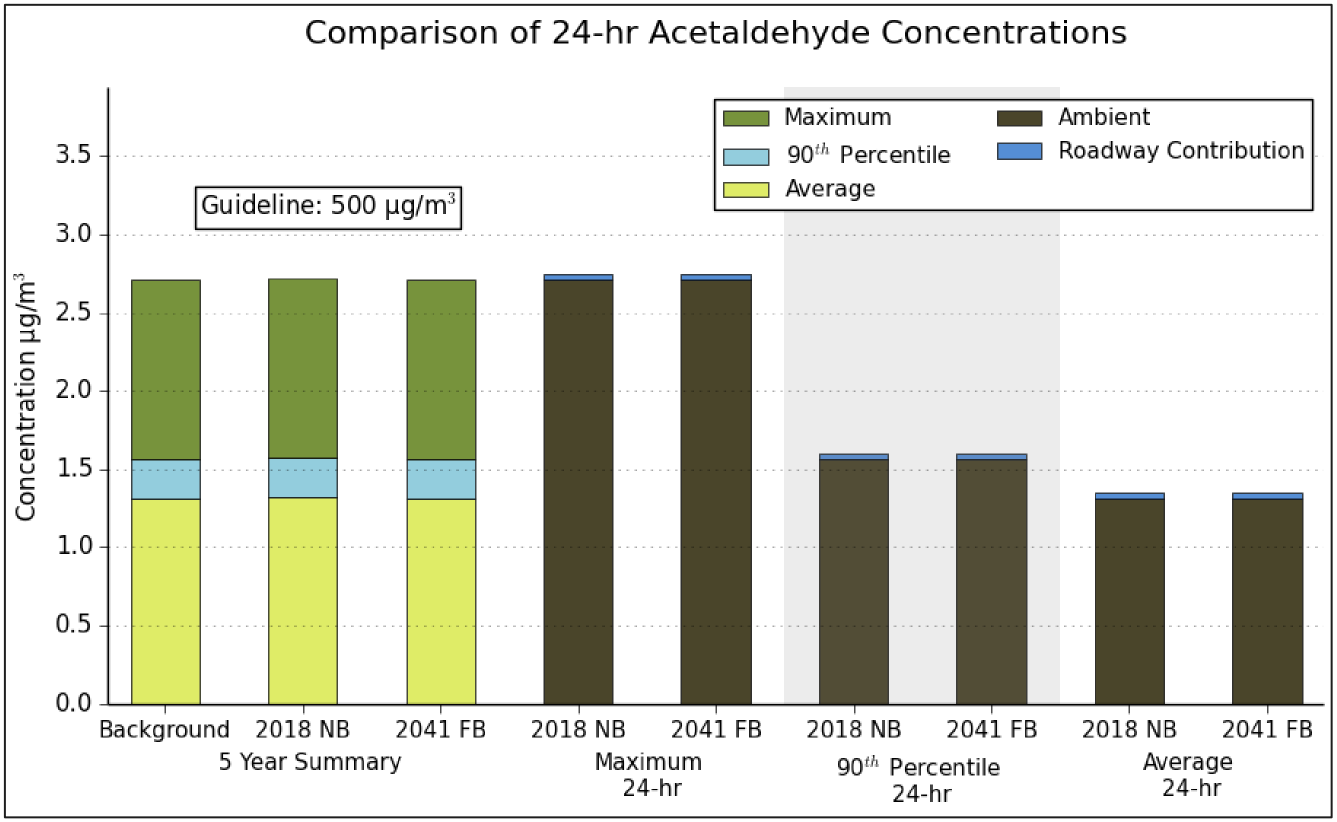
Ambient VOC concentrations are typically measured every 6 days in Ontario. In order to combine the ambient data to the modelled results, the measured concentrations were applied to the following 6 days when measurements were 6 days apart. When measurements were further than 6 days apart, the 90th percentile 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

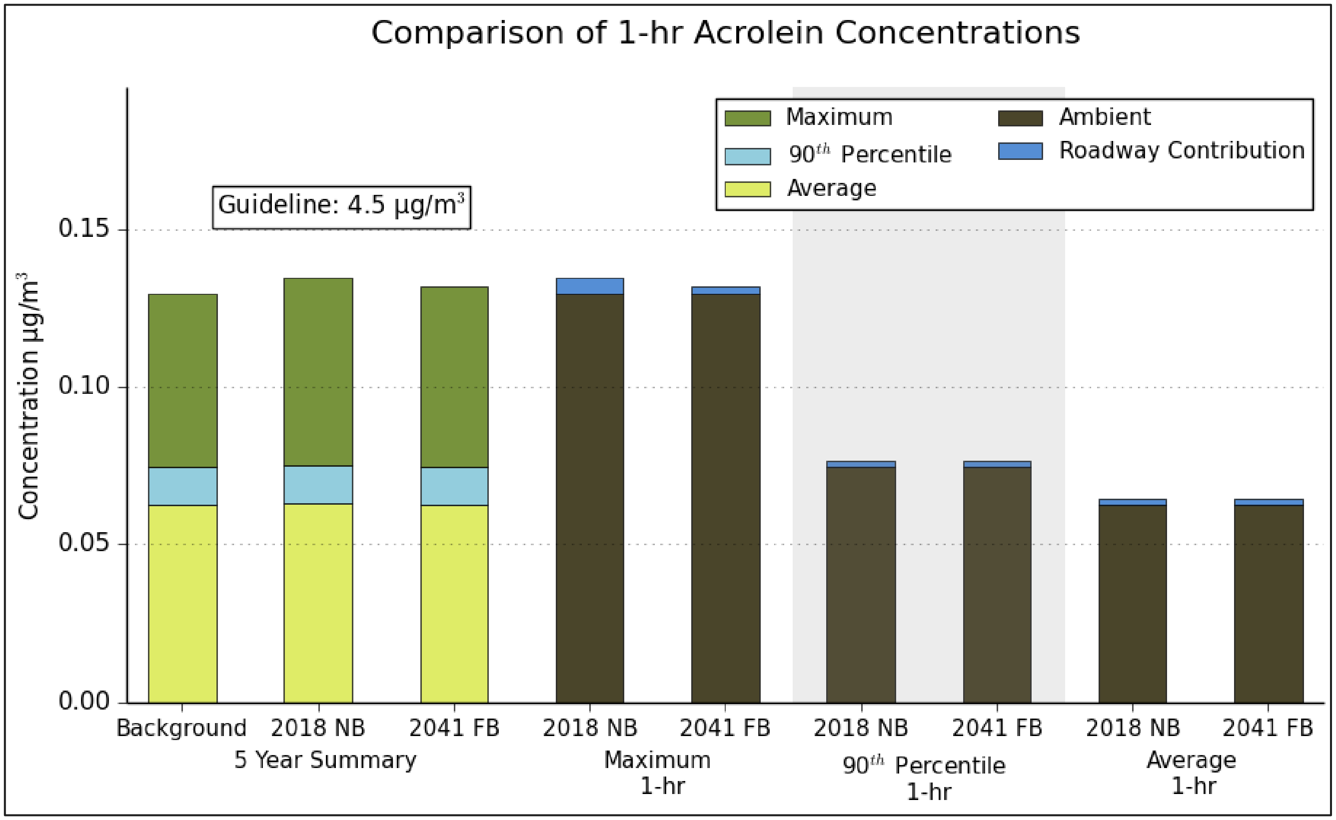
<table>
<tr><th>Statistical Analysis</th><th colspan="2">2041 FB</th></tr>
<tr><td rowspan="9">
</td><td colspan="2">% of MECP Guideline:</td></tr>
<tr><td>Maximum</td><td><1%</td></tr>
<tr><td>90th Percentile</td><td><1%</td></tr>
<tr><td>Average</td><td><1%</td></tr>
<tr><td colspan="2">Roadway Contribution:</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 colspan="2"></td></tr>
<tr><td colspan="3">Conclusions:
All combined concentrations were below the respective MECP guideline.
The contribution from the roadway to the maximum combined concentrations was less than 1%.</td></tr>
</table>

3.7.8 Acrolein

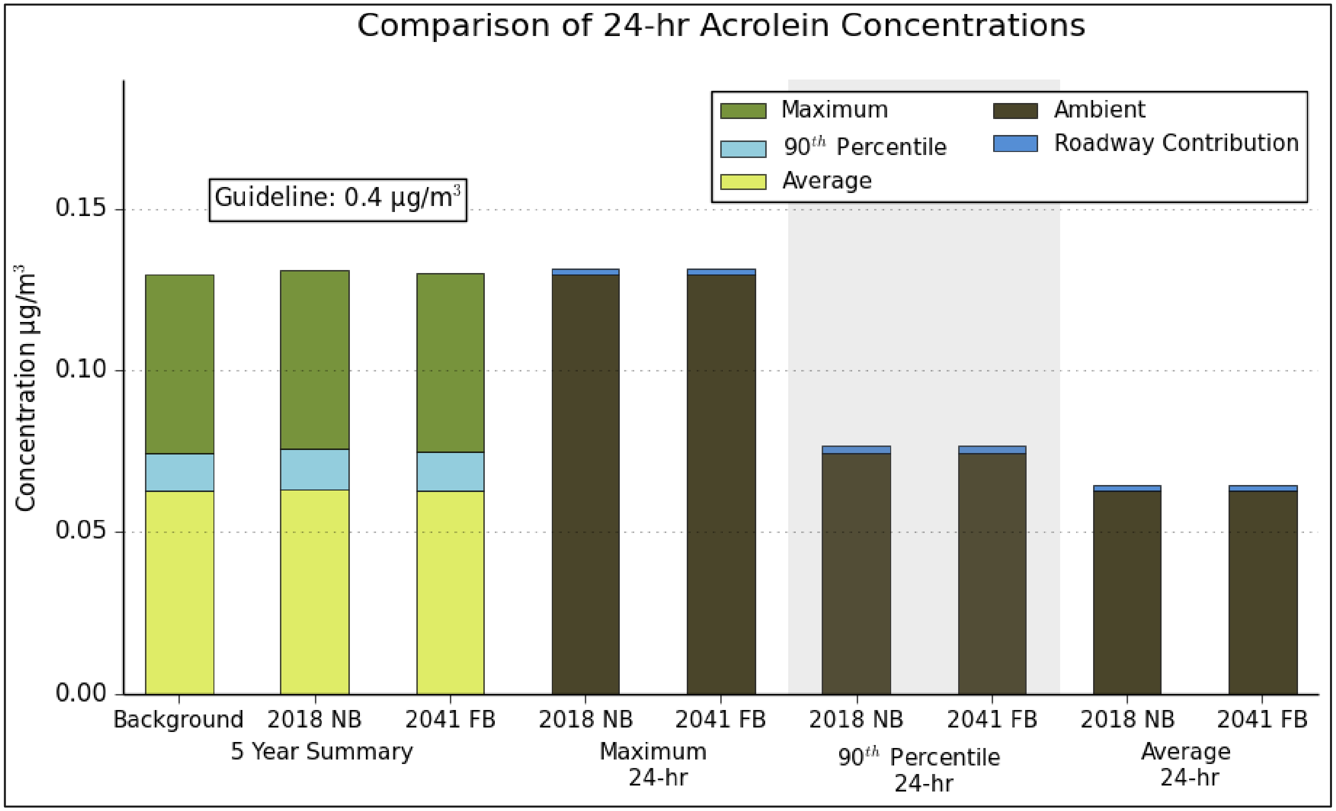
Table 20 presents the predicted combined concentrations for the worst-case sensitive receptor for 1-hour and 24-hour acrolein based on 5 years of meteorological data. The results conclude that:

- The combined concentrations were below the respective MECP 1-hr guideline. The contribution from the roadway was 2% or less.
- The combined concentrations were below the respective MECP 24-hr guideline. The contribution from the roadway was less than 1%.

Table 20: Summary of Predicted Acrolein Concentrations

Statistical Analysis	2041 FB	
	**% of MECP Guideline:**	
	Maximum	3%
	90th Percentile	2%
	Average	1%
	Roadway Contribution:	
	Maximum	2%
	90th Percentile	<1%
	Average	<1%

Statistical Analysis


Comparison of 24-hr Acrolein Concentrations

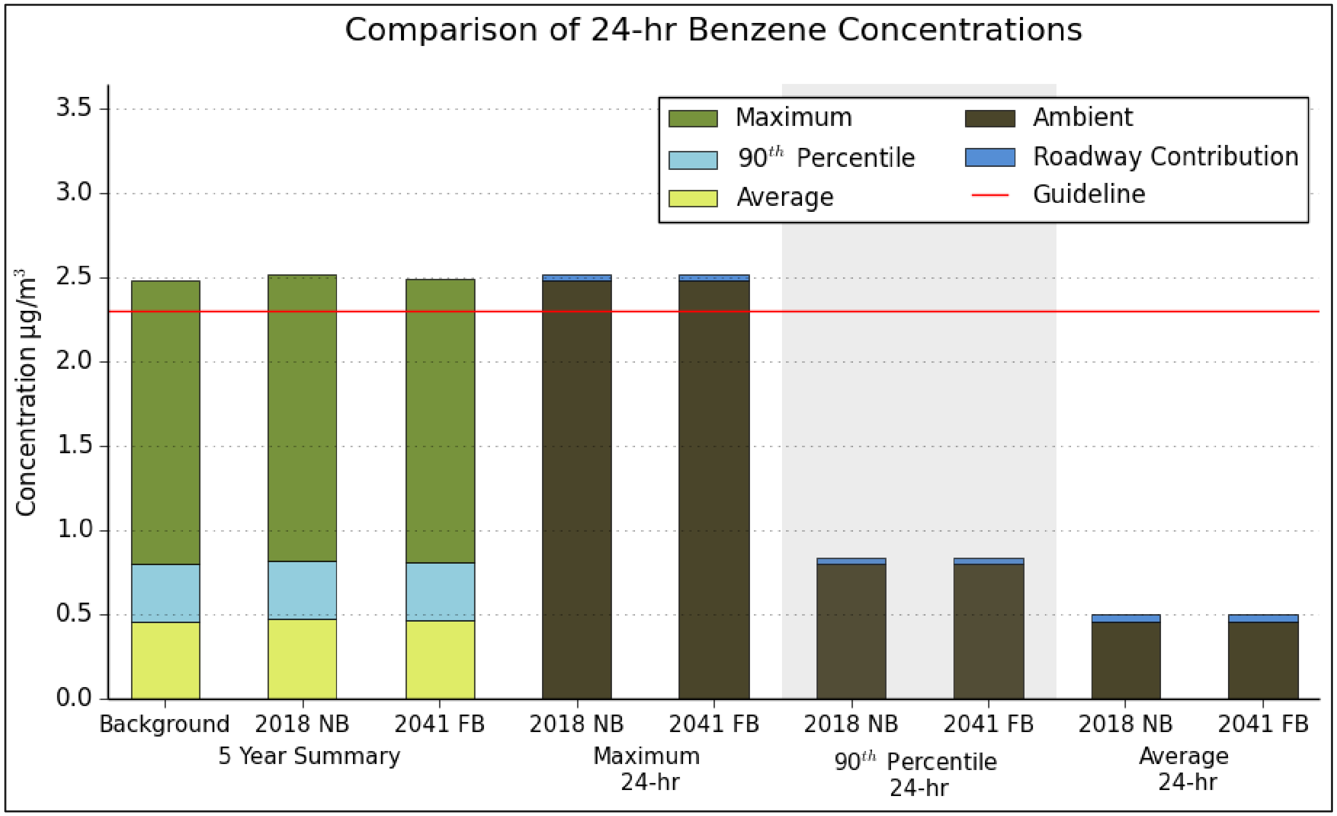
2041 FB	
% of MECP Guideline:	
Maximum	33%
90th Percentile	19%
Average	16%
Roadway Contribution	
Maximum	<1%
90th Percentile	<1%
Average	<1%

3.7.9 Benzene

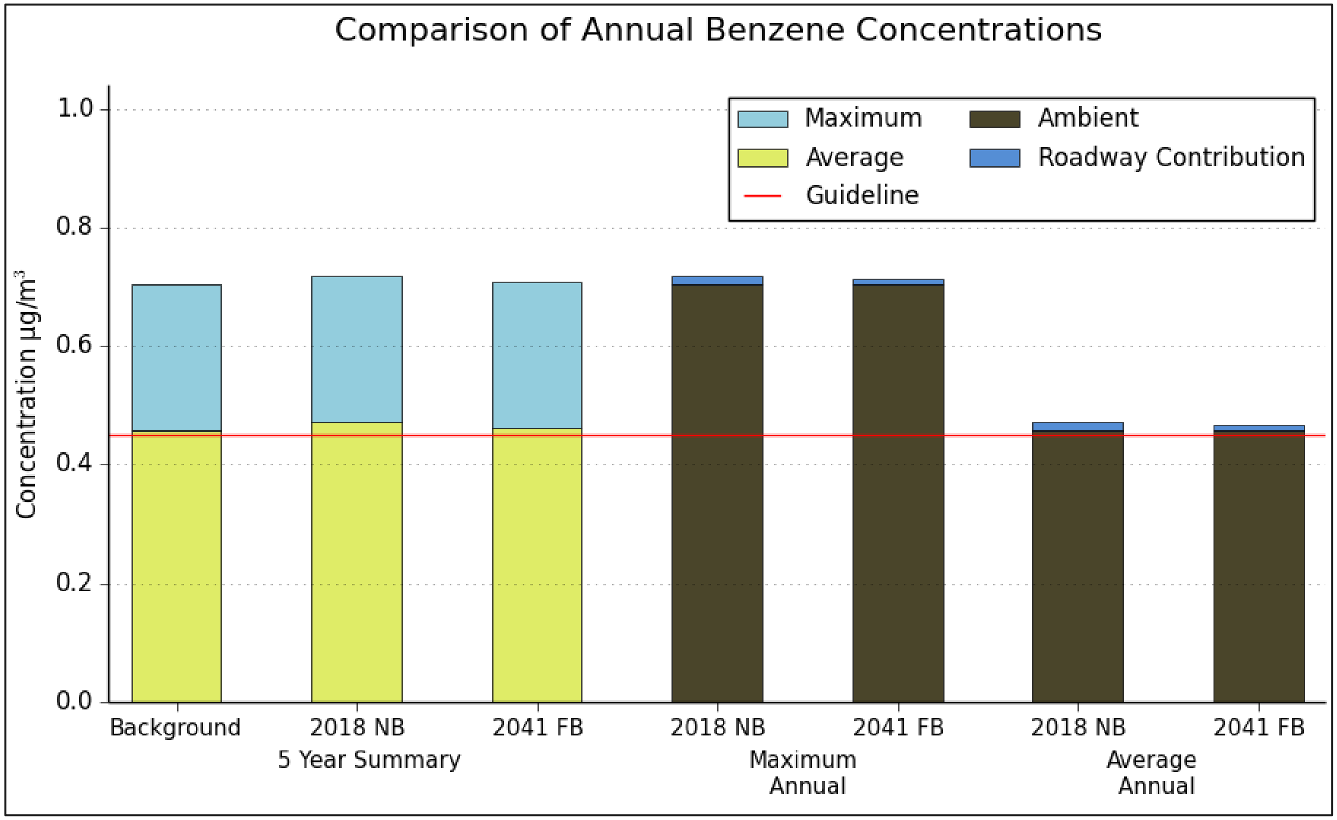
Table 21 presents the predicted combined concentrations for the worst-case sensitive receptor for 24-hour and annual benzene based on 5 years of meteorological data. The results conclude that:

- The combined concentrations exceeded the respective MECP 24-hr guideline. It should be noted that ambient concentrations were 108% of the guideline and the roadway contribution to the maximum was 1%.
- The combined concentration exceeded the MECP annual guideline. It should be noted that ambient concentrations were 156% of the guideline and the roadway contribution to the maximum was 1%.

Table 21: Summary of Predicted Benzene Concentrations

<table>
<tr><th>Statistical Analysis</th><th colspan="2">2041 FB</th></tr>
<tr><td rowspan="9">
</td><td colspan="2">% of MECP Guideline:</td></tr>
<tr><td>Maximum</td><td>108%</td></tr>
<tr><td>90th Percentile</td><td>35%</td></tr>
<tr><td>Average</td><td>20%</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 colspan="2"></td></tr>
</table>

Statistical Analysis



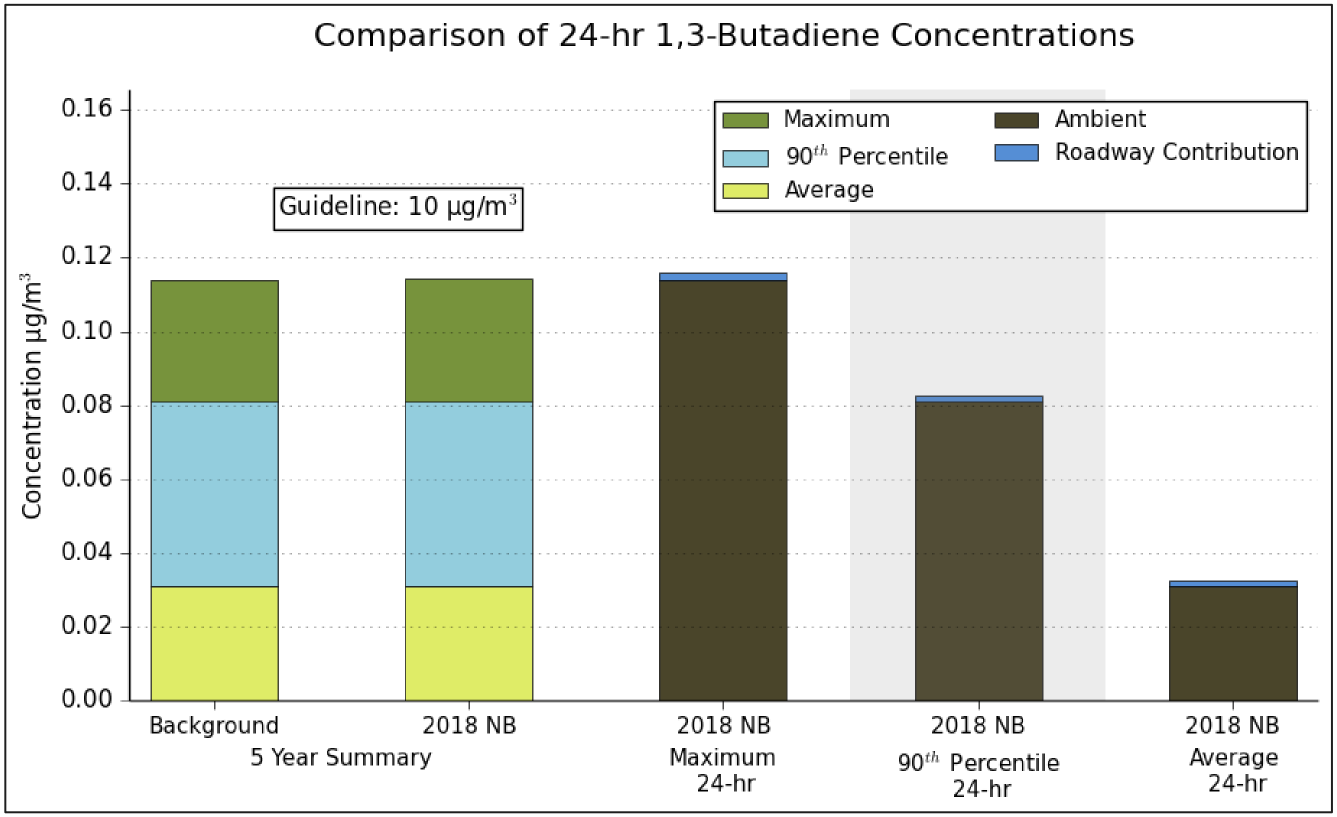
2041 FB	
% of MECP Guideline:	
Maximum	158%
Average	103%
Roadway Contribution:	
Maximum	1%
Average	2%

3.7.10 1,3-Butadiene

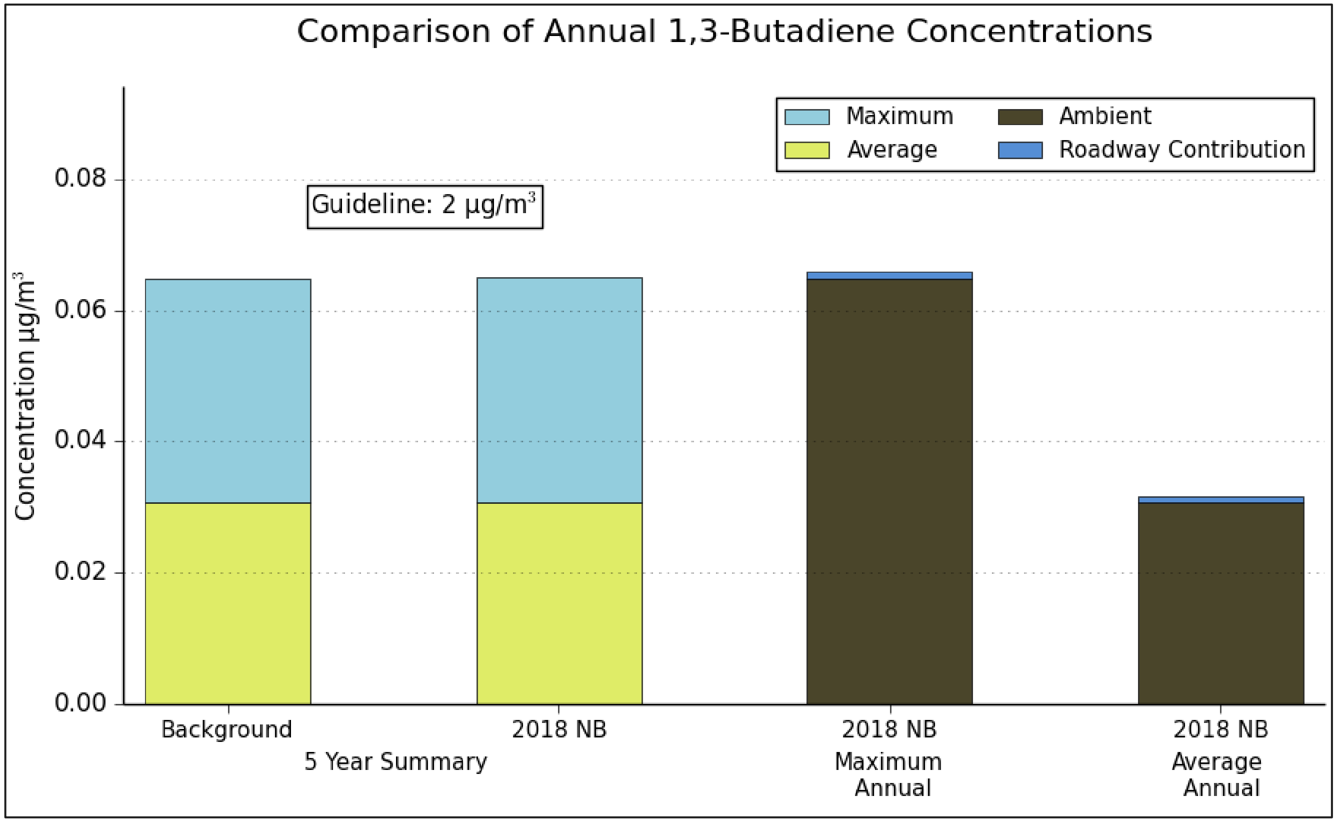
The 1,3-Butadiene emission rates from the MOVES 3.0 model for the Future Build year of 2041 are predicted to be zero. Therefore, the Future Build scenario was not modelled for 1,3-Butadiene and results are only presented for the No Build 2018 scenario. Table 22 presents the predicted combined concentrations 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 for the No Build Scenario.
- Overall, the combined concentrations were predicted to be a very small fraction of the applicable guidelines (3% or less).

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

Statistical Analysis	2018 NB	
	**% of MECP Guideline:**	
	Maximum	1%
	90th Percentile	1%
	Average	<1%
	Roadway Contribution:	
	Maximum	<1%
	90th Percentile	<1%
	Average	<1%

Statistical Analysis



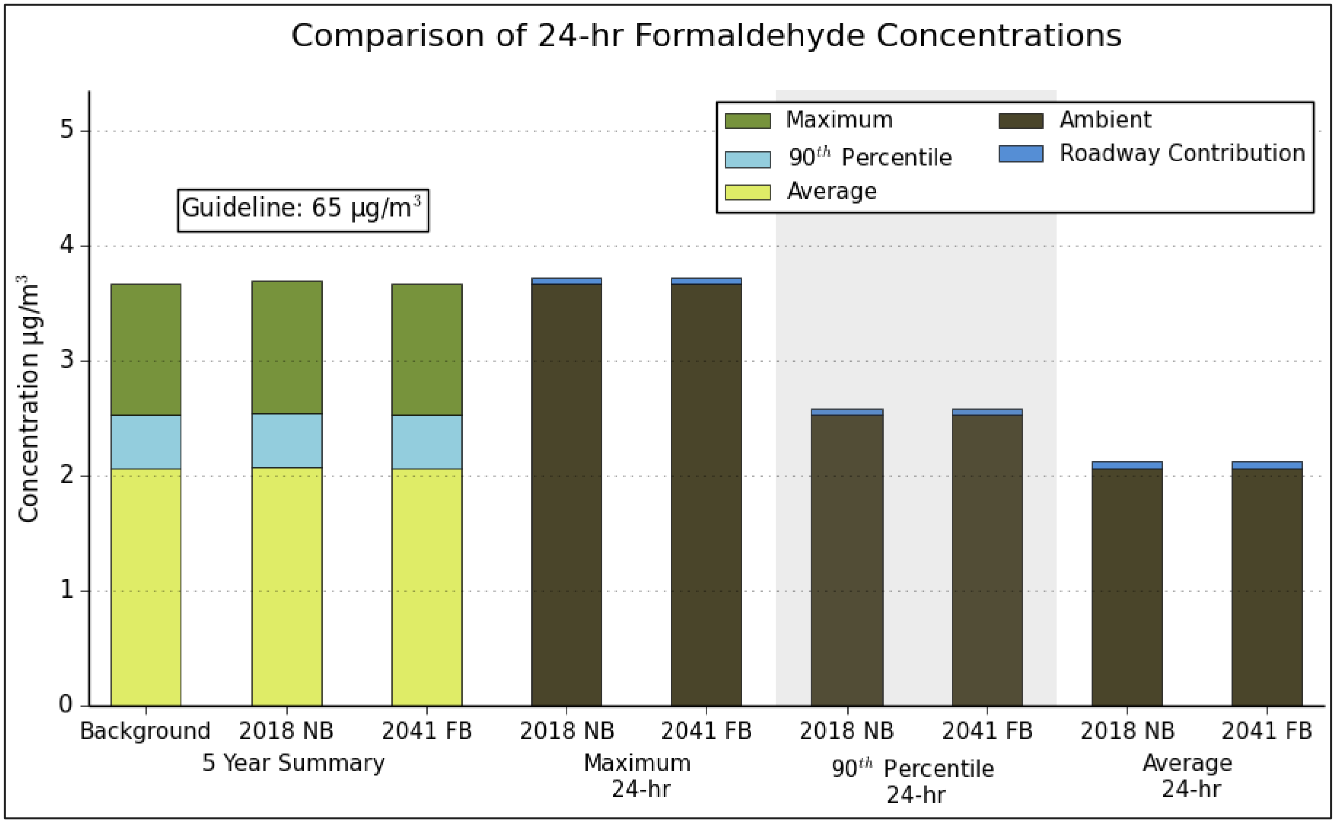
2018 NB	
% of MECP Guideline:	
Maximum	3%
Average	2%
Roadway Contribution:	
Maximum	<1%
Average	<1%

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

<table>
<tr><th>Statistical Analysis</th><th colspan="2">2041 FB</th></tr>
<tr><td rowspan="9"> </td><td colspan="2">% of MECP Guideline:</td></tr>
<tr><td>Maximum</td><td>6%</td></tr>
<tr><td>90th Percentile</td><td>4%</td></tr>
<tr><td>Average</td><td>3%</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 colspan="2"></td></tr>
<tr><td colspan="3">Conclusions:
All combined concentrations were below the respective MECP guideline.
The contribution from the roadway to the maximum combined concentration was <1%.</td></tr>
</table>

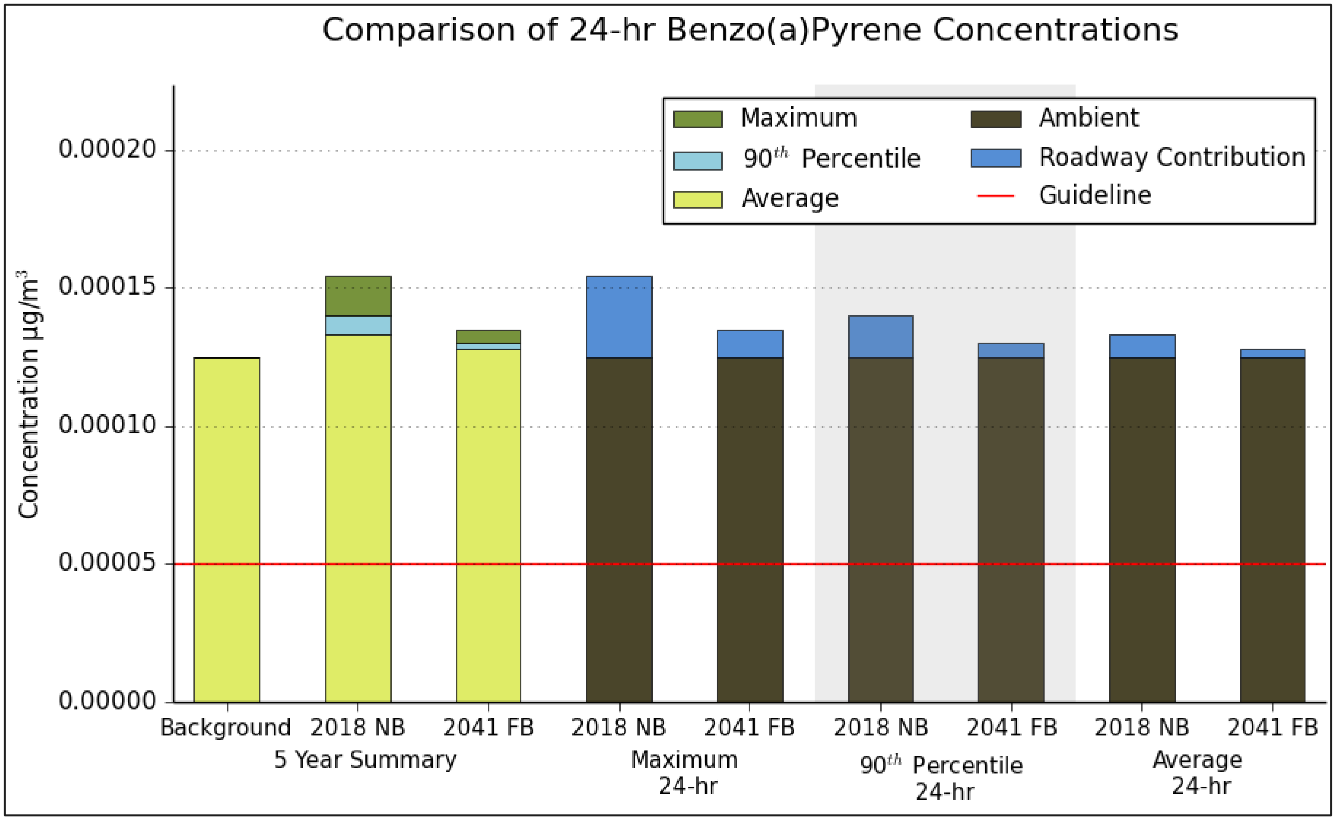
3.7.12 Benzo(a)Pyrene

It was found that the available ambient Benzo(a)Pyrene data was measured at inconsistent frequencies and time intervals. Therefore, the 90th percentile value of all measured concentrations between 2016 to 2021 at the Toronto West NAPS station was used in the assessment in order to assess combined impacts.

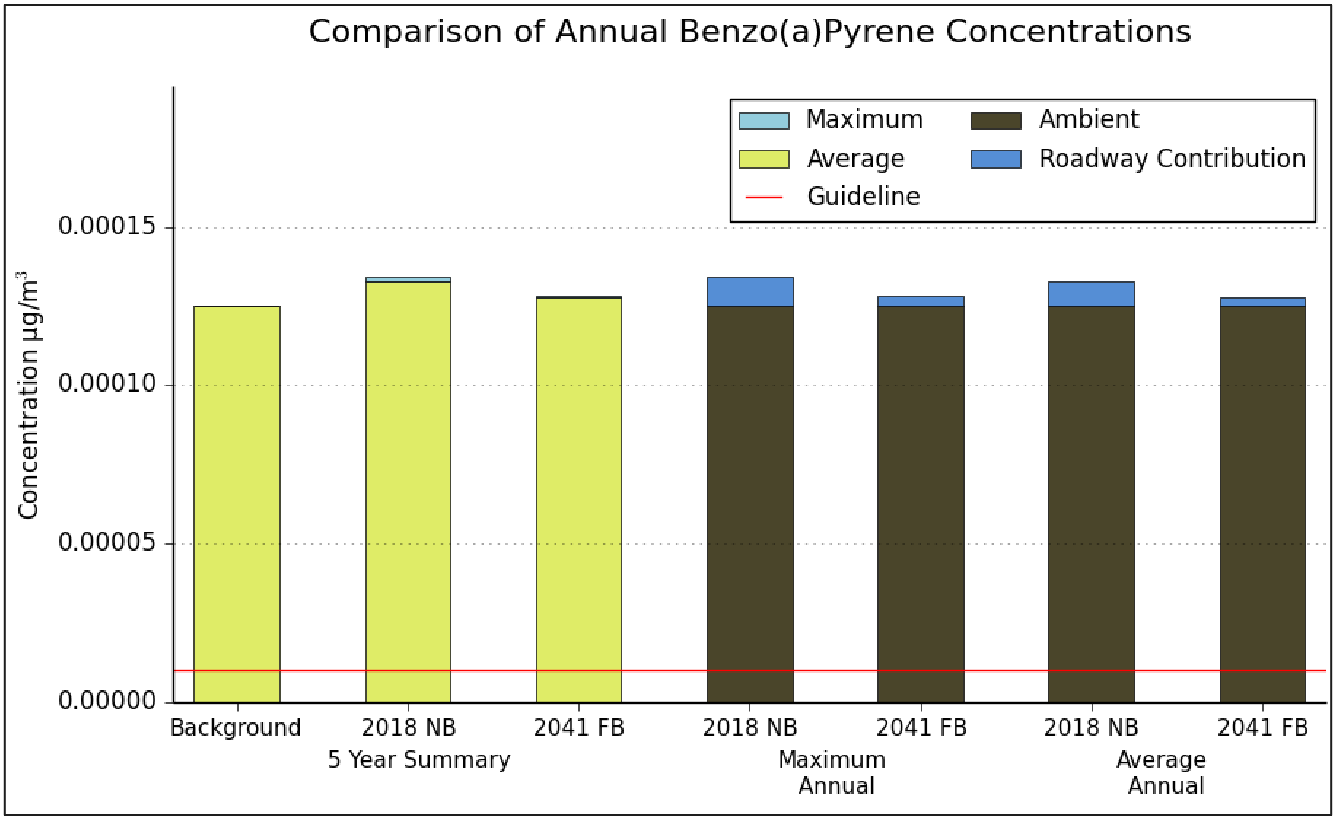
Table 24 presents the predicted combined concentrations for the worst-case sensitive receptor for 24-hour and annual Benzo(a)pyrene based on five years of meteorological data. The results conclude that:

- The maximum combined concentrations were above the MECP 24-hr guideline for all modelled scenarios. The 90th percentile background concentration at Toronto West station was 0.000125 µg/m^3 or 250% of the guideline.
- The maximum roadway concentrations were above the MECP annual guideline for all modelled scenarios. The 90th percentile annual average background concentration at Toronto West station was 0.0000946 µg/m^3 or 946% of the guideline.

Table 24: Summary of Predicted Benzo(a)Pyrene Concentrations

Statistical Analysis	2041 FB	
	**% of MECP Guideline:**	
	Maximum	270%
	90th Percentile	260%
	Average	255%
	Roadway Contribution	
	Maximum	7%
	90th Percentile	2%
	Average	2%

Statistical Analysis



2041 FB	
% of MECP Guideline:	
Maximum	1280%
Average	1277%
Roadway Contribution	
Maximum	3%
Annual Average	2%

4.0 Greenhouse Gas Assessment

In addition to the contaminants of interest assessed in the local air quality assessment, greenhouse gas (GHG) emissions were predicted from the project. Potential impacts were assessed by calculating the relative change in total emissions between the 2018 Existing and 2041 Future Build scenarios as well as comparing the total emission to the 2030 provincial and Canada-wide GHG targets. Total GHG emissions from the roadway were determined based on the length of the roadway, traffic volumes, and predicted emission rates.

From a GHG perspective, the contaminants of concern from motor vehicle emissions are carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O). These GHGs can be further classified according to their Global Warming Potential. The Global Warming Potential is a multiplier developed for each GHG, which allows comparison of the ability of each GHG to trap heat in the atmosphere, relative to carbon dioxide. Using these multipliers, total GHG emissions can be classified as CO2 equivalent emissions. For this assessment, the MOVES model was used to determine total CO2 equivalent emission rates for the posted speed and heavy-duty vehicle percentage on Teston Road Extension. Table 25 summarizes the length of the roadway, traffic volumes, and emission rates used to determine total GHG emissions on Teston Road in the 2041 Future Build scenario.

Table 25: Summary of Teston Road Traffic Volumes, Roadway Length and Emission Rates

Roadway	2018 Two-Way AADT	2041 Two-Way AADT	Length of Roadway (Miles)	Heavy/Medium Duty Vehicle Percentage (%)	Posted Speed (km/hr)	2018 CO_2 Equivalent Emission Rate (g/VMT)	2041 CO_2 Equivalent Emission Rate (g/VMT)
Teston Road – West of Jane Street to Keele Street	6,476	25,760	0.19	2/4	60	392	277
Teston Road – Keele Street to Dufferin Street	2,222[1]	27,790	1.31	3/6	60	454	326
Teston Road - Dufferin Street to Bathurst Street	16,285	23,350	1.27	2/4	60	392	277

Notes:

Between Keele Street and Dufferin Street, the No Build traffic volumes represent those between Keele Street and Rodinea Road, as there is no road connection between Rodinea Road and Dufferin Street currently. The Future Build volumes include traffic along the new roadway connection between Rodinea Road and Dufferin Street.

The total predicted annual GHG emissions for the 2018 Existing and 2041 Future Build scenarios are shown in Table 26. Also shown is the percent change in total GHG emissions between the scenarios. The results show that due to the increases in traffic volumes on existing routes, the total GHG emissions increase by 116%.

Table 27 shows the GHG emissions on Teston Road represent 0.00542% of the provincial target and 0.001762%of the Canada-wide target. The contribution of GHG emissions from the project is small in comparison to these provincial and national targets.

Table 26: Changes in predicted GHG Emissions

Roadway	2018 CO_2 Equivalent Emission Rate (g/VMT)	2041 CO_2 Equivalent Emission Rate (g/VMT)	Changes in Emission (%)
Teston Road	3,621	7,806	116%

Table 27: Predicted Future Build GHG Emissions compare to GHG Targets

Roadway	Total CO_2 Equivalent (tonnes/year)
Teston Road	7,806
Comparison to Canada-wide Target	0.001762%
Comparison to Ontario-wide Target	0.00542%
Canada-Wide 2030 GHG Target[1]	443,000,000
Ontario-Wide 2030 GHG Target[2]	144,000,000

5.0 Air Quality Impacts During Construction

During construction of the roadway, dust is the primary contaminant of concern. Other contaminants including NOx 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 non-chloride dust suppressants to reduce dust, use of wind barriers, and limiting exposed areas which may be a source of dust and equipment washing. Furthermore, as annual $PM_{2.5}$, 24-hr PM_{10}, and 24-hr TSP levels will exceed their corresponding guidelines in the future build scenario, additional mitigation measures such as planting vegetation (for example coniferous species and shrubs) should be considered to minimize particulate impacts at nearby sensitive receptors. It is recommended that these best management practices be followed during construction of the roadway to reduce any air quality impacts that may occur.

6.0 Conclusion

Presented in Table 28 is a summary of the worst-case modelling results for the 2041 Future Build based on 5-years of meteorological data. For each contaminant, combined concentrations are presented as a percentage of the applicable guideline.

---

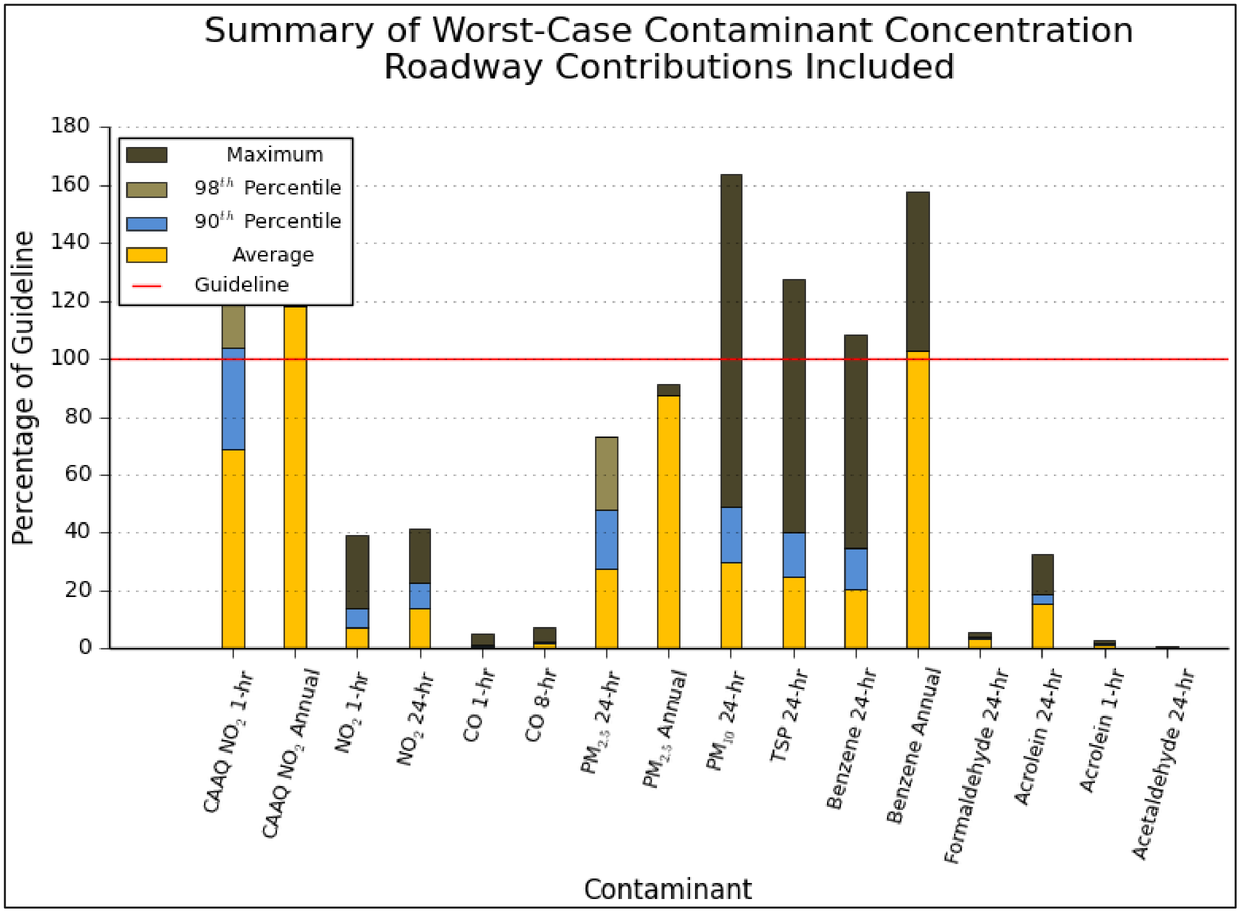
[1] Environment and Climate Change Canada (2030) Canadian Environmental Sustainability Indicators: Progress towards Canada's greenhouse gas emissions reduction plan. Available at: Clean Air, Strong Economy - Canada.ca

[2] Ontario Climate Change Strategy. Available at: 2030 Ontario Emissions Scenario as of March 25, 2022 (prod-environmental-registry.s3.amazonaws.com)

The maximum combined concentrations for the Future Build were below their respective MECP guidelines or CAAQS, with the exception of the 1-hr and annual NO_2 CAAQS, 24-hr PM_{10}, 24-hr TSP, 24-hr benzene, annual benzene and 24-hour and annual nezo(a)pyrene. Note that background concentrations exceeded the guideline for all of these contaminant averaging periods as well. The overall contribution from the roadway emissions to the combined concentrations was small.

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

Table 28: Worst-Case Summary of Predicted Combined Contaminant Concentrations 2041 Future Build

<table>
<tr><th>5 Year Statistical Summary</th><th colspan="2">% of Guideline</th></tr>
<tr><td rowspan="21">

Note Benzo(a)Pyrene is not shown on this graph, due to the fact that it exceeds the guideline by a significant amount and therefore skews the scale.</td><td colspan="2">2041 FB</td></tr>
<tr><td>CAAQS NO_2 (1-hr)</td><td>132%</td></tr>
<tr><td>CAAQS NO_2 (Annual)</td><td>128%</td></tr>
<tr><td>NO_2 (1-hr)</td><td>39%</td></tr>
<tr><td>NO_2 (24-hr)</td><td>41%</td></tr>
<tr><td>CO (1-hr)</td><td>5%</td></tr>
<tr><td>CO (8-hr)</td><td>7%</td></tr>
<tr><td>$PM_{2.5}$ (24-hr See Note)</td><td>73%</td></tr>
<tr><td>$PM_{2.5}$ (Annual)</td><td>91%</td></tr>
<tr><td>PM_{10}</td><td>164%</td></tr>
<tr><td>TSP</td><td>128%</td></tr>
<tr><td>Acetaldehyde</td><td><1%</td></tr>
<tr><td>Acrolein (1-hr)</td><td>3%</td></tr>
<tr><td>Acrolein (24-hr)</td><td>33%</td></tr>
<tr><td>Benzene (24-hr)</td><td>108%</td></tr>
<tr><td>Benzene (Annual)</td><td>158%</td></tr>
<tr><td>1,3-Butadiene (24-hr)</td><td>0%</td></tr>
<tr><td>1,3-Butadiene (Annual)</td><td>0%</td></tr>
<tr><td>Formaldehyde</td><td>6%</td></tr>
<tr><td>Benzo(a)Pyrene (24-hr)[1]</td><td>270%</td></tr>
<tr><td>Benzo(a)Pyrene (Annual)[1]</td><td>1280%</td></tr>
</table>

7.0 Closure

Should you have questions on the above report, please contact the undersigned.

Regards,

SLR Consulting (Canada) Ltd.

LICENSED PROFESSIONAL ENGINEER
J.S. GRAHAM
100172995
10/9/2024
PROVINCE OF ONTARIO

Jenny Graham, P.Eng.
Senior Air Quality Engineer

Mina Ghorbani, M.Eng., E.I.T.
Air Quality Engineer-In-Training

Figures

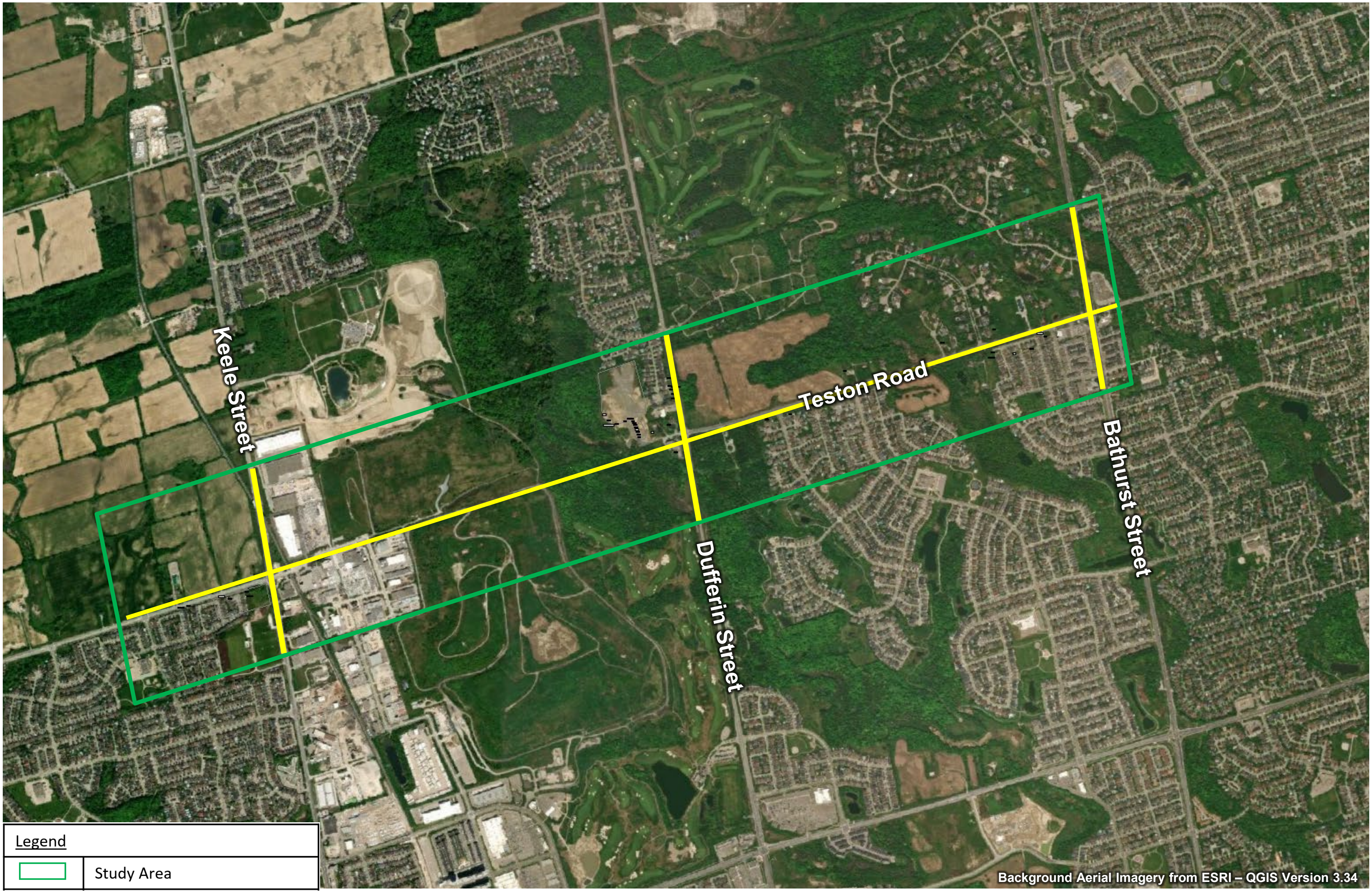
Teston Road Air Quality Assessment

West of Keele Street to Bathurst Street, Vaughan, York Region

Morrison Hershfield

SLR Project No.: 241.30212.00000

October 7, 2024



Background Aerial Imagery from ESRI – QGIS Version 3.34

Legend	
🟩	Study Area

CITY OF VAUGHAN

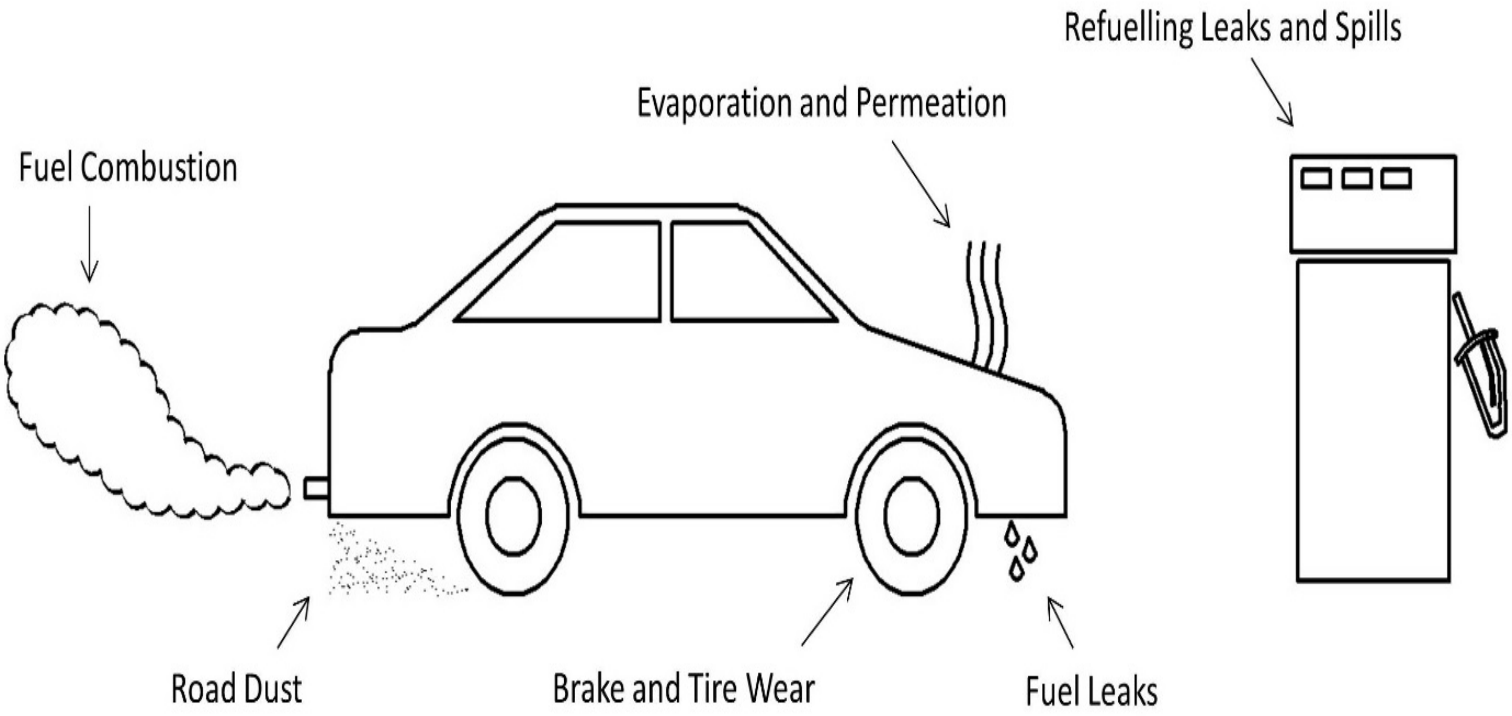
TESTON ROAD ENVIRONMENTAL ASSESSMENT

MODELLED ROAD SEGMENTS IN STUDY AREA

True North

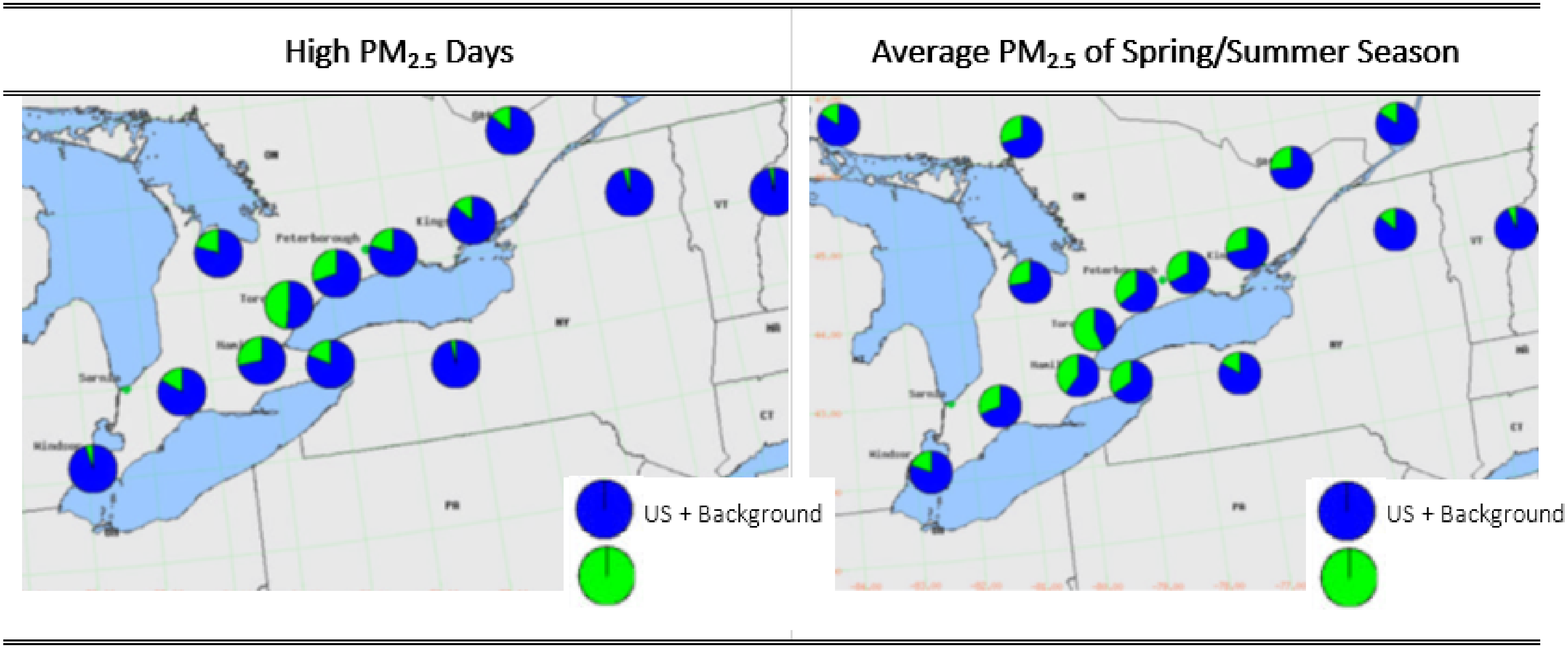
Scale:	1: 25,000		METRES
Date:	Oct 2024	Rev 0.0	Figure No. 1
Project No.	241.30212.00000		

SLR



CITY OF VAUGHAN	True North	Scale: N/A		METRES
TESTON ROAD ENVIRONMENTAL ASSESSMENT		Date: Oct 2024	Rev 0.0	Figure No. **2**
MOTOR VEHICLE EMISSION SOURCES		Project No. 241.30212.00000		

SLR



High PM$_{2.5}$ Days

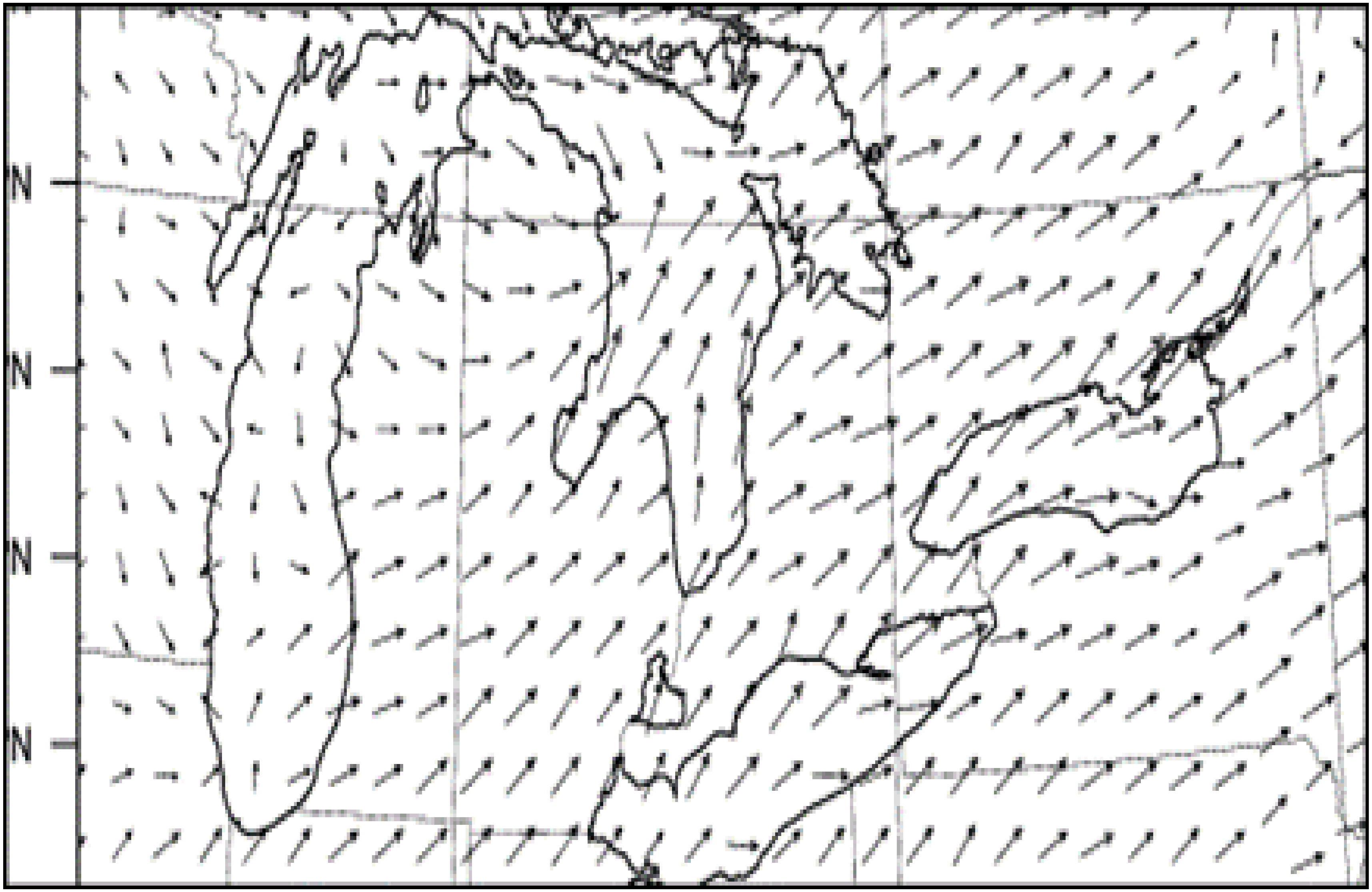
Average PM$_{2.5}$ of Spring/Summer Season

CITY OF VAUGHAN

TESTON ROAD ENVIRONMENTAL ASSESSMENT

EFFECT OF TRANS-BOUNDARY AIR POLLUTION (MECP, 2005)

True North	Scale: N/A	METRES	
	Date: Oct 2024	Rev 0.0	Figure No. 3
	Project No. 241.30212.00000		



CITY OF VAUGHAN

TESTON ROAD ENVIRONMENTAL ASSESSMENT

TYPICAL WIND DIRECTION DURING AN ONTARIO SMOG EPISODE

True North

Scale: N/A

METRES

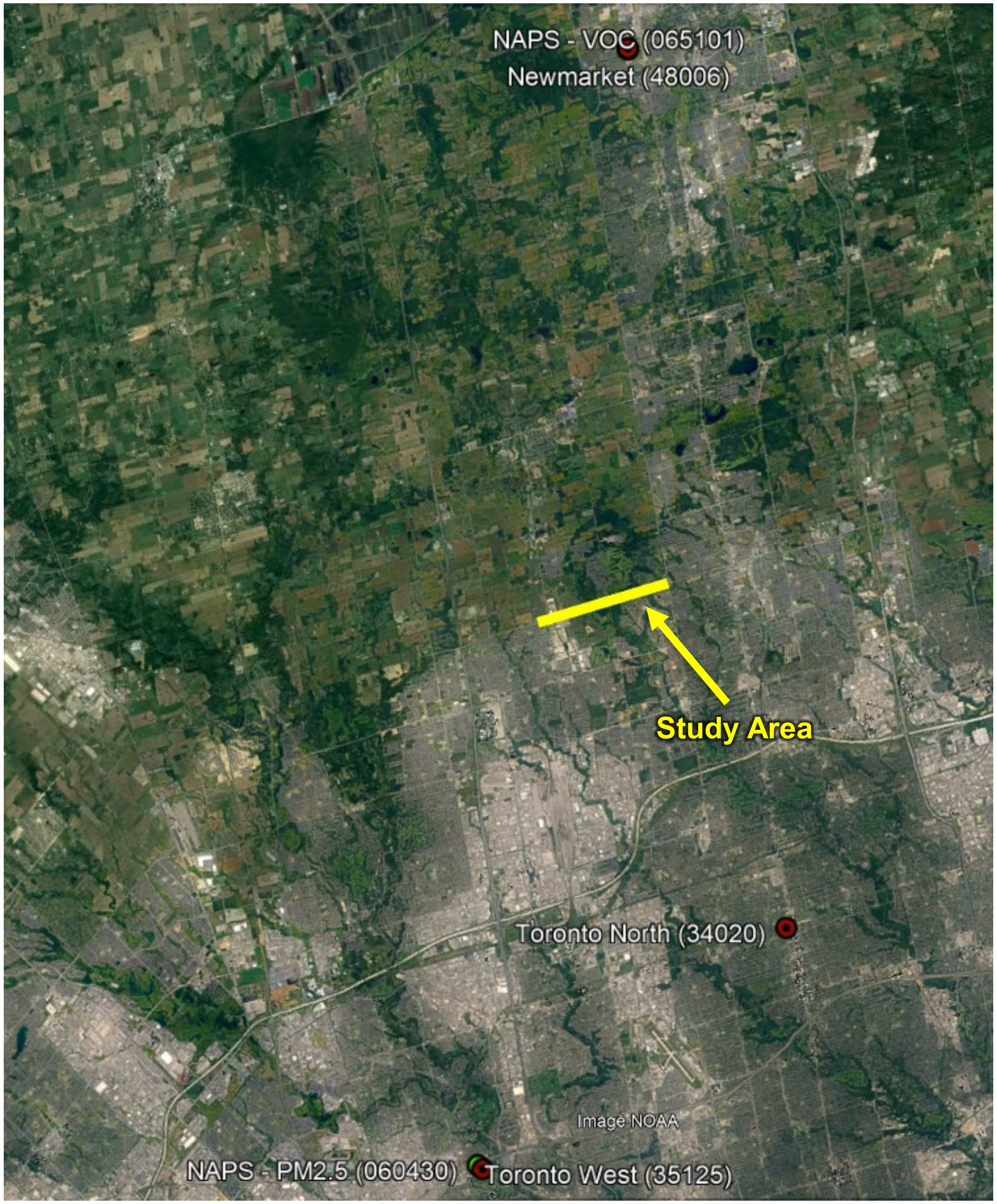
Date: Oct 2024

Rev 0.0

Figure No.
4

Project No. 241.30212.00000

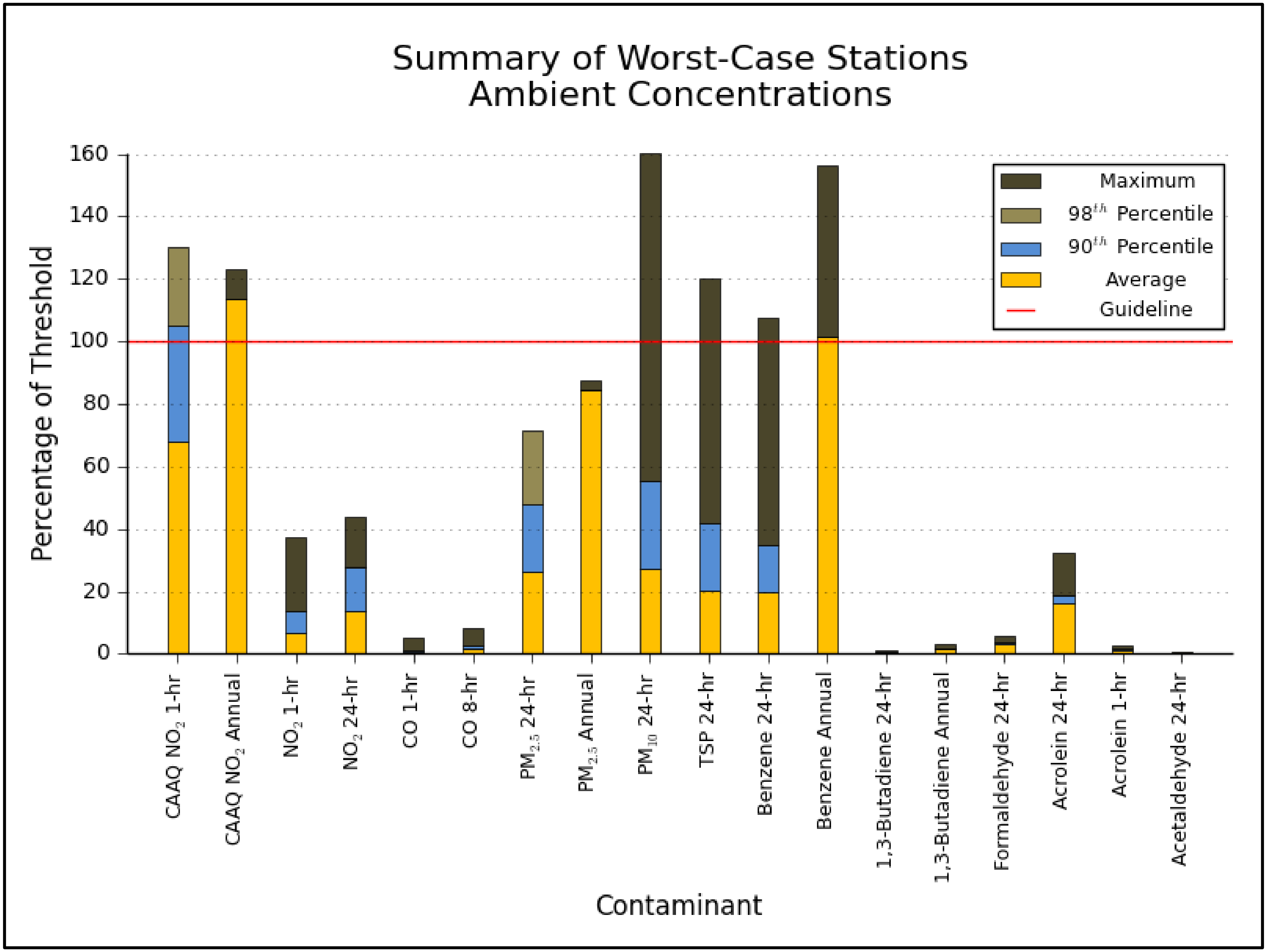
SLR



Background Aerial Imagery from Google Earth

CITY OF VAUGHAN	True North	Scale: N/A		METRES
TESTON ROAD ENVIRONMENTAL ASSESSMENT		Date: Oct 2024	Rev 0.0	Figure No. 5
LOCATION OF AMBIENT MONITORING STATIONS, RELEVANT TO THE STUDY AREA		Project No. 241.30212.00000		

SLR



CITY OF VAUGHAN

TESTON ROAD ENVIRONMENTAL ASSESSMENT

WORST-CASE SUMMARY OF AMBIENT BACKGROUND CONCENTRATIONS

True North

Scale: N/A

METRES

Date: Oct 2024

Rev 0.0

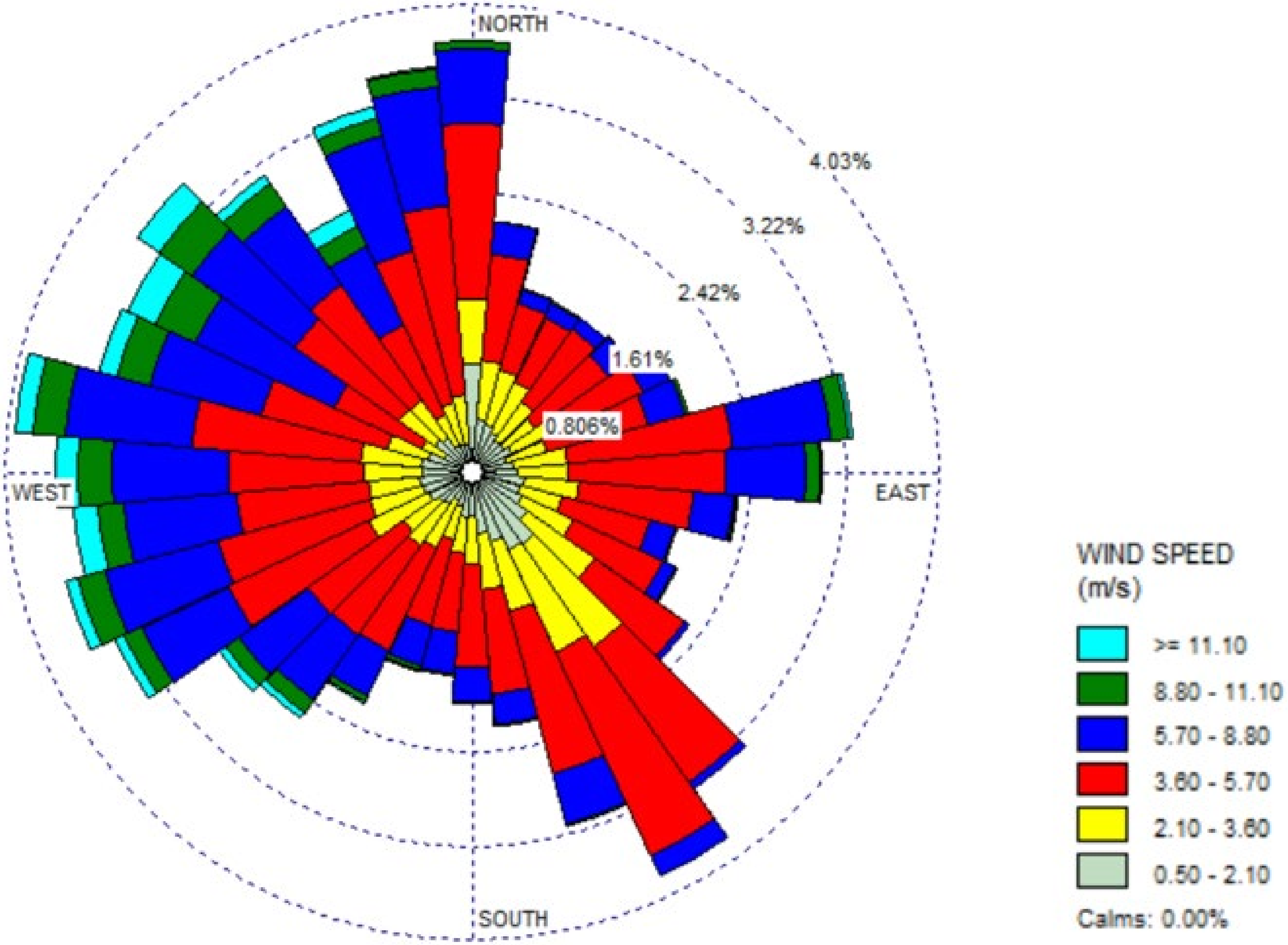
Figure No.
6

Project No. 241.30212.00000

SLR

Background Aerial Imagery from Google Earth

CITY OF VAUGHAN	True North	Scale: N/A	METRES	SLR
TESTON ROAD ENVIRONMENTAL ASSESSMENT		Date: Oct 2024	Rev 0.0	Figure No. 7
SENSITIVE RECEPTOR LOCATIONS		Project No. 241.30212.00000		



CITY OF VAUGHAN

TESTON ROAD ENVIRONMENTAL ASSESSMENT

WIND FREQUENCY DIAGRAM FOR PEARSON INTERNATIONAL AIRPORT (2017-2021)

True North

Scale: N/A METRES

Date: Oct 2024 Rev 0.0

Figure No. 8

Project No. 241.30212.00000

SLR

Appendix A Results for Each Receptor

Teston Road Air Quality Assessment

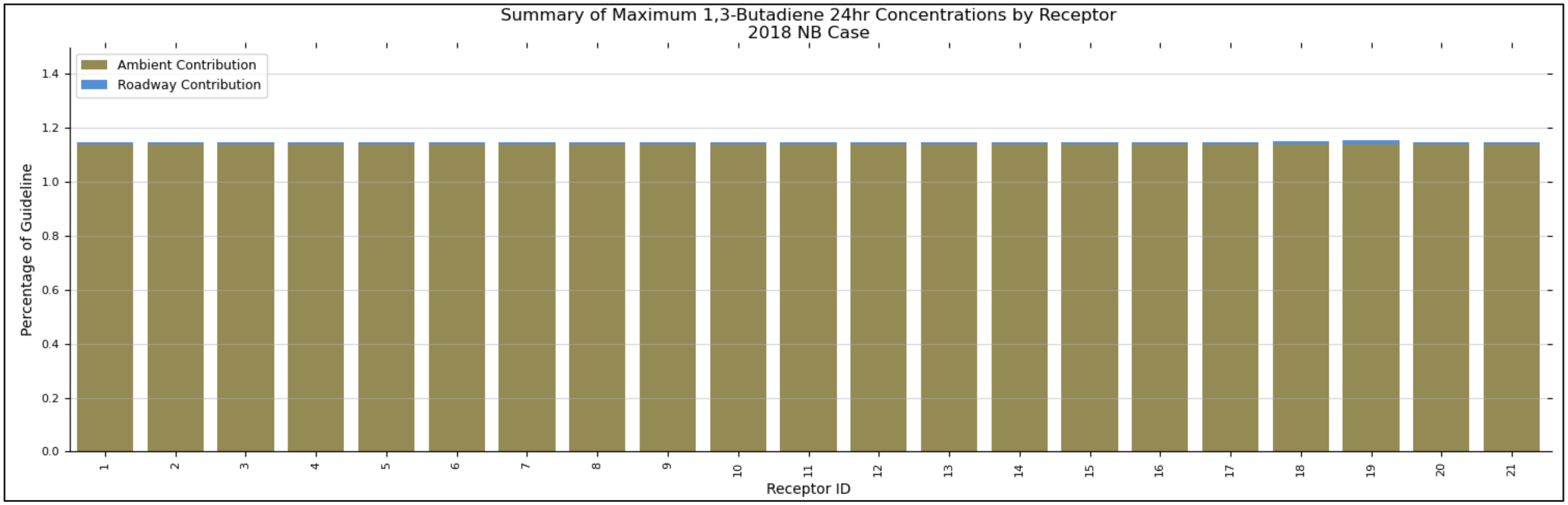
West of Keele Street to Bathurst Street, Vaughan, York Region

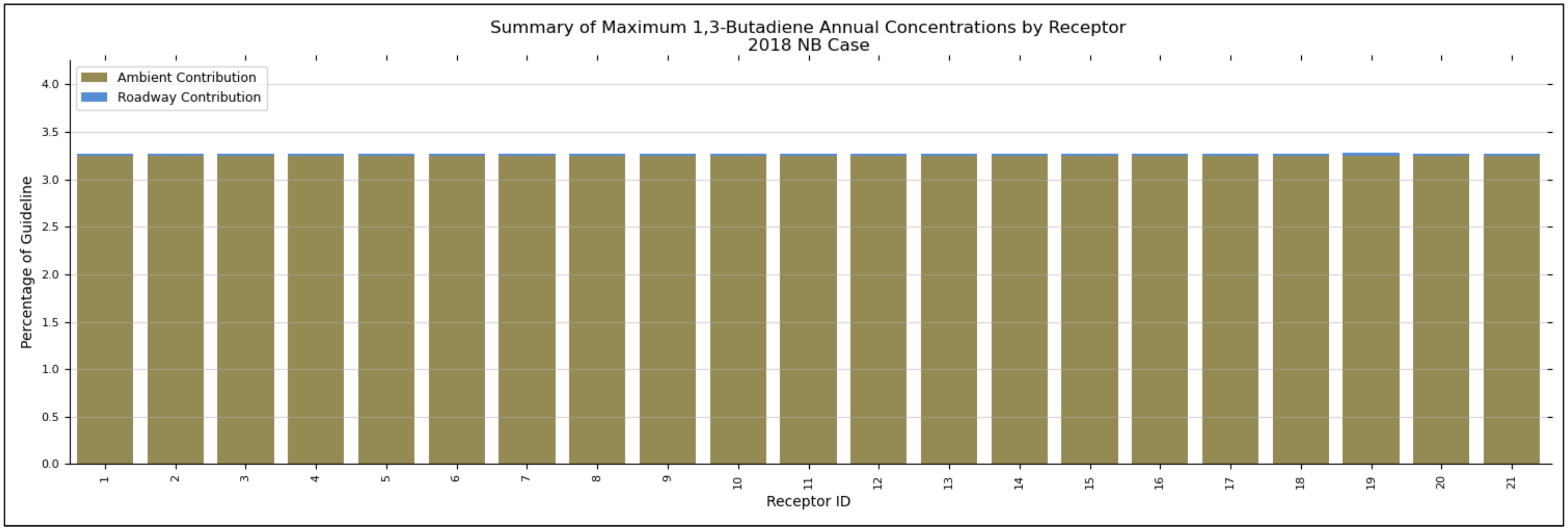
Morrison Hershfield

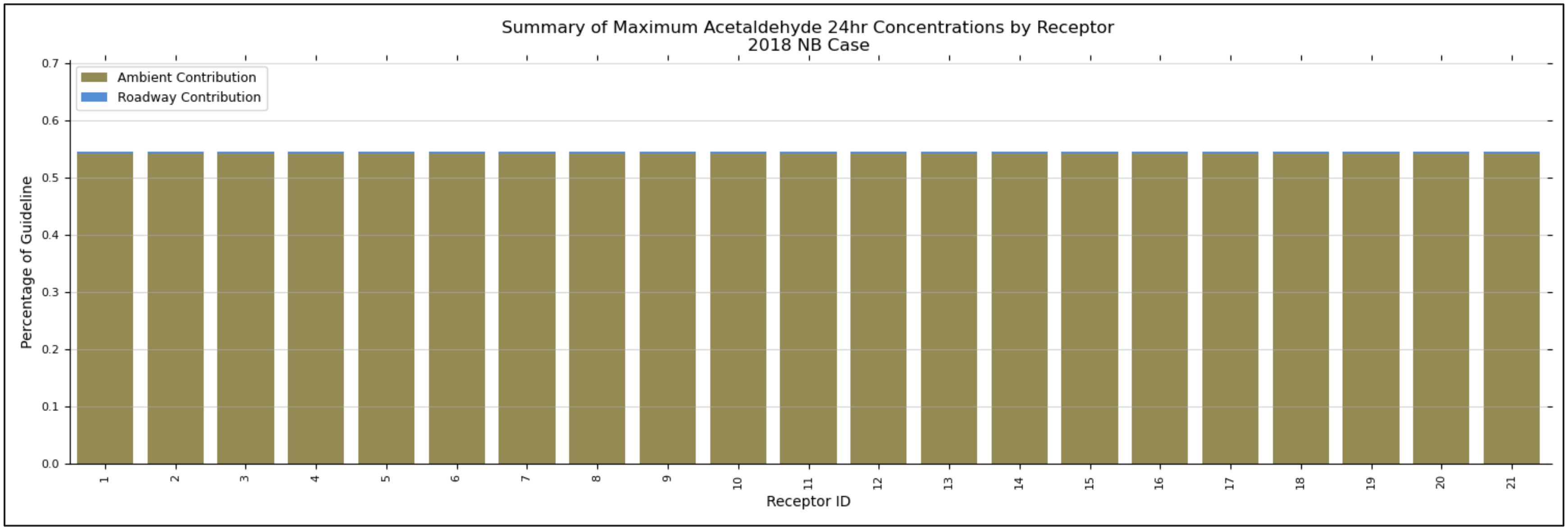
SLR Project No.: 241.30212.00000

October 7, 2024

Appendix A Results for Each Receptor






Summary of Maximum Acetaldehyde 24hr Concentrations by Receptor
2018 NB Case
Ambient Contribution
Roadway Contribution
Percentage of Guideline
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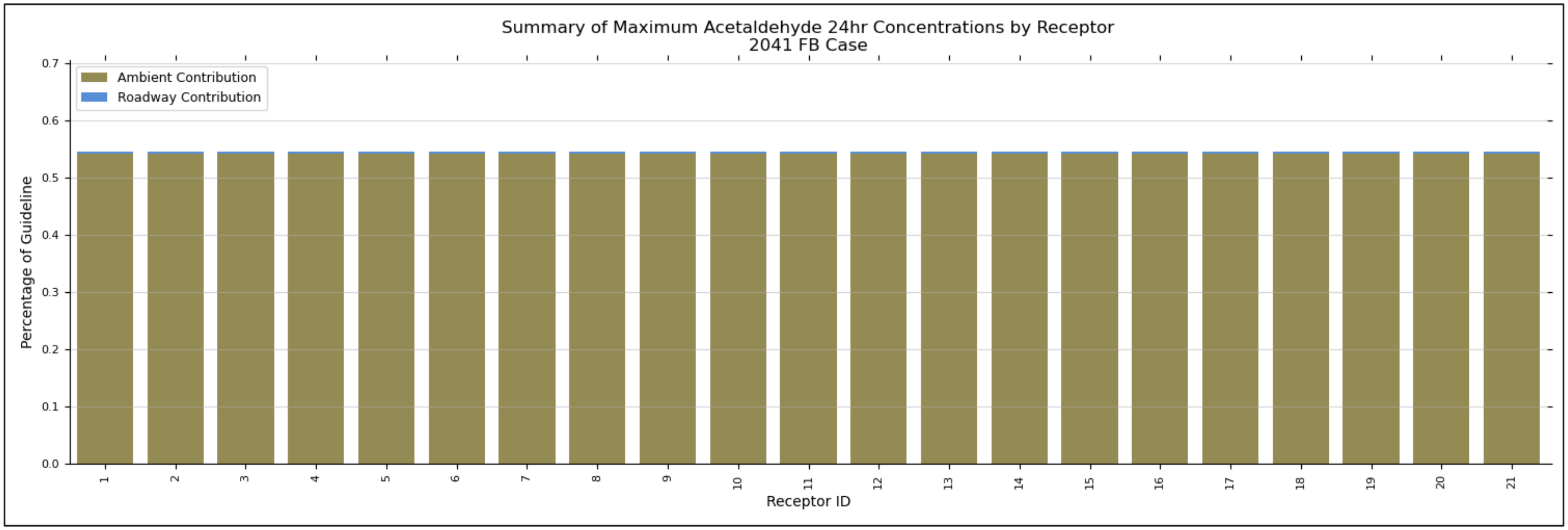
Receptor ID


Summary of Maximum Acetaldehyde 24hr Concentrations by Receptor
2041 FB Case
Ambient Contribution
Roadway Contribution
Percentage of Guideline
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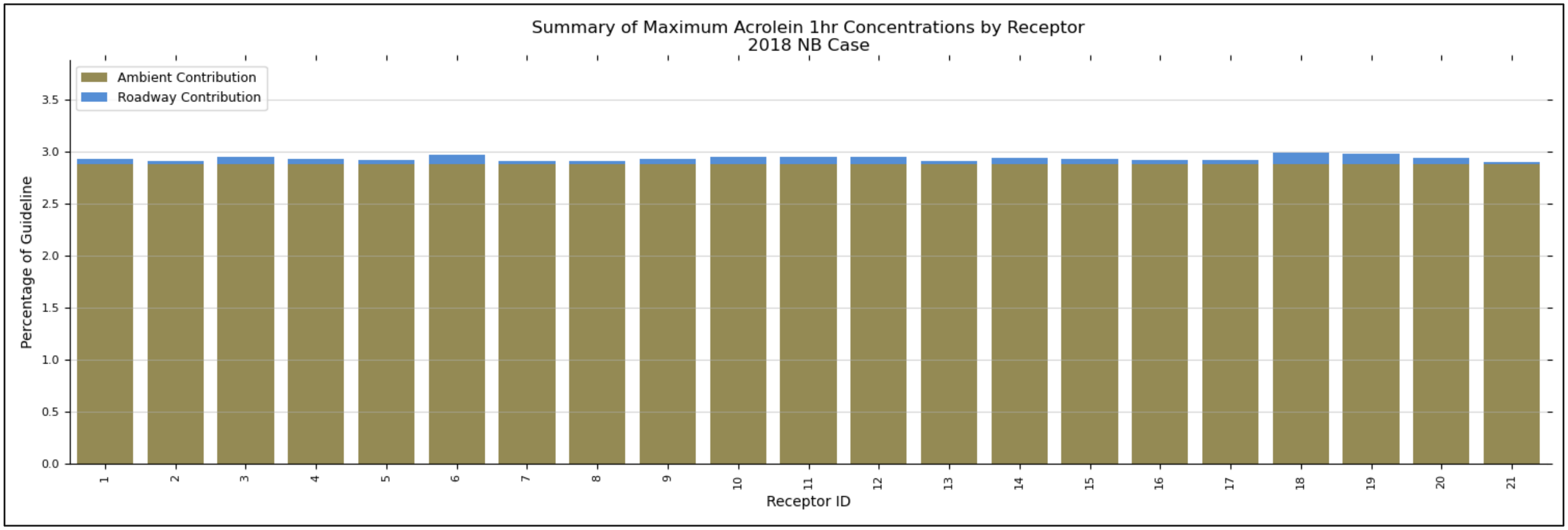
Summary of Maximum Acrolein 1hr Concentrations by Receptor
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Roadway Contribution
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Receptor ID
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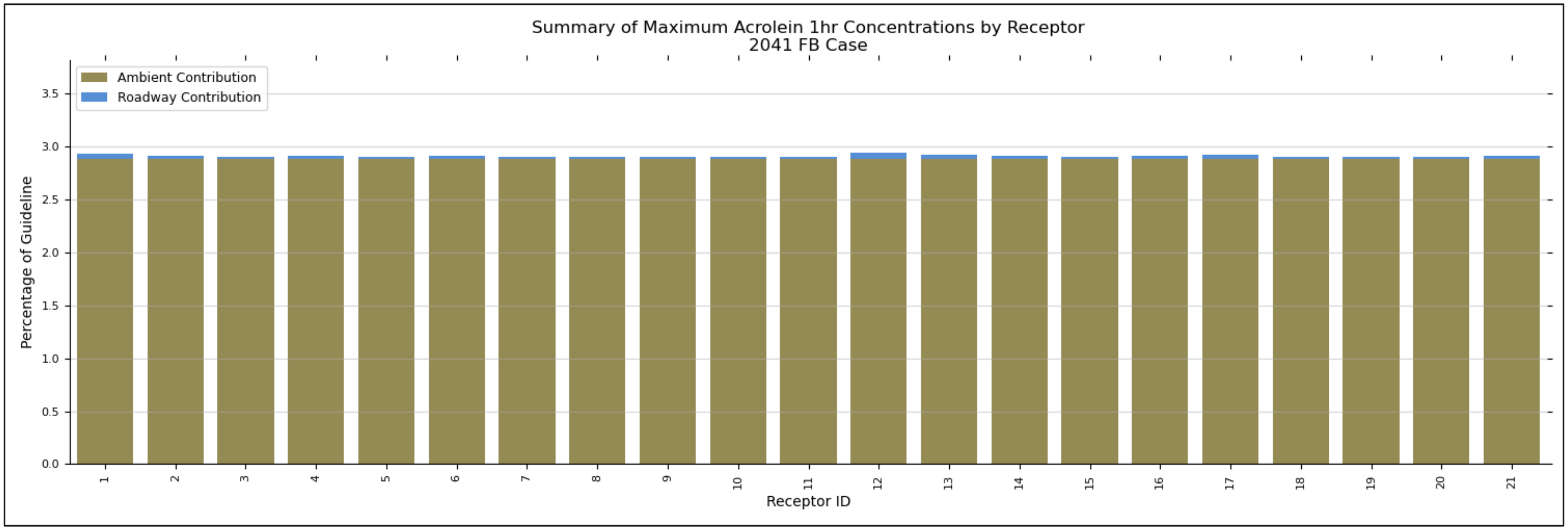
Summary of Maximum Acrolein 1hr Concentrations by Receptor
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Ambient Contribution
Roadway Contribution
Percentage of Guideline
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Receptor ID
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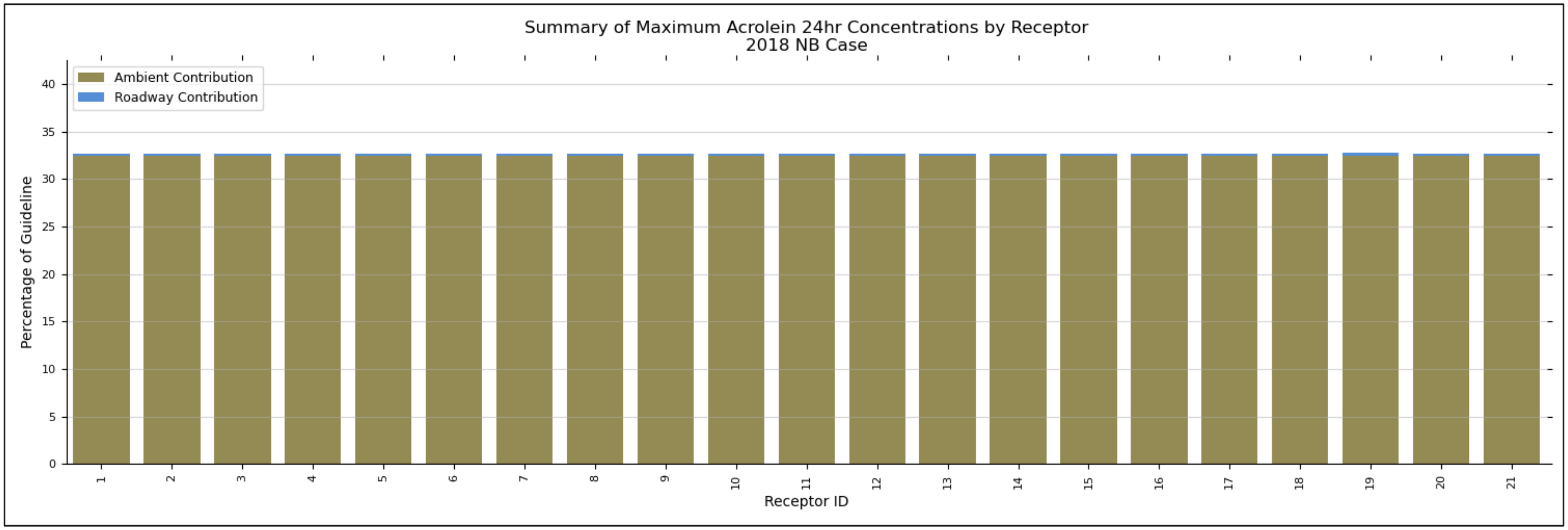
Summary of Maximum Acrolein 24hr Concentrations by Receptor
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Roadway Contribution
Percentage of Guideline
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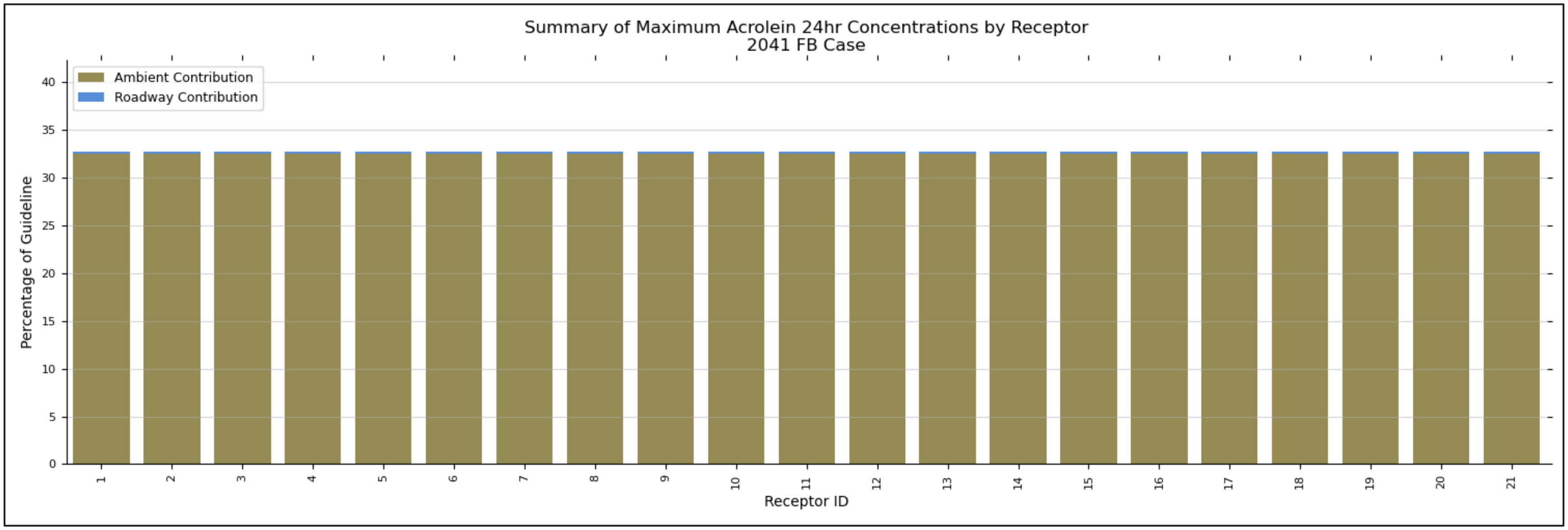
Summary of Maximum Acrolein 24hr Concentrations by Receptor
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Ambient Contribution
Roadway Contribution
Percentage of Guideline
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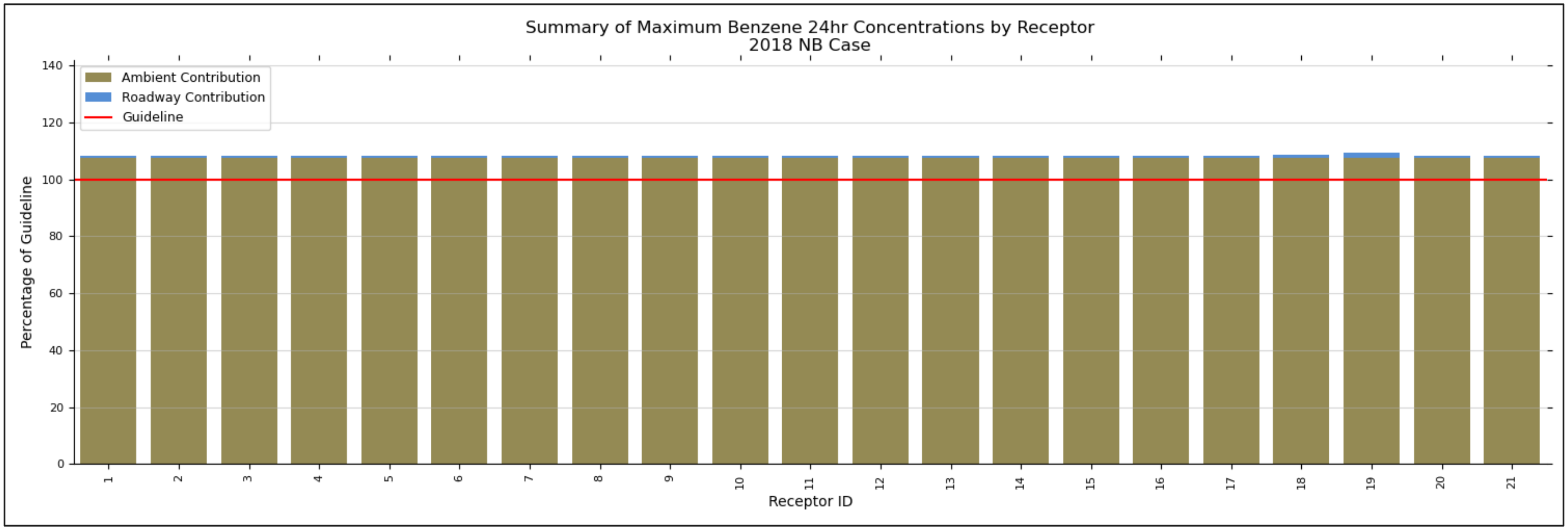
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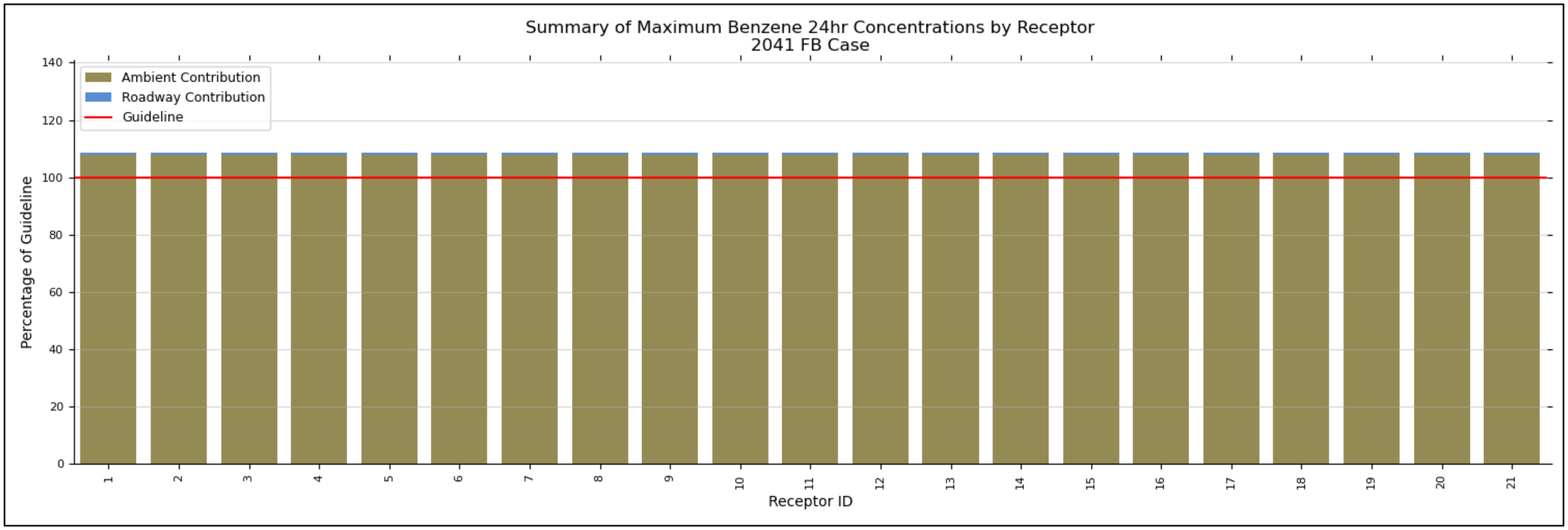
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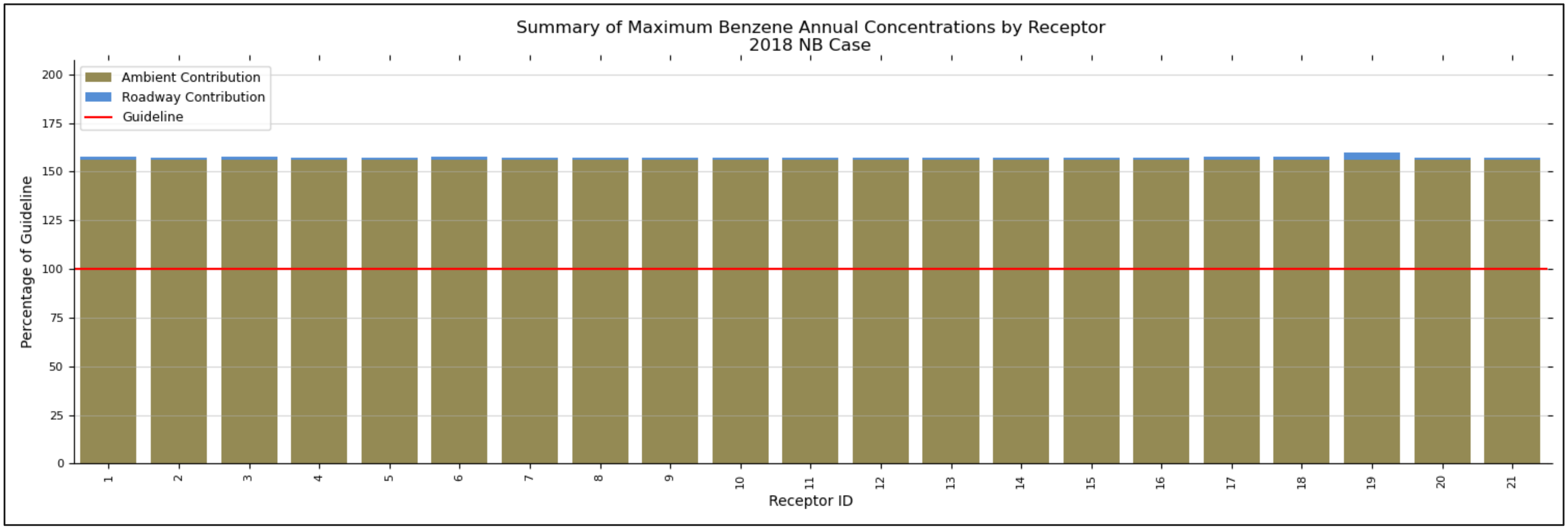
Summary of Maximum Benzene Annual Concentrations by Receptor
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Roadway Contribution
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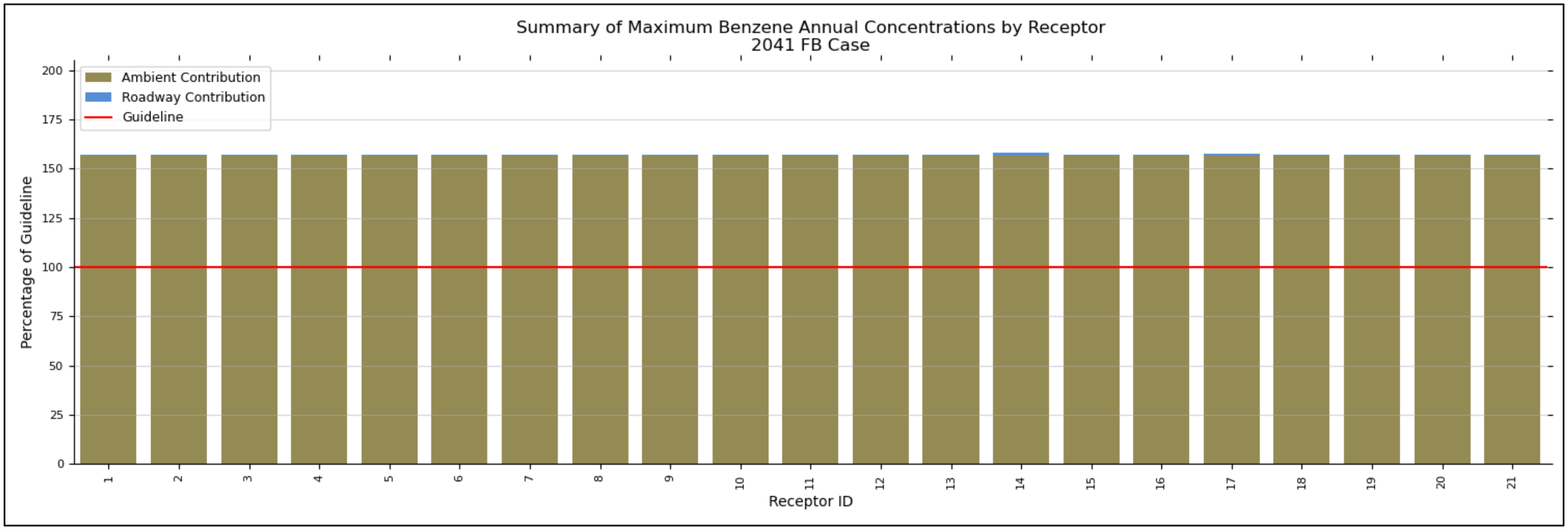
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Roadway Contribution
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Percentage of Guideline
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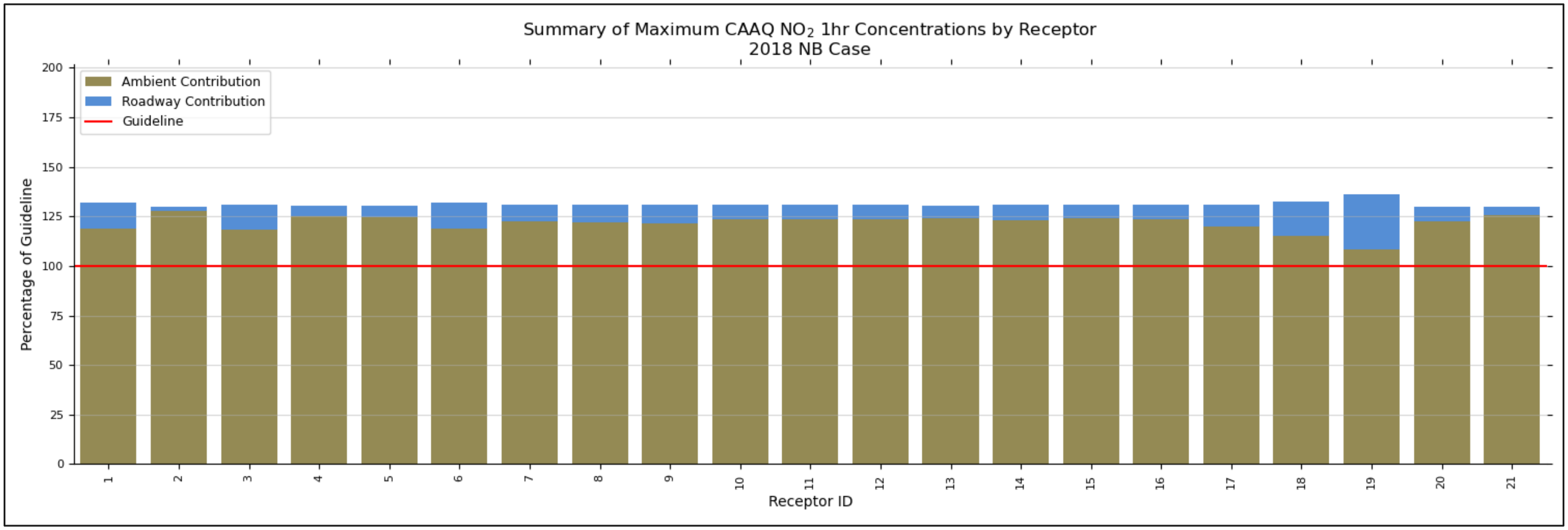
Summary of Maximum CAAQ NO_2 1hr Concentrations by Receptor
2018 NB Case
Ambient Contribution
Roadway Contribution
Guideline
Percentage of Guideline
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Receptor ID
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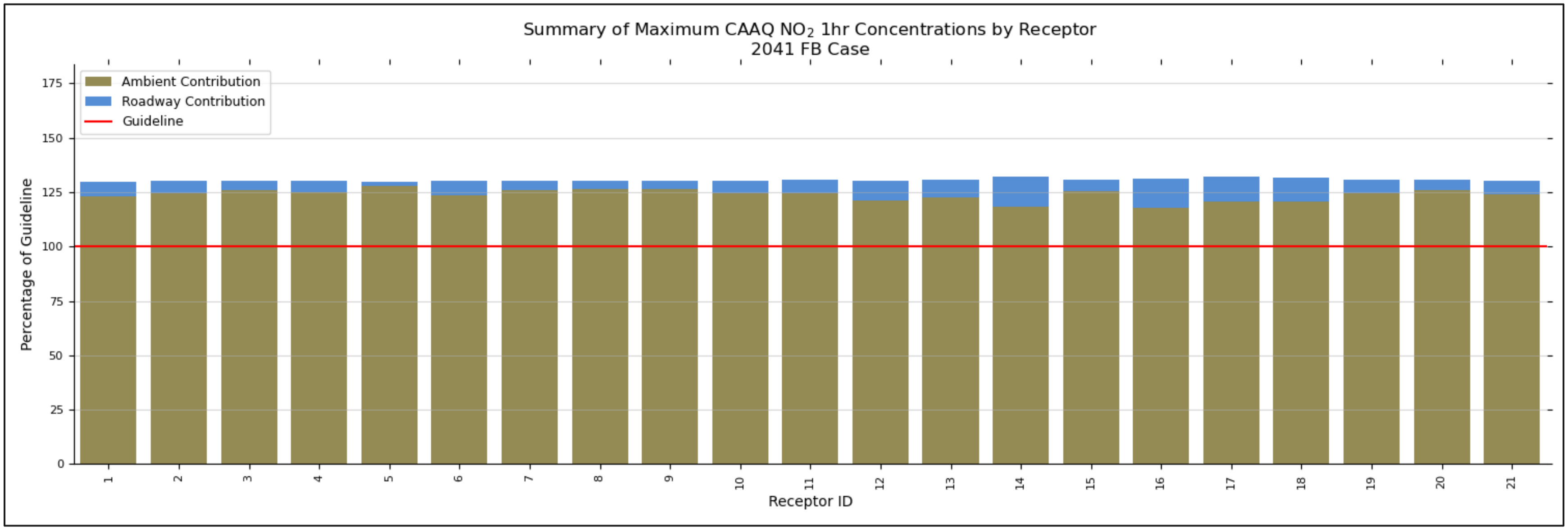
Summary of Maximum CAAQ NO_2 1hr Concentrations by Receptor
2041 FB Case
Ambient Contribution
Roadway Contribution
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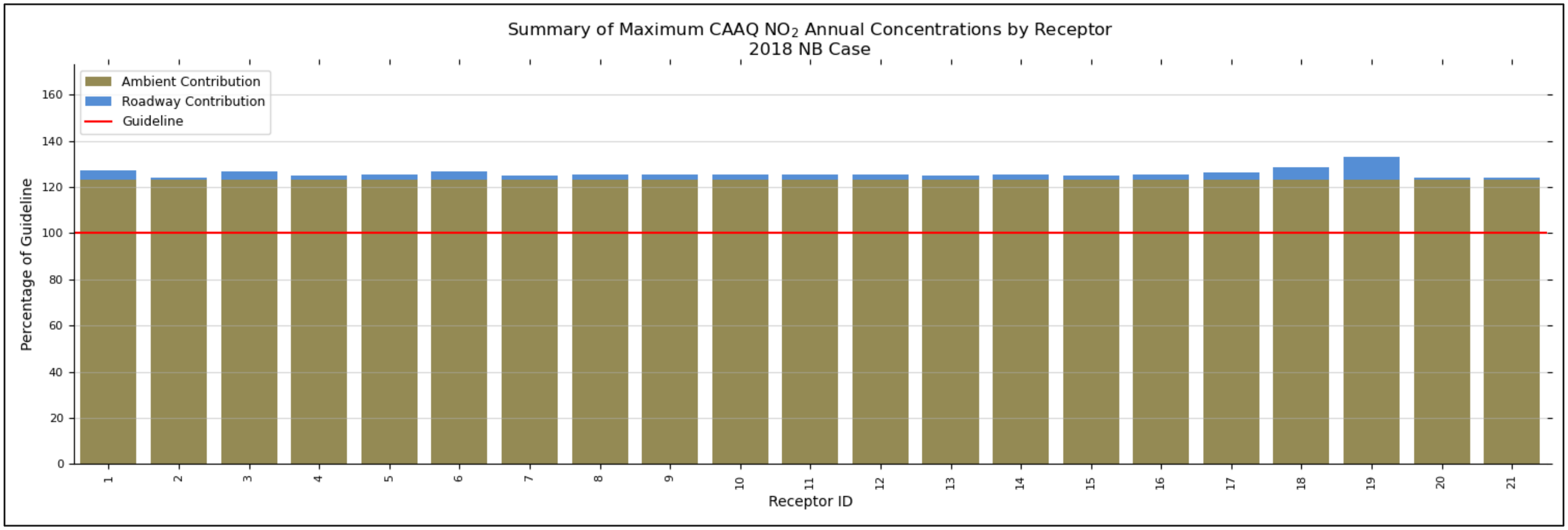
Summary of Maximum CAAQ NO₂ Annual Concentrations by Receptor
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Roadway Contribution
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Percentage of Guideline
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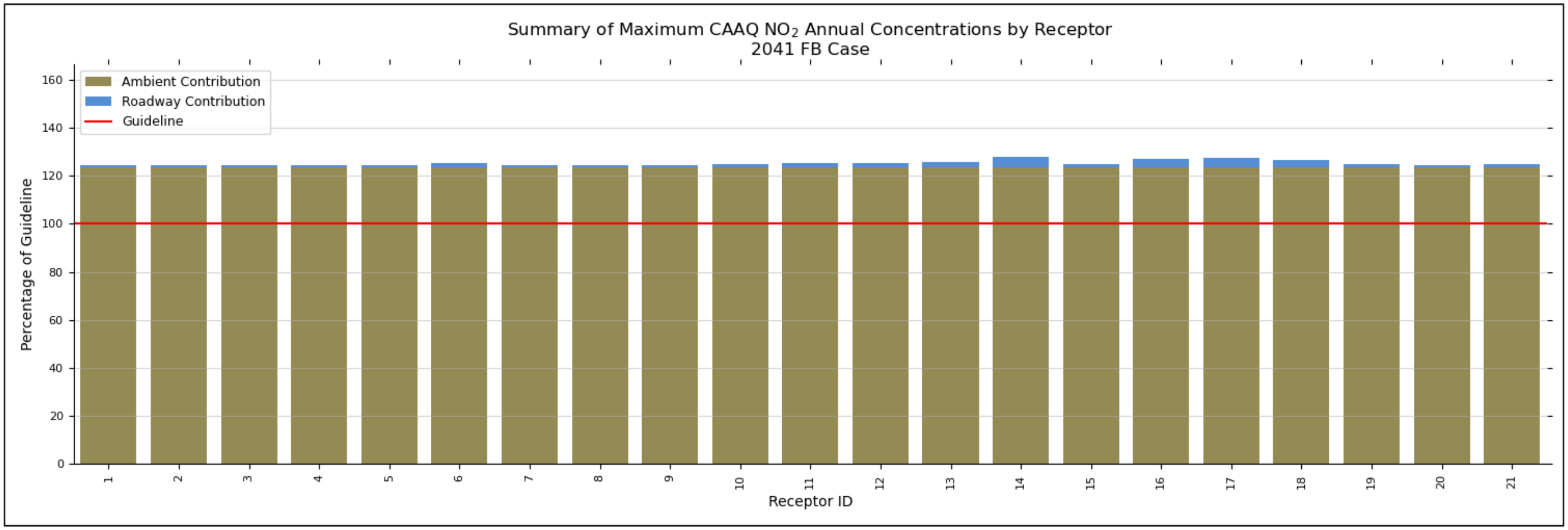
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Roadway Contribution
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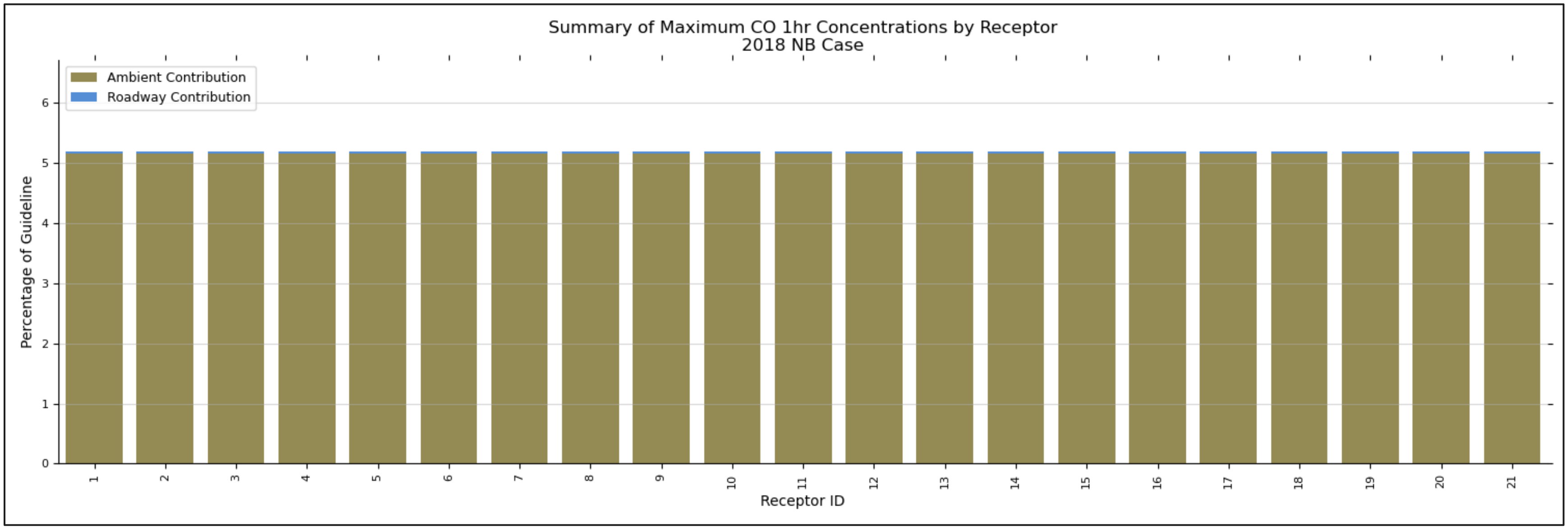
Summary of Maximum CO 1hr Concentrations by Receptor
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Roadway Contribution
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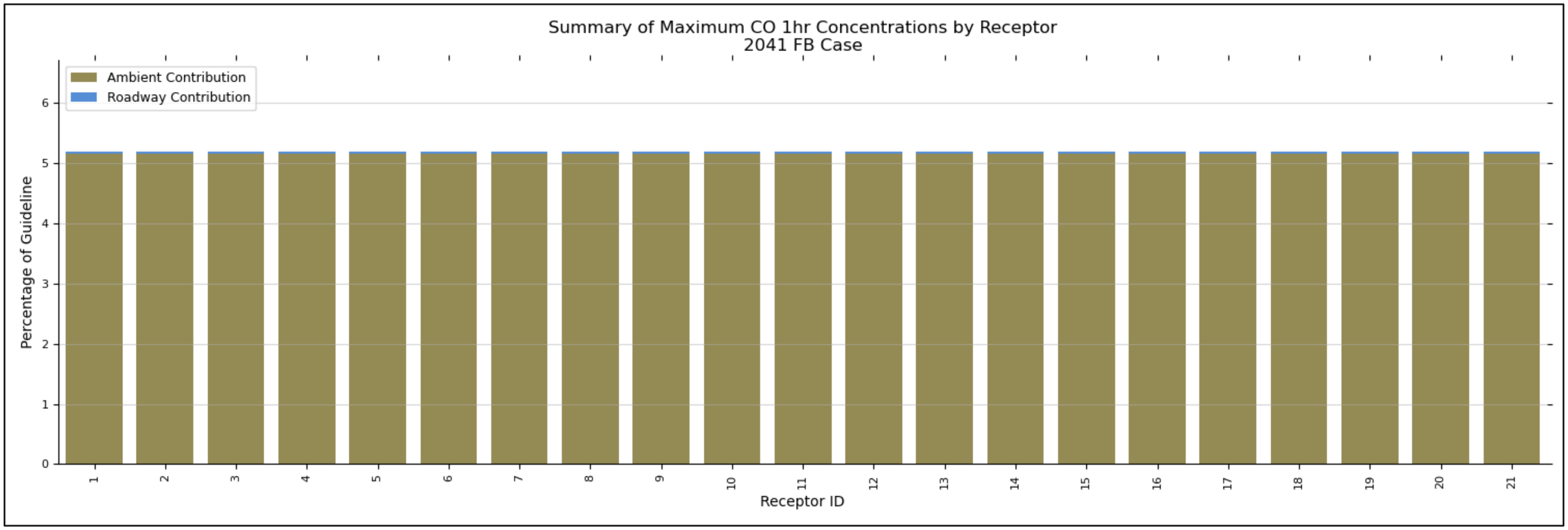
Summary of Maximum CO 1hr Concentrations by Receptor
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Roadway Contribution
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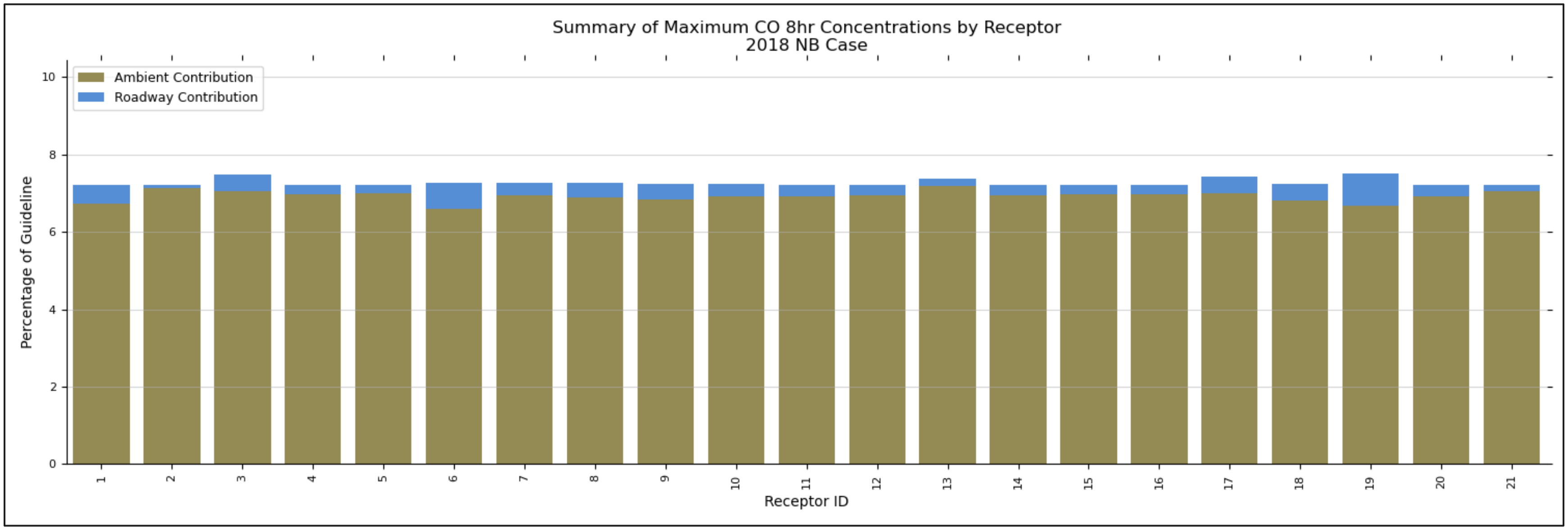
Receptor ID


Summary of Maximum CO 8hr Concentrations by Receptor
2018 NB Case
Ambient Contribution
Roadway Contribution
Percentage of Guideline
0
2
4
6
8
10
1
2
3
4
5
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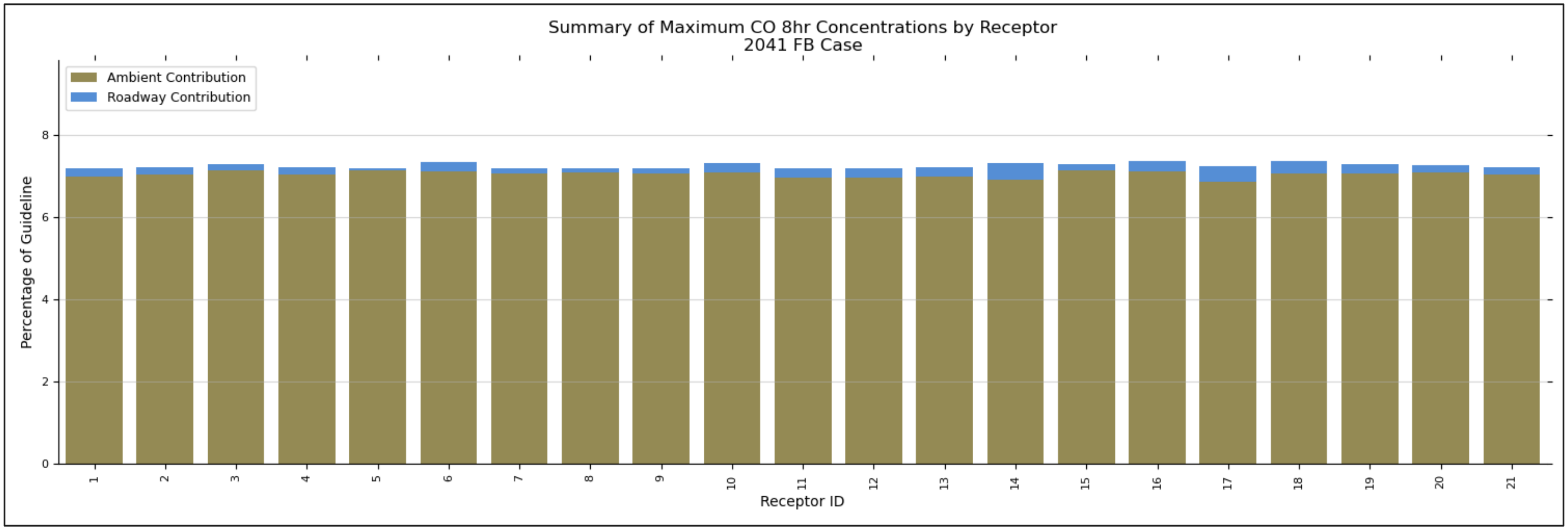
16
17
18
19
20
21
Receptor ID


Summary of Maximum CO 8hr Concentrations by Receptor
2041 FB Case
Ambient Contribution
Roadway Contribution
Percentage of Guideline
0
2
4
6
8
1
2
3
4
5
6
7
8
9
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11
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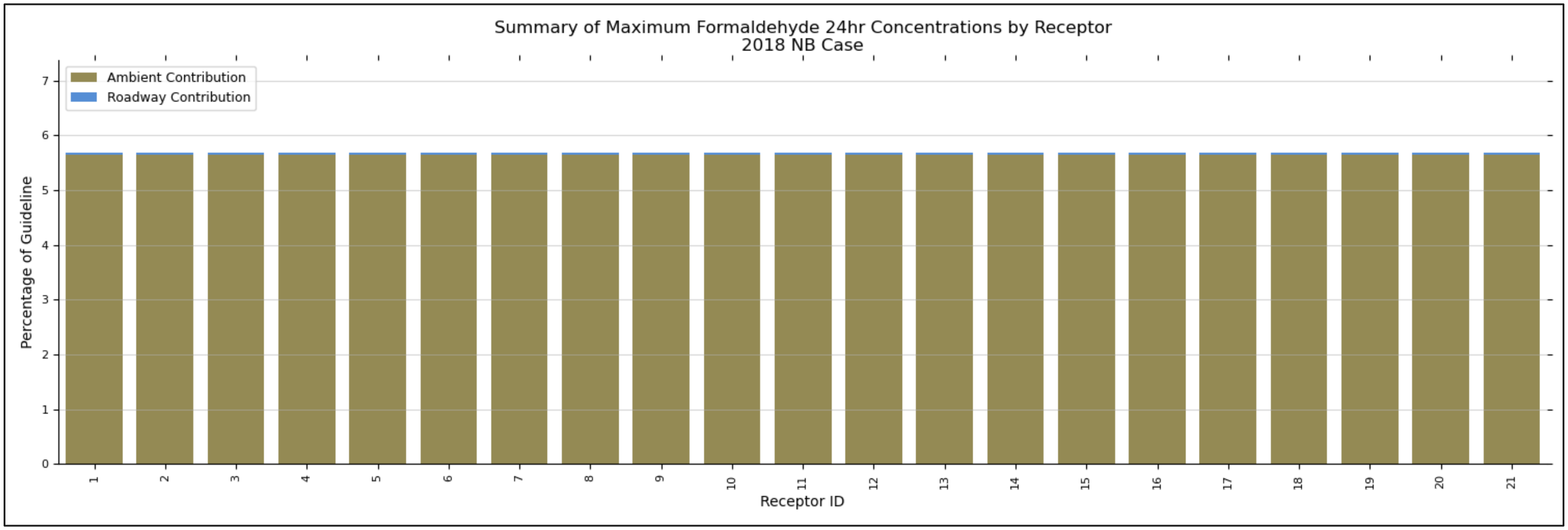
13
14
15
16
17
18
19
20
21
Receptor ID


Summary of Maximum Formaldehyde 24hr Concentrations by Receptor
2018 NB Case
Ambient Contribution
Roadway Contribution
Percentage of Guideline
0
1
2
3
4
5
6
7
Receptor ID
1
2
3
4
5
6
7
8
9
10
11
12
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14
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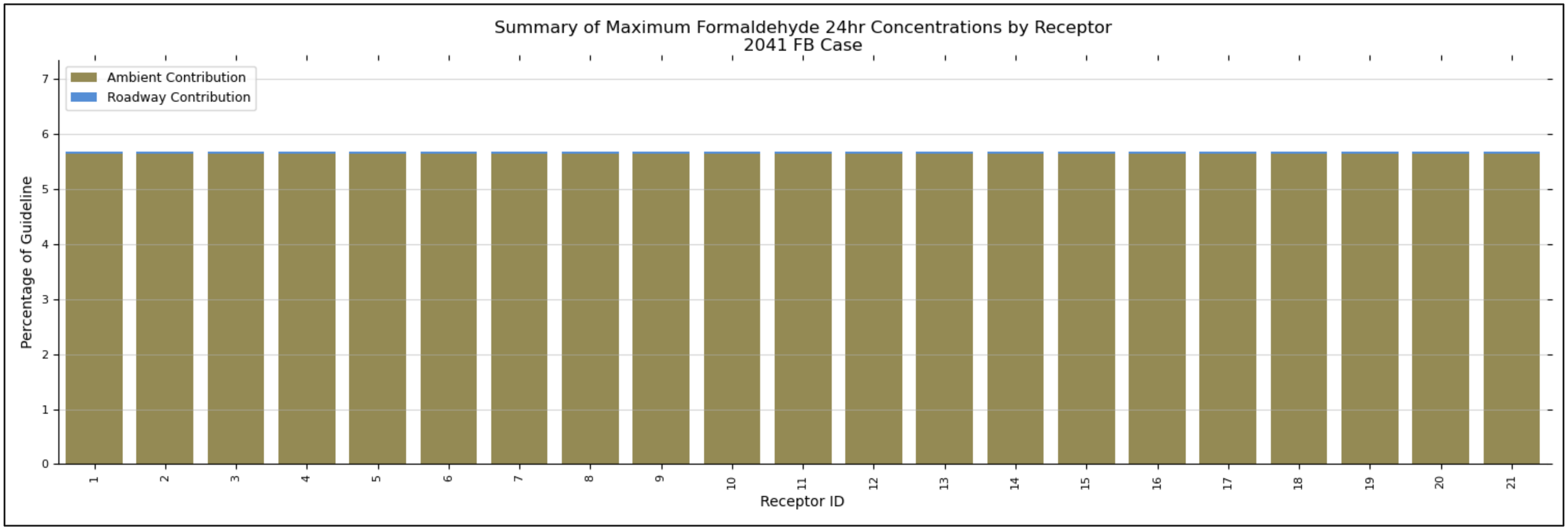
18
19
20
21


Summary of Maximum Formaldehyde 24hr Concentrations by Receptor
2041 FB Case
Ambient Contribution
Roadway Contribution
Percentage of Guideline
0
1
2
3
4
5
6
7
Receptor ID
1
2
3
4
5
6
7
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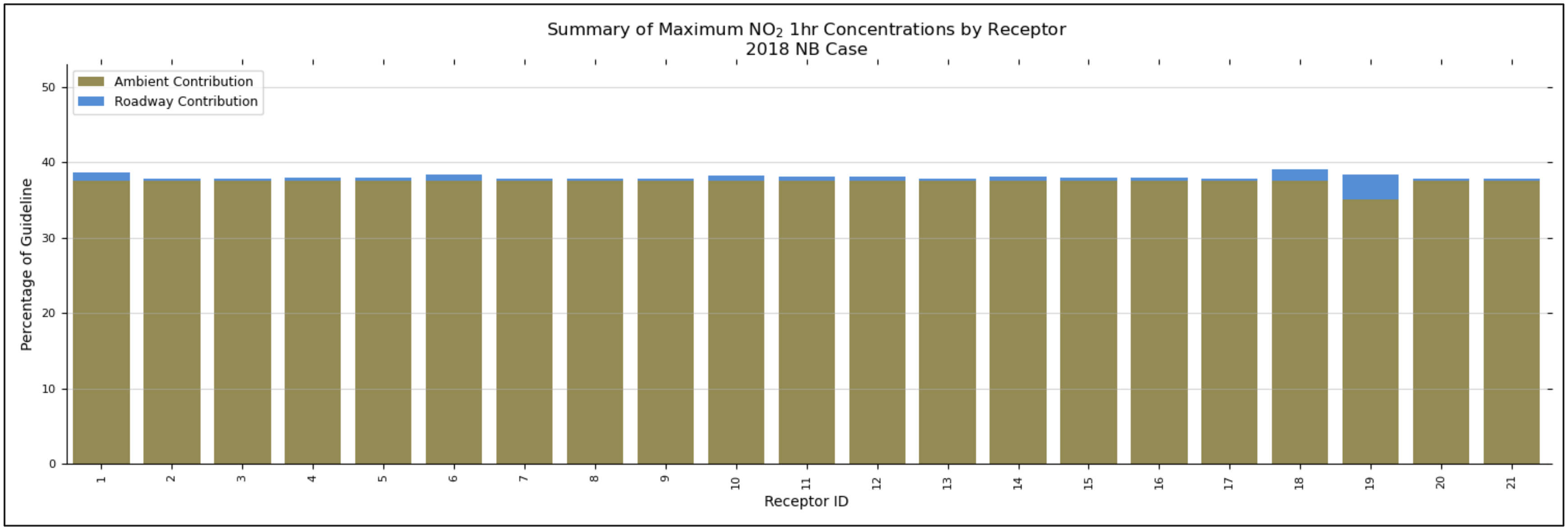
20
21


Summary of Maximum NO_2 1hr Concentrations by Receptor
2018 NB Case
Ambient Contribution
Roadway Contribution
Percentage of Guideline
0
10
20
30
40
50
Receptor ID
1
2
3
4
5
6
7
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9
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11
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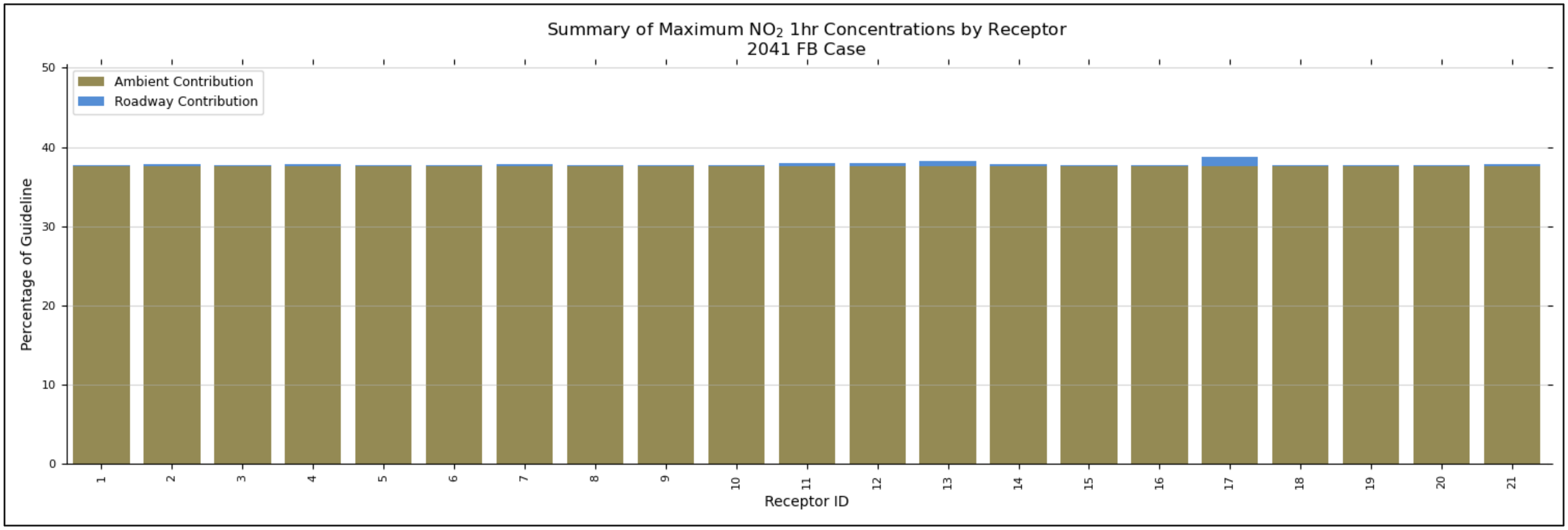
20
21


Summary of Maximum NO_2 1hr Concentrations by Receptor
2041 FB Case
Ambient Contribution
Roadway Contribution
Percentage of Guideline
0
10
20
30
40
50
Receptor ID
1
2
3
4
5
6
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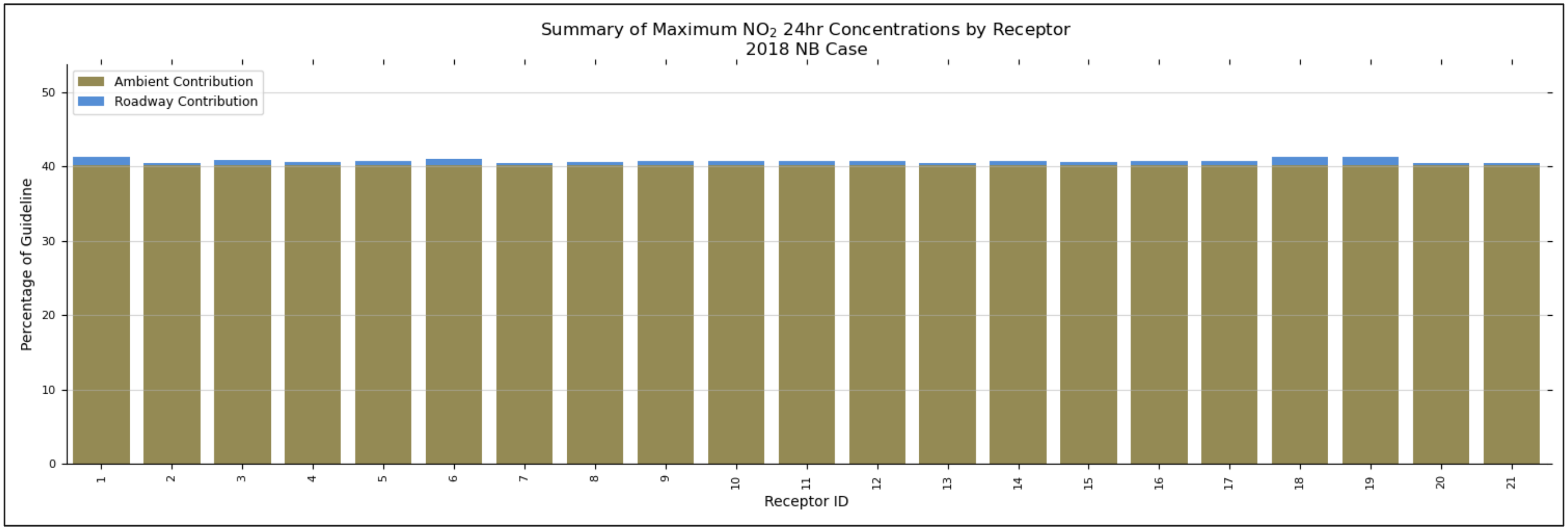
21


Summary of Maximum NO₂ 24hr Concentrations by Receptor
2018 NB Case
Ambient Contribution
Roadway Contribution
Percentage of Guideline
0
10
20
30
40
50
Receptor ID
1
2
3
4
5
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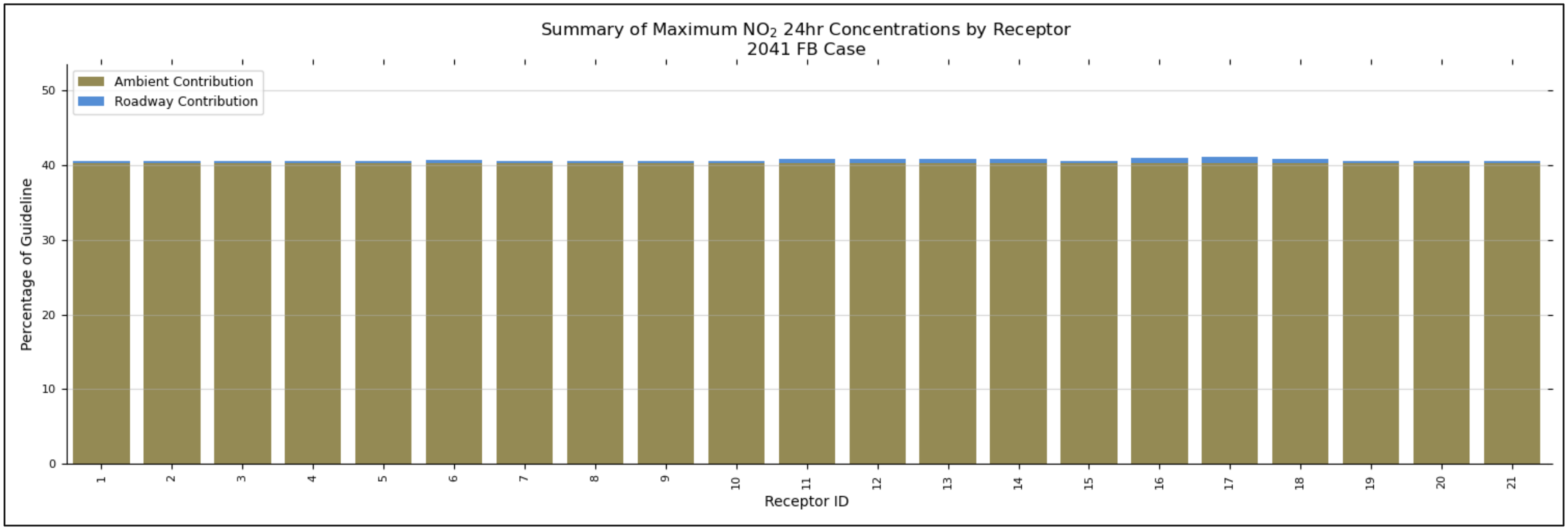
Summary of Maximum NO₂ 24hr Concentrations by Receptor
2041 FB Case
Ambient Contribution
Roadway Contribution
Percentage of Guideline
0
10
20
30
40
50
Receptor ID
1
2
3
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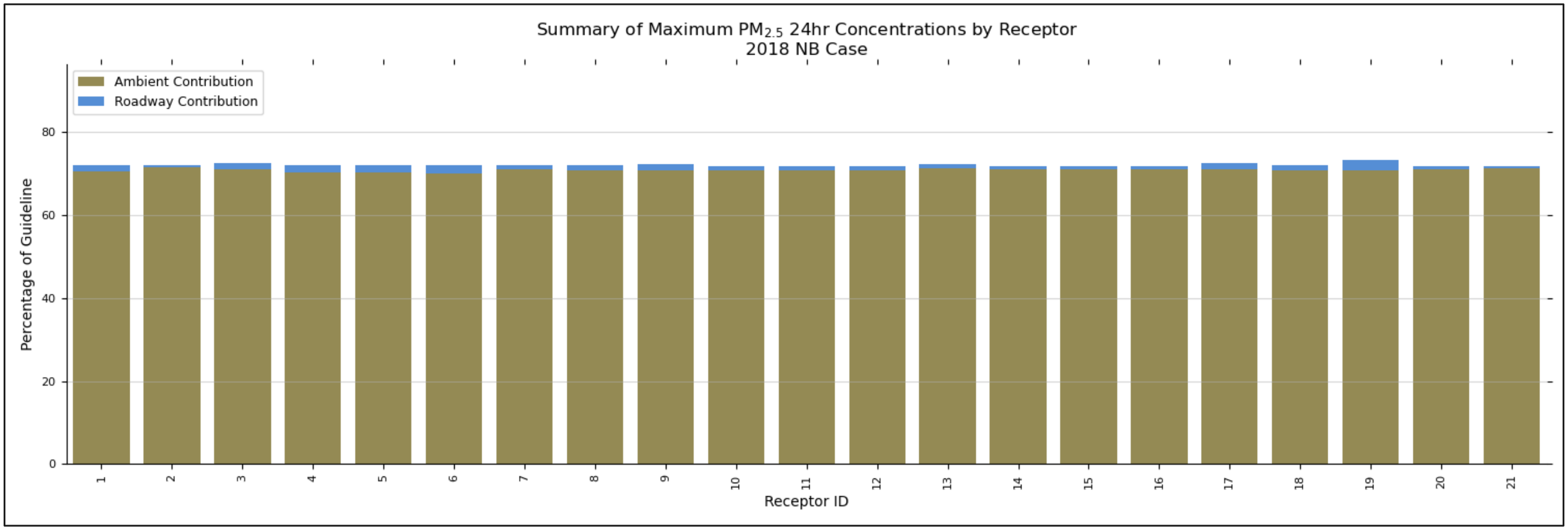
Summary of Maximum PM2.5 24hr Concentrations by Receptor
2018 NB Case
Ambient Contribution
Roadway Contribution
Percentage of Guideline
0
20
40
60
80
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
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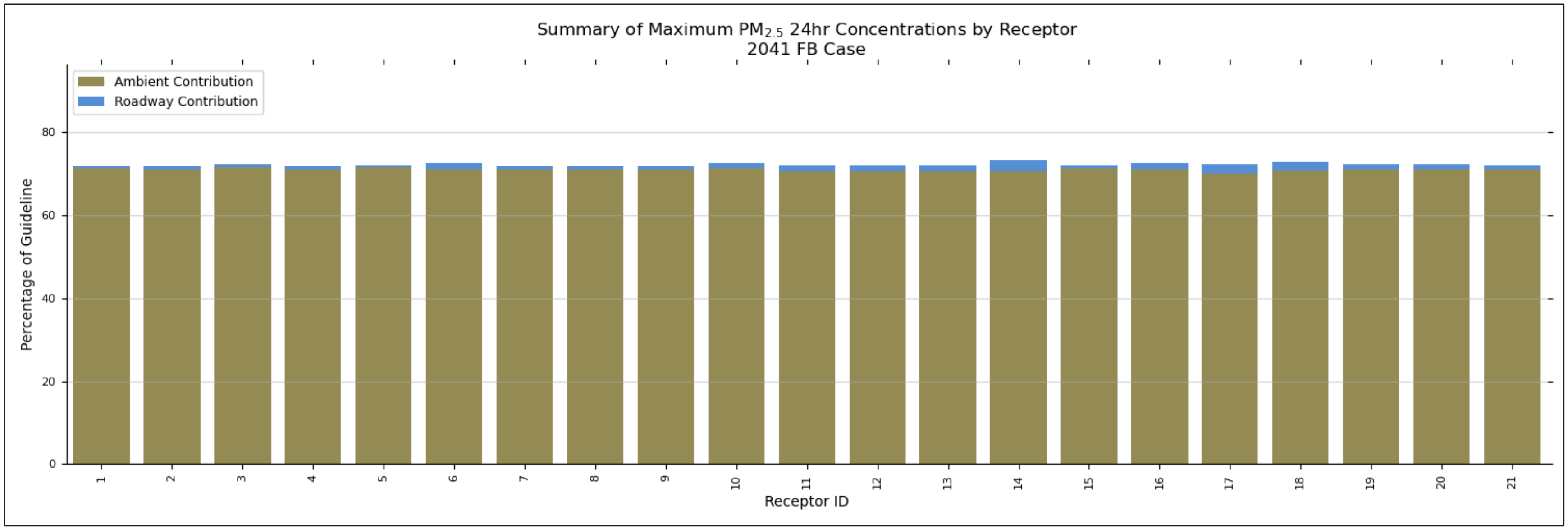
18
19
20
21
Receptor ID


Summary of Maximum PM2.5 24hr Concentrations by Receptor
2041 FB Case
Ambient Contribution
Roadway Contribution
Percentage of Guideline
0
20
40
60
80
1
2
3
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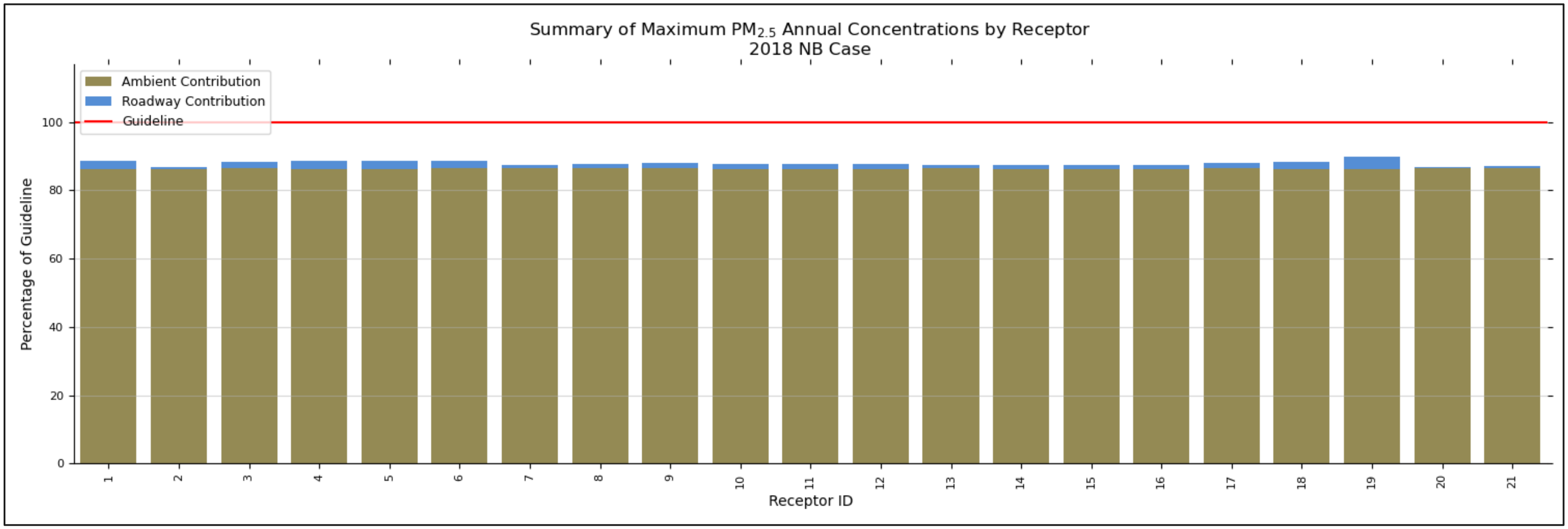
21
Receptor ID


Summary of Maximum PM2.5 Annual Concentrations by Receptor
2018 NB Case
Ambient Contribution
Roadway Contribution
Guideline
Percentage of Guideline
0
20
40
60
80
100
1
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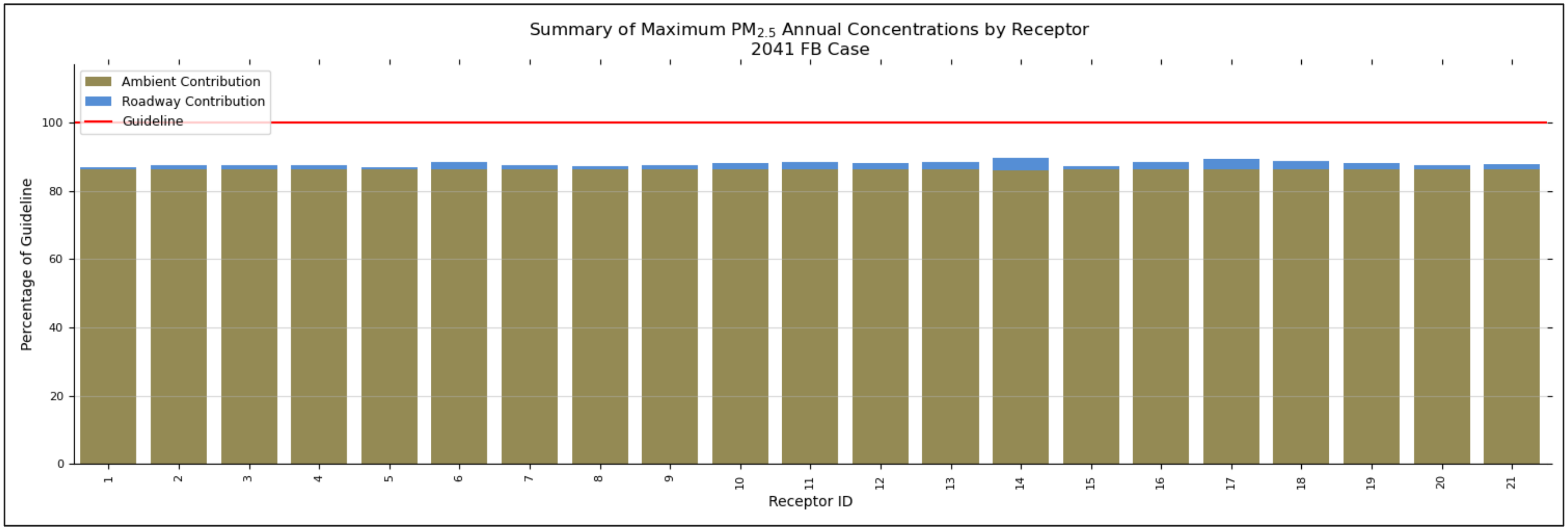
20
21
Receptor ID


Summary of Maximum PM2.5 Annual Concentrations by Receptor
2041 FB Case
Ambient Contribution
Roadway Contribution
Guideline
Percentage of Guideline
0
20
40
60
80
100
1
2
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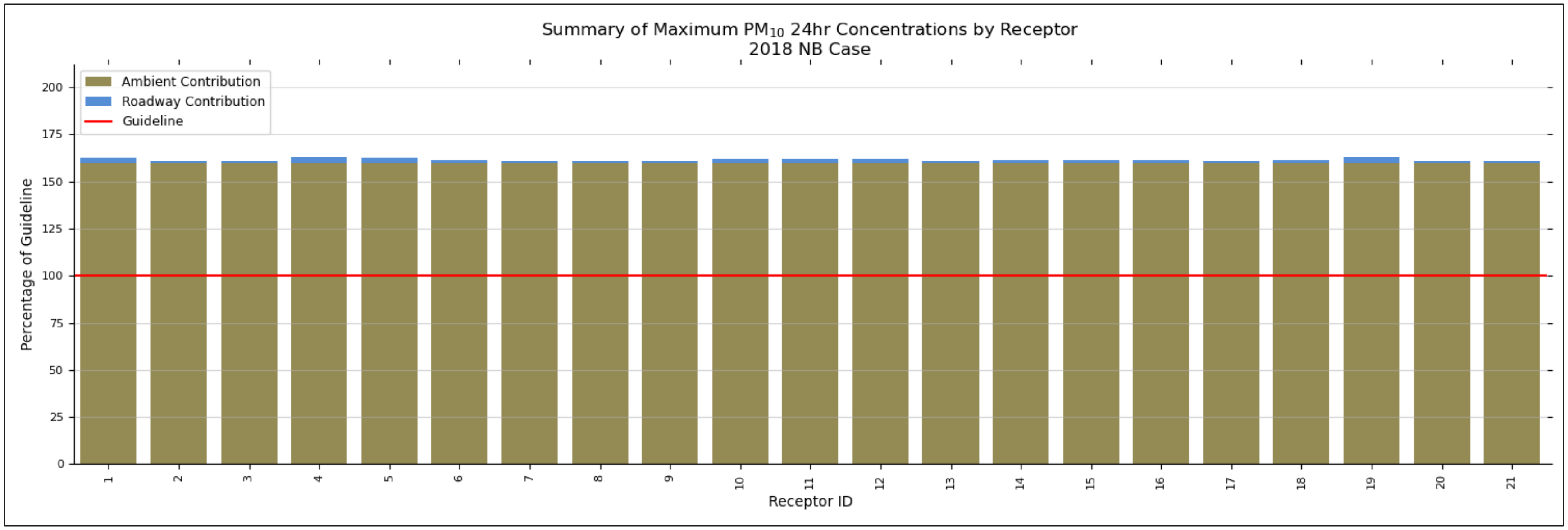
21
Receptor ID


Summary of Maximum PM_{10} 24hr Concentrations by Receptor
2018 NB Case
Ambient Contribution
Roadway Contribution
Guideline
Percentage of Guideline
0
25
50
75
100
125
150
175
200
Receptor ID
1
2
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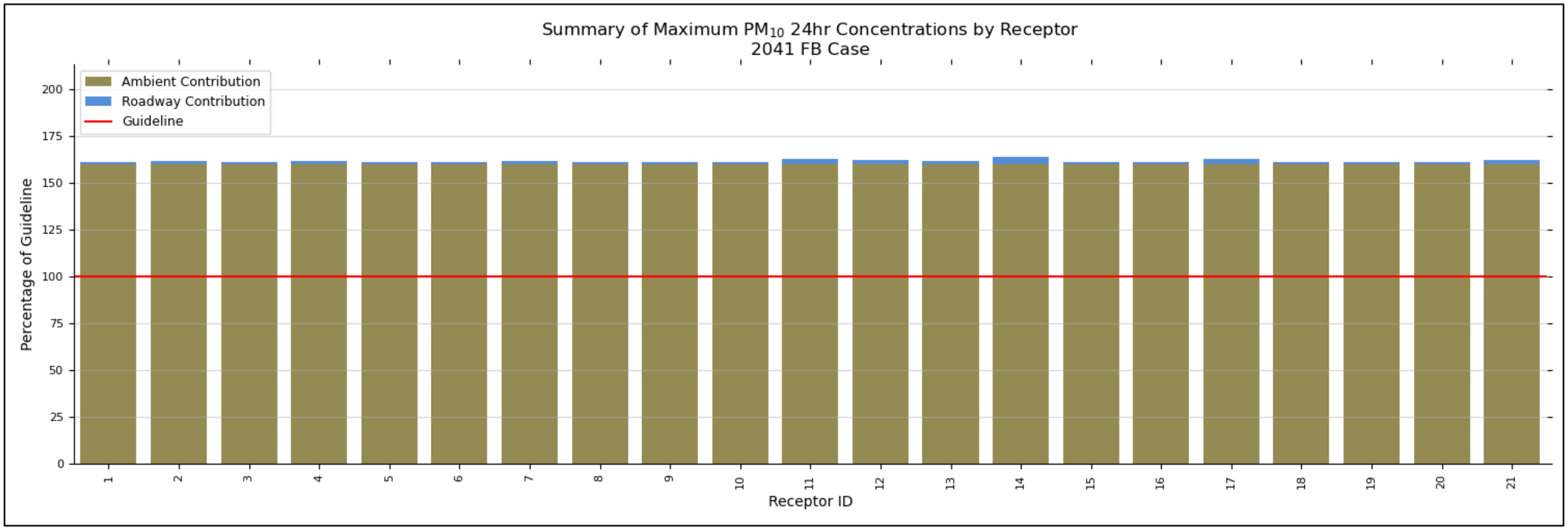
Summary of Maximum PM_{10} 24hr Concentrations by Receptor
2041 FB Case
Ambient Contribution
Roadway Contribution
Guideline
Percentage of Guideline
0
25
50
75
100
125
150
175
200
Receptor ID
1
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4
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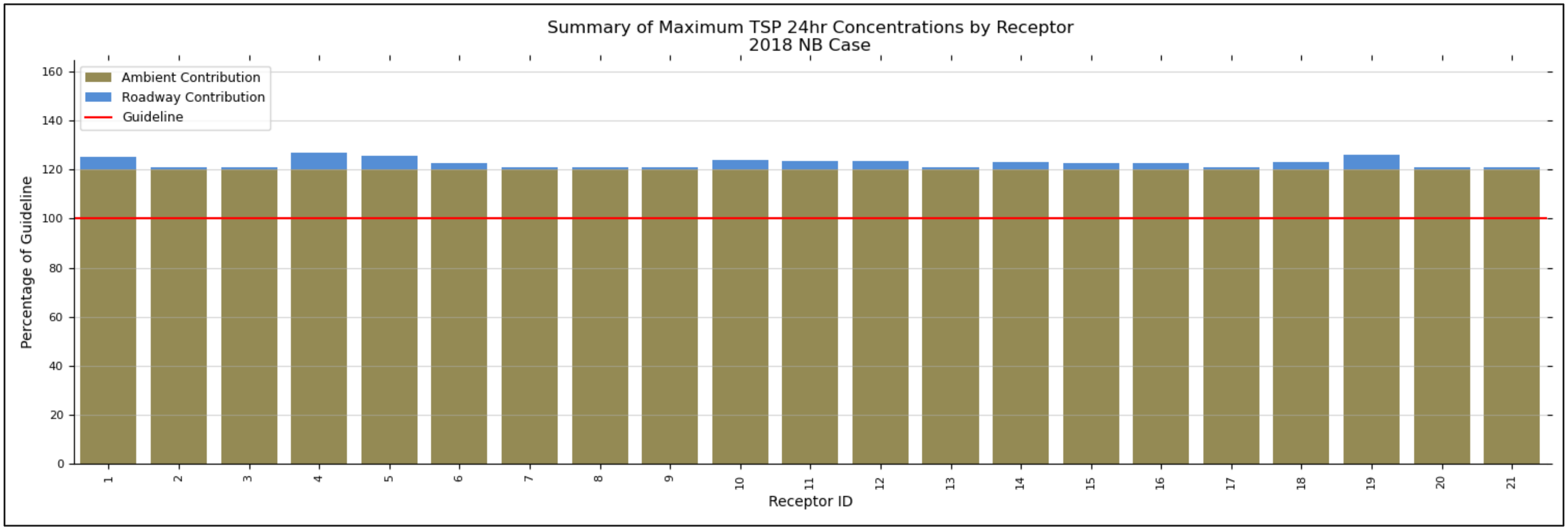
Summary of Maximum TSP 24hr Concentrations by Receptor
2018 NB Case
Ambient Contribution
Roadway Contribution
Guideline
Percentage of Guideline
0
20
40
60
80
100
120
140
160
Receptor ID
1
2
3
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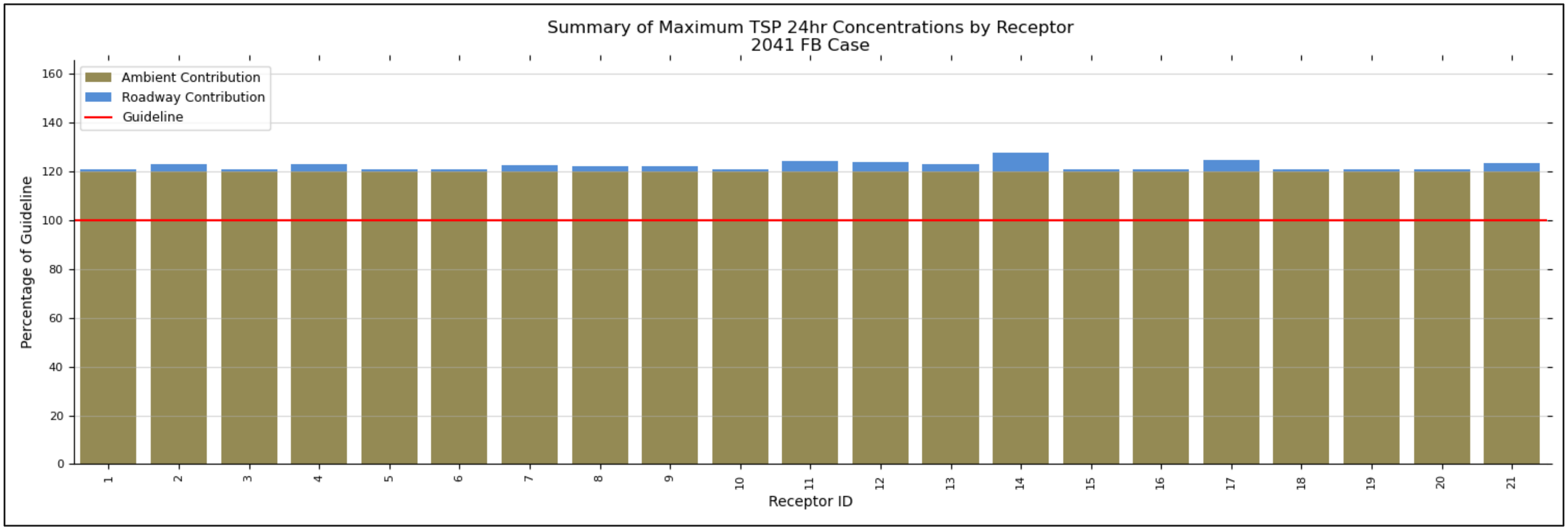
Summary of Maximum TSP 24hr Concentrations by Receptor
2041 FB Case
Ambient Contribution
Roadway Contribution
Guideline
Percentage of Guideline
0
20
40
60
80
100
120
140
160
Receptor ID
1
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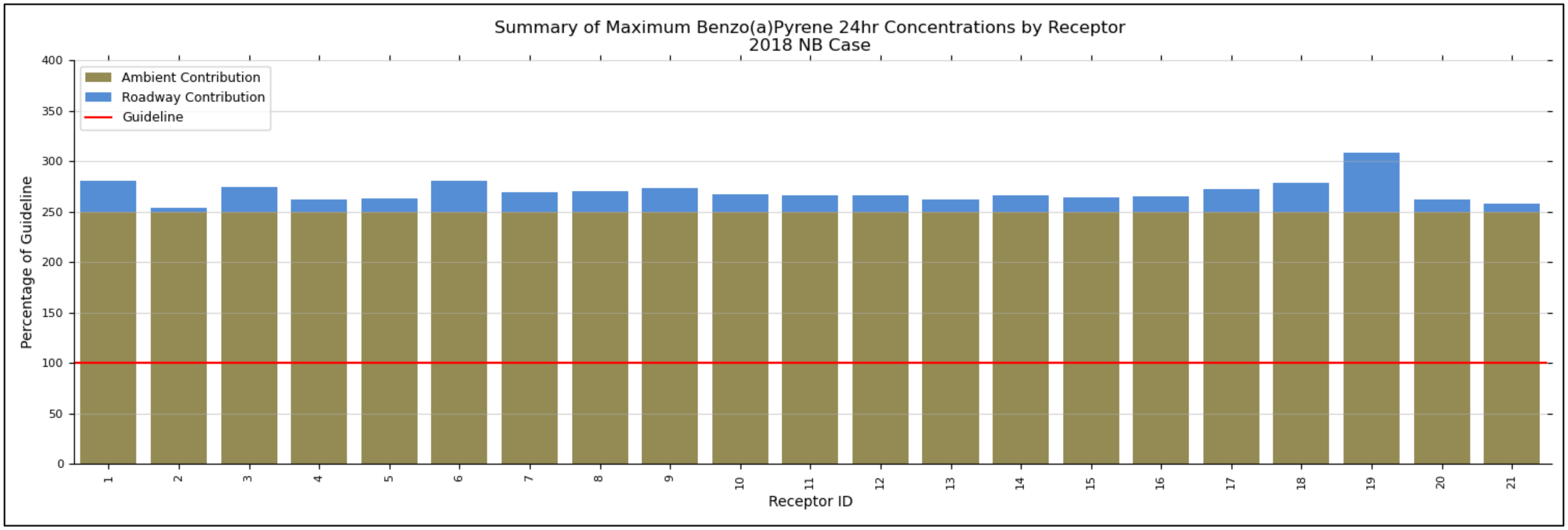
Summary of Maximum Benzo(a)Pyrene 24hr Concentrations by Receptor
2018 NB Case
Ambient Contribution
Roadway Contribution
Guideline
Percentage of Guideline
0
50
100
150
200
250
300
350
400
Receptor ID
1
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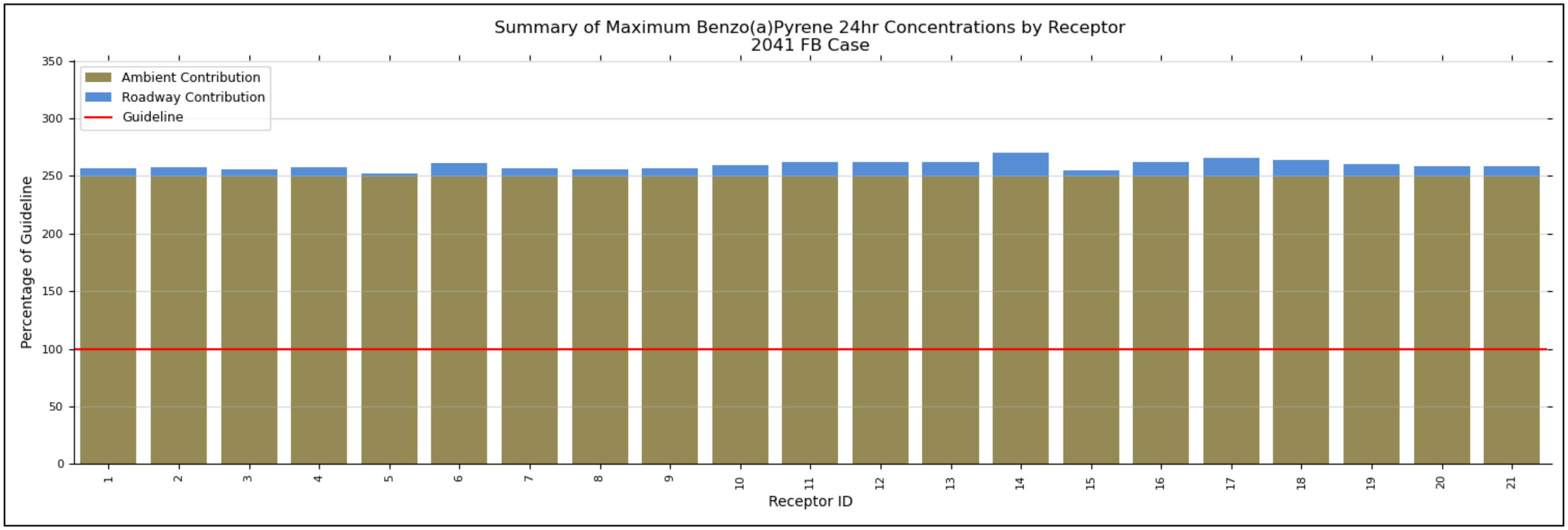
Summary of Maximum Benzo(a)Pyrene 24hr Concentrations by Receptor
2041 FB Case
Ambient Contribution
Roadway Contribution
Guideline
Percentage of Guideline
0
50
100
150
200
250
300
350
Receptor ID
1
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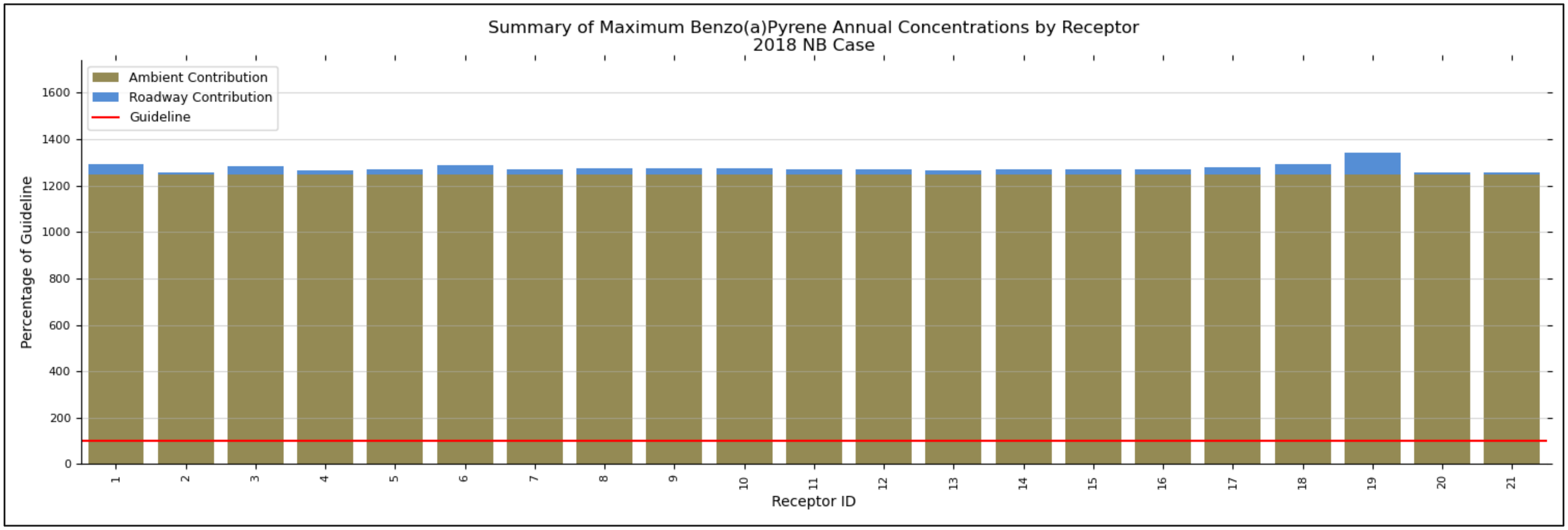
Summary of Maximum Benzo(a)Pyrene Annual Concentrations by Receptor
2018 NB Case
Ambient Contribution
Roadway Contribution
Guideline
Percentage of Guideline
0
200
400
600
800
1000
1200
1400
1600
Receptor ID
1
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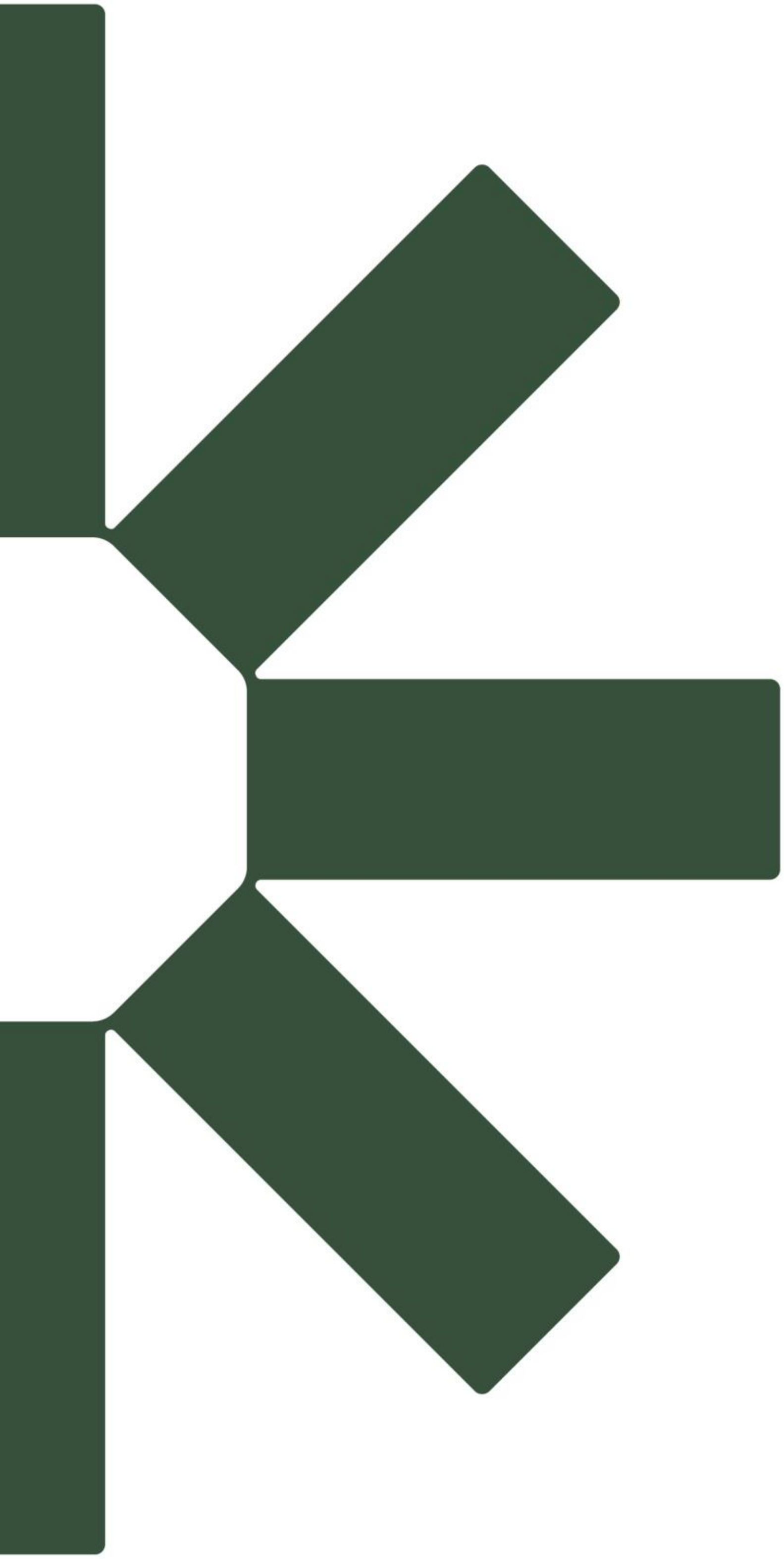

Making Sustainability Happen