# APPENDIX C4 – NOISE & VIBRATION AND AIR QUALITY REPORTS

# AIR QUALITY ASSESSMENT FOR SCARBOROUGH – MALVERN LRT EA

**Prepared for:**

**Toronto Transit Commission**

**Prepared by:**


**SENES Consultants Limited**
121 Granton Drive, Unit 12
Richmond Hill, Ontario
L4B 3N4


September 2009

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Reviewed by:
James W. S. Young, Ph.D., P.Eng.
Senior Air Quality Specialist

Prepared by:
Malcolm Smith, P.Eng.
Senior Environmental Engineer



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## EXECUTIVE SUMMARY

The Toronto Transit Commission and the City of Toronto have conducted a Transit Assessment Project to study methods to provide high-quality and reliable transit services between the TTC Kennedy Subway Station and the Scarborough-Malvern community. This study, named the Scarborough-Malvern Light Rail Transit (SMLRT) Assessment Study, recommends that bus service along Eglinton Avenue from Kennedy Station to Kingston Road and Morningside Road be replaced by Light Rail Transit (LRT) – electrically powered "light rail" vehicles operating in a designated centre lane.

SENES Consultants Limited (SENES) is part of the IBI Group project team retained by the Toronto Transit Commission (TTC) to study the Scarborough – Malvern LRT corridor. SENES was retained to prepare an Air Quality Assessment.

*Existing Conditions*

Analysis of MOE Toronto East monitoring data indicate that the existing air quality within the study area is typical of an urban setting, which is characterized by elevated pollutant concentrations in relation to rural areas, with periods of compromised air quality due to nitrogen oxides and fine particulate based contaminants, which typically occurs during smog events.

*Construction Impacts*

Impacts from construction activities can be reduced through the use of newer well maintained construction equipment. Dust impacts can be successfully mitigated through the use of proper controls, such as:

- periodic watering of unpaved construction areas;
- periodic watering of stockpiles;
- limiting speed of vehicle travel;
- use of water sprays during the loading, unloading of materials; and
- sweeping and/or water flushing of the entrances to the construction zones.

*Pollutant Burden Analysis*

The Air Quality Assessment study shows that installation of the Scarborough-Malvern Light Rail Transit (SMLRT) corridor will result in a reduction of particulate based pollutant emissions and will result in small changes to all gaseous pollutants emissions; therefore, no impacts are predicted based on the operation of the SMLRT system. Particulate based pollutants from within the study area corridor will be reduced by approximately 25% and gaseous pollutants will be reduced by approximately 2%. Carbon dioxide equivalent emissions ($CO_2$-e), which is the unit of measure for global warming potential, will be reduced within the study area corridor by 1.1 to 1.2 ktonnes/year.





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# 1.0 INTRODUCTION

## 1.1 PROJECT DESCRIPTION

The Toronto Transit Commission and the City of Toronto have conducted a Transit Assessment Project to study ways to provide high-quality and reliable transit services between the TTC Kennedy Subway Station and the Scarborough-Malvern community. This study, named the Scarborough-Malvern Light Rail Transit (SMLRT) Assessment Study, recommends that bus service along Eglinton Avenue from Kennedy Station to Kingston Road and Morningside Road be replaced by Light Rail Transit (LRT) – electrically powered “light rail” vehicles operating in a designated centre lane.

SENES Consultants Limited (SENES) is part of the IBI Group project team retained by the Toronto Transit Commission (TTC) to study the Scarborough – Malvern LRT corridor. SENES was retained to prepare an Air Quality Assessment.

## 1.2 STUDY AREA

The Scarborough-Malvern LRT corridor is a 13 km long corridor that links Kennedy Station, which serves the Bloor-Danforth Subway, the Scarborough RT and the proposed Eglinton Crosstown LRT, with northern Scarborough communities. Benefits of the line include providing a new high quality light rail service along several busy existing transit routes and a direct high quality transit service to the University of Toronto at Scarborough Campus (UTSC) and to Centennial College’s Ellesmere Road Campus.

The study area for the Air Quality Assessment is approximately 200 metres on either side of the following corridors:

- Eglinton Ave. East from Midland Ave. to Kingston Rd.;
- Kingston Rd. from Eglinton Ave. to Morningside Rd.; and,
- Morningside Rd. from Kingston Rd. to Milner Ave.

For air quality studies, however, physical boundaries have no meaning because air flows over and/or around everything. As a result, the air quality boundaries can be set arbitrarily to fit the important aspects of any project. Where possible, the project boundaries are used.

## 1.3 AIR QUALITY IMPACTS OF PROJECT ON THE ENVIRONMENT

Air quality manifests itself in two broad ways – through air pollutant concentrations which people can breathe into their lungs and through deposition of pollutants to various surfaces which leads to a build-up of soiling potential. Air quality is usually assessed through the examination of the pollutants that are linked with a particular project. In this case, the pollutants of concern are:

- Particulate Matter: $PM_{10}$, which are those particles 10 microns in diameter and smaller; and, $PM_{2.5}$, which are those particles 2.5 microns in diameter and smaller. Particulate Matter is emitted to the air by the action of the wind, by the action of the wheels of a vehicle on road surfaces, through deterioration of vehicle equipment (i.e., brake wear) and directly from the exhaust of engines;
- carbon monoxide (CO): is a gas formed by the incomplete combustion of carbon-based fuels. It is emitted in vehicle exhaust;
- nitrogen dioxides ($NO_x$): are gases formed when anything is burned in air. They are emitted in vehicle exhaust;
- Volatile Organic Compounds (VOCs) emitted as vapour from the fuels used in vehicles or as combustion products through the tailpipe; and,
- Greenhouse Gases (GhGs): Carbon Dioxide ($CO_2$), Nitrous Oxide ($N_2O$) and Methane ($CH_4$) emitted when any fuel is burned.





# 2.0 EXISTING ENVIRONMENTAL CONDITIONS

## 2.1 AIR QUALITY STANDARDS

Several measures are used to describe impacts from vehicles travelling on roadways. Those used in this assessment are as follows:

- Fine Particulate Matter less than 10 and 2.5 microns in diameter ($PM_{10}$ and $PM_{2.5}$);
- Criteria Air Contaminants (CACs): Carbon Monoxide (CO) and Nitrogen Oxides ($NO_x$) with a discussion of $NO_2$ and NO components;
- VOCs; and,
- GhGs ($CO_2$, $N_2O$ and $CH_4$).

The contaminants listed above and relevant criteria are discussed in some detail in the remainder of this section.

### 2.1.1 Fine Particulate Matter $PM_{10}$ and $PM_{2.5}$

Many studies over the past few years have indicated that fine particulate matter ($PM_{10}$ and $PM_{2.5}$) in the air is associated with various adverse health effects in people who already have compromised respiratory systems and suffer from asthma, chronic pneumonia and cardiovascular problems. However, the available studies have not been able to link the adverse health effects in such people to any one component of the pollution mix. Fine particulate matter is a mixture of chemically and physically diverse dusts and droplets, and some of these components may be important in determining the effects of $PM_{10}$ and $PM_{2.5}$ on health.

The current 24-hour suggested regulatory limits for fine particulate matter are presented in Table 2.1 as follows:

**TABLE 2.1**
**AIR QUALITY CRITERIA FOR $PM_{10}$ AND $PM_{2.5}$**

| Provincial: Ontario Ministry of the Environment | | | |
|---|---|---|---|
| **Pollutant** | **Averaging Period** | **Guideline Level** | **Ambient Air Quality Criteria** |
| $PM_{10}$ | 24 hours | Ontario Interim | 50 μg/m$^3$ |
| $PM_{2.5}$ | 24 hours | Proposed CWS (by 2010) | 30 μg/m$^3$* |

NOTE: CWS = Canada Wide Standard
* Compliance is measured as the 98$^{th}$ percentile over three years.

### 2.1.2 Criteria Air Contaminants (CO, $NO_X$)

Criteria Air Contaminants (CACs), including carbon monoxide and nitrogen oxides are common air pollutants that are typically released into the air by activities such as the combustion of fossil fuels.

Carbon monoxide (CO) is a colorless, odourless gas that is produced as a result of incomplete oxidation of carbon during combustion. According to the MOE, in Ontario, over 60% of the CO produced is from the transportation sector [MOE 1999]. The remainder is the result of other sources of fossil fuel combustion such as heating buildings, commercial and industrial operations, etc.

Nitrogen oxides ($NO_x$) is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying ratios. Nitrogen dioxide ($NO_2$) is the primary component of concern in $NO_x$. $NO_2$ is a reddish brown gas with a pungent odour, which, upon reaction with other atmospheric compounds, becomes a major contributor to smog, acid rain, inhalable particulates and reduced visibility. $NO_2$ also plays a major role in atmospheric reactions that produce ground level ozone. Man-made sources of $NO_x$ include all fossil fuel combustion such as heating buildings, commercial and industrial operations, etc. While, motor vehicle exhaust is a significant source of $NO_x$ only a small percentage is emitted as $NO_2$ directly from the tailpipe [X. Yao et al, 2005]. The main component of $NO_x$ from tailpipes is NO which reacts in the atmosphere over time and distance to form $NO_2$. The rate of reaction is influenced by many factors including initial concentration, sunlight, ozone concentrations and others.

The MOE AAQCs for CO and $NO_x$ are shown in Table 2.2

**TABLE 2.2**
**MOE AMBIENT AIR QUALITY CRITERIA FOR CRITERIA AIR CONTAMINANTS**

| Compound | CAS No | Ambient Air Quality Criteria (AAQC) | | | |
|---|---|---|---|---|---|
| | | Annual (µg/m³) | 24-hour (µg/m³) | 8-hour (µg/m³) | 1-hour (µg/m³) |
| Carbon Monoxide | 630-08-0 | NS | NS | 15,700 | 36,200 |
| Nitrogen Oxides | 10102-44-0 | NS | 200 | NS | 400 |

NS – No Standard.

### 2.1.3 Volatile Organic Compounds

Volatile Organic Compounds (VOCs) are defined technically as organic compounds having a saturation vapour pressure greater than 0.1 mm of mercury at 25°C and standard atmospheric pressure. Certain VOCs warrant special concern because they are capable of being transported





very long distances in the atmosphere and play an important role in the formation of ground-level ozone and fine particles. Almost all VOCs contribute to ground-level ozone, and most do not break down in the troposphere during photochemical reactions.

VOCs are emitted into the atmosphere from a variety of sources, including vehicles, fossil fuel combustion, steel-making, petroleum refining, fuel refilling, industrial and residential solvent use, paint application, manufacturing of synthetic materials (e.g. plastics, carpets), food processing, agricultural activities and wood processing and burning. The primary VOC constituents of tail-pipe emissions from vehicles are benzene, formaldehyde, acetaldehyde, acrolein, and 1,3-butadiene.

Many VOCs are odourous compounds at higher concentrations. Odours from vehicular exhaust are generally acknowledged to be associated with the presence of aldehyde constituents, other minor volatile organic compounds and nitrogen oxides in the exhaust. The aldehydes are largely comprised of formaldehyde, acrolein and acetaldehyde.

### 2.1.4 Greenhouse Gases

Green House Gases (GhGs) absorb and emit radiation within the thermal infrared range, which is the process regarded as the fundamental cause of the non-natural part of the "greenhouse effect." Greenhouse gases include carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), ozone and chlorofluorocarbons. Fossil fuel combustion is the main source of GhG emissions related to this Project, which results in emissions of methane ($CH_4$), carbon dioxide ($CO_2$) and nitrous oxide ($N_2O$).

For a given mixture of different GhGs and their amount, carbon dioxide equivalents ($CO_2$-e) is the unit of measure used to describe the amount of $CO_2$ that would have the same global warming potential as $CO_2$ when measured over a time period (typically a 100 year period). The carbon dioxide equivalency for a gas is calculated by multiplying the mass (of the gas) by its global warming potential. For example, the global warming potential for $CH_4$ over 100 years is 25 and for $N_2O$ is 298 [IPPC, 2007]. This means that the emission of 1 tonne of $CH_4$ is equivalent to the emission of 25 tonnes of $CO_2$, and the emission of 1 tonne of $N_2O$ is equivalent to the emission of 298 tonnes of $CO_2$.

## 2.2 EXISTING AIR QUALITY

### 2.2.1 Historical Ambient Monitoring Data

The Ontario Ministry of the Environment (MOE) measures air contaminants at various locations throughout Ontario, and reports on the state of Ontario's air quality on an annual basis. To assess the current air quality in the study area, historical air quality monitoring data from a nearby MOE monitoring station was considered. Tables 2.3 and 2.4 outline existing (year 2007) $NO_x$ and $PM_{2.5}$ measurements at the Toronto East (MOE Ref #33003) monitoring location, and presents a summary of the data in terms of mean, 90th percentile, 1-hr maximum and 24-hr maximum values. CO was not measured at the Toronto East monitoring location, therefore, data from the Toronto Downtown location is provided in Table 2.5.

The tables indicate that historically $NO_x$ and $PM_{2.5}$ have exceeded the standard from time to time by as much as double the allowable concentration (usually during smog events which are regional in nature). $PM_{10}$, VOCs and GhGs have not been measured at these locations during the past five years. In summary, the historical data outlines a typical urban/suburban airshed with occasional smog periods during which air quality is compromised. In Ontario, the smog season occurs from May through September, with most events of compromised air quality occurring due to transboundary pollution from polluted air masses that flow northward from the Ohio Valley in the United States.

**TABLE 2.3**
**TORONTO EAST (33003) 2007 AMBIENT AIR QUALITY MONITORING FOR $PM_{2.5}$**

| Averaging Time | AAQC | Concentration (µg/m³) |
|---|---|---|
| 24-hr Mean | - | 7.8 |
| 24-hr 90th Percentile | - | 15.9 |
| 24-hr Maximum | 30* | 41 |
| No. of Times above proposed CSW | - | 7 |

* Compliance is measured as the 98th percentile over three years, therefore 22 exceedances (2% of 365x3) of the 24-hr criteria is within compliance for three years or nominally 7 exceedances per year on average.

Note: All values are as calculated from hourly data available from the http://www.airqualityontario.ca/ website.





**TABLE 2.4**
**TORONTO EAST (33003) 2007 AMBIENT AIR QUALITY MONITORING FOR NITROGEN OXIDES**

| Averaging Time | AAQC | Concentration (µg/m³) |
|---|---|---|
| 1-hr Mean | - | 53 |
| 24-hr Mean | - | 53 |
| 1-hr 90th Percentile | - | 103 |
| 24-hr 90th Percentile | - | 92 |
| 1-hr Maximum | 400 | 858 |
| 24-hr Maximum | 200 | 246 |
| No. of Times above 1-hr AAQC | - | 32 |
| No. of Times above 24-hr AAQC | - | 1 |

Note: All values are as calculated from hourly data available from the http://www.airqualityontario.ca/ website.

**TABLE 2.5**
**TORONTO DOWNTOWN (31103) 2007 AMBIENT AIR QUALITY MONITORING FOR CARBON MONOXIDE**

| Averaging Time | AAQC | Concentration (µg/m³) |
|---|---|---|
| 1-hr Mean | - | 231 |
| 8-hr Mean | - | 231 |
| 1-hr 90th Percentile | - | 412 |
| 8-hr 90th Percentile | - | 406 |
| 1-hr Maximum | 36,200 | 1,947 |
| 8-hr Maximum | 15,700 | 1,222 |
| No. of Times above 1-hr AAQC | - | 0 |
| No. of Times above 8-hr AAQC | - | 0 |

Note: All values are as calculated from hourly data available from the http://www.airqualityontario.ca/ website.

Figure 2.1 presents the location of the MOE air quality monitoring (33003) location relative to the study area.

**FIGURE 2.1**
**MOE MONITORING STATION TORONTO EAST (33003)**


### 2.3 SENSITIVE RECEPTOR LOCATIONS WITHIN STUDY AREA

Sensitive receptors (i.e., hospitals, old age homes, schools, residential communities, etc) within the study area were identified through internet searches and internet based satellite images. Only sensitive receptors within 100 metres of the corridor were considered. Search results indicated numerous residential communities and other sensitive receptors throughout the study area corridor. It should be noted that because this air quality assessment is based on overall contaminant loadings within the study area and is not based on dispersion modelling, specific sensitive receptor locations were not considered.

Residential communities are located:

- Along most of Eglinton Ave. approximately 100 m north and south of the roadway immediately behind commercial properties;
- Along most of Kingston Road immediately adjacent to the roadway; and,
- Along Morningside Ave. close to the roadway from Kingston Road up to the University of Toronto campus.

Basically, since air does not respect any type of boundary, it can be said that anywhere that a person is found living, working or playing near this study area corridor is a sensitive location.





# 3.0 ATMOSPHERIC EMISSIONS

## 3.1 VEHICLE EMISSIONS ESTIMATION

### 3.1.1 Traffic Volumes

The rate of contaminant emissions from a section of road is proportional to the number and type of vehicles travelling along that road as well as vehicle speed. The IBI Group provided annual average daily traffic (AADT) volumes for all major roadways within the study area for the following scenarios (see Appendix B):

- Existing Conditions – 2007;
- Future with LRT – 2021;
- Future without LRT – 2021;
- Future with LRT – 2031; and,
- Future without LRT – 2031.

The traffic data provided by the IBI Group indicate that the roads within the study area are currently (year 2007) at capacity during peak hours. The traffic data is based on the anticipation that the peak hour volumes will decrease due to the capacity, however the overall AADT will increase due to the growth of the City of Toronto. The data assumes that the peak hours will extend from 3 hours to 5 hours to accommodate the spilled over traffic. The data assumes a 1% growth per annum for all the roads. For existing conditions and future without LRT scenarios, public transit is provided by buses mixed in with other traffic.

The future with LRT traffic data is based on removing one lane in each direction and installing the LRT system. This will reduce the number of lanes available to cars down to two lanes in each direction, however the traffic data reflects approximately the same number of vehicles on the road, which as stated above is based on a increase in the number of peak hours per day where the roads operate at capacity. It should be noted that the number of people travelling through the corridor will increase with the LRT system due to the anticipated increase in ridership with the new public transit system.

The "leakage" of vehicles from the study area corridor based on the installation of the SMLRT system has not been considered. Leakage is defined as those emissions that leave the study area but still contribute to overall pollutant emissions. As stated above reducing the number of lanes available to cars from three down to two lanes in each direction will result in a significantly greater number of hours where the roads operate at capacity. Some cars will find alternate travel routes, whereas some drivers will use the SMLRT system. In addition, the electricity required to power the LRT system trains will result in pollutant emissions, but not within the study area corridor.

### 3.1.2 Vehicle Emissions

All pollutants considered in this study are emitted in vehicle exhaust. Additionally, particulate ($PM_{10}$ and $PM_{2.5}$) is emitted from the roadway surface as a result of tire/break wear, and re-suspension of surface dust by (1) the action of the tires on the surface and (2) the wake created by the passing of the vehicle. Both tailpipe and mechanically generated fractions of particulate were included in this study. Tailpipe emissions from vehicles are a function of many variables. Some of the more important parameters are listed below.

- age of the vehicle (newer vehicles emit less);
- number of kilometres which the vehicle has driven;
- emission control equipment that may have been tampered with;
- type of fuel (gasoline, diesel);
- Reid Vapour Pressure (RVP) of gasoline used (adjusted seasonally);
- ambient air temperature;
- vehicle speed;
- rate of acceleration;
- time spent idling;
- type of vehicle (automobile, light truck, heavy truck, bus, etc.); and
- cold or hot start mode.

Vehicular emissions are generally estimated by using emission factors in units of mass of contaminant emitted per vehicle, per distance travelled. To obtain a mass emission rate for a particular road section, the length of the road section is multiplied by the number of vehicles using that section to obtain the total number of vehicle kilometres travelled (VKT). The VKT are then multiplied by the appropriate emission factors.

The vehicular emission rates were estimated for existing conditions (2007), and for the future years 2021 and 2031. Emission factors were obtained by running the MOBILE6C model (the 'C' denotes that the model has been adjusted for the average Canadian fleet by Environment Canada). Nitrous oxide ($N_2O$) emission factors are from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The MOBILE6C model was run for SENES by Air Improvement Resources (AIR), one of the original developers of the MOBILE model. The model outputs emission factors in grams per vehicle kilometre travelled (g/VKT) for all contaminants of concern. All expected technological and regulatory changes affecting future emissions up to 2021 and 2031 are built into the MOBILE6C model run, in order to generate the most representative emission factors possible. Table 3.1a, 3.1b and 3.1c summarize the emission





factors used in the existing conditions and future years for speeds of 60 km/hr and 100 km/h, which are the posted speed limits within the study area (note that only Hwy 401 has a posted speed limit of 100 km/hr).

**Table 3.1a – MOBILE6C Tailpipe Emission Factors for 2007**

| Cars | | | | |
|---|---|---|---|---|
| **Speed (km/h)** | **$PM_{10}$** | **$PM_{2.5}$** | **CO** | **$NO_x$** |
| 60 | 0.026 | 0.016 | 13 | 1.3 |
| 100 | 0.026 | 0.016 | 13 | 1.4 |
| **Speed (km/h)** | **VOCs** | **$CO_2$** | **$CH_4$** | **$N_20$*** |
| 60 | 0.53 | 340 | 0.031 | 0.008 |
| 100 | 0.52 | 340 | 0.030 | 0.008 |
| **Medium Trucks** | | | | |
| **Speed (km/h)** | **$PM_{10}$** | **$PM_{2.5}$** | **CO** | **$NO_x$** |
| 60 | 0.089 | 0.074 | 0.55 | 2.6 |
| 100 | 0.089 | 0.074 | 0.58 | 3.1 |
| **Speed (km/h)** | **VOCs** | **$CO_2$** | **$CH_4$** | **$N_20$*** |
| 60 | 0.11 | 490 | 0.006 | 0.001 |
| 100 | 0.11 | 490 | 0.006 | 0.001 |
| **Heavy Trucks (and Buses)** | | | | |
| **Speed (km/h)** | **$PM_{10}$** | **$PM_{2.5}$** | **CO** | **$NO_x$** |
| 60 | 0.15 | 0.13 | 0.84 | 5.0 |
| 100 | 0.15 | 0.13 | 0.89 | 5.9 |
| **Speed (km/h)** | **VOCs** | **$CO_2$** | **$CH_4$** | **$N_20$*** |
| 60 | 0.21 | 730 | 0.010 | 0.003 |
| 100 | 0.20 | 730 | 0.009 | 0.003 |

Emission factors are in g/VKT for all indicated speeds.
* Emission factors from 2006 IPCC Guidelines for National Greenhouse Gas Inventories

**Table 3.1b – MOBILE6C Tailpipe Emission Factors for 2021**

| Cars | | | | |
|---|---|---|---|---|
| Speed (km/h) | $PM_{10}$ | $PM_{2.5}$ | CO | $NO_x$ |
| 60 | 0.015 | 0.006 | 7.7 | 0.26 |
| 100 | 0.015 | 0.006 | 7.9 | 0.28 |
| Speed (km/h) | VOCs | $CO_2$ | $CH_4$ | $N_20$* |
| 60 | 0.22 | 351 | 0.016 | 0.008 |
| 100 | 0.22 | 351 | 0.016 | 0.008 |
| Medium Trucks | | | | |
| Speed (km/h) | $PM_{10}$ | $PM_{2.5}$ | CO | $NO_x$ |
| 60 | 0.020 | 0.011 | 0.085 | 0.33 |
| 100 | 0.020 | 0.011 | 0.091 | 0.39 |
| Speed (km/h) | VOCs | $CO_2$ | $CH_4$ | $N_20$* |
| 60 | 0.056 | 490 | 0.003 | 0.001 |
| 100 | 0.055 | 490 | 0.003 | 0.001 |
| Heavy Trucks (and Buses) | | | | |
| Speed (km/h) | $PM_{10}$ | $PM_{2.5}$ | CO | $NO_x$ |
| 60 | 0.028 | 0.017 | 0.13 | 0.57 |
| 100 | 0.028 | 0.017 | 0.14 | 0.68 |
| Speed (km/h) | VOCs | $CO_2$ | $CH_4$ | $N_20$* |
| 60 | 0.10 | 730 | 0.004 | 0.003 |
| 100 | 0.10 | 730 | 0.004 | 0.003 |

Emission factors are in g/VKT for all indicated speeds.
* Emission factors from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, assumed to equal 2007 emission factors





**Table 3.1c – MOBILE6C Tailpipe Emission Factors for 2031**

| Cars | | | | |
|---|---|---|---|---|
| Speed (km/h) | $PM_{10}$ | $PM_{2.5}$ | CO | $NO_x$ |
| 60 | 0.014 | 0.005 | 7.5 | 0.20 |
| 100 | 0.014 | 0.005 | 7.8 | 0.21 |
| Speed (km/h) | VOCs | $CO_2$ | $CH_4$ | $N_20$* |
| 60 | 0.21 | 351 | 0.015 | 0.008 |
| 100 | 0.21 | 351 | 0.014 | 0.008 |
| Medium Trucks | | | | |
| Speed (km/h) | $PM_{10}$ | $PM_{2.5}$ | CO | $NO_x$ |
| 60 | 0.016 | 0.008 | 0.052 | 0.15 |
| 100 | 0.016 | 0.008 | 0.055 | 0.18 |
| Speed (km/h) | VOCs | $CO_2$ | $CH_4$ | $N_20$* |
| 60 | 0.05 | 490 | 0.002 | 0.001 |
| 100 | 0.05 | 490 | 0.002 | 0.001 |
| Heavy Trucks (and Buses) | | | | |
| Speed (km/h) | $PM_{10}$ | $PM_{2.5}$ | CO | $NO_x$ |
| 60 | 0.022 | 0.011 | 0.076 | 0.26 |
| 100 | 0.022 | 0.011 | 0.081 | 0.31 |
| Speed (km/h) | VOCs | $CO_2$ | $CH_4$ | $N_20$* |
| 60 | 0.10 | 730 | 0.004 | 0.003 |
| 100 | 0.09 | 730 | 0.004 | 0.003 |

Emission factors are in g/VKT for all indicated speeds.
* Emission factors from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, assumed to equal 2007 emission factors

It should be noted that Table 3.1a, 3.1b and 3.1c indicate a progressive reduction in tailpipe emissions between 2007, 2021 and 2031, which is due to expected emission reductions from more sophisticated engine technologies and fuels.

### 3.1.3 Mechanically Generated Dust Emissions

The U.S. EPA provides an emission factor (U.S. EPA AP-42 Section 13.2.1 Paved Roads, 2006) to estimate the amount of dust suspended by vehicles on the road, according to the following equation:

$$E = k\left(\frac{sL}{2}\right)^{0.65} \times \left(\frac{W}{3}\right)^{1.5} - C$$

| | | |
|---|---|---|
| where: | E = particulate emission factor (g/VKT) | |
| | k = particle size multiplier | 24 (g/VKT) for TSP |
| | | 4.6 (g/VKT) for $PM_{10}$ |
| | | 0.66 (g/VKT) for $PM_{2.5}$ |
| | sL = silt loading (g/m$^2$) | 0.2 (500 – 5,000 vehicles per day) |
| | | 0.06 (5,000 – 10,000 vehicles per day) |
| | | 0.03 (> 10,000 vehicles per day) |

W = weight of fleet (tons/vehicle) 3.5 US Tons for cars (average)
20 US Tons for trucks (average)
C = emission factor for 1980's vehicle fleet exhaust, brake wear and tire wear
0.1317 (g/VKT) for TSP and $PM_{10}$
0.1005 (g/VKT) for $PM_{2.5}$
VKT = vehicle kilometres travelled

A heavier fleet average weight of vehicles travelling though the corridor will significantly increase mechanically generated dust emissions.

It should be noted that AP-42 Section 13.2.1 indicates that there may be situations where low silt loading and/or low average weight will yield calculated negative emissions from the equation outlined above. If this occurs, it is recommended that the calculated emissions be set to zero.

### 3.2 CONSTRUCTION EMISSIONS

The construction of the proposed LRT system has the potential to affect air quality in the vicinity of the site during the construction phase. Emissions that are associated with road construction activities are particulate matter (TSP, $PM_{10}$ and $PM_{2.5}$) and typical combustion emissions, such as CO, $NO_x$ and VOCs, from construction equipment. As with any construction site, these emissions will be of relatively short duration and are unlikely to have any long-lasting effect on the surrounding area. As outlined in Section 3.1.2 above, newer engines have lower emissions, therefore combustion emissions can be reduced thorough the use of newer construction equipment in good working order.

Dust impacts can be successfully mitigated through the use of best management practices and proper controls, such as:

- periodic watering of unpaved construction areas;
- periodic watering of stockpiles;
- limiting speed of vehicular travel;
- use of water sprays during the loading, unloading of materials; and
- sweeping and/or water flushing of the entrances to the construction zones.

These types of controls aid in minimizing impacts to the environment during the construction phase. Night time construction activities should also be considered in order to reduce the higher emissions from vehicles that are slowed down by the reduced existing road capacity during the day. It is recommended that only water be used as a dust suppressant.

New developments in materials science and their application will continue to provide options for construction processes that could help to reduce emissions related to the LRT system, road and





highway construction, rehabilitation and maintenance. Substitution of materials with more durable ones will typically result in overall emission reductions based on the extended service life of structures and pavements. Also new developments in engine technologies and more advanced high-efficiency, low-emission type construction equipment and vehicles can significantly reduce associated emissions. Thus it can be expected that project related emissions from projects that are carried out in the years to come will be lower than if the same activities were undertaken today.

# 4.0 POLLUTANT BURDEN ANALYSIS

To assess the potential changes in pollutant burden within the study area based on installation of the Scarborough-Malvern LRT, contaminant emissions of CO, $NO_x$, VOCs, GhGs ($CO_2$, $CH_4$, $N_2O$ and $CO_2$-e) and particulate matter ($PM_{10}$ and $PM_{2.5}$) were calculated for the following five scenarios:

- Existing conditions – 2007;
- Future without LRT – 2021;
- Future with LRT – 2021;
- Future without LRT – 2031; and
- Future with LRT – 2031.

The results of the pollutant burden analysis are presented below for the primary contaminants of concern $CO_2$-e, $NO_x$ and $PM_{10}$. Complete results for all contaminants are presented in Appendix A. It should be noted that as described in Section 3.1.1 above, "leakage" has not been considered in the pollutant burden analysis. Therefore, pollutant reduction values provided are only within the study area.

## 4.1 CARBON DIOXIDE EQUIVALENTS ($CO_2$-e)

As outlined in Table 4.1 below the $CO_2$-e pollutant burden within the study area corridor is estimated to be reduced by 1.1 ktonnes per year based on the installation of the LRT system (or a reduction of approximately 2%). This reduction is based on approximately the same number of vehicles on the road but with buses replaced by the LRT system (see also Section 3.1.1 above).

**Table 4.1 Corridor Specific $CO_2$-e Pollutant Burden**

| Scenario | $CO_2$-e Pollutant Burden in ktonnes/year | Reduction Based on LRT in ktonnes/year |
|---|---|---|
| Existing Conditions | 51.2 | n/a |
| 2021 without LRT | 59.4 | 1.1 (2%) |
| 2021 with LRT | 58.3 | |
| 2031 without LRT | 64.2 | 1.2 (2%) |
| 2031 with LRT | 63.0 | |

These results in Table 4.1 do not include the pollutant burden from Highway 401. As a comparison annual $CO_2$-e emissions from Highway 401 for a 400 metre section under Morningside Ave. (200 metres on either side of Morningside Ave.) were calculated to be 19.4 ktonnes $CO_2$-e for the year 2021 and 26.1 ktonnes $CO_2$-e for the year 2031.





As outlined in Section 2.1.4 above, $CO_2$-e is a combination of $CO_2$, $CH_4$ and $N_2O$ emissions, and as outlined in Appendix A, $CO_2$, $CH_4$ and $N_2O$ all exhibit similar reductions based on the installation of the LRT system.

## 4.2 NITROGEN OXIDES ($NO_X$)

As outlined in Table 4.2 below the $NO_x$ pollutant burden within the study area corridor is estimated to be reduced by 0.9 tonnes $NO_x$ in 2021 and 0.2 tonnes $NO_x$ in 2031 based on installation of the LRT system. The table also illustrates a significant decrease of $NO_x$ emissions from existing conditions to the future scenarios, which is also due to reduced emissions per vehicle based on expected emission reductions from more sophisticated engine technologies and fuels. In recent years there have been significant advancements in the ability of automakers to reduce $NO_x$ tailpipe emissions.

**Table 4.2 Corridor Specific $NO_x$ Pollutant Burden**

| Scenario | $NO_x$ Pollutant Burden in tonnes/year | Reduction Based on LRT in tonnes/year |
|---|---|---|
| Existing Conditions | 212 | n/a |
| 2021 without LRT | 44.2 | 0.9 (2.1%) |
| 2021 with LRT | 43.3 | |
| 2031 without LRT | 35.4 | 0.2 (0.5%) |
| 2031 with LRT | 35.2 | |

As with Table 4.1 above, the results in Table 4.2 do not include the pollutant burden from Highway 401 or from surrounding roads. As a comparison annual $NO_x$ emissions from Highway 401 for a 400 metre section under Morningside Ave. (200 metres on either side of Morningside Ave.) were calculated to be 15.4 tonnes $NO_x$ for the year 2021 and 15.7 tonnes $NO_x$ for the year 2031.

As outlined in Appendix A, CO and VOC emissions increase slightly (approximately 1% to 2%), which is due to a greater number of gasoline powered vehicles on the road (essentially gasoline powered cars and the LRT system replacing diesel buses). As illustrated in Figures 3.1a to 3.1c above, gasoline powered vehicles emit greater CO and VOC concentrations than diesel powered buses.

### 4.3 PARTICULATE MATTER – 10 MICRONS ($PM_{10}$)

As outlined in Table 4.3 below the $PM_{10}$ pollutant burden within the study area corridor is estimated to be reduced by approximately 5.1 tonnes $PM_{10}$ in 2021 and 5.4 tonnes in 2031 based on installation of the LRT corridor (or a reduction of approximately 25%). The table also illustrates a decrease of $PM_{10}$ emissions from existing conditions to the future scenarios, which is also due to reduced emissions per vehicle based on expected emission reductions from more sophisticated engine technologies and fuels. It should be noted that the significant decrease in particulate based compounds when compared to gaseous compounds is due to a lower fleet average vehicle weight with the removal of buses from the roadway.

**Table 4.3 Corridor Specific $PM_{10}$ Pollutant Burden**

| Scenario | $PM_{10}$ Pollutant Burden in tonnes/year | Reduction Based on LRT in tonnes/year |
|---|---|---|
| Existing Conditions | 22.1 | n/a |
| 2021 without LRT | 20.4 | 5.1 (25%) |
| 2021 with LRT | 15.2 | |
| 2031 without LRT | 21.3 | 5.4 (25%) |
| 2031 with LRT | 15.9 | |

As with Tables 4.1 and 4.2 above, the results in Table 4.3 do not include the pollutant burden from Highway 401 or any of the surrounding roads. As a comparison annual $PM_{10}$ emissions from Highway 401 for a 400 metre section under Morningside Ave. (200 metres on either side of Morningside Ave.) were calculated to be 14 tonnes $PM_{10}$ for the year 2021 and 18 tonnes $PM_{10}$ for the year 2031.

As outlined in Appendix A, $PM_{2.5}$ exhibits similar reductions to those described above for $PM_{10}$.



Air Quality Assessment for Scarborough – Malvern LRT EA

# 5.0 CONCLUSIONS

## 5.1 CONCLUSIONS

_Existing Conditions_

Analysis of MOE Toronto East monitoring data indicate that the existing air quality within the study area is typical of an urban setting, which is characterized by elevated pollutant concentrations in relation to rural areas, with periods of compromised air quality due to nitrogen oxides and fine particulate based contaminants, which typically occurs during smog events.

_Construction Impacts_

Impacts from construction activities can be reduced through the use of newer well maintained construction equipment. Dust impacts can be successfully mitigated through the use of proper controls, such as:

- periodic watering of unpaved construction areas;
- periodic watering of stockpiles;
- limiting speed of vehicle travel;
- use of water sprays during the loading, unloading of materials; and
- sweeping and/or water flushing of the entrances to the construction zones.

_Pollutant Burden Analysis_

The Air Quality Assessment study shows that installation of the Scarborough-Malvern Light Rail Transit (SMLRT) corridor will result in a reduction of particulate based pollutant emissions and will result in small changes to all gaseous pollutants emissions; therefore, no impacts are predicted based on the operation of the SMLRT system. Particulate based pollutants from within the study area corridor will be reduced by approximately 25% and gaseous pollutants will be reduced by approximately 2%. Carbon dioxide equivalent emissions ($CO_2$-e), which is the unit of measure for global warming potential, will be reduced within the study area corridor by 1.1 to 1.2 ktonnes/year.

## 5.2 RECOMMENDATIONS

Installation of the SMLRT system will reduce pollutant emissions. Further measures recommended to reduce current and future particulate based air quality impacts from all transportation sources along the SMLRT corridor include the following:

- increased tree planting adjacent to the roadway; and,
- increased road vacuum sweeping and flushing.

Trees located along the roadway, will act as screens and can reduce (by up to 90%) the particulate matter flowing horizontally from the roadway (Watson and Chow, 2000). Road flushing and sweeping can reduce silt loading on the roadways, often significantly.

The construction of the proposed SMLRT corridor has the potential to affect the air quality in the vicinity of the site during the construction phase. As with any construction site, these emissions will be of relatively short duration and are unlikely to have any long-lasting effect on the surrounding area. Impacts from construction activities can be reduced through the use of newer well maintained construction equipment.

Night time construction activities should also be considered in order to reduce the higher emissions from vehicles that are slowed down by the reduced existing road capacity during the day.





## 6.0 REFERENCES

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# APPENDIX A

# COMPLETE TABLES OF RESULTS



Air Quality Assessment for Scarborough – Malvern LRT EA

**Table A.1 Corridor Specific $CO_2$-e Pollutant Burden**

| Scenario | $CO_2$-e Pollutant Burden (ktonnes/year) | Reduction Based on LRT (ktonnes/year) |
|---|---|---|
| Existing Conditions | 51.2 | n/a |
| 2021 without LRT | 59.4 | 1.1 |
| 2021 with LRT | 58.3 | |
| 2031 without LRT | 64.2 | 1.2 |
| 2031 with LRT | 63.0 | |

**Table A.2 Corridor Specific $NO_x$ Pollutant Burden**

| Scenario | $NO_x$ Pollutant Burden (tonnes/year) | Reduction Based on LRT (tonnes/year) |
|---|---|---|
| Existing Conditions | 212 | n/a |
| 2021 without LRT | 44.2 | 0.9 |
| 2021 with LRT | 43.3 | |
| 2031 without LRT | 35.4 | 0.2 |
| 2031 with LRT | 35.2 | |

**Table A.3 Corridor Specific $PM_{10}$ Pollutant Burden**

| Scenario | $PM_{10}$ Pollutant Burden (tonnes/year) | Reduction Based on LRT (tonnes/year) |
|---|---|---|
| Existing Conditions | 22.1 | n/a |
| 2021 without LRT | 20.4 | 5.1 |
| 2021 with LRT | 15.2 | |
| 2031 without LRT | 21.3 | 5.4 |
| 2031 with LRT | 15.9 | |

**Table A.4 Corridor Specific CO Pollutant Burden**

| Scenario | CO Pollutant Burden (tonnes/year) | Increase Based on LRT (tonnes/year) |
|---|---|---|
| Existing Conditions | 1708 | n/a |
| 2021 without LRT | 1159 | 23 |
| 2021 with LRT | 1182 | |
| 2031 without LRT | 1225 | 25 |
| 2031 with LRT | 1250 | |

**Table A.5 Corridor Specific VOCs Pollutant Burden**

| Scenario | VOCs Pollutant Burden (tonnes/year) | Increase Based on LRT (tonnes/year) |
|---|---|---|
| Existing Conditions | 72.8 | n/a |
| 2021 without LRT | 34.4 | 0.3 |
| 2021 with LRT | 34.7 | |
| 2031 without LRT | 34.8 | 0.4 |
| 2031 with LRT | 35.2 | |

**Table A.6 Corridor Specific $CO_2$ Pollutant Burden**

| Scenario | $CO_2$ Pollutant Burden (ktonnes/year) | Reduction Based on LRT (ktonnes/year) |
|---|---|---|
| Existing Conditions | 50.8 | n/a |
| 2021 without LRT | 59.0 | 1.1 |
| 2021 with LRT | 57.9 | |
| 2031 without LRT | 63.7 | 1.2 |
| 2031 with LRT | 62.5 | |

**Table A.7 Corridor Specific $CH_4$ Pollutant Burden**

| Scenario | $CH_4$ Pollutant Burden (tonnes/year) | Increase Based on LRT (tonnes/year) |
|---|---|---|
| Existing Conditions | 4.2 | n/a |
| 2021 without LRT | 2.4 | 0.0 |
| 2021 with LRT | 2.4 | |
| 2031 without LRT | 2.5 | 0.0 |
| 2031 with LRT | 2.5 | |

**Table A.8 Corridor Specific $N_2O$ Pollutant Burden**

| Scenario | $N_2O$ Pollutant Burden (tonnes/year) | Reduction Based on LRT (tonnes/year) |
|---|---|---|
| Existing Conditions | 1.09 | n/a |
| 2021 without LRT | 1.2 | 0.0 |
| 2021 with LRT | 1.2 | |
| 2031 without LRT | 1.3 | 0.0 |
| 2031 with LRT | 1.3 | |





**Table A.9 Corridor Specific $PM_{2.5}$ Pollutant Burden**

| Scenario | $PM_{2.5}$ Pollutant Burden (tonnes/year) | Reduction Based on LRT (tonnes/year) |
|---|---|---|
| Existing Conditions | 3.11 | n/a |
| 2021 without LRT | 1.06 | 0.06 |
| 2021 with LRT | 1.00 | |
| 2031 without LRT | 1.00 | 0.05 |
| 2031 with LRT | 0.95 | |

# APPENDIX B

# TRAFFIC VOLUME DATA



*Air Quality Assessment for Scarborough – Malvern LRT EA*

**Existing AADT (2007)**

| LOCATION | SECTION | | Posted Speed Limit | 24 Hour AADT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Total (cars-bus-trucks) | | Cars | | Bus | | Medium Trucks | | Heavy Trucks | |
| | FROM | TO | | NB / WB | SB / EB | NB / WB | SB / EB | NB / WB | SB / EB | NB / WB | SB / EB | NB / WB | SB / EB |
| **North South Roads** | | | | | | | | | | | | | |
| Morningside Ave | Kingston Rd | Warmsworth St | 60 | 9,532 | 8,798 | 9,209 | 8,239 | 162 | 132 | 92 | 322 | 69 | 106 |
| | Warmsworth St | Fairwood Cres | 60 | 11,866 | 10,954 | 11,166 | 10,136 | 202 | 285 | 285 | 401 | 214 | 131 |
| | Fairwood Cres | Ellesmere Rd | 60 | 10,930 | 11,840 | 10,193 | 10,957 | 186 | 308 | 315 | 433 | 236 | 142 |
| | Ellesmere Rd | Military Trail | 60 | 11,357 | 12,303 | 10,687 | 11,485 | 193 | 320 | 273 | 375 | 204 | 123 |
| | Military Trail | Milner Ave | 60 | 14,928 | 16,172 | 14,173 | 15,228 | 254 | 420 | 287 | 395 | 215 | 129 |
| Military Trail | Ellesmere Rd | Morningside Rd | 60 | 4,176 | 5,314 | 3,859 | 4,875 | 71 | 138 | 140 | 227 | 105 | 74 |
| **East West Roads** | | | | | | | | | | | | | |
| Eglinton Ave E | Midland Ave | Failmouth Ave | 60 | 15,401 | 13,119 | 14,161 | 11,311 | 616 | 485 | 470 | 756 | 154 | 567 |
| | Failmouth Ave | Brimley Rd | 60 | 12,965 | 15,846 | 11,920 | 13,710 | 415 | 539 | 475 | 913 | 156 | 685 |
| | Brimley Rd | Oswego Rd | 60 | 14,924 | 13,776 | 13,842 | 11,688 | 478 | 468 | 455 | 926 | 149 | 694 |
| | Oswego Rd | McCowan Rd | 60 | 15,455 | 13,165 | 14,647 | 11,143 | 433 | 474 | 283 | 885 | 93 | 664 |
| | McCowan Rd | Torrance Rd | 60 | 14,700 | 13,570 | 13,693 | 11,599 | 412 | 489 | 448 | 847 | 147 | 635 |
| | Torrance Rd | Cedar Brae Blvd (Bellamy | 60 | 13,047 | 12,043 | 12,153 | 10,497 | 365 | 434 | 398 | 636 | 130 | 477 |
| | edar Brae Blvd (Bellam | Mason Rd | 60 | 11,268 | 10,402 | 10,281 | 9,126 | 439 | 489 | 412 | 449 | 135 | 337 |
| | Mason Rd | Markham Rd | 60 | 11,248 | 10,382 | 10,353 | 8,848 | 439 | 488 | 343 | 598 | 112 | 449 |
| | Markham Rd | Cedar Drive | 60 | 9,277 | 8,563 | 8,464 | 7,298 | 362 | 402 | 340 | 493 | 111 | 370 |
| | Cedar Drive | Kingston Rd | 60 | 8,703 | 7,717 | 8,001 | 6,762 | 278 | 178 | 319 | 445 | 104 | 333 |
| Ellesmere Rd | Morningside Rd | Military Trail | 60 | 7,610 | 5,741 | 7,020 | 4,933 | 282 | 132 | 232 | 386 | 76 | 289 |
| Kingston | Eglinton Ave E | Scarborough Golf Club R | 60 | 26,426 | 23,434 | 24,713 | 22,633 | 396 | 211 | 893 | 337 | 423 | 253 |
| | carborough Golf Club R | Cormwell Rd | 60 | 24,152 | 21,418 | 23,348 | 20,758 | 217 | 300 | 442 | 206 | 145 | 154 |
| | Cormwell Rd | Dale Ave | 60 | 21,391 | 18,969 | 20,678 | 18,385 | 193 | 266 | 391 | 182 | 128 | 137 |
| | Dale Ave | Celeste Dr | 60 | 18,225 | 22,275 | 17,618 | 21,589 | 164 | 312 | 334 | 214 | 109 | 160 |
| | Celeste Dr | Overature Rd | 60 | 19,580 | 20,380 | 18,611 | 19,752 | 176 | 285 | 597 | 196 | 196 | 147 |
| | Overature Rd | Galloway Rd | 60 | 18,836 | 19,604 | 17,598 | 18,836 | 170 | 274 | 804 | 282 | 264 | 212 |
| | Galloway Rd | Poplar Rd | 60 | 16,631 | 17,309 | 15,202 | 16,631 | 216 | 242 | 913 | 249 | 299 | 187 |
| | Poplar Rd | Lawrence Rd | 60 | 16,572 | 17,248 | 15,283 | 16,572 | 215 | 241 | 809 | 248 | 265 | 186 |
| | Lawrence Rd | Morningside Rd | 60 | 16,283 | 16,947 | 15,148 | 16,283 | 212 | 237 | 695 | 244 | 228 | 183 |
| | Morningside Rd | Amiens Rd | 60 | 16,405 | 17,075 | 15,196 | 16,405 | 279 | 239 | 701 | 246 | 230 | 184 |
| | Amiens Rd | Fairwood Cres | 60 | 16,871 | 17,559 | 15,627 | 16,871 | 287 | 246 | 720 | 253 | 236 | 190 |

Note:
1. Bus/Truck voulmes, directional split were estimated based on the City of Toronto turning movement counts

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**Future Without LRT (2021)**

| LOCATION | SECTION FROM | SECTION TO | Posted Speed Limit | Total (cars-bus-trucks) NB / WB | Total (cars-bus-trucks) SB / EB | Cars NB / WB | Cars SB / EB | Bus NB / WB | Bus SB / EB | Medium Trucks NB / WB | Medium Trucks SB / EB | Heavy Trucks NB / WB | Heavy Trucks SB / EB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **North South Roads** | | | | | | | | | | | | | |
| Morningside Ave | Kingston Rd | Warmsworth St | 60 | 10,863 | 10,027 | 10,496 | 9,389 | 185 | 150 | 104 | 367 | 78 | 120 |
| | Warmsworth St | Fairwood Cres | 60 | 13,528 | 12,487 | 12,730 | 11,556 | 230 | 325 | 325 | 457 | 243 | 150 |
| | Fairwood Cres | Ellesmere Rd | 60 | 12,460 | 13,498 | 11,620 | 12,491 | 212 | 351 | 359 | 494 | 269 | 162 |
| | Ellesmere Rd | Military Trail | 60 | 12,947 | 14,026 | 12,183 | 13,093 | 220 | 365 | 311 | 428 | 233 | 140 |
| | Military Trail | Milner Ave | 60 | 17,018 | 18,436 | 16,157 | 17,359 | 289 | 479 | 327 | 450 | 245 | 147 |
| Military Trail | Ellesmere Rd | Morningside Rd | 60 | 4,760 | 6,058 | 4,399 | 5,557 | 81 | 158 | 160 | 259 | 120 | 85 |
| **East West Roads** | | | | | | | | | | | | | |
| Eglinton Ave E | Midland Ave | Failmouth Ave | 60 | 17,557 | 14,956 | 16,144 | 12,895 | 702 | 553 | 535 | 861 | 176 | 646 |
| | Failmouth Ave | Brimley Rd | 60 | 14,780 | 18,064 | 13,588 | 15,629 | 473 | 614 | 541 | 1,040 | 177 | 780 |
| | Brimley Rd | Oswego Rd | 60 | 17,013 | 15,705 | 15,780 | 13,324 | 544 | 534 | 519 | 1,055 | 170 | 792 |
| | Oswego Rd | McCowan Rd | 60 | 17,618 | 15,008 | 16,697 | 12,703 | 493 | 540 | 322 | 1,009 | 106 | 756 |
| | McCowan Rd | Torrance Rd | 60 | 16,758 | 15,469 | 15,611 | 13,223 | 469 | 557 | 511 | 965 | 168 | 724 |
| | Torrance Rd | Cedar Brae Blvd (Bellamy | 60 | 14,873 | 13,729 | 13,855 | 11,966 | 416 | 494 | 454 | 725 | 149 | 544 |
| | edar Brae Blvd (Bellam | Mason Rd | 60 | 12,846 | 11,858 | 11,721 | 10,404 | 501 | 557 | 470 | 512 | 154 | 384 |
| | Mason Rd | Markham Rd | 60 | 12,822 | 11,836 | 11,803 | 10,087 | 500 | 556 | 391 | 682 | 128 | 511 |
| | Markham Rd | Cedar Drive | 60 | 10,576 | 9,762 | 9,649 | 8,319 | 412 | 459 | 387 | 562 | 127 | 422 |
| | Cedar Drive | Kingston Rd | 60 | 9,921 | 8,798 | 9,121 | 7,709 | 317 | 202 | 363 | 507 | 119 | 380 |
| Ellesmere Rd | Morningside Rd | Military Trail | 60 | 8,675 | 6,544 | 8,003 | 5,624 | 321 | 151 | 265 | 440 | 87 | 330 |
| Kingston | Eglinton Ave E | Scarborough Golf Club R | 60 | 30,125 | 26,715 | 28,173 | 25,801 | 452 | 240 | 1,018 | 385 | 482 | 289 |
| | carborough Golf Club R | Cormwell Rd | 60 | 27,533 | 24,416 | 26,617 | 23,664 | 248 | 342 | 504 | 234 | 165 | 176 |
| | Cormwell Rd | Dale Ave | 60 | 24,386 | 21,625 | 23,573 | 20,959 | 219 | 303 | 446 | 208 | 146 | 156 |
| | Dale Ave | Celeste Dr | 60 | 20,777 | 25,394 | 20,085 | 24,611 | 187 | 356 | 380 | 244 | 125 | 183 |
| | Celeste Dr | Overature Rd | 60 | 22,322 | 23,233 | 21,217 | 22,517 | 201 | 325 | 681 | 223 | 223 | 167 |
| | Overature Rd | Galloway Rd | 60 | 21,473 | 22,349 | 20,062 | 21,473 | 193 | 313 | 917 | 322 | 301 | 241 |
| | Galloway Rd | Poplar Rd | 60 | 18,959 | 19,733 | 17,330 | 18,959 | 246 | 276 | 1,041 | 284 | 341 | 213 |
| | Poplar Rd | Lawrence Rd | 60 | 18,892 | 19,663 | 17,422 | 18,892 | 246 | 275 | 922 | 283 | 302 | 212 |
| | Lawrence Rd | Morningside Rd | 60 | 18,562 | 19,320 | 17,268 | 18,563 | 241 | 270 | 793 | 278 | 260 | 209 |
| | Morningside Rd | Amiens Rd | 60 | 18,702 | 19,465 | 17,324 | 18,702 | 318 | 273 | 799 | 280 | 262 | 210 |
| | Amiens Rd | Fairwood Cres | 60 | 19,233 | 20,018 | 17,815 | 19,233 | 327 | 280 | 821 | 288 | 269 | 216 |

Note:
1. Bus/Truck voulmes, directional split were estimated based on the City of Toronto turning movement counts



*Air Quality Assessment for Scarborough – Malvern LRT EA*

**Future With LRT (2021)**

| LOCATION | SECTION FROM | SECTION TO | Posted Speed Limit | Total (cars-bus-trucks) NB / WB | Total (cars-bus-trucks) SB / EB | Cars NB / WB | Cars SB / EB | LRT NB / WB | LRT SB / EB | Medium Trucks NB / WB | Medium Trucks SB / EB | Heavy Trucks NB / WB | Heavy Trucks SB / EB |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **North South Roads** | | | | | | | | | | | | | |
| Morningside Ave | Kingston Rd | Warmsworth St | 60 | 10,866 | 10,030 | 10,683 | 9,543 | 236 | 236 | 104 | 367 | 78 | 120 |
| | Warmsworth St | Fairwood Cres | 60 | 13,528 | 12,487 | 12,960 | 11,880 | 236 | 236 | 325 | 457 | 243 | 150 |
| | Fairwood Cres | Ellesmere Rd | 60 | 12,460 | 13,498 | 11,832 | 12,842 | 236 | 236 | 359 | 494 | 269 | 162 |
| | Ellesmere Rd | Military Trail | 60 | 12,947 | 14,026 | 12,403 | 13,458 | 236 | 236 | 311 | 428 | 233 | 140 |
| | Military Trail | Milner Ave | 60 | 17,018 | 18,436 | 16,446 | 17,839 | 236 | 236 | 327 | 450 | 245 | 147 |
| Military Trail | Ellesmere Rd | Morningside Rd | 60 | 4,760 | 6,058 | 4,480 | 5,715 | 236 | 236 | 160 | 259 | 120 | 85 |
| **East West Roads** | | | | | | | | | | | | | |
| Eglinton Ave E | Midland Ave | Failmouth Ave | 60 | 17,557 | 14,956 | 16,846 | 13,448 | 236 | 236 | 535 | 861 | 176 | 646 |
| | Failmouth Ave | Brimley Rd | 60 | 14,780 | 18,064 | 14,061 | 16,243 | 236 | 236 | 541 | 1,040 | 177 | 780 |
| | Brimley Rd | Oswego Rd | 60 | 17,013 | 15,705 | 16,324 | 13,858 | 236 | 236 | 519 | 1,055 | 170 | 792 |
| | Oswego Rd | McCowan Rd | 60 | 17,618 | 15,008 | 17,190 | 13,243 | 236 | 236 | 322 | 1,009 | 106 | 756 |
| | McCowan Rd | Torrance Rd | 60 | 16,758 | 15,469 | 16,080 | 13,780 | 236 | 236 | 511 | 965 | 168 | 724 |
| | Torrance Rd | Cedar Brae Blvd (Bellamy | 60 | 14,873 | 13,729 | 14,271 | 12,461 | 236 | 236 | 454 | 725 | 149 | 544 |
| | edar Brae Blvd (Bellam | Mason Rd | 60 | 12,846 | 11,858 | 12,222 | 10,961 | 236 | 236 | 470 | 512 | 154 | 384 |
| | Mason Rd | Markham Rd | 60 | 12,822 | 11,836 | 12,303 | 10,643 | 236 | 236 | 391 | 682 | 128 | 511 |
| | Markham Rd | Cedar Drive | 60 | 10,576 | 9,762 | 10,062 | 8,778 | 236 | 236 | 387 | 562 | 127 | 422 |
| | Cedar Drive | Kingston Rd | 60 | 9,921 | 8,798 | 9,439 | 7,911 | 236 | 236 | 363 | 507 | 119 | 380 |
| Ellesmere Rd | Morningside Rd | Military Trail | 60 | 8,675 | 6,544 | 8,323 | 5,775 | 236 | 236 | 265 | 440 | 87 | 330 |
| Kingston | Eglinton Ave E | Scarborough Golf Club R | 60 | 30,125 | 26,715 | 28,101 | 26,066 | 236 | 236 | 1,157 | 489 | 868 | 160 |
| | carborough Golf Club R | Cormwell Rd | 60 | 27,533 | 24,416 | 26,840 | 24,021 | 236 | 236 | 396 | 298 | 297 | 98 |
| | Cormwell Rd | Dale Ave | 60 | 24,386 | 21,625 | 23,771 | 21,275 | 236 | 236 | 351 | 264 | 263 | 86 |
| | Dale Ave | Celeste Dr | 60 | 20,777 | 25,394 | 20,253 | 24,982 | 236 | 236 | 299 | 310 | 224 | 102 |
| | Celeste Dr | Overature Rd | 60 | 22,322 | 23,233 | 21,384 | 22,856 | 236 | 236 | 536 | 283 | 402 | 93 |
| | Overature Rd | Galloway Rd | 60 | 21,473 | 22,349 | 20,210 | 21,806 | 236 | 236 | 721 | 409 | 541 | 134 |
| | Galloway Rd | Poplar Rd | 60 | 18,959 | 19,733 | 17,526 | 19,253 | 236 | 236 | 819 | 361 | 614 | 118 |
| | Poplar Rd | Lawrence Rd | 60 | 18,892 | 19,663 | 17,622 | 19,185 | 236 | 236 | 725 | 360 | 544 | 118 |
| | Lawrence Rd | Morningside Rd | 60 | 18,562 | 19,320 | 17,471 | 18,850 | 236 | 236 | 624 | 354 | 468 | 116 |
| | Morningside Rd | Amiens Rd | 60 | 18,702 | 19,465 | 17,602 | 18,992 | 236 | 236 | 628 | 356 | 471 | 117 |
| | Amiens Rd | Fairwood Cres | 60 | 19,233 | 20,018 | 18,102 | 19,531 | 236 | 236 | 646 | 366 | 485 | 120 |

Note:
1. Bus/Truck voulmes, directional split were estimated based on the City of Toronto turning movement counts

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**Future Without LRT (2031)**

| LOCATION | SECTION | | 24 Hour AADT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Total (cars and trucks only) | | Cars | | Bus | | Medium Trucks | | Heavy Trucks | |
| | FROM | TO | NB / WB | SB / EB | NB / WB | SB / EB | NB / WB | SB / EB | NB / WB | SB / EB | NB / WB | SB / EB |
| North South Roads | | | | | | | | | | | | |
| Morningside Ave | Kingston Rd | Warmsworth St | 11,819 | 10,910 | 11,420 | 10,216 | 201 | 164 | 113 | 399 | 85 | 131 |
| | Warmsworth St | Fairwood Cres | 14,714 | 13,582 | 13,846 | 12,569 | 250 | 353 | 353 | 497 | 265 | 163 |
| | Fairwood Cres | Ellesmere Rd | 13,553 | 14,682 | 12,639 | 13,587 | 230 | 382 | 390 | 537 | 293 | 176 |
| | Ellesmere Rd | Military Trail | 14,082 | 15,256 | 13,252 | 14,241 | 239 | 397 | 338 | 465 | 253 | 153 |
| | Military Trail | Milner Ave | 18,511 | 20,053 | 17,574 | 18,882 | 315 | 521 | 355 | 489 | 267 | 160 |
| Military Trail | Ellesmere Rd | Morningside Rd | 5,178 | 6,590 | 4,785 | 6,045 | 88 | 171 | 174 | 281 | 130 | 92 |
| East West Roads | | | | | | | | | | | | |
| Eglinton Ave E | Midland Ave | Failmouth Ave | 19,097 | 16,268 | 17,560 | 14,026 | 764 | 602 | 582 | 937 | 191 | 703 |
| | Failmouth Ave | Brimley Rd | 16,076 | 19,648 | 14,780 | 17,000 | 514 | 668 | 588 | 1,132 | 193 | 849 |
| | Brimley Rd | Oswego Rd | 18,506 | 17,082 | 17,164 | 14,493 | 592 | 581 | 564 | 1,148 | 185 | 861 |
| | Oswego Rd | McCowan Rd | 19,164 | 16,325 | 18,162 | 13,817 | 537 | 588 | 351 | 1,097 | 115 | 823 |
| | McCowan Rd | Torrance Rd | 18,228 | 16,826 | 16,980 | 14,383 | 510 | 606 | 556 | 1,050 | 182 | 787 |
| | Torrance Rd | Cedar Brae Blvd (Bellamy) | 16,178 | 14,934 | 15,070 | 13,016 | 453 | 538 | 493 | 788 | 162 | 591 |
| | edar Brae Blvd (Bellam | Mason Rd | 13,973 | 12,898 | 12,749 | 11,317 | 545 | 606 | 511 | 557 | 168 | 418 |
| | Mason Rd | Markham Rd | 13,947 | 12,874 | 12,838 | 10,971 | 544 | 605 | 425 | 742 | 139 | 556 |
| | Markham Rd | Cedar Drive | 11,503 | 10,618 | 10,496 | 9,049 | 449 | 499 | 421 | 612 | 138 | 459 |
| | Cedar Drive | Kingston Rd | 10,791 | 9,570 | 9,921 | 8,385 | 345 | 220 | 395 | 551 | 129 | 413 |
| Ellesmere Rd | Morningside Rd | Military Trail | 9,436 | 7,118 | 8,705 | 6,117 | 349 | 164 | 288 | 478 | 94 | 359 |
| Kingston | Eglinton Ave E | Scarborough Golf Club Rd | 32,768 | 29,058 | 30,645 | 28,065 | 492 | 262 | 1,108 | 418 | 524 | 314 |
| | carborough Golf Club R | Cormwell Rd | 29,949 | 26,558 | 28,951 | 25,740 | 270 | 372 | 548 | 255 | 180 | 191 |
| | Cormwell Rd | Dale Ave | 26,525 | 23,522 | 25,641 | 22,797 | 239 | 329 | 485 | 226 | 159 | 169 |
| | Dale Ave | Celeste Dr | 22,599 | 27,621 | 21,846 | 26,770 | 203 | 387 | 414 | 265 | 136 | 199 |
| | Celeste Dr | Overature Rd | 24,280 | 25,271 | 23,078 | 24,492 | 219 | 354 | 741 | 243 | 243 | 182 |
| | Overature Rd | Galloway Rd | 23,356 | 24,309 | 21,822 | 23,357 | 210 | 340 | 997 | 350 | 327 | 263 |
| | Galloway Rd | Poplar Rd | 20,622 | 21,464 | 18,851 | 20,622 | 268 | 300 | 1,132 | 309 | 371 | 232 |
| | Poplar Rd | Lawrence Rd | 20,549 | 21,388 | 18,950 | 20,549 | 267 | 299 | 1,003 | 308 | 329 | 231 |
| | Lawrence Rd | Morningside Rd | 20,191 | 21,015 | 18,783 | 20,191 | 262 | 294 | 862 | 303 | 283 | 227 |
| | Morningside Rd | Amiens Rd | 20,342 | 21,173 | 18,843 | 20,343 | 346 | 296 | 869 | 305 | 285 | 229 |
| | Amiens Rd | Fairwood Cres | 20,920 | 21,774 | 19,378 | 20,920 | 356 | 305 | 893 | 314 | 293 | 235 |



*Air Quality Assessment for Scarborough – Malvern LRT EA*

**Future With LRT (2031)**

| LOCATION | SECTION | | 24 Hour AADT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Total (cars and trucks only) | | Cars | | LRT | | Medium Trucks | | Heavy Trucks | |
| | FROM | TO | NB / WB | SB / EB | NB / WB | SB / EB | NB / WB | SB / EB | NB / WB | SB / EB | NB / WB | SB / EB |
| North South Roads | | | | | | | | | | | | |
| Morningside Ave | Kingston Rd | Warmsworth St | 11,819 | 10,910 | 11,621 | 10,380 | 236 | 236 | 113 | 399 | 85 | 131 |
| | Warmsworth St | Fairwood Cres | 14,714 | 13,582 | 14,096 | 12,922 | 236 | 236 | 353 | 497 | 265 | 163 |
| | Fairwood Cres | Ellesmere Rd | 13,553 | 14,682 | 12,870 | 13,969 | 236 | 236 | 390 | 537 | 293 | 176 |
| | Ellesmere Rd | Military Trail | 14,082 | 15,256 | 13,491 | 14,638 | 236 | 236 | 338 | 465 | 253 | 153 |
| | Military Trail | Milner Ave | 18,511 | 20,053 | 17,889 | 19,404 | 236 | 236 | 355 | 489 | 267 | 160 |
| Military Trail | Ellesmere Rd | Morningside Rd | 5,178 | 6,590 | 4,873 | 6,216 | 236 | 236 | 174 | 281 | 130 | 92 |
| East West Roads | | | | | | | | | | | | |
| Eglinton Ave E | Midland Ave | Failmouth Ave | 19,097 | 16,268 | 18,324 | 14,628 | 236 | 236 | 582 | 937 | 191 | 703 |
| | Failmouth Ave | Brimley Rd | 16,076 | 19,648 | 15,295 | 17,668 | 236 | 236 | 588 | 1,132 | 193 | 849 |
| | Brimley Rd | Oswego Rd | 18,506 | 17,082 | 17,756 | 15,073 | 236 | 236 | 564 | 1,148 | 185 | 861 |
| | Oswego Rd | McCowan Rd | 19,164 | 16,325 | 18,698 | 14,405 | 236 | 236 | 351 | 1,097 | 115 | 823 |
| | McCowan Rd | Torrance Rd | 18,228 | 16,826 | 17,490 | 14,989 | 236 | 236 | 556 | 1,050 | 182 | 787 |
| | Torrance Rd | Cedar Brae Blvd (Bellamy) | 16,178 | 14,934 | 15,523 | 13,554 | 236 | 236 | 493 | 788 | 162 | 591 |
| | edar Brae Blvd (Bellam | Mason Rd | 13,973 | 12,898 | 13,294 | 11,923 | 236 | 236 | 511 | 557 | 168 | 418 |
| | Mason Rd | Markham Rd | 13,947 | 12,874 | 13,382 | 11,576 | 236 | 236 | 425 | 742 | 139 | 556 |
| | Markham Rd | Cedar Drive | 11,503 | 10,618 | 10,944 | 9,548 | 236 | 236 | 421 | 612 | 138 | 459 |
| | Cedar Drive | Kingston Rd | 10,791 | 9,570 | 10,267 | 8,605 | 236 | 236 | 395 | 551 | 129 | 413 |
| Ellesmere Rd | Morningside Rd | Military Trail | 9,436 | 7,118 | 9,054 | 6,281 | 236 | 236 | 288 | 478 | 94 | 359 |
| Kingston | Eglinton Ave E | Scarborough Golf Club Rd | 32,768 | 29,058 | 30,566 | 28,352 | 236 | 236 | 1,258 | 532 | 944 | 174 |
| | carborough Golf Club R | Cormwell Rd | 29,949 | 26,558 | 29,194 | 26,128 | 236 | 236 | 431 | 324 | 323 | 106 |
| | Cormwell Rd | Dale Ave | 26,525 | 23,522 | 25,856 | 23,141 | 236 | 236 | 382 | 287 | 286 | 94 |
| | Dale Ave | Celeste Dr | 22,599 | 27,621 | 22,030 | 27,174 | 236 | 236 | 325 | 337 | 244 | 110 |
| | Celeste Dr | Overature Rd | 24,280 | 25,271 | 23,260 | 24,861 | 236 | 236 | 583 | 308 | 437 | 101 |
| | Overature Rd | Galloway Rd | 23,356 | 24,309 | 21,983 | 23,719 | 236 | 236 | 785 | 445 | 589 | 146 |
| | Galloway Rd | Poplar Rd | 20,622 | 21,464 | 19,063 | 20,942 | 236 | 236 | 891 | 393 | 668 | 129 |
| | Poplar Rd | Lawrence Rd | 20,549 | 21,388 | 19,168 | 20,868 | 236 | 236 | 789 | 391 | 592 | 128 |
| | Lawrence Rd | Morningside Rd | 20,191 | 21,015 | 19,003 | 20,504 | 236 | 236 | 678 | 385 | 509 | 126 |
| | Morningside Rd | Amiens Rd | 20,342 | 21,173 | 19,146 | 20,658 | 236 | 236 | 684 | 387 | 513 | 127 |
| | Amiens Rd | Fairwood Cres | 20,920 | 21,774 | 19,690 | 21,244 | 236 | 236 | 703 | 398 | 527 | 131 |

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