Ontario Ministry of Transportation

Highway 17 Planning & Class EA Study
Air Quality Assessment Report
GWP 5670-10-00

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Acronyms

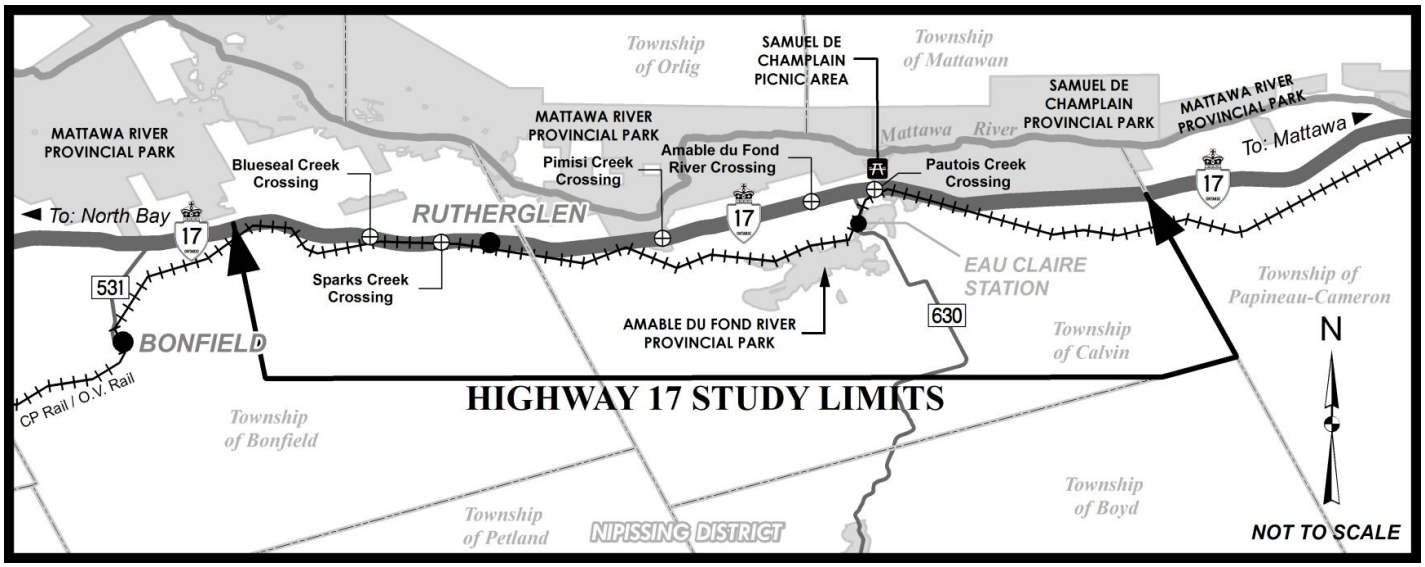
Abbreviation	Description
AADT	Average Annual Daily Traffic
AAQC	Ambient Air Quality Criteria
ASL	Above Sea Level
ATS	Average Travel Speed
CCME	Canadian Council of Ministers of the Environment
CH_4	Methane
CO	Carbon Monoxide
EA	Environmental Assessment
GHG	Greenhouse Gas
LOS	Level of Service
MOE	Ontario Ministry of the Environment
MTO	Ontario Ministry of Transportation
NH_3	Ammonia
NO	Nitric Oxide
N_2O	Nitrous Oxide
NO_2	Nitrogen Dioxide
NOx	Oxides of Nitrogen
NAPS	National Air Pollution Surveillance
PM	Particulate Matter
ppb	Parts Per Billion
ppm	Parts Per Million
SO_2	Sulphur Dioxide
VOC	Volatile Organic Compounds
VMT	Vehicle Miles Travelled

Symbol	Unit of Measure
µg	Micrograms
$\mu g/m^3$	Micrograms per cubic meter
km	Kilometre
µm	Micron

Executive Summary

AECOM was retained by the Ministry of Transportation to prepare an Air Quality Assessment for a 23.5 km section of Highway 17 from 2.2 km east of Highway 531 easterly to the boundary road between the Townships of Calvin and Papineau-Cameron. The study limits are shown in **Exhibit ES 1**.

Exhibit ES 1 Class EA Study Limits



Highway 17 is a vital link internationally and as part of the Northern Highway System, inter-regionally between Northern Ontario and Western Canada, and between Southeastern Ontario and Eastern Canada. MTO has initiated a planning process for Highway 17 between Ottawa and Sault Ste. Marie with several planning projects underway for selected sections of the highway.

Within the Study Area, Highway 17 is primarily a two lane highway with limited access restrictions and access in both directions provided via private driveways and local roadways. The planning and Class Environmental Assessment (EA) study this air quality analysis supports has been completed to identify a recommended plan for Highway 17 to improve future traffic operations and to enhance highway safety from Bonfield to the boundary road of Calvin Township and the Township of Papineau-Cameron.

The recommended highway plan for this Highway 17 segment would be designated as a 4-lane RFD (rural, freeway, divide) with two lanes in each direction and a 30m median within a total right-of-way width of 110m and access is restricted to interchanges. The plan includes segments of widening / improving the existing highway and segments of realigned highway. Specifically, the recommended plan for the highway includes:

- Realignment of Highway 17 from Highway 531 to east of Rutherglen;
- Widening and realignment of Highway 17 from east of Rutherglen to west of Highway 630;
- Realignment of Highway 17 from west of Highway 630 to west of Pautois Creek;
- Widening of Highway 17 from west of Pautois Creek to the east study limit (just east of Boundary Road);
- Closure of existing Highway 17 from east of Highway 630 to west of Pautois Creek;
- Retention of existing Highway 17 as a service road at all other locations;

- Interchanges at Rutherglen Line, Highway 630 and Boundary Road;
- Grade Separations at Trout Pond Road and Trunk Road; and
- A cul-de-sac at McNutt Road.

The purpose of the Air Quality Assessment is to determine the potential air quality impacts of the recommended plan, utilizing the Ministry of Transportation Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Projects (MTO Guide). The study also provides recommendations on mitigation measures that can be implemented to reduce the potential for air quality effects from construction.

Three scenarios were investigated, specifically:

- Current (2013)
- Future No Build (2035)
- Future Build (2035)

The objective of the report is to provide a comparison of the air quality impacts resulting from the recommended plan to an established future baseline and evaluate how the proposed project may potentially affect air quality in the Study Area. The pollutants of concern related to transportation air quality are nitrogen oxides (NO_x), carbon monoxide (CO), and particulate matter (PM_{10} and $PM_{2.5}$). The VOC emissions of acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde were also assessed.

Regional air quality impacts were assessed based on ambient air quality from local air quality monitoring stations and compared to established standards or guidelines.

Ambient data for PM_{10} is not readily available. Background values for PM_{10} was calculated using Ministry of the Environment (MOE) approved ratios ($PM_{2.5}$ / PM_{10} = 0.54) (Lall et al (2004)).

As discussed in Section 2 of this report, the Base Case for this specific project was assessed using ambient air concentrations for the pollutants of interest extracted from Ontario Ministry of Environment and the Federal National Air Pollution Surveillance (NAPS) program.

Further, the air quality impact on a local level due to the realignment and widening of Highway 17 was assessed by considering impacts from vehicle emissions for the above mentioned scenarios. Using the traffic information, representative emission rates for the contaminants of concern were predicted using MOBILE 6.2C, a mobile vehicle emissions software package developed by the United States Environmental Protection Agency (US EPA). The contaminant emission rates were compared with emissions from nearby industrial facilities.

The main findings of the air quality assessment are outlined below:

- Base ambient air quality assessment within the Study Area shows the contaminants of concern are below their corresponding established provincial and federal air quality standards or guidelines, as shown in **Table ES1** and **ES2**.
- Based on traffic data provided, traffic volumes are expected to increase by 50% from 2013 to 2035.
- For the Future Build scenario, the majority of contaminant emissions are slightly higher than the Future No-Build scenario, except for VOC's, Acrolein and Greenhouse Gases which are slightly lower in the Future Build scenario as shown in **Table ES3**. There was no change in particulate matter (PM_{10} and $PM_{2.5}$) emissions.

- Although the total emissions are higher in the Future-Build scenario, the impact on sensitive receptors near the Study Area will be reduced as a result of the improvements in the free flow traffic. However, improvement in the highway will also lead to increased demand and higher traffic volume which results in higher contaminant emissions.
- The Future Build scenario has higher emissions than the Current (baseline) scenario for PM_{10}, $PM_{2.5}$, carbon monoxide (CO), carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) as shown in **Table ES3**. The increase in emissions is proportional to an increase in traffic volume. The Future Build scenario has lower emissions than the current (baseline) for Nitrogen Oxides (NOx), VOC's, Benzene, 1,3 butadiene, formaldehyde, acetaldehyde and acrolein. The decrease in emissions is expected due to improvements in vehicle flow and advancements in fuels and emissions control technology.
- For the majority of the contaminants of concern, the Industrial facilities within the vicinity of the Study Area have more impact to the local air quality than the increased vehicular emissions from the expansion of Highway 17, as shown in **Table ES4**.
- Contaminant emissions' contribution from the recommended plan for Highway 17 to the provincial and national mobile emissions is negligible, as shown in **Table ES5**.

Further, this study identified construction related air emissions such as particulate matter from material handling operations, soil excavation and combustion emissions from construction equipment.

An investigation of zoning and average wind data indicates that construction activities would predominantly affect rural areas north and south of Highway 17. The air quality impacts of construction related activities can be effectively mitigated through the following mitigation measures:

- ensuring the use of heavy equipment in good condition of maintenance and compliant with applicable federal regulations for off-road diesel engines;
- operational procedures including those measures to be specified in the Dust Control Plan; and
- ensuring that the areas most impacted in particulate levels are vegetated to reduce the cumulative particulate impacts.

It should be noted that this study did not consider local air quality impacts at representative receptors within the Study Area. This was deemed unwarranted because the recommend highway segment is situated in a rural area with a limited number of sensitive receptors and given that the analysis detailed in this report determined that the majority of emissions from the project for contaminants of concern are considered negligible and below the established provincial and federal air quality standard or guideline levels.

Table ES1 Ambient Air Quality Concentrations

Contaminant	Station Name	NAPS ID	90th Percentile of Hourly Concentrations (ppb)					Concentration (µg/m^3)
			2008	2009	2010	Average	Maximum	Average
NOx	North Bay	62001	26.0	28.0	23.0	25.7	28.0	52.8
NO_2	North Bay	62001	18.0	20.0	17.0	18.3	20.0	9.80
PM_{10}	North Bay	62001	18.5	16.7	16.7	17.3	18.5	17.3
$PM_{2.5}$	North Bay	62001	10.0	9.00	9.00	9.33	10.0	9.33
CO	Ottawa Downtown	60104	0.42	0.39	0.40	0.40	0.42	505
90th Percentile of Daily Concentration in µg/m3								
Benzene	Egbert	64401	0.46	0.52	0.51	0.50	0.52	
1,3-Butadiene	Egbert	64401	0.01	0.01	0.01	0.01	0.01	
Formaldehyde	Egbert	64401	1.96	1.02	1.27	1.42	1.96	
Acetaldehyde	Egbert	64401	4.93	2.53	5.24	4.30	5.24	
Acrolein	Windsor	65101	0.07	0.07	0.07	0.07	0.07	

NO_2- Nitrogen Dioxide

Table ES2 Summary of Applicable Guidelines and Standards

Contaminant	Source	Averaging Time (hr)	Value (µg/m^3)
NO_2	AAQC	1	400
	AAQC	24	200
CO	AAQC	1	36,200
	AAQC	8	15,700
PM_{10}	MOE Interim Reference Level	24	50
$PM_{2.5}$	Canada Wide Standard (CCME)	24	30
Acetaldehyde	AAQC	24	500
Acrolein	AAQC	24	0.4
Benzene	AAQC	24	2.3
	AAQC	Annual	0.45
1,3-Butadiene	AAQC	24	10
	AAQC	Annual	2
Formaldehyde	AAQC	24	65

Table ES3 Vehicle Emission Rates

Contaminant	Current (2013) Vehicle Emissions (tonnes/year)	Future No Build (2035) Vehicle Emissions (tonnes/year)	Future Build (2035) Vehicle Emissions (tonnes/year)	Future Build (2035) Vs Future No Build (2035) Percent Change (%)
PM_{10}	25.77	38.8	38.38	0.01%
$PM_{2.5}$	4.19	5.99	5.99	0.04%
NOx	32.23	11.28	12.02	6.52%
CO	352.67	394.51	412.02	4.44%
VOC	17.12	12.70	12.41	-2.23%
Benzene	0.51	0.37	0.37	0.42%
1,3 butadiene	0.06	0.04	0.04	13.17%
Formaldehyde	0.16	0.14	0.14	3.10%
Acetaldehyde	0.08	0.06	0.07	12.89%
Acrolein	0.01	0.01	0.01	-2.41%
CO_2	18063.03	27763.74	27752.38	-0.04%
Methane (CH_4)	1.12	172	1.72	-0.04%
Nitrous Oxide (N_2O)	1.42	2.19	2.19	-0.04%

Notes:
(1) Values for PM10 were calculated using MOE approved ratios (PM2.5/PM10=0.54) Lall et al. (2004)
(2) Values for Methane (CH_4) and Nitrous Oxide (N_2O) were calculated using emission factor ratios provided in Table 6 of the Ministry of Transportation "Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas (GHG) Emissions of Provincial Transportation Projects".

Table ES4 Emissions from Nearby Industrial Sources (Tonnes/Year)

Contaminant	**Air Emissions in Tonnes (total of 5 facilities)**					Future-2035 Build **Vehicle Emissions (tonnes/year**
	2008	**2009**	**2010**	**Average**	**Maximum**	
PM_{10}	22.87	17.30	22.00	20.72	22.87	38.38
$PM_{2.5}$	19.87	13.74	19.52	17.71	19.87	5.99
Nitrogen Oxides (NOx)	152.00	78.60	58.90	96.50	152.00	12.02
Carbon Monoxide (CO)	71.00	31.00	32.00	44.77	71.00	412.02
VOC	115.10	102.00	113.20	110.10	115.10	12.41
Formaldehyde	17.00	14.00	15.00	15.33	17.00	0.14

Table ES5 Summary of Regional Criteria Contaminants (Tonnes/Year)

Contaminant	**Sectors**	**Future-Build Scenario (2035)**	**Ontario (2010)**	**% Project Contribution**	**Canada (2010)**	**% Project Contribution**
PM_{10}	Mobile Sources	38.38	16,939	0.21%	68,292	0.056%
$PM_{2.5}$	Mobile Sources	5.99	14,888	0.038%	61,062	0.010%
NOx	Mobile Sources	12.02	271,665	0.004%	1,138,423	0.001%
VOC	Mobile Sources	12.41	145,766	0.01%	491,491	0.003%
CO	Mobile Sources	412.02	2,038,268	0.02%	6,514,674	0.006%

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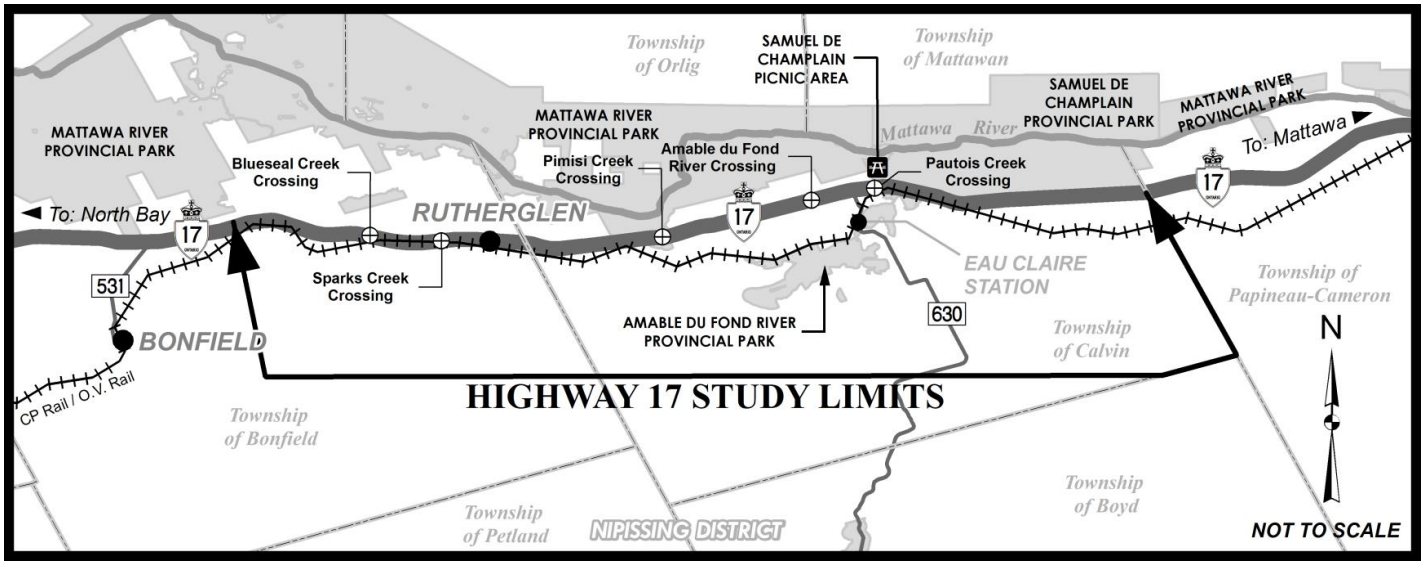
Appendices

1. Introduction

AECOM was retained by the Ministry of Transportation to prepare an Air Quality Assessment for a 23.5 km section of Highway 17 from 2.2 km east of Highway 531 easterly to the boundary road between the Townships of Calvin and Papineau-Cameron. The study limits are shown in **Figure 1.1**.

Figure 1.1: Class EA Study Limits



Highway 17 is a vital link internationally and as part of the Northern Highway System, inter-regionally between Northern Ontario and Western Canada, and between Southeastern Ontario and Eastern Canada. MTO has initiated a planning process for Highway 17 between Ottawa and Sault Ste. Marie with several planning projects underway for selected sections of the highway.

Within the Study Area, Highway 17 is primarily a two lane highway with limited access restrictions and access in both directions provided via private driveways and local roadways. The planning and Class Environmental Assessment (EA) study this air quality analysis supports has been completed to identify a recommended plan for Highway 17 to improve future traffic operations and to enhance highway safety from Bonfield to the boundary road of Calvin Township and the Township of Papineau-Cameron.

The recommended plan for this Highway 17 segment would be designated as a 4-lane RFD (rural, freeway, divide) with two lanes in each direction and a 30m median within a total right-of-way width of 110m and access is restricted to interchanges. The plan includes segments of widening / improving the existing highway and segments of realigned highway. Specifically, the recommended plan for the highway includes:

- Realignment of Highway 17 from Highway 531 to east of Rutherglen;
- Widening and realignment of Highway 17 from east of Rutherglen to west of Highway 630;
- Realignment of Highway 17 from west of Highway 630 to west of Pautois Creek;
- Widening of Highway 17 from west of Pautois Creek to the east study limit (just east of Boundary Road);
- Closure of existing Highway 17 from east of Highway 630 to west of Pautois Creek;
- Retention of existing Highway 17 as a service road at all other locations;

- Interchanges at Rutherglen Line, Highway 630 and Boundary Road;
- Grade Separations at Trout Pond Road and Trunk Road; and
- A cul-de-sac at McNutt Road.

The purpose of the Air Quality Assessment is to determine the potential air quality impacts as they relate to the preferred alternative / selected transportation planning and route option (hereafter referred to as the "recommended highway plan"). This work was undertaken in compliance with the MTO June 2012 'Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas Emissions of Provincial Transportation Projects'. In accordance with Section 3.4 of the Guide, the work included the four stipulated tasks applicable to Group B undertakings:

- Detailed assessment of the "recommended highway plan":
  - Assessment of local air quality impacts;
  - Assessment of regional air quality impacts; and
  - Assessment of the incremental increase or decrease in GHG emissions.
- Assessment of need for mitigation;
- Evaluation of mitigation options; and
- Reporting (under this cover).

As indicated in Section 3.3 of the MTO Guide:

- Local air quality impacts refers to impacts in the immediate vicinity of the transportation system (typically limited to the area within approximately 500m of the road) where the concentration of transportation-related air pollutants may exceed the ambient air quality criteria for one or more hours in a typical year;
- Regional air quality impacts refers to impacts to the geographic area (depending upon the specifics of the transportation system and the natural and social geography around it) in which the planned transportation system is likely to have a significant contribution to the cumulative air pollution and greenhouse gas emissions load.

2. Approach and Methodology for Detailed Assessment of the Recommended Highway Plan

2.1 Methodology for Assessment of Local Air Quality Impacts for the Recommended Highway Plan

The air quality study consisted of an assessment to address the air quality impacts of the recommended plan for widening and realignment of Highway 17. The impacts studied are broadly defined in terms of local and regional air quality impacts.

Local air quality impacts were assessed by determining the baseline ambient air quality within the Study Area from local monitoring stations and comparing them to applicable regulatory limits. In addition, the local air quality assessment considered the impacts from vehicular emissions within the Study Area. The highway is situated in a rural area with a limited number of sensitive receptors; therefore this report does not consider local air quality impacts at representative receptors within the Study Area.

Three scenarios were investigated, specifically:

- Current (2013)
- Future No Build (2035)
- Future Build (2035)

Baseline ambient air quality was assessed based on publicly available historical data from ambient air quality monitoring stations operated by the MOE and Environment Canada.

The current (2013) scenario considers the existing highway configuration, traffic volume and traffic speed. The Future No Build (2035) scenario assumes that the existing highway configuration will not change (i.e. no highway improvements); however traffic volumes will increase due to population growth. The Future Build (2035) scenario considers the construction of the preferred Highway 17 improvement plan

As per the Guide, the study assessed impacts from transportation related emissions such as nitrogen oxides (NO_x), carbon monoxide (CO), and particulate matter (PM_{10} and $PM_{2.5}$). Select VOC emissions were also assessed as directed by the Ministry of the Environment (MOE). They include acetaldehyde, acrolein, benzene, 1,3-butadiene, and formaldehyde.

Background values for PM_{10} were calculated using MOE approved ratios ($PM_{2.5}$ / PM_{10} = 0.54) Lall et al. (2004).

Using the traffic information, representative emission rates for the contaminants of concern were predicted using MOBILE 6.2C, a mobile vehicle emissions software package developed by the United States Environmental Protection Agency (US EPA). The contaminant emission rates were compared with emissions from nearby industrial facilities. Further model input details are described in the corresponding sections.

2.2 Methodology for Assessment of Regional Air Quality Impacts for the Recommended Highway Plan

Regional air quality impacts were assessed by estimating and comparing the incremental change in the pollution burden for the region (considers emissions from the total transportation mix) between the “build” and “no-build” scenarios for the year 2035. An emission inventory approach was used to determine the regional air quality impacts.

3. Applicable Guidelines and Standards for Air Quality Assessment

Contaminants of interest for the project are listed in the following table, along with their corresponding standards, criteria, and guidelines. The applicable standards and guidelines are based on the following agencies:

- MOE Ambient Air Quality Criteria (AAQC)
- Proposed Canada Wide Standards (CCME)

A summary of standards proposed for the Air Quality Assessment is shown below in **Table 3.1**. Where multiple sources of standards are available, the most stringent values are shown. The MOE interim 24-hour reference level for PM_{10} was added for comparison.

Table 3.1: Summary of Applicable Guidelines and Standards

Contaminant	Source	Averaging Time (hr)	Value ($\mu g/m^3$)
NO_2	AAQC	1	400
	AAQC	24	200
CO	AAQC	1	36,200
	AAQC	8	15,700
PM_{10}	MOE Interim Reference Level	24	50
$PM_{2.5}$	Canada Wide Standard (CCME)	24	30
Acetaldehyde	AAQC	24	500
Acrolein	AAQC	24	0.4
Benzene	AAQC	24	2.3
	AAQC	Annual	0.45
1,3-Butadiene	AAQC	24	10
	AAQC	Annual	2
Formaldehyde	AAQC	24	65

AAQCs are acceptable effects-based levels in ambient air. Limits are set based on the “limiting effect” and are the lowest concentrations at which an adverse effect may be experienced. Effects considered may be health, odour, vegetation, soiling, visibility, corrosion or others. Limits have variable averaging times appropriate for the effect that they are intended to protect against. AAQCs are used for assessing general air quality and the potential for causing an adverse effect. They are set at levels below which adverse health and/or environmental effects are not expected.

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

4. Modelling Inputs

4.1 Existing Ambient Air Quality

A general estimate of the baseline ambient air quality was made using publicly available historical air quality data from ambient air quality monitoring stations within Ontario. The monitoring stations are operated by the Ontario Ministry of the Environment (MOE) and Environment Canada. It was assumed that the historic ambient air quality will be the same for both the Future Build (2035) and Future No Build scenarios (2035). This is a conservative estimate as there are numerous federal, provincial, and municipal initiatives which are currently being implemented to reduce the levels of ambient air pollutants. For vehicle emissions it is anticipated that due to anticipated more stringent vehicle emission limits, the on road emissions will decrease despite increasing traffic.

Hourly, daily and annual ambient concentrations of air quality pollutants ($PM_{2.5}$, and NO_x) were obtained from the North Bay monitoring station (**Table 4.1**).

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

- 1 and 24 hour ambient concentrations for the contaminants were obtained from the 90th percentile of hourly measurements from the North Bay Station (average value) from 2008-2010.
- As PM_{10} is not monitored, MOE approved ratio ($PM_{2.5}$ / PM_{10} = 0.54) was used to estimate ambient concentrations.

Table 4.1: North Bay Monitoring Station Information

	North Bay Information
Station Name:	North Bay
NAPS Number	62001
Address:	Chippewa St. W., Dept. National Defense.
Latitude:	46.323
Longitude:	-79.449
Station Type:	Urban
Height of Air Intake:	4 m
Elevation ASL:	219 m
Pollutants Measured:	O_3, $PM_{2.5}$, NO_2, NO_x

ASL- Above Sea Level

Carbon monoxide (CO) data was obtained from the Ottawa Downtown monitoring station (**Table 4.2**). Data for CO was provided as the daily average for the years 2008-2010. The 90th percentile daily measurements value was used as the daily background value. The daily average from 2008-2010 was selected to be the annual background contaminant value.

Table 4.2: Ottawa Downtown Monitoring Station Information

	Ottawa Downtown Information
Station Name:	Ottawa Downtown
NAPS Number	60104
Address:	Rideau St./ Wurttemberg St.
Latitude:	45.434
Longitude:	-75.676
Station Type:	Urban
Height of Air Intake:	4 m
Elevation ASL:	68 m
Pollutants Measured:	CO

ASL- Above Sea Level

Ambient air monitoring for VOCs is less common and the available monitoring stations were not close to the Study Area as compared to stations monitoring NO_x. Environment Canada's National Air Pollution Surveillance Program (NAPS) Egbert monitoring station (**Table 4.3**) and Windsor West monitoring station (**Table 4.4**) were chosen for ambient background Benzene, 1,3-Butadiene, Formaldehyde, Acetaldehyde and Acrolein concentrations. The data for the VOCs was provided as a daily average for the years 2008-2010. For each contaminant, the 90th percentile daily measurements value was used as the daily background contaminant value. The daily average from 2008-2010 was selected to be the average annual background contaminant value.

Table 4.3: Egbert Monitoring Station Information

	Egbert Information
Station Name:	Egbert
NAPS Number	64401
Address:	Egbert
Latitude:	44.33
Longitude:	-79.78
Station Type:	Rural
Height of Air Intake:	-
Elevation ASL:	253 m
Pollutants Measured:	Benzene, 1,3-Butadiene, Formaldehyde, Acetaldehyde

ASL- Above Sea Level

Table 4.4: Windsor Monitoring Station Information

	Windsor Information
Station Name:	Windsor
NAPS Number	60211
Address:	College and South
Latitude:	42.29
Longitude:	-83.07
Station Type:	Urban
Height of Air Intake:	-
Elevation ASL:	184 m
Pollutants Measured:	Acrolein

ASL- Above Sea Level

Table 4.5 shows the ambient concentration values used as the background concentration. As shown in **Table 4.5**, the monitored data for the contaminants of concern are below the established air quality standards or guidelines.

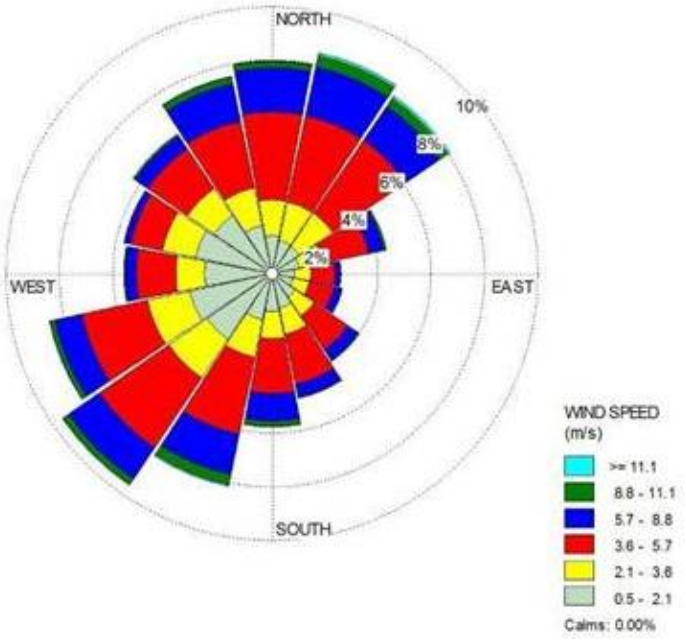
Table 4.5: Ambient Air Quality Concentrations

Contaminants	Station Name	NAPS ID	90th Percentile of Hourly Concentrations (ppb)					Concentration (µg/m^3)
			2008	2009	2010	Average	Maximum	Average
NOx	North Bay	62001	26.0	28.0	23.0	25.7	28.0	52.8
NO_2	North Bay	62001	18.0	20.0	17.0	18.3	20.0	9.8
PM10	North Bay	62001	18.5	16.7	16.7	17.3	18.5	17.3
PM2.5	North Bay	62001	10.0	9.00	9.00	9.33	10.0	9.33
CO	Ottawa Downtown	60104	0.42	0.39	0.40	0.40	0.42	505
Concentration in µg/m3								
Benzene	Egbert	64401	0.46	0.52	0.51	0.50	0.52	
1,3-Butadiene	Egbert	64401	0.01	0.01	0.01	0.01	0.01	
Formaldehyde	Egbert	64401	1.96	1.02	1.27	1.42	1.96	
Acetaldehyde	Egbert	64401	4.93	2.53	5.24	4.30	5.24	
Acrolein	Windsor	65101	0.07	0.07	0.07	0.07	0.07	

4.2 Meteorology

Five years of pre-processed regional meteorological data from 1996 – 2000 for Northern Region (North Bay-Sudbury-Sault St. Marie, Timmins) was obtained from the Ministry of Environment (MOE). The meteorological data (surface) was collected at Sudbury Airport in Sudbury and the upper data was collected at the White Lake, Michigan station. The data is generally accepted by the MOE for Environmental Assessment and Air Quality Assessment purposes. The windrose for the five (5) year period showing the wind direction (blowing from) and wind speed is presented in **Figure 4.1**. The predominant wind direction is blowing from the north and southwest sectors.

Figure 4.1: Windrose for Northern Region, Ontario.



5. Data Collection and Analysis

5.1 Traffic and Fleet Composition

Traffic data for the Current (2013), Future Build (2035) and Future No Build (2035) scenarios was provided by the AECOM traffic team in 2011 **(Appendix B**). The default MOBILE6.2C fleet composition was used for all scenarios.

5.2 Zoning

Zoning maps within the Study Area are included in **Appendix C**. Land uses along the Study Area include mainly rural areas and isolated residential areas and farmhouses. The community of Rutherglen is located in the Study Area.

6. Mitigation Measures during Construction Activity

Air emissions generated during construction activities will result in the creation and inhalation of vapours and particulate matter, both by construction workers and the surrounding community. Key potential air-impacting activities include, but are not limited to:

- clearing and grubbing;
- grading and rock blasting;
- granular base;
- drainage;
- structure construction;
- road surface / paving; and
- equipment and materials associated with the above.

Based on the windrose information presented in **Figure 4.1** and local zoning (**Section 5.2**), construction activities would predominantly affect rural areas north and south of Highway 17. Factors that will affect construction related air quality impacts include a person's proximity to the construction activity, the number of machines operating at that location and the meteorological conditions at the time those activities occur. When considering mitigation strategies and practices, special consideration should be given to areas zoned as Open Space, Conservation (**Section 5.2**) as well as the predominant wind directions.

Exposure to construction related emissions can be mitigated by the following:

- Ensuring the use of heavy equipment in good condition of maintenance and compliant with applicable federal regulations for off-road diesel engines;
- Ensuring all machinery is maintained and operated in accordance with the manufacturers specifications;
- Locating stationary equipment (e.g., generators, compressors etc.) as far away from sensitive receptors as practical; and
- Implementing those measures specified in a Dust Control Plan (to be developed during the Detailed Design Phase) to minimize the generation of dust via materials handling, vehicle movement and wind erosion.

Finally, since the expanded road segment will bring the road closer to certain residential developments and other sensitive receptors, it is recommended that the areas most impacted by particulate levels are vegetated to reduce the cumulative particulate impacts.

7. Emission Inventory and Assessment of Results

The air quality assessment included the development of emission factors and quantification of emission rates related to vehicle emissions(i.e., vehicular engine exhaust, evaporative losses, tire wear and brake wear from a defined fleet of vehicles operating with a defined driving cycle) using U.S EPA's MOBILE6.2C vehicle emissions model. Emissions of particulate matter are also generated from re-suspension of dust. These emissions are estimated using empirical formula provided in chapter 13.2.1 from U.S EPA's AP-42 document. Emission factors and emission rates were developed for the three (3) scenarios as summarized in the following sections.

7.1 Re-Suspended Road Dust

Emission factors for re-suspended $PM_{2.5}$ and PM_{10} were estimated using the following equations from Chapter 13.2.1 of the U.S EPA's AP-42 document:

The emission factor equation is given in Equation 7.1.

$$E_i = k * (sL/2)^{0.65} * (W/3)^{1.5-C} \qquad \textbf{Equation 7.1}$$

Where:

E_i	=	particulate emission factor, g/VKT
k	=	the particulate size multiplier
sL	=	silt loading, g/m^2
W	=	average vehicle weight (Assumed 3 tons as recommended by MTO)
C	=	Emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear:

The Emission factors for re-suspended $PM_{2.5}$ and PM_{10} for the scenarios being investigated are summarized in **Table 7.1**.

Table 7.1: Traffic Volume Projections

Contaminant	Year	k (g/KM)	W (tons)	ADT Category	sL (g/m^2)	C (g/KM)	Re-Suspended PM (g/ VKT)
PM_{10}	2013	4.6	3	5000-10,000	0.06	0.1317	0.47
$PM_{2.5}$	2013	0.66	3	5000-10,000	0.06	0.1005	0.07
PM_{10}	2035	4.6	3	5000-10,000	0.06	0.1317	0.47
$PM_{2.5}$	2035	0.66	3	5000-10,000	0.06	0.1005	0.07

Detailed emission rates calculations are presented in **Appendix D**.

7.2 Vehicle Emission Factors from MOBILE 6.2C

Mobile vehicle emissions are categorized as:

- Exhaust emissions that are the products of fuel combustion;
- Evaporative emissions; and
- Particulate emissions associated with brake wear and tire wear.

Evaporative emissions are divided into five emission sub-categories (i.e., hot soak, diurnal, running, resting and refuelling losses) that describe the different phases of a vehicle operating cycle that include a standing hot or cold engine, a running engine, fuel tank vapour losses due to the diurnal air temperature cycle and vapour displacement losses due to refuelling.

As indicated above, the USEPA has developed an emission factor model (MOBILE) for estimating both exhaust and evaporative emissions from a defined fleet of vehicles operating with a defined driving cycle. The most recent available version of the model is MOBILE6.2. Environment Canada has developed a Canadian version of the U.S EPA's MOBILE6.2 model, referred to as MOBILE6.2C. The default files provided with MOBILE6.2C are typical of the vehicle fleet, vehicle operating patterns and emission regulations in Canada.

This model was used to generate composite emission factors (i.e., grams of pollutant emitted per vehicle mile traveled, g/VmT) for CO, NO_x, $PM_{2.5}$, and VOCs. Emission factors were developed for the months of January to represent the winter season and July to represent the summer season for the Current, Future Build and Future No Build scenarios.

To model free flow vehicle emissions from the above traffic scenarios, current traffic volume and traffic volume projections provided by the AECOM traffic team in 2011 (**Appendix B**) were used. The traffic volume projections are presented in **Table 7.2**.

Table 7.2 Traffic Volume Projections

Traffic Projections	Time Period (Year)				
	2008	**2012**	**2015**	**2025**	**2035**
Average Annual Daily Traffic (AADT)	4,900	5,075	5,700	7,000	8,200
Summer Average Daily Traffic (SADT)	6,050	6,363	7,100	8,700	10,200
Design Hour Volume (DHV)*	480	500	560	690	800
Peak Hourly Volume (PHV)**	735	760	860	1,050	1,240
Growth rate = 0.9% (2008 to 2012), *DHV = Commuter Tourist Recreation 9.8%, Trucks 14.7%, **PHV=15% of AADT					

Based on the traffic volume projections, the Average Annual Daily Traffic for 2013 is estimated as presented in **Table 7.3**.

Table 7.3 Traffic Projections (2013)

Traffic Projections	Time Period
	2013
Average Annual Daily Traffic (AADT)	5,404
Summer Average Daily Traffic (SADT)	6,739

Average travel speed (ATS) for the scenarios being investigated were based on traffic speed projections were provided by the AECOM traffic team in 2011 (**Appendix B**). The traffic speed projections are shown in **Table 7.4**.

Table 7.4 Traffic Speed Projections

Traffic Speed Projections	Time Period (Year)				
	2008	2012	2015	2025	2035
ATS (km/h)	74.7	74.4	73.0	72.1	70.0

As shown in Table 7.4, the projected average travel speed for the Future No Build (2035) scenario is 70 km/h. Based on the speed projections presented in Table 7.4; average vehicle speed for the Current (2013) scenarios is estimated as presented in **Table 7.5**.

Table 7.5 Traffic Speed Projections (2013)

Traffic Speed Projections	Time Period (Year)
	2013
ATS (km/h)	73.8

Further, it is assumed a Level of Service (LOS) C rating is considered desirable for a future build scenario. The following table provides LOS and corresponding average travel speed (km/h)

Table 7.6 LOS and Average Travel Speed

LOS	Percent Time-Spent-Following	Average Travel Speed (km/h)
A	≤35	> 90
B	> 35-50	> 80-90
C	> 50-65	> 70-80
D	> 65-80	> 60-70
E	> 80	≤ 60
F	Applies whenever the flow rate exceeds the segment capacity	

From the above table, an Average Travel Speed of 80 km/h was assumed for the 2035 Build scenario, which corresponds to a LOS of C.

Emission factors for vehicles were estimated with MOBILE6.2C. **Table 7.7** presents the input data for the model.

Table 7.7: MOBILE6.2C Input Data

Parameter	Input	Reference
External Conditions		
Years of Evaluation	2013, 2035	
Month of Evaluation	(July, January)	
Temperature ˚C(Min, Max)	(14.62, 26.3) (-14.6,-4.7)	Environment Canada
Humidity	Hourly Relative Humidity	Environment Canada
Altitude	Low	
Emissions Inspections and Maintenance Program	[8.] Ontario Drive Clean	(3)
Fuel Options		
Reid Vapour Pressure (RVP) in PSI	8.9 psi (summer), 14.8 (winter)	(2)
Diesel Sulphur Content	15 ppm	(3)
Gasoline Sulphur Content	default	
Air Toxics		
Gasoline Aromatics (%)	28.4	(2)
Gasoline Olefin (%)	10.3	(2)
Gasoline Benzene (%)	0.8	(2
Vapour Pressure of gasoline at 200 F (%)	47.3 (summer)	(2)
Vapour Pressure of gasoline at 300 F (%)	83.3	(2)
Oxygenate Volume % of Ethanol or Ethyl Alcohol (Ethanol)	(10% volume, 20% market share)	(4)
Vehicle Activity		
Fractions of Vehicle Miles Travelled (VMT)	Default	
Average Speed[mph]-2013, 2035-No Build, 2035-Build	45.8, 43.5, 50	Default file for MOBILE 6.2
Starts per day	default	
Distribution of vehicle starts during day	default	Default file for MOBILE 6.2
Soak Distribution	default	Default file for MOBILE 6.2
Hot Soak activity	default	Default file for MOBILE 6.2
Diurnal Soak activity	default	Default file for MOBILE 6.2
Weekday trip length distribution	default	Default file for MOBILE 6.2
Weekend trip length distribution	default	Default file for MOBILE 6.2
Weekend use vehicle activity	default	Default file for MOBILE 6.2
Vehicle Fleet Characteristics		
Distribution of Vehicle Registration	default	Default file for MOBILE 6.2
Diesel Fractions	default	Default file for MOBILE 6.2
Annual Mileage accumulation rates	Ontario - Created by Environment Canada	Default file for MOBILE 6.2
Vehicle Miles Travelled (VMT) fraction	default	Default file for MOBILE 6.2
Natural gas vehicles (NGV) fraction	default	Default file for MOBILE 6.2
Alternate emission factor for NGVs	default	Default file for MOBILE 6.2

Notes:

1. Ontario Ministry of Transportation "Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas (GHG) Emissions of Provincial Transportation Projects", January 2012
2. Emission of air toxics from on-highway sources in Canada: Estimated impacts of various vehicle and fuel control strategies. Environment Canada technical report M6C-02 –E, Prepared by SENES Consultants Limited and Air Improvement resource Inc.
3. Ontario Ministry of the Environment Drive Test Emissions Program (Drive Clean). It should be noted that the Drive Clean program does not currently affect vehicles registered in northern Ontario. The future build scenario assumes the drive clean program scope will be expanded to include vehicles in northern Ontario in the future.

Tables 7.8 and **7.9** show the emission factors calculated by MOBILE6.2C and AP-42 Empirical Equation used to estimate emission rates for the three scenarios being investigated for the summer and winter, respectively. To assess the worst-case emissions, the modeling was based on vehicles operating in both July and January to account for seasonal traffic variation.

Table 7.8: Emission Factors-Summer

Contaminant	Current (2013) Vehicle Emissions Factor (g/km)		Future-2035 No Build Vehicle Emissions Factor (g/km)		Future-2035 Build Vehicle Emissions Factor (g/km)	
	MOBILE6.2C	Re-Suspended PM	MOBILE6.2C	Re-Suspended PM	MOBILE6.2 C	Re-Suspended PM
PM_{10}	0.0237	0.47	0.0155	0.47	0.0155	0.47
$PM_{2.5}$	0.0128	0.07	0.0084	0.07	0.0084	0.07
NO_x	0.5370	N.A	0.1200	N.A	0.1293	N.A
CO	3.8912	N.A	2.7968	N.A	2.9627	N.A
VOC	0.3182	N.A	0.1603	N.A	0.1554	N.A
Benzene	0.0078	N.A	0.0040	N.A	0.0040	N.A
1,3 butadiene	0.0009	N.A	0.0005	N.A	0.0005	N.A
Formaldehyde	0.0028	N.A	0.0017	N.A	0.0017	N.A
Acetaldehyde	0.0012	N.A	0.0007	N.A	0.0007	N.A
Acrolein	0.0001	N.A	0.0001	N.A	0.0001	N.A
CO_2	347.20	N.A	351.83	N.A	351.8272	N.A

Notes:
N.A- Not Applicable
1. Values for PM10 were calculated using MOE approved ratios (PM2.5/PM10=0.54)

Table 7.9: Emission Factors-Winter

Contaminant	Current (2013) Vehicle Emissions Factor (g/km)		Future-2035 No Build Vehicle Emissions Factor (g/km)		Future-2035 Build Vehicle Emissions Factor (g/km)	
	MOBILE6.2C	Re-Suspended PM	MOBILE6.2C	Re-Suspended PM	MOBILE6.2 C	Re-Suspended PM
PM_{10}	0.0244	0.47	0.0153	0.47	0.0155	0.47
$PM_{2.5}$	0.0132	0.07	0.0083	0.07	0.0084	0.07
NO_x	0.7209	N.A	0.1715	N.A	0.1809	N.A
CO	10.3642	N.A	7.7390	N.A	8.0305	N.A
VOC	0.3418	N.A	0.1616	N.A	0.1597	N.A
Benzene	0.0122	N.A	0.0056	N.A	0.0056	N.A
1,3 butadiene	0.0013	N.A	0.0005	N.A	0.0006	N.A
Formaldehyde	0.0036	N.A	0.0017	N.A	0.0019	N.A
Acetaldehyde	0.0019	N.A	0.0007	N.A	0.0010	N.A
Acrolein	0.0002	N.A	0.0001	N.A	0.0001	N.A
CO_2	346.41	N.A	351.50	N.A	351.50	N.A

Notes:
N.A- Not Applicable
1. Values for PM10 were calculated using MOE approved ratios (PM2.5/PM10=0.54)

Table 7.10 summarizes the vehicle tailpipe emissions and re-suspended particulate matter emissions resulting from the Current scenario, the Future No-Build and Future Build scenarios and presents a comparison in air emissions between the Future No-Build and Future Build scenarios.

Emission calculations presented in **Table 7.10** are based on the following assumptions:

- Traffic volume projections and traffic speed projections presented in **Tables 7.2-7.6**.
- It is conservatively assumed that the travelled distance by vehicles along Highway 17 is 23.5 kilometers which is the length of realigned and widened segment of Highway 17.
- It is assumed that summer traffic volumes persist for six months of the year and average traffic volumes persists for the remaining six months of the year.

Detailed emission rates calculations are presented in **Appendix D**.

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

Table 7.10: Vehicle Emissions

Contaminant	Current (2013) Vehicle Emissions (tonnes/year)	Future No Build (2035) Vehicle Emissions (tonnes/year)	Future Build (2035) Vehicle Emissions (tonnes/year)	Future Build (2035) Vs Future No Build (2035) Percent Change (%)
PM_{10}	25.77	38.38	38.38	0.01%
$PM_{2.5}$	4.19	5.99	5.99	0.04%
NO_x	32.23	11.28	12.02	6.52%
CO	352.67	394.51	412.02	4.44%
VOC	17.12	12.70	12.41	-2.23%
Benzene	0.51	0.37	0.37	0.42%
1,3 butadiene	0.06	0.04	0.04	13.17%
Formaldehyde	0.16	0.14	0.14	3.10%
Acetaldehyde	0.08	0.06	0.07	12.89%
Acrolein	0.01	0.01	0.01	-2.41%
CO_2	18063.03	27763.74	27752.38	-0.04%
Methane (CH_4)	1.12	1.72	1.72	-0.04%
Nitrous Oxide (N_2O)	1.42	2.19	2.19	-0.04%

Notes:
1. Values for PM10 were calculated using MOE approved ratios (PM2.5/PM10=0.54)
2. Values for Methane (CH4) and Nitrous Oxide (N_2O) were calculated using emission factor ratios provided in Table 6 of the Ministry of the Environment report titled "Environmental Guide for Assessing and Mitigating the Air Quality Impacts and Greenhouse Gas (GHG) Emissions of Provincial Transportation Projects".

8. Assessment of Impacts

8.1 Assessment of Local Air Quality Impacts

Annual emissions from the highway are dependent on the emission rates determined by MOBILE6.2C and traffic volumes. Based on the traffic analysis, the traffic volume is expected to increase by 50% from 2013 to 2035.

As shown in **Table 7.10** the results indicate that the majority of contaminant emissions will be slightly higher with the Future Build scenario compared with the Future No-Build scenario, except for VOC's, acrolein and Greenhouse Gases which are slightly lower in the Future Build scenario. Although, the total vehicle emissions are higher in the Future Build scenario compared with the No-Build scenario, the impact on sensitive receptors near the Study Area will be reduced as a result of the improvements in free flow traffic. However, it should be noted the highway improvements will likely increase traffic volumes and negatively impact air quality due to increased demand.

As shown in **Table 7.10**, the Future Build scenario has lower emissions than the Current (baseline) scenario for nitrogen oxides (NOx), VOC, benzene, 1,3-butadiene, formaldehyde, and acetaldehyde, as result of improvements in free flow traffic and advancements in fuels and emission control technology. However, the Future Build scenario has higher emissions than the current (baseline) for $PM_{2.5}$, PM_{10}, carbon monoxide (CO), carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The increase in emissions is proportional to an increase in traffic volume.

Table 8.1 presents air emissions from a number of industrial facilities located within the vicinity of the Study Area in North Bay, Ontario. The emissions data collected are from Environment Canada's National Pollutant Release Inventory (NPRI) from the 2008 to 2010 reporting years. As shown in the **Table 8.1**, for the majority of the contaminants, the nearby industrial facilities have more impact to the local air quality than the increased vehicular emissions from the increased use of Highway 17 and the recommended highway plan.

Table 8.1: Emissions from Nearby Industrial Sources (Tonnes/Year)

Contaminant	Air Emissions in Tonnes (total of 5 facilities)					Future-2035 Build Vehicle Emissions (tonnes/year)
	2008	2009	2010	Average	Maximum	
PM_{10}	22.87	17.30	22.00	20.72	22.87	38.38
$PM_{2.5}$	19.87	13.74	19.52	17.71	19.87	5.99
Nitrogen Oxides (NOx)	152.00	78.60	58.90	96.50	152.00	12.02
Carbon Monoxide (CO)	71.00	31.00	32.00	44.77	71.00	412.02
VOC	115.10	102.00	113.20	110.10	115.10	12.41
Formaldehyde	17.00	14.00	15.00	15.33	17.00	0.14

8.2 Assessment of Regional Impacts

In order to assess regional impacts, vehicle emissions from the recommended plan for Highway 17 were compared with emissions from mobile sources in Ontario and Canada as shown in **Table 8.2**. Mobile emission inventory was obtained from Environment Canada's National Pollutant Release Inventory (NPRI). The results show that the emissions contribution of the recommended plan to the provincial and national mobile emissions is negligible.

Table 8.2: Summary of Regional Criteria Contaminants (Tonnes/Year)

Contaminant	Sectors	Future-Build Scenario (2035)	Ontario (2010)	% Project Contribution	Canada (2010)	% Project Contribution
PM_{10}	Mobile Sources	38.38	16,939	0.23%	68,292	0.056%
$PM_{2.5}$	Mobile Sources	5.99	14,888	0.040%	61,062	0.010%
NOX	Mobile Sources	12.02	271,665	0.004%	1,138,423	0.001%
VOC	Mobile Sources	12.41	145,766	0.01%	491,491	0.003%
CO	Mobile Sources	412.02	2,038,268	0.02%	6,514,674	0.006%

9. Summary of Detailed Assessment for the Recommended Highway Plan

The air quality assessment reviewed current standards and guidelines for air contaminants of CO, NO_x, PM and VOCs. Ambient air concentrations were taken from local monitoring stations. Three scenarios were developed in order to assess the air quality implications associated with the recommended plan for Highway 17 within the study limits:

- Current (2013)
- Future No Build (2035)
- Future Build (2035)

Emissions analysis for CO, NO_x, $PM_{2.5}$, and VOCs (benzene, 1,3-butadiene, formaldehyde, acetaldehyde, and acrolein), was conducted using MOBILE 6.2C. The main findings of the air quality assessment are outlined below:

- Traffic volumes are expected to increase by approximately 50% from 2013 to 2035.
- For the Future Build scenario, the majority of contaminant emissions are slightly higher than the Future No-Build scenario, except for VOC's, Acrolein and Greenhouse Gases which are slightly lower in the Future Build scenario as shown in **Table ES3**. There was no change in particulate matter (PM_{10} and $PM_{2.5}$) emissions.
- Although the total emissions may be higher in the Future-Build scenario, the impact on sensitive receptors near the Study Area will be reduced as a result of the improvements in the free flow traffic. However, improvement in the highway will lead to increased demand and higher traffic volumes which will result in higher contaminant emissions.
- The Future Build scenario has higher emissions than the current (baseline) for PM_{10}, $PM_{2.5}$, carbon monoxide (CO), carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) as shown in **Table ES3**. The increase in emissions is proportional to an increase in traffic volume. The Future Build scenario has lower emissions than the current (baseline) for Nitrogen Oxides (NOx), VOC's, Benzene, 1,3 butadiene, formaldehyde, acetaldehyde and acrolein. There was no change in acrolein emissions. The decrease in emissions is expected due to improvements in vehicle flow and advancements in fuels and emissions control technology.
- Contaminant emissions contribution of the recommended plan for Highway 17 to the provincial and national mobile emissions is negligible.

It should be noted that this study did not consider local air quality impacts at representative receptors within the Study Area. This was deemed unwarranted because the recommend highway segment is situated in a rural area with a limited number of sensitive receptors and given that the analysis detailed in this report determined that the majority of emissions from the project for contaminants of concern are considered negligible and below the established provincial and federal air quality standard or guideline levels.

10. References

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Appendix A.
Air Quality Monitoring Data

Table A1- Ottawa Downtown Air Quality Monitoring Data

Station Name	NAPS ID	Location	90th Percentile of Hourly Concentrations (ppm)				
			2008	2009	2010	Average	Maximum
CO							
Ottawa Downtown	60104	Rideau St./ Wurtemburg St.	0.42	0.39	0.40	0.40	0.42
						0.40	0.42

Table A2- North Bay Air Quality Monitoring Data-NOx

Station Name	NAPS ID	Location	90th Percentile of Hourly Concentrations (ppb)				
			2008	2009	2010	Average	Maximum
NOx							
North Bay	65101	Chippewa St. W., Dept. National Defence	26.00	28.00	23.00	25.67	28.00
						25.67	28.00

Table A3- North Bay Air Quality Monitoring Data-NO

Station Name	NAPS ID	Location	90th Percentile of Hourly Concentrations (ppb)				
			2008	2009	2010	Average	Maximum
NO							
North Bay	65101	Chippewa St. W., Dept. National Defence	8.00	8.00	6.00	7.33	8.00
						7.33	8.00

Table A4- North Bay Air Quality Monitoring Data-NO2

Station Name	NAPS ID	Location	90th Percentile of Hourly Concentrations (ppb)				
			2008	2009	2010	Average	Maximum
NO2							
North Bay	65101	Chippewa St. W., Dept. National Defence	18.00	20.00	17.00	18.33	20.00
						18.33	20.00

Table A5 North Bay Air Quality Monitoring Data-TSP

Station Name	NAPS ID	Location	90th Percentile of Hourly Concentrations (ug/m3)				
			2008	2009	2010	Average	Maximum
Total Suspended Particulate							
North Bay	62001	Chippewa St. W., Dept. National Defence	33.33	30.00	30.00	31.11	33.33
						31.11	33.33

Table A6 North Bay Air Quality Monitoring Data-PM10

Station Name	NAPS ID	Location	90th Percentile of Hourly Concentrations (ug/m3)				
			2008	2009	2010	Average	Maximum
PM10							
North Bay	62001	Chippewa St. W., Dept. National Defence	18.52	16.67	16.67	17.28	18.52
						17.28	18.52

Table A7 North Bay Air Quality Monitoring Data-PM2.5

Station Name	NAPS ID	Location	90th Percentile of Hourly Concentrations (ug/m3)				
			2008	2009	2010	Average	Maximum
PM2.5							
North Bay	62001	Chippewa St. W., Dept. National Defence	10.00	9.00	9.00	9.33	10.00
						9.33	10.00

Table A8 Egbert Air Quality Monitoring Data-Benzene

Station Name	NAPS ID	Location	90th Percentile of Hourly Concentrations (ug/m3)				
			2008	2009	2010	Average	Maximum
Benzene							
Egbert	64401	Egbert	0.46	0.52	0.51	0.50	0.52
						0.50	0.52

Table A9 Egbert Air Quality Monitoring Data- 1,3-Butadiene

Station Name	NAPS ID	Location	90th Percentile of Hourly Concentrations (ug/m3)				
			2008	2009	2010	Average	Maximum
1,3-Butadiene							
Egbert	64401	Egbert	0.014	0.012	0.013	0.013	0.014
						0.013	0.014

Table A10 Egbert Air Quality Monitoring Data-Formaldehyde

Station Name	NAPS ID	Location	90th Percentile of Hourly Concentrations (ug/m3)				
			2008	2009	2010	Average	Maximum
Formaldehyde							
Egbert	64401	Egbert	1.96	1.02	1.27	1.42	1.96
						1.42	1.96

Table 11 Egbert Air Quality Monitoring Data-Acetaldehyde

Station Name	NAPS ID	Location	90th Percentile of Hourly Concentrations (ug/m3)				
			2008	2009	2010	Average	Maximum
Acetaldehyde							
Egbert	64401	Egbert	4.83	2.53	5.24	4.20	5.24
						4.20	5.24

Table 12 Windsor Air Quality Monitoring Data-Acrolein

Station Name	NAPS ID	Location	90th Percentile of Hourly Concentrations (ug/m3)				
			2008	2009	2010	Average	Maximum
Acrolein							
Windsor	65101	College Ave./ South St	0.07	0.07	0.07	0.07	0.07
						0.07	0.07

Appendix B.
Traffic Data

Highway 17 Traffic Volume Projections, Highway 531 to Highway 630

Traffic Projections	Time Period (Year)				
	2008	2012	2015	2025	2035
Average Annual Daily Traffic (AADT)	4,900	5,075	5,700	7,000	8,200
Summer Average Daily Traffic (SADT)	6,050	6,363	7,100	8,700	10,200
Design Hour Volume (DHV)*	480	500	560	690	800
Peak Hourly Volume (PHV)**	735	760	860	1,050	1,240

*Growth rate = 0.9% (2008 to 2012), *DHV = Commuter Tourist Recreation 9.8%, Trucks 14.6%, **PHV=15% of AADT*

Traffic volumes are projected to increase at an average rate of 4% per year from 2012 to 2015, 2% per year from 2015 to 2025 and 1.5% per year from 2025 to 2035.

Two-Lane Highway Analysis Level of Service Criteria, Class I Highways

LOS	Percent Time-Spent-Following	Average Travel Speed (Km/h)
A	≤35	> 90
B	> 35-50	> 80-90
C	> 50-65	> 70-80
D	> 65-80	> 60-70
E	> 80	≤ 60
F	Applies whenever the flow rate exceeds the segment capacity	

Comparison of LOS for Traffic Projection Scenarios

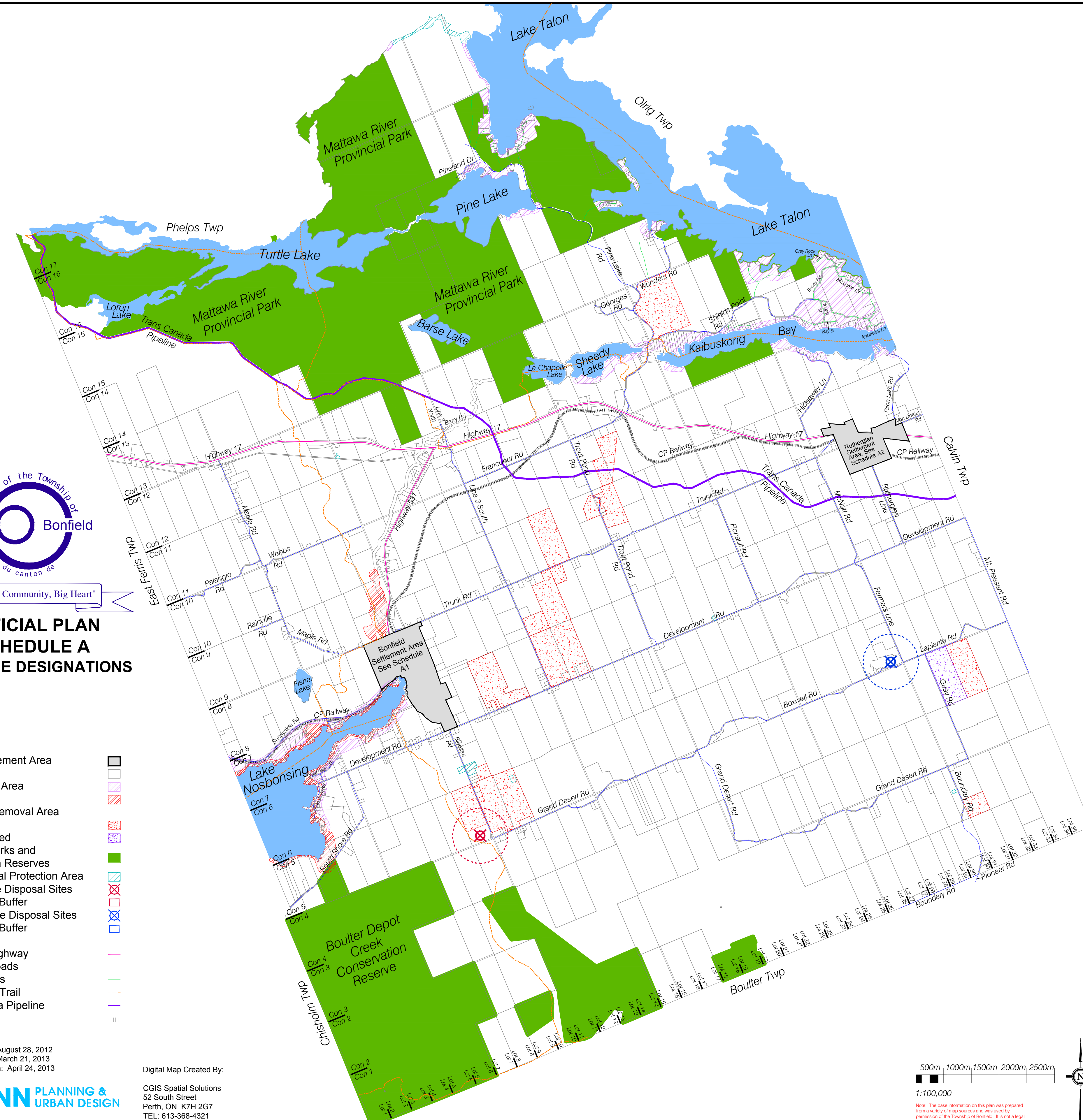
	Time Period (Year)				
	2008	2012	2015	2025	2035
V_p	940	973	1100	1,199	1,416
PTSF	66.1%	66.9%	70.0%	71.7%	75.4%
LOS	D	D	D	D	D
ATS (km/h)	74.6	74.3	73.0	72.1	70.0
ATS LOS*	D	D	D	D	D
v/c	0.29	0.30	0.34	0.37	0.44

** based on the Average Travel Speed (ATS)*

Appendix C.
Zoning Maps

"Small Community, Big Heart"

OFFICIAL PLAN SCHEDULE A
LAND USE DESIGNATIONS



- Hamlet Settlement Area
- Rural Area
- Recreational Area
- Hazard Land
- Aggregate Removal Area
  - Active
  - Revoked
- Provincial Parks and Conservation Reserves
- Environmental Protection Area
- Active Waste Disposal Sites
  - 500m Buffer
- Former Waste Disposal Sites
  - 500m Buffer
- Provincial Highway
- Township Roads
- Private Roads
- Snowmobile Trail
- TransCanada Pipeline
- Railway

Council Adoption: August 28, 2012
MMAH Approval: March 21, 2013
Office Consolidation: April 24, 2013

FOTENN PLANNING & URBAN DESIGN

Digital Map Created By:

CGIS Spatial Solutions
52 South Street
Perth, ON K7H 2G7
TEL: 613-368-4321
www.cgis.com

500m 1000m 1500m 2000m 2500m

1:100,000

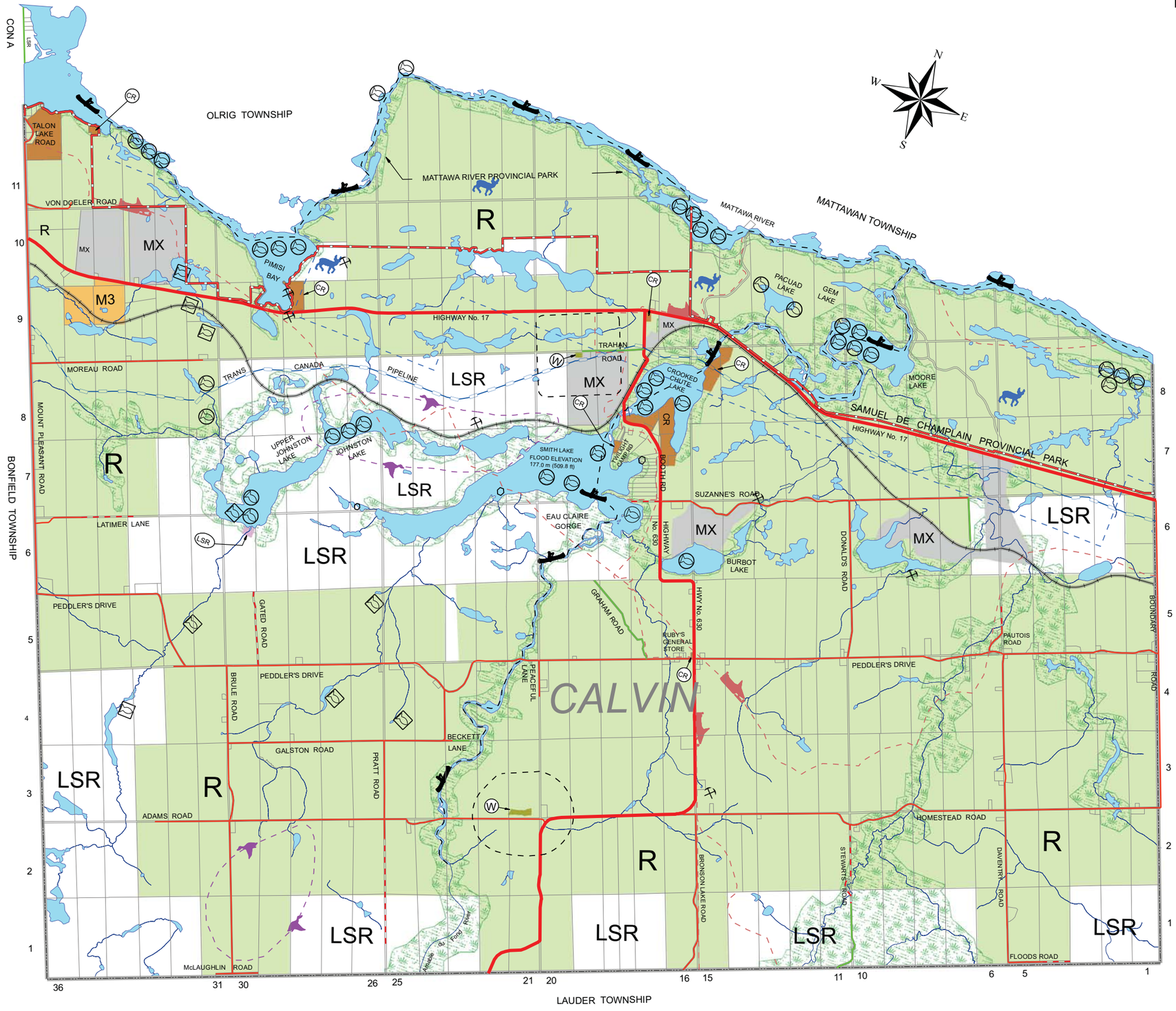
Note: The base information on this plan was prepared from a variety of map sources and was used by permission of the Township of Bonfield. It is not a legal plan of survey. For precise location of plan features recourse should be had to the original source data.

ZONING BY-LAW FOR THE
EAST NIPISSING PLANNING AREA
TOWNSHIP OF CALVIN

SCHEDULE "A" TO
BY-LAW No. 2000-011

October 20, 2009

SCALE
0 1000 3000 metres



LEGEND

NATURAL HERITAGE FEATURES
- WATERFOWL CONCENTRATION AREA
- DEER YARD
- MOOSE WINTERING AREA
- MOOSE AQUATIC FEEDING AREA
- WARM WATER HABITAT
- LARGEMOUTH BASS
- MUSKELLUNGE
- PIKE
- SMALLMOUTH BASS
- WALLEYE
- STURGEON
- COLD WATER HABITAT
- ATLANTIC SALMON
- BROOK TROUT
- LAKE TROUT
- RAINBOW TROUT
- SPLAKE
- BROOK TROUT SPAWNING AREA
- HERONRY
- OSPREY
- LOON

TRANSPORTATION AND INFRASTRUCTURE CORRIDORS
- PROVINCIAL HIGHWAY
- TOWNSHIP ROADS (Yearly Maintained)
- TOWNSHIP ROADS (Seasonally Maintained)
- PRIVATE ROADS
- RESOURCE ACCESS ROADS
- RAIL LINE
- TRANS CANADA PIPELINE
- SNOWMOBILE TRAIL

ZONES
- R — RURAL
- LSR — LIMITED SERVICES RURAL
- CR — COMMERCIAL / RECREATIONAL
- M1 — GENERAL INDUSTRIAL
- M3 — HEAVY INDUSTRIAL
- MX — MINERAL AGGREGATE RESOURCE
- W — WASTE MANAGEMENT FACILITY
- 500m INFLUENCE AREA
- ENVIRONMENTAL PROTECTION

NATURAL AND HUMAN MADE HAZARDS
- MINE HAZARD

FLOOD ELEVATIONS: SPECIFIC ELEVATIONS SHOWN ON SCHEDULE

OTHER FEATURES
- CANOE TRAIL
- TOWNSHIP BOUNDARY

Tunnock Consulting Ltd.

PAUL H. TORRANCE SURVEYING LTD.
GEOMATICS SERVICES

Appendix D.
Calculation Details

Table D1-MOBILE6.2C Emission Factor Calculations-Current (2013)

Conversion	
0.621504	miles/km

Vehicle emissions

2013 Average Annual Vehicle Kilometers Travelled	23,177,606	kilometers/year
2035 Average Annual Vehicle Kilometers Travelled	35,167,750	kilometers/year
2013 Summer Annual Vehicle Kilometers Travelled	28,899,871	kilometers/year
2035 Summer Annual Vehicle Kilometers Travelled	43,745,250	kilometers/year

Emission Factors

	Highway 17-Current							
	Summer				Winter			
PM2.5	0.0206	g/mile	0.0128	g/km	0.0212	g/mile	0.0132	g/km
Composite NOx	0.864	g/mile	0.5370	g/km	1.16	g/mile	0.7209	g/km
Composite CO	6.261	g/mile	3.8912	g/km	16.676	g/mile	10.3642	g/km
Composite VOC	0.512	g/mile	0.3182	g/km	0.55	g/mile	0.3418	g/km
Benzene (Tot)	12.559	mg/mile	0.0078	g/km	19.678	mg/mile	0.0122	g/km
1,3 Butadiene	1.481	mg/mile	0.0009	g/km	2.169	mg/mile	0.0013	g/km
Formaldehyde	4.546	mg/mile	0.0028	g/km	5.756	mg/mile	0.0036	g/km
Acetaldehyde	1.973	mg/mile	0.0012	g/km	2.987	mg/mile	0.0019	g/km
Acrolein	0.21	mg/mile	0.0001	g/km	0.336	mg/mile	0.0002	g/km
CO2	558.65	g/mile	347.20	g/km	557.37	g/mile	346.41	g/km

Total emissions per year

	Summer				Winter			
PM2.5	370,005	g/year	0.37	tonnes/year	305,385	g/year	0.31	tonnes/year
Composite NOx	15,518,638	g/year	15.52	tonnes/year	16,709,772	g/year	16.71	tonnes/year
Composite CO	112,456,240	g/year	112.46	tonnes/year	240,217,374	g/year	240.22	tonnes/year
Composite VOC	9,196,230	g/year	9.20	tonnes/year	7,922,737	g/year	7.92	tonnes/year
Benzene (Tot)	225,577	g/year	0.23	tonnes/year	283,461	g/year	0.28	tonnes/year
1,3 Butadiene	26,601	g/year	0.03	tonnes/year	31,244	g/year	0.03	tonnes/year
Formaldehyde	81,652	g/year	0.08	tonnes/year	82,915	g/year	0.08	tonnes/year
Acetaldehyde	35,438	g/year	0.04	tonnes/year	43,028	g/year	0.04	tonnes/year
Acrolein	3,772	g/year	0.00	tonnes/year	4,840	g/year	0.00	tonnes/year
CO2	1.00E+10	g/year	10,034.13	tonnes/year	8.03E+09	g/year	8,029	tonnes/year

Table D2- MOBILE6.2C Emission Factor Calculations-Future No Build (2035)

Conversion
0.621504 miles/km

Vehicle emissions

2013 Average Annual Vehicle Kilometers Travelled	23,177,606 kilometers
2035 Average Annual Vehicle Kilometers Travelled	35,167,750 kilometers
2013 Summer Annual Vehicle Kilometers Travelled	28,899,871 kilometers
2035 Summer Annual Vehicle Kilometers Travelled	43,745,250 kilometers

Emission Factors

	Highway 17-2035-No Build							
	Summer				Winter			
PM2.5	0.0135	g/mile	0.0084	g/km	0.0134	g/mile	0.0083	g/km
Composite NOx	0.193	g/mile	0.1200	g/km	0.276	g/mile	0.1715	g/km
Composite CO	4.5	g/mile	2.7968	g/km	12.452	g/mile	7.7390	g/km
Composite VOC	0.258	g/mile	0.1603	g/km	0.26	g/mile	0.1616	g/km
Benzene (Tot)	6.40800	mg/mile	0.0040	g/km	9.022	mg/mile	0.0056	g/km
1,3 Butadiene	0.791	mg/mile	0.0005	g/km	0.791	mg/mile	0.0005	g/km
Formaldehyde	2.801	mg/mile	0.0017	g/km	2.801	mg/mile	0.0017	g/km
Acetaldehyde	1.17400	mg/mile	0.0007	g/km	1.174	mg/mile	0.0007	g/km
Acrolein	0.126	mg/mile	0.0001	g/km	0.174	mg/mile	0.0001	g/km
CO2	566.09	g/mile	351.83	g/km	565.57	g/mile	351.5040	g/km

Total emissions per year

	Summer				Winter			
PM2.5	367,036	g/year	0.37	tonnes/year	292,882	g/year	0.29	tonnes/year
Composite NOx	5,247,255	g/year	5.25	tonnes/year	6,032,504	g/year	6.03	tonnes/year
Composite CO	122,345,323	g/year	122.35	tonnes/year	272,162,103	g/year	272.16	tonnes/year
Composite VOC	7,014,465	g/year	7.01	tonnes/year	5,682,794	g/year	5.68	tonnes/year
Benzene (Tot)	174,220	g/year	0.17	tonnes/year	197,193	g/year	0.20	tonnes/year
1,3 Butadiene	21,506	g/year	0.02	tonnes/year	17,289	g/year	0.02	tonnes/year
Formaldehdye	76,153	g/year	0.08	tonnes/year	61,221	g/year	0.06	tonnes/year
Acetaldehyde	31,919	g/year	0.03	tonnes/year	25,660	g/year	0.03	tonnes/year
Acrolein	3,426	g/year	0.00	tonnes/year	3,803	g/year	0.00	tonnes/year
CO2	15,390,769,778	g/year	15390.77	tonnes/year	12,372,971,782.16	g/year	12372.97	tonnes/year

Table D3-MOBILE6.2C Emission Factor Calculations-Future Build (2035)

Conversion
0.621504 miles/km

Vehicle emissions

2013 Average Annual Vehicle Kilometers Travelled	23,177,606 kilometers
2035 Average Annual Vehicle Kilometers Travelled	35,167,750 kilometers
2013 Summer Annual Vehicle Kilometers Travelled	28,899,871 kilometers
2035 Summer Annual Vehicle Kilometers Travelled	43,745,250 kilometers

Emission Factors

	Highway 17-2035-Build							
	Summer				Winter			
PM2.5	0.0135	g/mile	0.0084	g/km	0.0135	g/mile	0.0084	g/km
SO2	0.0093	g/mile	0.0058	g/km	0.0093	g/mile	0.0058	g/km
Ammonia (NH3)	0.0924	g/mile	0.0574	g/km	0.0924	g/mile	0.0574	g/km
Composite NOx	0.208	g/mile	0.1293	g/km	0.291	g/mile	0.1809	g/km
Composite CO	4.767	g/mile	2.9627	g/km	12.921	g/mile	8.0305	g/km
Composite VOC	0.25	g/mile	0.1554	g/km	0.257	g/mile	0.1597	g/km
Benzene (Tot)	6.42300	mg/mile	0.0040	g/km	9.07500	mg/mile	0.0056	g/km
1,3 Butadiene	0.79	mg/mile	0.0005	g/km	1.026	mg/mile	0.0006	g/km
Formaldehyde	2.714	mg/mile	0.0017	g/km	3.104	mg/mile	0.0019	g/km
Acetaldehyde	1.14400	mg/mile	0.0007	g/km	1.55100	mg/mile	0.0010	g/km
Acrolein	0.122	mg/mile	0.0001	g/km	0.171	mg/mile	0.0001	g/km
CO2	566.09	g/mile	351.8272	g/km	565.57	g/mile	351.5040	g/km

Total emissions per year

	Summer				Winter			
PM2.5	367,036	g/year	0.37	tonnes/year	295,068	g/year	0.30	tonnes/year
SO2	252,847	g/year	0.25	tonnes/year	203,269	g/year	0.20	tonnes/year
Ammonia (NH3)	2,512,157	g/year	2.51	tonnes/year	2,019,577	g/year	2.02	tonnes/year
Composite NOx	5,655,073	g/year	5.66	tonnes/year	6,360,358	g/year	6.36	tonnes/year
Composite CO	129,604,479	g/year	129.60	tonnes/year	282,412,988	g/year	282.41	tonnes/year
Composite VOC	6,796,962	g/year	6.80	tonnes/year	5,617,223	g/year	5.62	tonnes/year
Benzene (Tot)	174,628	g/year	0.17	tonnes/year	198,351	g/year	0.20	tonnes/year
1,3 Butadiene	21,478	g/year	0.02	tonnes/year	22,425	g/year	0.02	tonnes/year
Formaldehdye	73,788	g/year	0.07	tonnes/year	67,844	g/year	0.07	tonnes/year
Acetaldehyde	31,103	g/year	0.03	tonnes/year	33,900	g/year	0.03	tonnes/year
Acrolein	3,317	g/year	0.003	tonnes/year	3,738	g/year	0.004	tonnes/year
CO2	15,390,769,778	g/year	15,391	tonnes/year	12,361,606,195	g/year	12,362	tonnes/year

Table D4-Re-Suspended Particulate Matter Emission Factors

Contaminant	Year	Particulate Size multiplier (g/KM)[2]	Average Vehicle Weight (tons)[3]	ADT Category	Silt loading (g/M^2)	C^2 (g/KM)	Re-Suspended PM (g/ VKT)	Re-Suspended PM-Winter (tonnes/year)	Re-Suspended PM-Summer (tonnes/year)
PM10	2013	4.6	3	5000-10000	0.06	0.1317	0.47	10.91	13.61
PM2.5	2013	0.66	3	5000-10000	0.06	0.1005	0.07	1.57	1.95
PM10	2035	4.6	3	5000-10000	0.06	0.1317	0.47	16.56	20.60
PM2.5	2035	0.66	3	5000-10000	0.06	0.1005	0.07	2.38	2.96

Notes

1 Emission factors based on Equation 13.2.1 US EPA AP 42 Chapter 13. $E_i = k * (sL / 2)^{0.65} * (W / 3)^{1.5 - C}$
Equation can be found in page 36 of the MTO Environmental Guide for Assessing and Mitigating the air quality impact and greenhouse gas emissions of provincial transportation proejcts.
http://www.mto.gov.on.ca/english/environmental-assessment-and-protection/MTO-Air-Quality-Guide-en-26-01-2012.pdf

2 Particle Size multiplier and C can be found in page 37 of the MTO Environmental Guide for Assessing and Mitigating the air quality impact and greenhouse gas emissions of provincial transportation projects.
http://www.mto.gov.on.ca/english/environmental-assessment-and-protection/MTO-Air-Quality-Guide-en-26-01-2012.pdf

3 Recommended by MTO/MOE-Source :RWDI 2010 Report Titled "BBTCA Air Quality Assessment"

Annual Vehicle Kilometres Travelled

2013 Average Annual Vehicle Kilometers Travelled	23,177,606 kilometers
2035 Average Annual Vehicle Kilometers Travelled	35,167,750 kilometers
2013 Summer Annual Vehicle Kilometers Travelled	28,899,871 kilometers
2035 Summer Annual Vehicle Kilometers Travelled	43,745,250 kilometers

Conversion

1.00E+06 g/tonne

Appendix E.

Emission Factors and MOBILE6.2C Input/Output

Electronic (CD) Submission

```
*
**************************************
*
* MOBILE6 Input File Produced by:
* MOBILE View Ver. 1.2
* Lakes Environmental Software Inc.
* Date: 5/8/2014
* File: C:\Documents and Settings\abdihalimh\My Documents\MOBILE
\Highway17.inp
*
**************************************
* PROJECT DATA
* Highway 17
* Highway 17 Widening
*
**************************************
*
*123456789012345678:
MOBILE6 INPUT FILE :
REPORT FILE        : HIGHWA~1.TXT REPLACE
SPREADSHEET        : HIGHWA~2.TAB
POLLUTANTS         : HC CO NOX CO2
PARTICULATES       :
AIR TOXICS         : BENZ BUTA FORM ACET ACRO
RUN DATA
*
**************************************
* RUN DATA
* Run_1
*
EXPRESS HC AS  VOC :
HOURLY TEMP        : 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
                     0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0
FUEL RVP           : 14.7
ABSOLUTE HUMIDITY  : 0.0
PEAK SUN           : 12 1
SUNRISE/SUNSET     : 8 5
FUEL PROGRAM       : 1
*
I/M PROGRAM        : 1 1999 2051 2 TRC OBD I/M
I/M MODEL YEARS    : 1 1998 2050
I/M VEHICLES       : 1 22222 11111111 2
I/M COMPLIANCE     : 1 99.0
I/M WAIVER RATES   : 1 0.0 0.0
I/M STRINGENCY     : 1 10.0
NO I/M TTC CREDITS : 1
*
I/M PROGRAM        : 2 1987 2051 2 TRC 2500/IDLE
I/M MODEL YEARS    : 2 1987 1997
I/M VEHICLES       : 2 22222 11111111 2
I/M COMPLIANCE     : 2 99.0
I/M WAIVER RATES   : 2 0.0 0.0
I/M STRINGENCY     : 2 10.0
NO I/M TTC CREDITS : 2
*
SCENARIO RECORD    : Run_1 Run_1-January Run_1 January Weekday Existing
(2013)
CALENDAR YEAR      : 2013
MIN/MAX TEMP       : 5.9 23.7
RELATIVE HUMIDITY  : 83.4 83.2 82.9 81.9 82.7 80.6 79.1 78.8 78.3 78.4
```

```
78.0 79.2
                    80.2 80.8 82.3 82.7 83.1 82.6 82.8 82.9 83.6 83.8
84.2 83.6
BAROMETRIC PRES    : 29.4
AVERAGE SPEED      : 46.00  Freeway  92.00 0.00 0.00 8.00
DIESEL SULFUR      : 15
PARTICLE SIZE      : 2.5
PARTICULATE EF     : pmgzml.csv pmgdr1.csv pmgdr2.csv pmdzml.csv
pmddr1.csv pmddr2.csv
FUEL PROGRAM       : 1
GAS AROMATIC%      : 28.4
GAS OLEFIN%        : 10.3
GAS BENZENE%       : 0.8
E200               : 53.7
E300               : 83.3
OXYGENATE          : MTBE     0.0000      0.000
                   : ETBE     0.0000      0.000
                   : ETOH    10.0000      0.200
                   : TAME     0.0000      0.000
RVP OXY WAIVER     : 1
*
SCENARIO RECORD    : Run_1 Run_1-January Run_1 January Weekday
FutureNoBuild (2035)
CALENDAR YEAR      : 2035
MIN/MAX TEMP       : 5.9 23.7
RELATIVE HUMIDITY  : 74.9 74.5 74.2 73.2 71.0 68.6 66.9 66.0 64.8 64.9
66.3 66.9
                    68.4 68.7 69.7 70.4 70.8 71.4 72.0 72.8 73.9 74.3
74.2 74.2
BAROMETRIC PRES    : 29.4
AVERAGE SPEED      : 43.50  Freeway  92.00 0.00 0.00 8.00
DIESEL SULFUR      : 15
PARTICLE SIZE      : 2.5
PARTICULATE EF     : pmgzml.csv pmgdr1.csv pmgdr2.csv pmdzml.csv
pmddr1.csv pmddr2.csv
FUEL PROGRAM       : 1
GAS AROMATIC%      : 28.4
GAS OLEFIN%        : 10.3
GAS BENZENE%       : 0.8
E200               : 53.7
E300               : 83.3
OXYGENATE          : MTBE     0.0000      0.000
                   : ETBE     0.0000      0.000
                   : ETOH    10.0000      0.200
                   : TAME     0.0000      0.000
RVP OXY WAIVER     : 1
*
SCENARIO RECORD    : Run_1 Run_1-January Run_1 January Weekday
FutureBuild(2035)
CALENDAR YEAR      : 2035
MIN/MAX TEMP       : 5.9 23.7
RELATIVE HUMIDITY  : 74.9 74.5 74.2 73.2 71.0 68.6 66.9 66.0 64.8 64.9
66.3 66.9
                    68.4 68.7 69.7 70.4 70.8 71.4 72.0 72.8 73.9 74.3
74.2 74.2
BAROMETRIC PRES    : 29.4
AVERAGE SPEED      : 50.00  Freeway  92.00 0.00 0.00 8.00
DIESEL SULFUR      : 15
PARTICLE SIZE      : 2.5
PARTICULATE EF     : pmgzml.csv pmgdr1.csv pmgdr2.csv pmdzml.csv
```

```
pmddr1.csv pmddr2.csv
FUEL PROGRAM       : 1
GAS AROMATIC%      : 28.4
GAS OLEFIN%        : 10.3
GAS BENZENE%       : 0.8
E200               : 53.7
E300               : 83.3
OXYGENATE          : MTBE     0.0000      0.000
                   : ETBE     0.0000      0.000
                   : ETOH    10.0000      0.200
                   : TAME     0.0000      0.000
RVP OXY WAIVER     : 1
*
END OF RUN
****************************************
* RUN DATA
* Run_2
*
EXPRESS HC AS  VOC :
MIN/MAX TEMP       : 58.1 79.4
FUEL RVP           : 8.9
ABSOLUTE HUMIDITY  : 0.0
PEAK SUN           : 12 1
SUNRISE/SUNSET     : 5 8
FUEL PROGRAM       : 1
*
I/M PROGRAM        : 1 1999 2051 2 TRC 2500/IDLE
I/M MODEL YEARS    : 1 1987 1997
I/M VEHICLES       : 1 22222 11111111 2
I/M COMPLIANCE     : 1 99.0
I/M WAIVER RATES   : 1 0.0 0.0
I/M STRINGENCY     : 1 10.0
NO I/M TTC CREDITS : 1
*
I/M PROGRAM        : 2 1999 2051 2 TRC OBD I/M
I/M MODEL YEARS    : 2 1998 2050
I/M VEHICLES       : 2 22222 11111111 2
I/M COMPLIANCE     : 2 99.0
I/M WAIVER RATES   : 2 0.0 0.0
I/M STRINGENCY     : 2 10.0
NO I/M TTC CREDITS : 2
*
SCENARIO RECORD    : Run_2 Run_2-July Run_2 July Weekday Existing (2013)
CALENDAR YEAR      : 2013
EVALUATION MONTH   : 7
MIN/MAX TEMP       : 58.1 79.4
RELATIVE HUMIDITY  : 81.4 76.6 69.2 65.3 60.0 58.1 55.2 52.8 50.7 50.7
50.2 51.0
                     52.5 56.8 63.3 67.7 69.5 70.9 71.4 74.4 77.0 79.9
81.7 83.3
BAROMETRIC PRES    : 29.33
SUNRISE/SUNSET     : 7 9
AVERAGE SPEED      : 46.00  Freeway  92.00 0.00 0.00 8.00
DIESEL SULFUR      : 15
PARTICLE SIZE      : 2.5
PARTICULATE EF     : pmgzml.csv pmgdr1.csv pmgdr2.csv pmdzml.csv
pmddr1.csv pmddr2.csv
FUEL PROGRAM       : 1
GAS AROMATIC%      : 28.4
GAS OLEFIN%        : 10.3
```

```
GAS BENZENE%       : 0.8
E200               : 47.3
E300               : 83.3
OXYGENATE          : MTBE     0.0000      0.000
                   : ETBE     0.0000      0.000
                   : ETOH    10.0000      0.200
                   : TAME     0.0000      0.000
RVP OXY WAIVER     : 1
*
SCENARIO RECORD    : Run_2 Run_2-July Run_2 July Weekday FutureNoBuild
(2035)
CALENDAR YEAR      : 2035
EVALUATION MONTH   : 7
RELATIVE HUMIDITY  : 81.3 77.4 71.9 67.4 64.1 62.1 60.4 59.6 58.0 57.6
57.7 58.0
                     59.7 61.7 65.1 67.9 70.8 73.1 75.9 78.0 79.6 80.5
81.8 83.2
BAROMETRIC PRES    : 29.33
SUNRISE/SUNSET     : 7 9
AVERAGE SPEED      : 43.50  Freeway  92.00 0.00 0.00 8.00
DIESEL SULFUR      : 15
PARTICLE SIZE      : 2.5
PARTICULATE EF     : pmgzml.csv pmgdr1.csv pmgdr2.csv pmdzml.csv
pmddr1.csv pmddr2.csv
FUEL PROGRAM       : 1
GAS AROMATIC%      : 28.4
GAS OLEFIN%        : 10.3
GAS BENZENE%       : 0.8
E200               : 47.3
E300               : 83.3
OXYGENATE          : MTBE     0.0000      0.000
                   : ETBE     0.0000      0.000
                   : ETOH    10.0000      0.200
                   : TAME     0.0000      0.000
RVP OXY WAIVER     : 1
*
SCENARIO RECORD    : Run_2 Run_2-July Run_2 July Weekday FutureBuild
(2035)
CALENDAR YEAR      : 2035
EVALUATION MONTH   : 7
RELATIVE HUMIDITY  : 81.4 76.6 69.2 65.3 60.0 58.1 55.2 52.8 50.7 50.7
50.2 51.0
                     52.5 56.8 63.3 67.7 69.5 70.9 71.4 74.4 77.0 79.9
81.7 83.3
BAROMETRIC PRES    : 29.33
SUNRISE/SUNSET     : 7 9
AVERAGE SPEED      : 50.00  Freeway  92.00 0.00 0.00 8.00
DIESEL SULFUR      : 15
PARTICLE SIZE      : 2.5
PARTICULATE EF     : pmgzml.csv pmgdr1.csv pmgdr2.csv pmdzml.csv
pmddr1.csv pmddr2.csv
FUEL PROGRAM       : 1
GAS AROMATIC%      : 28.4
GAS OLEFIN%        : 10.3
GAS BENZENE%       : 0.8
E200               : 47.3
E300               : 83.3
OXYGENATE          : MTBE     0.0000      0.000
                   : ETBE     0.0000      0.000
                   : ETOH    10.0000      0.200
```

```
                    : TAME     0.0000      0.000
RVP OXY WAIVER      : 1
*
END OF RUN
```

Table E1- Summary of MOBILE6.2C Input and Output-Current (2013)

Calendar Year	2013	2013
Month	July	Jan.
Altitude	Low	Low
Min. Temperature [C]	14.52	-14.5
Max. Temperature [C]	26.3	-4.6
Min. Rel. Humidity [%]	0	0
Max. Rel. Humidity [%]	0	0
Barometric Pressure [inHg]	29.33	29.4
Nominal Fuel RVP [psi]	8.9	14.7
Gas Sulfur Content [ppm]	30	30
Dsl Sulfur Content [ppm]	15	15
Gasoline Aromatics (%)	28.4	28.4
Gasoline Olefin (%)	10.3	10.3
Gasoline Benzene (%)	0.8	0.8
Vapour Pressure of Gasoline at 200 F(%)	47.3	53.7
Vapour Pressure of Gasoline at 300 F(%)	83.3	83.3
Oxygenate Volume % of Ethanol or Ethyl Alcohol (Ethanol)	10% volume, 20% market share	10% volume, 20% market share
	2013	2013
	Highway 17 Freeway	Highway 17 Freeway
Speed [mph]	45.8	45.8
Contaminants	Highway 17 Freeway	Highway 17 Freeway
Composite VOC (g/mile)	0.512	0.55
Composite CO (g/mile)	6.261	16.676
Composite NOx (g/mile(	0.864	1.16
Composite CO2 (g/mile)	558.65	557.37
SO2 (g/mile)	0.0092	0.0092
NH3 (g/mile)	0.0925	0.0926
PM25 (g/mile)	0.0206	0.0212
1,3 Butadiene (mg/mile)	1.481	2.169
Formaldehdye (mg/mile)	4.546	5.756
Acetaldehyde (mg/mile)	1.973	2.987
Acrolein (mg/mile)	0.210	0.336
Benzene Exh (mg/mille)	11.178	19.053
Benzene Evp (mg/mile)	1.381	0.625
Benzene (mg/mile)	12.559	19.678

Conversion 0.6213 miles
kilometer

Table E2- Summary of MOBILE6.2C Input and Output-Future No Build (2035)

Calendar Year	2035-No Build	2035-No Build
Month	July	Jan.
Altitude	Low	Low
Min. Temperature [C]	14.52	-14.5
Max. Temperature [C]	26.34	-4.6
Min. Rel. Humidity [%]	0	0
Max. Rel. Humidity [%]	0	0
Barometric Pressure [inHg]	29.33	29.4
Nominal Fuel RVP [psi]	8.9	14.7
Gas Sulfur Content [ppm]	30	30
Dsl Sulfur Content [ppm]	15	15
Gasoline Aromatics (%)	28.4	28.4
Gasoline Olefin (%)	10.3	10.3
Gasoline Benzene (%)	0.8	0.8
Vapour Pressure of Gasoline at 200 F(%)	47.3	53.7
Vapour Pressure of Gasoline at 300 F(%)	83.3	83.3
Oxygenate Volume % of Ethanol or Ethyl Alcohol (Ethanol)	10% volume, 20% market share	10% volume, 20% market share
	2035-No Build	2035-No Build
	Highway 17 Freeway	Highway 17 Freeway
Speed [mph]	43.5	43.5
Contaminants	Highway 17 Freeway	Highway 17 Freeway
Composite VOC	0.258	0.260
Composite CO	4.5	12.452
Composite NOx	0.193	0.276
Composite CO2 (g/mile)	566.09	565.57
SO2	0.0093	0.0093
NH3	0.0924	0.0925
PM25	0.0135	0.0134
1,3 Butadiene (mg/mile)	0.791	1.026
Formaldehdye (mg/mile)	2.801	3.191
Acetaldehyde (mg/mile)	1.174	1.578
Acrolein (mg/mile)	0.126	0.174
Benzene Exh (mg/mille)	5.766	8.743
Benzene Evp (mg/mile)	0.642	0.279
Benzene (mg/mile)	6.408	9.022

Conversion 0.6213 miles
kilometer

Table E3- Summary of MOBILE6.2C Input and Output-Future Build (2035)

Calendar Year	2035-Build	2035-Build
Month	July	Jan.
Altitude	Low	Low
Min. Temperature [C]	14.52	-14.5
Max. Temperature [C]	26.34	-4.6
Min. Rel. Humidity [%]	0	0
Max. Rel. Humidity [%]	0	0
Barometric Pressure [inHg]	29.33	29.4
Nominal Fuel RVP [psi]	8.9	14.7
Gas Sulfur Content [ppm]	30	30
Dsl Sulfur Content [ppm]	15	15
Gasoline Aromatics (%)	28.4	28.4
Gasoline Olefin (%)	10.3	10.3
Gasoline Benzene (%)	0.8	0.8
Vapour Pressure of Gasoline at 200 F(%)	47.3	53.7
Vapour Pressure of Gasoline at 300 F(%)	83.3	83.3
Oxygenate Volume % of Ethanol or Ethyl Alcohol (Ethanol)	10% volume, 20% market share	10% volume, 20% market share
	2035-Build	2035-Build
	Highway 17 Freeway	Highway 17 Freeway
Speed [mph]	50	50
Contaminants	Highway 17 Freeway	Highway 17 Freeway
Composite VOC	0.250	0.257
Composite CO	4.767	12.921
Composite NOx	0.208	0.291
Composite CO2 (g/mile)	566.09	565.57
SO2	0.0093	0.0093
NH3	0.0924	0.0924
PM25	0.0135	0.0135
1,3 Butadiene (mg/mile)	0.79	1.026
Formaldehdye (mg/mile)	2.714	3.104
Acetaldehyde (mg/mile)	1.144	1.551
Acrolein (mg/mile)	0.122	0.171
Benzene Exh (mg/mille)	5.823	8.818
Benzene Evp (mg/mile)	0.6	0.257
Benzene (mg/mile)	6.423	9.075

Conversion 0.6213 miles
kilometer