Appendix B.4
Air Quality

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Hamilton LRT B-Line

Hamilton, Ontario

Draft Report

Air Quality Assessment

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EXECUTIVE SUMMARY

RWDI AIR Inc. was retained to perform an air quality study for the proposed B-Line LRT. Since the LRT is an electrified rail system, it does not produce any significant local air emissions. On the contrary, it displaces emissions that otherwise would be generated by alternative methods of carrying its passengers, either automobile or bus. However, the existing traffic conditions and routes are expected to be altered to accommodate the B-Line LRT. Certain streets will be made one-way; the direction of flow of traffic will be reversed on others and the number of lanes on some roads will change. With the proposed LRT line in place traffic is expected to increase on certain sections of roads and decrease on others when compared to a "no LRT" scenario for the year 2021. The areas where traffic is expected to increase are the primary focus of this study. It assesses whether increased vehicle emissions in these areas will cause local air pollutant levels to exceed desirable limits to a noticeably greater extent than would otherwise be the case.

RWDI determined the detailed traffic movements for the entire study area based on the traffic data provided by SDG. Based on this detailed traffic analyses, RWDI identified three areas for detailed air quality study. Two of the areas (the section of Barton St from Kenilworth to Strathearne Ave and the section of York Blvd from Locke St to Hess St) were selected with the worst combination of high traffic volumes, large increase in traffic, and their proximity to the residential areas. For comparative purposes, another location (area centered on the intersection of King St and Main St) was selected with a large decrease in traffic with the LRT in place. The air quality assessment on these areas provides sufficient information about the worst-case air quality impact, both negative and positive, due to the implementation of B-Line LRT route.

Computer modeling, in combination with historical monitoring data, was used to predict the impact of projected traffic changes on local air quality. The computer model predicted the maximum contribution of the relevant traffic, and the historical monitoring data provided an estimate of the maximum contribution from background emission sources in the surrounding area (occasional events of elevated background concentration were excluded from the analysis).

For most contaminants, the predicted maximum concentrations at sensitive receptors near the roadways in the study area are within applicable air quality thresholds when combined with background concentrations. This is true for all roadway assessed, regardless of whether traffic changes with the LRT in place are positive or negative. The exceptional contaminants are benzene, and to some extent PM_{10}.

In the case of inhalable particulate matter (PM_{10}), the anticipated increase in traffic along York Boulevard may result in some slight exceedances of the applicable threshold at adjacent residences, but only under worst-case weather conditions, which would be infrequent. Along King Street and Main Street, on the other hand, PM_{10} levels will be reduced somewhat compared to existing levels, due to a reduction in traffic volumes with the LRT in place. Overall, the net effect for PM_{10} is anticipated to be small.

For benzene, both maximum 24-hour and annual concentrations exceed the thresholds at all locations, irrespective of positive or negative traffic changes and mainly due to the fact that the ambient background concentrations alone are higher than the thresholds. The anticipated changes in road traffic will add slightly to the benzene levels in some areas (most notably along York Boulevard) and will improve benzene levels slightly in other areas (along King Street and Main Street). Overall the net effect of the LRT on benzene levels is anticipated to be small.

The potential for additional tree plantings on public land adjacent to York Boulevard between Inchbury Street and Hess Street should be investigated, and additional plantings on private land adjacent to the road should be encouraged. This could potentially include additional tree plantings in the median, and in any open green spaces adjacent to the roadway, such as the open area south of York Boulevard, between Pearl Street and Ray Street.

In order to reduce the potential for air quality impacts during construction, it is recommended that an emissions management plan based on established best practices be implemented.

Given that changes in road traffic with the LRT in place are expected to have only a small impact on local air quality (negative in some areas and positive in others), a monitoring program, over and above existing monitoring in downtown Hamilton, has not been proposed.

1. INTRODUCTION

The City of Hamilton is proposing to develop a 5 line rapid transit network, as shown in Figure 1. Light rail transit (LRT) has been selected as the preferred mode. The LRT B-Line from McMaster University, via the Downtown to Eastgate Square has been identified as the first route.

RWDI AIR Inc. was retained to perform an air quality study for the proposed B-Line LRT. Since the LRT is an electrified rail system, it does not produce any significant local air emissions. On the contrary, it displaces emissions that otherwise would be generated by alternative methods of carrying its passengers, either automobile or bus. However, the existing traffic conditions and routes are expected to be altered to accommodate the B-Line LRT. Certain streets will be made one-way; the direction of flow of traffic will be reversed on others and the number of lanes on some roads will change. With the proposed LRT line in place traffic is expected to increase on certain sections of roads and decrease on others when compared to a “no LRT” scenario for the year 2021. The areas where traffic is expected to increase are the primary focus of this study. It assesses whether increased vehicle emissions in these areas will cause local air pollutant levels to exceed desirable limits to a noticeably greater extent than would otherwise be the case.

2. STUDY AREA

SDG provided traffic volumes (AM & PM Peak) for both “No LRT” and “LRT” scenarios for 2021. RWDI determined the detailed traffic movements for the entire study area based on the traffic data provided by SDG. The traffic movements for the study area are shown in Appendix A. These figures show the 2021 AM and PM peak traffic volumes at most of the major intersections in the study area for both “No LRT” and “LRT” scenarios. They also show the traffic increase or decrease for each of the intersections. Based on this detailed traffic analyses, RWDI identified three areas for detailed air quality study. Two of the areas were selected with the worst combination of high traffic volumes, large increase in traffic, and their proximity to the residential areas. For comparative purposes, another location was selected with a large decrease in traffic with the LRT in place. The air quality assessment on these areas would provide sufficient information about the worst-case air quality impact, both negative and positive, due to the implementation of B-Line LRT route.

The three areas selected are:

- Area centered on the intersection of King Street and Main Street (King/Main). Both of these streets are projected to have a significant decrease in traffic throughout the Downtown area with the LRT in place, and this particular area has relatively many residences in close proximity. Traffic arriving at this intersection during the peak hours is projected to decrease by approximately 50% (i.e., about 2000 fewer vehicles/hour in 2021) for the LRT scenario, compared to the No LRT scenario. Figure 2 shows the area around this intersection that was included in the detailed air quality analysis.

- The section of Barton Street from Kenilworth to Strathearne Avenue (Barton). Both Barton Street and Cannon Street are expected to have increases in traffic along most of their length with the LRT in place, but this particular section is expected to support a relatively high traffic volume in 2021 and have the largest increase in traffic. The projected traffic increase with the LRT in place is about 50% during the AM peak hour (i.e., an increase of about 1000 vehicles/hour) and 20% during the PM peak (about 500 vehicles/hour). Figure 3 shows the section of Barton Street that was included in the detailed air quality analysis.

- The section of York Boulevard from Locke Street to Hess Street (York). This area is expected to support a relatively high traffic volume, and is expected to have an increase in traffic with the LRT in place of about 25% during the AM peak hour (an increase of about 900 vehicles/hour), and about 35% during the PM peak hour (an increase of about 1300 vehicles/hour). Figures 4 show the section of York Boulevard included in the analysis.

3. CONTAMINANTS OF INTEREST

Airborne contaminants are produced from a variety of sources, including industrial activities and vehicular traffic. Hamilton is known for its many heavy industries, including large steel production facilities. Some of the main industrial emission sources in Hamilton, according to 2009 NPRI data; include the U.S Steel and Dofasco Steel Plants, Columbian Chemicals Canada Plant, the Hamilton Specialty Bar Plant and the Hamilton Community Energy Centre. Table 1 lists the contaminants that were analyzed in this study. The shown in the table are those that have relatively high emission rates associated with motor vehicles and also have relatively stringent guidelines for airborne concentration.

Table 1: Contaminants of Interest

Contaminant	Symbol or Chemical Formula
Carbon Monoxide	CO
Nitrogen Dioxide	NO_2
Respirable Particulate Matter	$PM_{2.5}$
Inhalable Particulate Matter	PM_{10}
Benzene	C_6H_6
1,3-Butadiene	C_4H_6
Formaldehyde	CH_2O
Acetaldehyde	CH_3CHO
Acrolein	C_3H_4O

4. RELEVANT GUIDELINES

The Province of Ontario has established both criteria and standards for concentrations of airborne contaminants (see Reference [2]). The Ambient Air Quality Criteria (AAQC's) are effects-based levels in air, based on health and/or other effects. They are used in environmental assessments, special air monitoring studies and assessments of general air quality to determine the potential for adverse effects. The standards, on the other hand, are established by Ontario Regulation 419/05, and are legal requirements which emitters in Ontario must meet. Most of the standards are based on the AAQC's but, in some cases, the standard and AAQC for a contaminant differ from each other. Since Ontario Regulation 419/05 does not apply to discharges of contaminants from motor vehicles only the AAQC's apply to the present assessment.

In addition to provincial AAQC's, the Federal Government and the Canadian Council of Ministers of the Environment have established National Ambient Air Quality Objectives and Canada-Wide standards (CWS) for some contaminants [3, 4]. These levels are effects-based levels in air based on health and other effects, depending on the pollutant. Of particular relevance is the CWS for $PM_{2.5}$ (respirable particulate matter), since $PM_{2.5}$ currently does not have a provincial AAQC in Ontario.

The aforementioned air quality criteria, objectives and standards are collectively referred to as air quality thresholds in this report. The thresholds used to assess potential project impacts are summarized in Table 2. In general, if the concentration or deposition level of an airborne pollutant can be maintained below its threshold, then either no health effect is observed or the effect is small enough that it presents an acceptably low risk to the population and the environment. It should also be noted that these thresholds represent target levels and are not specifically enforceable for motor vehicle emissions.

Table 2: Summary of Relevant Air Quality Thresholds (µg/m^3)

Pollutant	Criterion (µg/m³)	Averaging Period	Source	Reference
$PM_{2.5}$	30	24-hour	CWS	[4]
	30	24-hour	AAQC	[2]
PM_{10}	50	24-hour	AAQC	[2]
CO	36,200	1-hour	AAQC	[2]
	15,700	8-hour	AAQC	[2]
NO_2	400	1-hour	AAQC	[2]
	200	24-hour	AAQC	[2]
Benzene	2.3	24-hour	AAQC	[7]
	0.45	Annual	AAQC	[7]
1,3-Butadiene	10	24-hour	AAQC	[8]
	2	Annual	AAQC	[8]
Acrolein	4.5	1-hour	AAQC	[9]
	0.4	24-hour	AAQC	[9]
Acetaldehyde	500	30-minute	AAQC	[2]
	500	24-hour	AAQC	[2]
Formaldehyde	65	24-hour	AAQC	[2]

The World Health Organization (WHO) published new air quality guidelines for several contaminants in the year 2000 with updates in 2005 for $PM_{2.5}$, PM_{10}, NO_2 and SO_2. Table 3 summarizes the WHO guidelines for some of the contaminants of interest. Some jurisdictions have adopted these globally applicable guidelines as their own and, as such, it was considered prudent to include them for reference purposes, even though they have not been officially adopted in Ontario at this time.

Table 3: Summary of Relevant Air Quality Thresholds from the World Health Organization

Pollutant	Criterion (µg/m³)	Averaging Period	Source
$PM_{2.5}$	25	24-hour	WHO
	10	Annual	WHO
PM_{10}	50	24-hour	WHO
	20	Annual	WHO
CO	30,000	1-hour	WHO
	10,000	8-hour	WHO
NO_2	200	1-hour	WHO
	40	Annual	WHO
Formaldehyde	100	30-minute	WHO

5. BACKGROUND AIR QUALITY CONDITIONS

Current general air quality conditions in the study area were determined by looking at historical air pollutant monitoring data from stations throughout the Hamilton area. These data are available from a variety of sources, including:

- Ontario Ministry of the Environment (MOE) stations;
- Hamilton Air Monitoring Network (HAMN) stations; and,
- National Air Pollutant Surveillance Network (NAPS) stations.

Where monitoring results for a specific contaminant were not available from the Hamilton area monitoring stations, data from the most representative available stations in Southern Ontario were used as surrogates. The air pollutant monitoring data were used as a representation of present-day outdoor concentrations of the contaminants of concern (CACs, VOCs, and PAHs) in the Hamilton area. These are referred to as background concentrations. Background concentrations can vary widely from day-to-day, depending on the weather conditions, and also vary from place-to-place.

The proposed B-Line runs in a general east-west direction, from Eastgate Square to McMaster University. Table 4 summarizes the air quality monitoring stations used to develop the background concentrations for the B-Line study. Based on their location, the MOE Hamilton Downtown, the MOE Hamilton West, NAPS Hamilton Downtown and the HAMN stations are the most representative in terms of background concentrations for the B-Line. Formaldehyde, acetaldehyde, and acrolein are not monitored at any of the Hamilton-area stations; therefore, ambient concentrations of these contaminants were obtained from the nearest available station, NAPS Toronto Ruskin & Perth.

Table 4: Ambient Station Information

Pollutant	Stations / Years with Data Available
Nitrogen Dioxide (NO_2)	MOE Hamilton Downtown: 2003-2008 MOE Hamilton West: 2003 HAMN - Station 29567: 2009 HAMN - Station 29102: 2006-2009 HAMN - Station 29547: 2009
Carbon Monoxide (CO)	MOE Hamilton Downtown: 2003-2008
Respirable Particulate Matter ($PM_{2.5}$)	MOE Hamilton Downtown: 2003-2008 MOE Hamilton West: 2003-2008
Inhalable Particulate Matter (PM_{10})	HAMN - Station 29567: 2006-2009 HAMN - Station 29113: 2009 HAMN - Station 29102: 2006-2009 HAMN - Station 29547: 2009
Formaldehyde	NAPS Toronto Ruskin & Perth: 1999-2003
Acetaldehyde	NAPS Toronto Ruskin & Perth: 1999-2003
Benzene	MOE Hamilton Downtown: 2003-2004 HAMN - Station 29567: 2006-2009 HAMN - Station 29113: 2006-2009 HAMN - Station 29102: 2006-2009
1,3-Butadiene	NAPS Elgin & Kelly, Hamilton Downtown: 1999-2003
Acrolein	NAPS Toronto Ruskin & Perth: 1999-2003

The locations of these stations, with the exception of the NAPS Toronto Station, are shown in Figure 5. Table 5, presented below, shows representative high-end values, averaged over multiple years of data and multiple monitoring sites throughout the Hamilton area. These background air quality conditions are applicable to the B-Line study area. One exception is PM_{10}, as these data came mainly from HAMN stations in the industrial basin, close to the steel mills. PM_{10} in the B-Line study area are expected to be considerably lower. As noted in the footnote of Table 5, an alternate estimate of PM_{10} was derived from the $PM_{2.5}$ data.

Table 5: Ambient Monitoring Results for the MOE Hamilton Downtown, the MOE Hamilton West, NAPS and HAMN stations (µg/m³)

Pollutant	Statistic	Result (Over all Years and Stations)		AAQC or CWS
		Maximum	Average	(µg/m³)
NO_2 (µg/m³)	1-hr Maximum	101	85	400
	24-hr Maximum	76	55	200
	Annual Mean	26	20	- -
	1hr-90th Percentile	45	40	- -
	Times > 1-hr AAQC (400)	0	0	- -
	Times > 24-hr AAQC (200)	0	0	- -
CO (µg/m³)	1-hr Maximum	7,195	4,375	36,200
	8-hr Maximum	2,109	1,782	15,700
	Annual Mean	530	354	- -
	1hr-90th Percentile	1,302	747	- -
	Times > 1-hr AAQC (36,200)	0	0	- -
	Times > 24-hr AAQC (15,700)	0	0	- -
$PM_{2.5}$ TEOM (µg/m³)	1-hr Maximum	108	80	- -
	24-hr Maximum	46	41	30
	Annual Mean	11	8.9	- -
	1hr-90th Percentile	24	20.4	- -
	24hr-90th Percentile	21	18.1	- -
	Times > CWS (30)	15	7.8	- -
PM_{10} TEOM[1] (µg/m³)	1-hr Maximum	1,000	558	- -
	24-hr Maximum	338	141	50
	Annual Mean	41	31	- -
	1hr-90th Percentile	44.4	37.8	- -
	24hr-90th Percentile	n/a	n/a	- -
	Times > 24-hr AAQC (50)	83	45	- -
Formaldehyde (µg/m³)	24-hr Maximum	11.1	7.1	65
	Annual Mean	2.8	2.7	- -
	1hr-90th Percentile	5.8	4.6	- -
Acetaldehyde (µg/m³)	24-hr Maximum	5.1	4.4	500
	Annual Mean	1.8	1.7	- -
	1hr-90th Percentile	3.2	2.7	- -

Pollutant	Statistic	Result (Over all Years and Stations)		AAQC or CWS
		Maximum	Average	(µg/m³)
Benzene (µg/m³)	24-hr Maximum	193	19	2.3
	Annual Mean	2.4	1.4	0.45
	24hr-90th Percentile	3.8	3.6	- -
1,3-Butadiene (µg/m³)	24-hr Maximum	0.72	0.54	10
	Annual Mean	0.15	0.13	2
	1hr-90th Percentile	0.43	0.29	- -
Acrolein (µg/m³)	24-hr Maximum	0.90	0.44	4.5
	Annual Mean	0.10	0.10	0.4
	1hr-90th Percentile	0.30	0.22	- -
Ozone (ppb)	1-hr Max	110	92	- -
	24-hr Max	80	68	- -
	Annual Mean	25	23	- -
	1hr-90th Percentile	45	43	- -
	24hr-90th Percentile	41	37	- -

Notes: [1] PM_{10} data came only from HAMN stations in close proximity to the steel mills. PM10 is better represented by scaling from the average $PM_{2.5}$ data by using an average equation, $PM_{10} = PM_{2.5}/0.54$. This gives a mean value of 16 µg/m³ and a 90th percentile value of 33.5 µg/m³

Table 5 provides the maximum concentrations for the 1-hour and 24-hour averaging periods, as applicable. This table also includes the annual mean and 90th percentile concentrations, where available. The annual mean values are representative of typical conditions, the 90th percentile values (values of concentration which are exceeded only 10% of the time) are representative of typical high-concentration periods, and maximum values are representative of rare, extreme events.

The majority of the contaminants are less than their relevant AAQC, even when considering the maximum concentrations over multiple stations and multiple years. However, PM_{10}, $PM_{2.5}$, and benzene do exceed their criteria at least some of the time.

PM_{10} and $PM_{2.5}$ have maximum concentrations that are above their 24-hour AAQC and CWS. These elevated maximums result from high particulate matter events that occur in Hamilton from time-to-time. However, for both of these contaminants, the annual means are well below the AAQC, indicating that on an average day, the ambient concentrations of PM_{10} and $PM_{2.5}$ are below the criterion. In the case of $PM_{2.5}$, the concentrations remain below the CWS at the 90th percentile level and, at the average monitoring station in an average year, meet it at approximately the 98th percentile level (i.e., the CWS is exceeded less than 8 days/year). In the case of PM_{10}, the AAQC is exceeded at approximately the 88th percentile level at the average HAMN monitoring station in the industrial basin, in an average year (i.e., exceeded on 45 days/year). In the B-Line study area, it is estimated that PM_{10} is below the AAQC at the 90th percentile level.

For benzene, the overall maximum concentrations are quite high, and represent rare, outlying events. The 90th percentile values and annual means are much lower than the overall maxima, although still above the proposed AAQC.

Ozone is included in the above table because although it is not emitted directly from vehicle exhausts, it is used in predicting the formation of NO_2 from vehicular NO_x emissions (see Section 7.5).

Some of the VOC species (acrolein and acetaldehyde) have AAQC's that apply to an averaging time of 1 hour or less, but the historical monitoring data are available on a 24-hour basis only. In these cases, the 90th percentile background concentration for the shorter averaging times was assumed to be equal to that based on the 24-hour averages.

The 24-hr and 1-hr 90th percentile background values of PM_{10} shown in the table were estimated from observed $PM_{2.5}$ levels, using published data on the ratio of PM_{10} to $PM_{2.5}$. Studies in the U.S. have found that the $PM_{2.5}/PM_{10}$ ratio is normally distributed with a mean of 0.54, a median of 0.53, a minimum of 0.16, and a maximum of 0.94 [10]. This result was based on an analysis of a large amount of data and stations. Therefore, 90th percentile background PM_{10} concentrations were calculated using the mean $PM_{2.5}/PM_{10}$ ratio of 0.54.

6. DISPERSION MODELLING METHODOLOGY

The methodology consists of the following basic steps:

- Vehicle emissions modeling to predict emission rates of the Contaminants of concerns (CoC's) from local traffic;
- Dispersion modeling, to predict how the emitted pollutants disperse into the surrounding area and to determine the resulting airborne concentrations of CoC's contributed by the local traffic; and
- Review of historical monitoring data to determine background concentrations of CoC's onto which the contribution from local traffic is added.

Details of the methodology are provided in the following sections.

6.1 Emission Rate Calculations

The standard approach for estimating vehicular emissions is to use computer simulation techniques that are based on extensive previous testing of a wide range of vehicles. The MOBILE6.2 model, developed for this purpose by the U.S. Environmental Protection Agency, was used to generate emission factors (i.e., emission rate in grams/second, per vehicle, per kilometre of travel). There is a Canadian version of the program, MOBILE6.2C; however, the final version of the program has not been officially released. RWDI completed a comparative analysis of the results from MOBILE6.2 and MOBILE6.2C (draft version) based on default input values, with a vehicle speed of 100 km/hr for a horizon year of 2031. Table B3 represents the estimated emissions data from that comparative analysis and shows the MOBILE6.2 version produces slightly higher emission factors. MOBILE6.2 was applied in this assessment. Key model inputs including climate data and vehicle classification information are provided in Appendix B.

A new model for estimating vehicular emissions has been developed by the U.S. Environmental Protection Agency - MOVES2010a (MOVES). MOVES implementation has been effective as of March 2, 2010 with a grace period of two years. This model is going to be mandatory in the U.S. for transportation conformity analysis from March 2, 2012. The two years grace period has been granted to allow different agencies to get accustomed to the new model as well as to prepare necessary background documents and user-specified databases required for transportation conformity analysis. In Canada, Environment Canada is planning to implement the model in accordance with the US time line, however, the model is not yet ready for Canadian applications.

Vehicle exhaust emissions are sensitive to outside temperature conditions, and tend to be much higher during the winter months than during the summer. For the present assessment, MOBILE6.2 was programmed to provide emissions under winter temperature conditions, representing the worst-case.

Exhaust emissions also vary widely by type of vehicle, and MOBILE6.2 provides emission factors for several different categories (Classes 1 to 8). These individual emission factors were aggregated to produce a composite emission factor for each pollutant, representing the average vehicle. This required information on the mix of different vehicle types using the roadway. The vehicle mix for the study area provided by SDG (96% Cars and 4% trucks) seems to be different than that from the national average of 94% cars and 6% trucks reported by Statistics Canada in their 2009 vehicle survey report. As a conservative approach, Statistics Canada data was used in this study.

For any signalized intersection (e.g., on arterial roads), it was necessary to obtain emission factors to represent the idling that occurs at those locations. MOBILE6.2 did not directly provide emission factors for engines at idle but, as per U.S. EPA guidance, emission factors based on an operating speed of 4 km/hr were used to represent idling.

For particulate matter, emissions result from the re-suspension of dust as vehicles travel over a roadway surface, in addition to tailpipe emissions. The road dust emissions were calculated based on the revised version of U.S. EPA's AP-42, Chapter 13.2.1, released in January 2011. The tailpipe emission factor for particulate matter is added to the road dust emission factor in order to account for both emission sources. Appendix B presents that emission factors generated using MOBILE6.2.

6.2 Dispersion Modelling

Air contaminants emitted from vehicles on a roadway will drift downwind and disperse as they travel. The degree to which the contaminants disperse depends on the weather-related factors, such as wind speed and amount of turbulence. The only approach to determine potential future downwind concentrations from a proposed project is through the use of computer simulation that predicts the dispersal of air pollutants as they drift away from the roads. These simulations are referred to as dispersion models.

Dispersion modelling is a common approach for assessing local air quality near an emission source such as vehicular traffic. The U.S. EPA developed a model known as CAL3QHCR that is intended specifically to predict air contaminant levels downwind of roadways. The model takes emission factors and combines them with historical hourly meteorological data, information on traffic volumes, and the configuration of the roadway. It uses this information to predict roadway contributions to air quality levels at selected locations (sensitive receptors) adjacent to the roadway under a variety of weather conditions.

The CAL3QHCR dispersion model predicts air pollutant concentrations near a roadway by first allocating the vehicle emissions to linear segments of the roadway, known as roadway links. A new link must be defined whenever the road width, traffic volume, speed, alignment, or type of traffic movement (free flow or queue) changes. The sections of roadway that were included in the modelling are shown in Figures 2 through 4. These figures also show the selected receptors.

A free flow link is defined as a straight segment of roadway having a constant width, height, traffic volume, travel speed, and vehicle emission factor. A queue link is defined as a straight segment of roadway with constant width and emission source strength, on which vehicle idling takes place for specified periods of time (e.g., at signalized intersections). The model calculates the contribution from all of the relevant links to each individual receptor so that the cumulative impact can be determined [12, 13].

6.3 Meteorological Data

Two meteorological datasets were needed in order to run the CAL3QHCR model: upper air data and surface data. The data sets used in the analysis were selected based on guidance from the Ontario Ministry of the Environment for regulatory dispersion modelling in Ontario [14]. Upper air data were obtained for Buffalo, New York (the nearest source of such data) for the year 2009. Surface data were obtained for Hamilton Airport, also for the year 2009. These meteorological datasets were processed for use with CAL3QHCR.

The choice of meteorological year was based on the results of a screening level analysis. This screening-level assessment involved running the CAL3QHCR model for a single contaminant using each of five years of hourly meteorological data (2005 – 2009), and comparing the results. The year 2009 was found to result in an above average concentration levels compared to the other four years for both 1-hour and 24-hr averaging times, when all receptors were taken into consideration and was therefore the year of data adopted as worst-case for use with the study.

6.4 Combining Model Results with Background Data

CAL3QHCR predicted the roadway's contribution to concentrations of contaminants at nearby sensitive receptors. The results were combined with the data on background concentrations. The background concentrations represented the contributions from all other emissions sources in the area and were derived from historical monitoring data, as described in Section 5. The resulting cumulative concentrations were then compared to applicable thresholds.

The maximum CAL3QHCR result for each contaminant, under the worst-case meteorological condition, was added to an estimate of the maximum coincident background concentration. The latter was based on the 90th percentile level from the historical monitoring data, averaged over all available ambient monitoring stations. This approach excludes occasional events of elevated background concentration which have a low likelihood of occurring at the same time as the maximum contribution from the modelled roadways.

6.5 Ozone Limiting Method

When oxides of nitrogen (NO_x) are emitted in diesel exhaust, their initial composition is dominated by nitric oxide (NO). Once in the outside air, some of the NO is oxidized in reactions with other pollutants (principally ground-level ozone) to produce NO_2, which is a contaminant of concern with established air quality thresholds.

For the purposes of this assessment, the Ozone Limiting Method (OLM) was used to estimate the maximum short-term NO_2 concentrations resulting from emissions of NO_x. This method assumes that the conversion of NO to NO_2 is limited only by the amount of ozone (O_3) present in the outside air. If the concentration of available O_3 (ppm) is less than that of the NO contributed by the modelled roadway emissions, then the portion of NO that is converted to NO_2 equals the available O_3. On the other hand, if the concentration of available O_3 exceeds that of the NO contributed by the modelled roadway, then all of the NO is converted to NO_2. The OLM method also assumes that approximately 10% of the emitted NO_x is already in the form of NO_2 before exiting the tailpipe.

The OLM is expressed mathematically as follows:

$$\text{If } 0.9NO_x < O_3, \text{ then } NO_2 = NO_x$$
$$\text{If } 0.9NO_x > O_3, \text{ then } NO_2 = 0.1NO_x + O_3$$

For initial worst-case estimates of cumulative NO_2 concentrations, an average of 90th percentile ozone concentration over 2003-2008 ambient background data from Hamilton Downtown station was used in this calculation.

7. RESULTS

7.1 Assessment of Maximum Local Impacts

Tables 6 to 8 present a summary of the predicted maximum cumulative concentrations (maximum modelled project contribution plus 90th percentile or maximum annual background) at the most impacted sensitive receptor for the Barton, King/Main, and York sections of the study area, respectively. The resultant concentrations are compared to applicable thresholds. Predicted maximum concentrations for each contaminant at all sensitive receptor location are provided in Appendix C.

Table 6: Maximum Predicted Concentrations in µg/m^3 for the Barton Section (2021 with LRT)

Contaminant	Averaging Period	Most Impacted Receptor	Predicted Conc. (µg/m^3)	90th Percentile Background (µg/m^3)[1]	Cumulative Conc. (µg/m^3)	Threshold (µg/m^3)	% of Threshold
CO	1 hr	R13	1132	747	1879	36,200	5%
CO[2]	8 hr	R13	632	747	1379	15,700	9%
NO_2	1 hr	R13	79	40	119	400	30%
NO_2	24 hr	R11	22	34	56	200	28%
$PM_{2.5}$	24 hr	R11	2.2	18	20.2	30	67%
PM_{10}	24 hr	R11	6.6	34	40.6	50	81%
Formaldehyde	24 hr	R11	0.31	4.6	4.9	65	8%
Acetaldehyde	24 hr	R11	0.12	2.7	2.82	500	1%
Acetaldehyde[3]	30 min	R13	0.48	8.1	8.6	500	2%
Benzene	24 hr	R11	0.63	3.6	4.23	2.3	184%
Benzene	Annual	R11	0.15	1.4	1.55	0.45	345%
1,3-Butadiene	24 hr	R11	0.07	0.29	0.36	10	4%
1,3-Butadiene	Annual	R11	0.02	0.13	0.15	2	7%
Acrolein	24 hr	R11	0.02	0.22	0.24	0.4	59%
Acrolein	1-hr	R13	0.054	0.22	0.27	4.5	6%

Note: [1] 1-hr, ½-hour, and 24-hour background concentrations were based on 90th percentile values. Annual background values were based on the annual mean value, averaged over the available ambient monitoring stations.
[2] 8-hr predicted CO concentration is calculated from 1-hr predicted concentration using a published conversion factor (Ontario Regulation 419/05, 17(1)).
[3] 30-minute acetaldehyde concentration is calculated from 1-hr predicted concentration using a published conversion factor (Ontario Regulation 419/05, 17(1)).

Table 7: Maximum Predicted Concentrations in µg/m^3 for the King/Main Section (2021 with LRT)

Contaminant	Averaging Period	Most Impacted Receptor	Predicted Conc. (µg/m^3)	90th Percentile Background (µg/m^3) [1]	Cumulative Conc. (µg/m^3)	Threshold (µg/m^3)	% of Threshold
CO	1 hr	R2	1006	747	1753	36,200	7%
CO[2]	8 hr	R2	562	747	1309	15,700	8%
NO_2	1 hr	R2	48	40	88	400	22%
NO_2	24 hr	R6	13	34	47	200	24%
$PM_{2.5}$	24 hr	R6	3	18	21.1	30	70%
PM_{10}	24 hr	R6	8	34	41.8	50	84%
Formaldehyde	24 hr	R6	0.21	4.6	4.8	65	7%
Acetaldehyde	24 hr	R6	0.08	2.7	2.78	500	1%
Acetaldehyde[3]	30 min	R2	0.36	8.1	8.5	500	2%
Benzene	24 hr	R6	0.48	3.6	4.08	2.3	177%
Benzene	Annual	R2	0.11	1.4	1.51	0.45	335%
1,3-Butadiene	24 hr	R6	0.048	0.29	0.34	10	3%
1,3-Butadiene	Annual	R2	0.011	0.13	0.14	2	7%
Acrolein	24 hr	R6	0.011	0.22	0.23	0.4	58%
Acrolein	1-hr	R2	0.041	0.22	0.26	5	6%

Note: [1] 1-hr, ½-hour, and 24-hour background concentrations were based on 90th percentile values. Annual background values were based on the annual mean value, averaged over the available ambient monitoring stations.
[2] 8-hr predicted CO concentration is calculated from 1-hr predicted concentration using a published conversion factor (Ontario Regulation 419/05, 17(1)).
[3] 30-minute acetaldehyde concentration is calculated from 1-hr predicted concentration using a published conversion factor (Ontario Regulation 419/05, 17(1)).

Table 8: Maximum Predicted Concentrations in µg/m^3 for the York Section (2021 with LRT)

Contaminant	Averaging Period	Most Impacted Receptor	Predicted Conc. (µg/m^3)	90th Percentile Background (µg/m^3) [1]	Cumulative Conc. (µg/m^3)	Threshold (µg/m^3)	% of Threshold
CO	1 hr	R7	1702	747	2449	36,200	5%
CO[2]	8 hr	R7	951	747	1698	15,700	11%
NO_2	1 hr	R7	98	40	138	400	34%
NO_2	24 hr	R7	37	34	71	200	36%
$PM_{2.5}$	24 hr	R5	5	18	22.5	30	75%
PM_{10}	24 hr	R5	17	34	50.6	50	101%
Formaldehyde	24 hr	R11	0.53	4.6	5.1	65	8%
Acetaldehyde	24 hr	R11	0.20	2.7	2.90	500	1%
Acetaldehyde[3]	30 min	R7	0.71	8.1	8.8	500	2%
Benzene	24 hr	R11	1.12	3.6	4.72	2.3	205%
Benzene	Annual	R11	0.30	1.4	1.70	0.45	377%
1,3-Butadiene	24 hr	R11	0.115	0.29	0.41	10	4%
1,3-Butadiene	Annual	R11	0.031	0.13	0.16	2	8%
Acrolein	24 hr	R11	0.026	0.22	0.25	0.4	62%
Acrolein	1-hr	R7	0.078	0.22	0.30	5	7%

Note: [1] 1-hr, ½-hour, and 24-hour background concentrations were based on 90th percentile values. Annual background values were based on the annual mean value, averaged over the available ambient monitoring stations.
[2] 8-hr predicted CO concentration is calculated from 1-hr predicted concentration using a published conversion factor (Ontario Regulation 419/05, 17(1)).
[3] 30-minute acetaldehyde concentration is calculated from 1-hr predicted concentration using a published conversion factor (Ontario Regulation 419/05, 17(1)).

The results in Tables 6 to 8 show that, for most of the contaminants and averaging times, the predicted maximum cumulative concentrations are well within the applicable thresholds. In these cases, therefore, the anticipated changes in road traffic with the LRT in place do not have a significant effect. The exceptions are benzene and PM_{10} (inhalable particulate matter), which are discussed in the following paragraphs.

Benzene is a gaseous organic compound with evidence of adverse effects in humans (the direct evidence is based industrial exposures at much higher levels than those predicted here). In all cases, the roadway's maximum contribution to benzene levels, on its own, is well within the proposed AAQC for benzene, but when it is added to the background concentration, the resulting cumulative concentrations exceed the criteria at all receptors. In fact, the background concentrations for both averaging times alone were higher than the applicable thresholds. In most cases, the contribution of the modeled road traffic is very small in relation to the background concentration (generally less than 10%, even at locations adjacent to the roadways). This indicates that the traffic changes associated with implementation of the LRT will have only a very small impact on the cumulative concentrations

The largest predicted cumulative concentrations for benzene occur along York Boulevard. This roadway's predicted contribution to benzene levels is about 30% of background at the most-impacted receptor, with the LRT in place. Without the LRT in place, this contribution would be only about 20% of background, indicating that the effect of the traffic change on maximum cumulative benzene levels is only about 10% at the most-impacted receptors. Along King Street and Main Street, the maximum cumulative benzene concentrations are expected to improve slightly due to the projected decrease in traffic volume on these roads, with the LRT in place.

PM_{10}, or inhalable particulate matter, has evidence of respiratory effects in humans. The strongest association with health effects occurs with the respirable fraction of PM_{10}, referred to as $PM_{2.5}$, which has its own criteria and was assessed separately in this study. The WHO guidelines for PM_{10} were derived from those developed for $PM_{2.5}$ and the WHO has indicated that the quantitative evidence on coarse PM (i.e., PM_{10}) is insufficient to develop separate guidelines from fine PM ($PM_{2.5}$) [15].

The anticipated increase in traffic on York Boulevard with the LRT in place is predicted to cause the maximum cumulative concentration of PM_{10} (inhalable particulate matter) to exceed its AAQC slightly at one of the modeled receptors (an adjacent residence). This result is associated with worst-case weather conditions, which would be infrequent. Without the LRT, the predicted maximum cumulative concentration of PM_{10} would be slightly below its AAQC.

Given the small impact area, small magnitude of the exceedance, and the fact that predicted maximum concentrations of $PM_{2.5}$ (i.e. the respirable fraction of PM_{10} particles) are within their threshold, the effect of the predicted exceedance for PM_{10} is considered to be very small.

7.2 Mitigation Measures

Trees have been found to be effective in both aiding the mixing and dispersion of various pollutants and in the capture of particulate matter, helping to prevent the spread of particulate matter away from the roadway. In the case of the Roadway 401 improvements project, tree plantings would be beneficial in areas where there is risk of sensitive receptors being affected by PM_{10} concentrations above threshold levels and space permits, such as the residences backing onto the north side of Roadway 401 located east and west of Warden Avenue, and the residences backing onto the north side of Roadway 401 located east and west of Brimley Road.

The maximum PM_{10} concentrations contributed by the roadway are generally associated with very low wind speeds. A study done by Fugii et al. (2008), used wind tunnel tests to measure how much motor vehicle exhaust particulate passes through a 2m wide vegetative barrier under various wind speeds [17]. The particulate removal was very effective at wind speeds less than about 2 m/s, especially for conifers (Redwood). At 1 m/s the removal efficiency was as high as around 80%. Above 2 m/s, the removal efficiency was very low - less than 20%. The study concluded that the effectiveness of vegetation barriers is greatest at low wind speeds and where the planting is done very close to the source.

The benefit of vegetation plantings would be primarily for particulate matter (PM_{10}), but may also extend to other pollutants to some extent, since the foliage will provide some uptake of gaseous pollutants and increase the mixing and dispersion of these pollutants as well.

Several studies have also looked at the effect of noise barriers on air pollutant levels downwind of roadways. The findings are somewhat more mixed than in the case of vegetation. Baldauf et al. (2008) found 15-50% reductions in carbon monoxide and ultrafine particles behind a barrier when the wind was perpendicular to the roadway; however, they also found that the concentrations behind a barrier might be somewhat higher compared to no barrier under certain other wind conditions [18]. Ning et al. (2010) measured reduced pollutant concentrations immediately downwind of noise barriers but a surge in concentration farther downwind (80-100m), and a longer distance to return to background pollutant concentrations 250-400m) compared to no barrier (150-200m) [19]. Hagler et al. predicted 15% to 61% reductions in gaseous pollutants at 20m from a roadway and at half the height of the barrier, for barriers ranging from 3 to 18m high, and for wind perpendicular to the roadway [20].

In summary, recently published studies indicate that tall vegetation is very effective at reducing pollutant concentrations downwind of roadways, and that noise barriers can also reduce pollutant levels in areas immediately behind the barrier (within 80m).

7.3 Emissions during the Construction Phase

Air quality impacts from the construction phase are not included in the assessment. Construction activities will involve heavy equipment that generates air pollutants and dust; however, these impacts are temporary in nature. The emissions are highly variable and difficult to predict, depending on the specific activities that are taking place and the effectiveness of the mitigation measures. The best manner to deal with these emissions is through diligent implementation of operating procedures such as application of dust suppressants, reduced travel speeds for heavy vehicles, efficient staging of activities and minimization of haul distances, covering up stockpiles, etc. It is recommended that in order to minimize potential air quality impacts during construction, the construction tendering process should include requirements for implementation of an emissions management plan. Such a plan would set out established best management practices for dust and other emissions. Some of the best practices include the following [21, 22, 23, 24, 25]:

- Use of reformulated fuels, emulsified fuels, exhaust catalyst and filtration technologies, cleaner engine repowers, and new alternative-fuelled trucks to reduce emissions from construction equipment.
- Regular cleaning of construction sites and access roads to remove construction-caused debris and dust.
- Dust suppression on unpaved haul roads and other traffic areas susceptible to dust, subject to the area being free of sensitive plant, water or other ecosystems that may be affected by dust suppression chemicals.
- Covered loads when hauling fine-grained materials.
- Prompt cleaning of paved streets/roads where tracking of soil, mud or dust has occurred.
- Tire washes and other methods to prevent trucks and other vehicles from tracking soil, mud or dust onto paved streets or roads.
- Covered stockpiles of soil, sand and aggregate as necessary.
- Compliance with posted speed limits and, as appropriate, further reductions in speeds when travelling sites on unpaved surfaces.

8. CONCLUSIONS

For most contaminants, the predicted maximum concentrations at sensitive receptors near the roadways in the study area are within applicable air quality thresholds when combined with background concentrations. This is true for all roadway assessed, regardless of whether traffic changes with the LRT in place are positive or negative. The exceptional contaminants are benzene, and to some extent PM_{10}.

In the case of inhalable particulate matter (PM_{10}), the anticipated increase in traffic along York Boulevard may result in some slight exceedances of the applicable criterion at adjacent residences, but only under worst-case weather conditions, which would be infrequent. Along King Street and Main Street, on the other hand, PM_{10} levels will be reduced somewhat compared to existing levels, due to a reduction in traffic volumes with the LRT in place. Overall, the net effect for PM_{10} is anticipated to be small.

For benzene, both maximum 24-hour and annual concentrations exceed the thresholds at all locations, irrespective of positive or negative traffic changes and mainly due to the fact that the ambient background concentrations alone are higher than the thresholds. The anticipated changes in road traffic will add slightly to the benzene levels in some areas (most notably along York Boulevard) and will improve benzene levels slightly in other areas (along King Street and Main Street). Overall the net effect of the LRT on benzene levels is anticipated to be small.

The potential for additional tree plantings on public land adjacent to York Boulevard between Inchbury Street and Hess Street should be investigated, and additional plantings on private land adjacent to the road should be encouraged. This could potentially include additional tree plantings in the median, and in any open green spaces adjacent to the roadway, such as the open area south of York Boulevard, between Pearl Street and Ray Street.

In order to reduce the potential for air quality impacts during construction, it is recommended that an emissions management plan based on established best practices be implemented.

Given that changes in road traffic with the LRT in place are expected to have only a small impact on local air quality (negative in some areas and positive in others), a monitoring program, over and above existing monitoring in downtown Hamilton, has not been proposed.

REFERENCES

1. Statistics Canada, 2010, Canadian Vehicle Survey: Annual 2009, Catalogue no. 53-223-X, page 24.
2. MOE, 2008. Summary of Point of Impingement Standards, Point of Impingement Guidelines, and Ambient Air Quality Criteria. *Ontario Ministry of the Environment.*
3. Health Canada, 1999. CEPA/FPAC Working Group on Air Quality Objectives and Guidelines. National Ambient Air Quality Objectives. *Health Canada.* [Online]

   http://www.hc-sc.gc.ca/ewh-semt/pubs/air/naaqo-onqaa/index-eng.php
4. CCME, 2000. Canadian Council of Ministers of the Environment. Canada-Wide Standards of Particulate Matter and Ozone. *Endorsed by CCME Council of Ministers*, Quebec City. [Online] http://www.ccme.ca/assets/pdf/pmozone_standard_e.pdf
5. MOE, 2000-2008. Air Quality in Ontario Summary Reports: 2000-2008. Ontario Ministry of the Environment. http://www.ene.gov.on.ca/en/publications/index.php
6. EC, 1999-2005. National Air Pollution Surveillance Network, Annual Summary Reports: 1999-2005. *Environment Canada*. [Online] http://www.etc-cte.ec.gc.ca/napsstations/main.aspx
7. Regulation Proposal Notice: Proposal to Amend Ontario Regulation 419/05: Air Pollution – Local Air Quality, under the Environmental Protection Act, to include an Ontario Air Standard for Benzene. EBR Registry Number: 010-7186. Ontario Ministry of the Environment, Standards Development Branch, July 2009.

8. Regulation Proposal Notice: Proposal to Amend Ontario Regulation 419/05: Air Pollution - Local Air Quality made under the Environmental Protection Act to include an Ontario Air Standard for 1,3-Butadiene. EBR Registry Number: 010-6214. Ontario Ministry of the Environment, Standards Development Branch, July 2009.
9. Ontario Air Standards for Acrolein. Ontario Ministry of the Environment, Standards Development Branch. December, 2009.
10. Lall, R., Kendall, M., Ito, K., Thurston, G., (2004). Estimation of historical annual $PM_{2.5}$ exposures for health effects assessment. *Atmospheric Environment 38(2004) 5217-5226*.
11. Claggett, Michael, (2010). Implications of the MOVES 2010 Model on Mobile Source Emissions Estimates. *AWMA em (July 2010) 10-15.*
12. United States Environmental Protection Agency. Addendum to the User's Guide to CAL3QHC Version 2 (CAL3QHCR User's Guide). September 1995.
13. United States Environmental Protection Agency. User's Guide to CAL3QHCR Version 2: A Modelling Methodology for Prediction Pollutant Concentrations near Roadway Intersections (454/R-92-006). September 1995.
14. MOE, March 2009. Air Dispersion Modelling Guideline for Ontario. Ontario Ministry of the Environment. http://www.ene.gov.on.ca/envision/gp/5165e02.pdf .
15. WHO, 2005. WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide, and sulphur dioxide. Accessed at http://whqlibdoc.who.int/hq/2006/WHO_SDE_PHE_OEH_06.02_eng.pdf)
16. Ontario Ministry of the Environment, 2009: Rationale for the Development of Ontario Air Standards for Benzene. Standards Development Branch. http://www.downloads.ene.gov.on.ca/envision/env_reg/er/documents/2009/010-7186.pdf.
17. Fujii,E.; Lawton, J., Cahill, T.A., Barnes, D.E., Hayes, C., Spada, N., McPheron, G. Removal Rates of Particulate Matter onto Vegetation as a Function of Particle Size. Report to the Breathe California of Sacramento Emigrant Trails Health Effects Task Force (HETF) and Sacramento Metropolitan AQMD, 2008.
18. Bauldaf, R.; Thoma, E.; Khlystov, A.; Isakov, V.; Bowker, G.; Long, T.; and Snow, R. Impacts of noise barriers on near-road air quality. *Atmospheric Environment 42(2008) 7502-7507.*
19. Ning, Z.; Hudda, N.; Daher, N.; Kam W.; Herner, J.; Kozawa, K.; Mara, S.; Sioutas C. Impact of roadside noise barriers on particle size distributions and pollutants concentrations near freeways. *Atmospheric Environment 44(2010) 3118-3127*.
20. Hagler, G.; Tang, W.; Freeman, M.; Heist, D. Model evaluation of roadside barrier impact on near-road air pollution. *Atmospheric Environment 45(2011) 2522-2530.*
21. Health Canada, 2004. Canadian Handbook on Health Impact Assessment. Health Canada, Vol.4: Health Impacts by Industrial Sector Cat. H46-2/04-363E, ISBN 0-662-38011-8.
22. Sacramento Metropolitan Air Quality District, 2004. Guide to Air Quality Assessment in Sacramento County. Sacramento County, CA, the USA.
23. The State of Alaska, 2009. Particulate Matter – PM_{10} Dust Control Options. [Online] http://dec.alaska.gov/air/anpms/pm/pm10_ctrl.htm. (Last Accessed March 27, 2009)
24. Orleman J. A., Kalman T. J., Cummings J. A. & Lim E.Y., 1983, Fugitive Dust Control Technology. Noyes Data Corporation, New Jersey, USA.
25. Ministry of Water, Land, and Air, British Columbia, 2005. Best Management Practices to Mitigate Road Dust from Winter Traction Material. British Columbia, Canada.

FIGURES

Figure 1: Proposed Hamilton Rapid Transit System

Figure 2: Intersection of King/Main Street Model Area

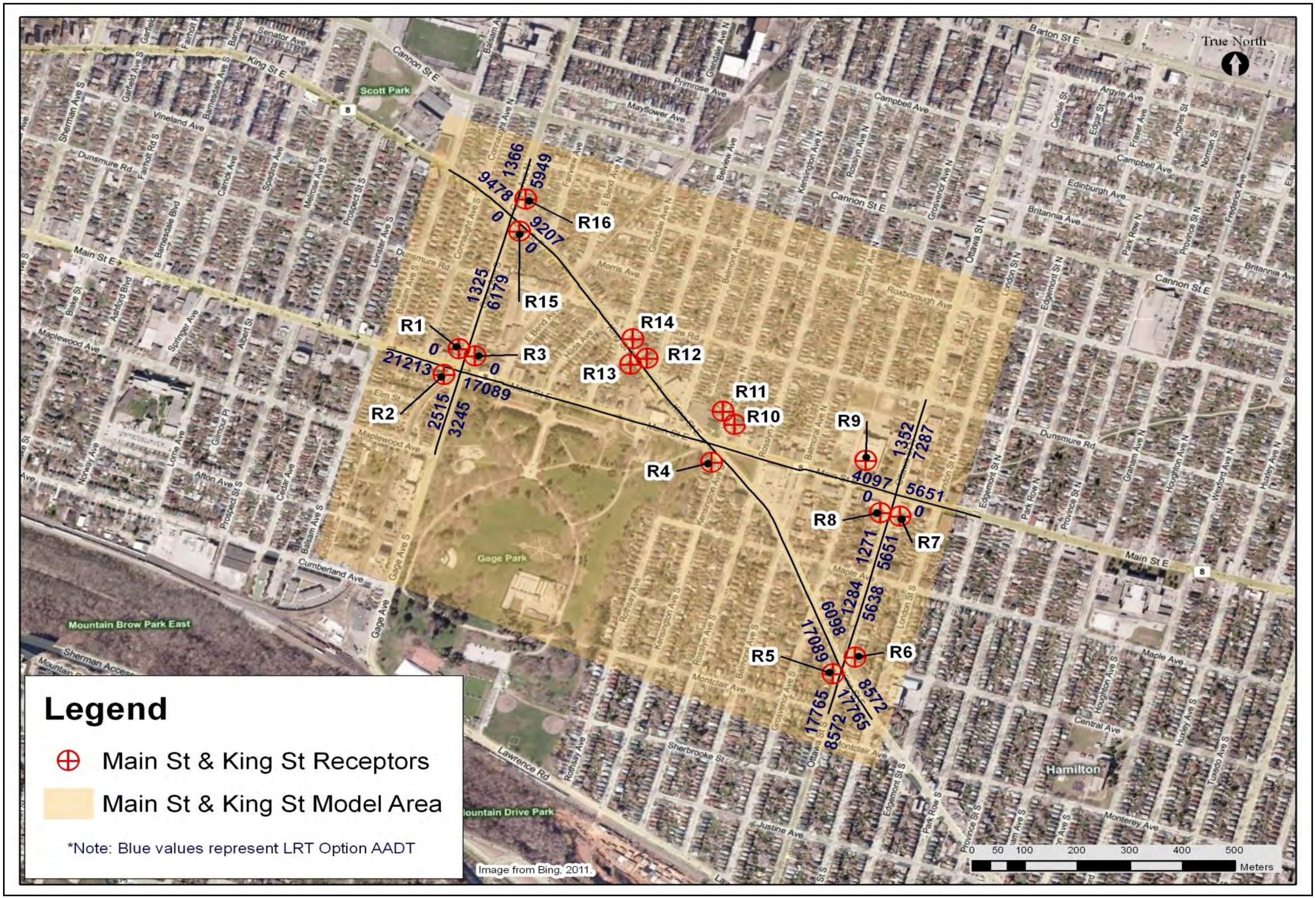


Figure 3: Barton Street Model Area

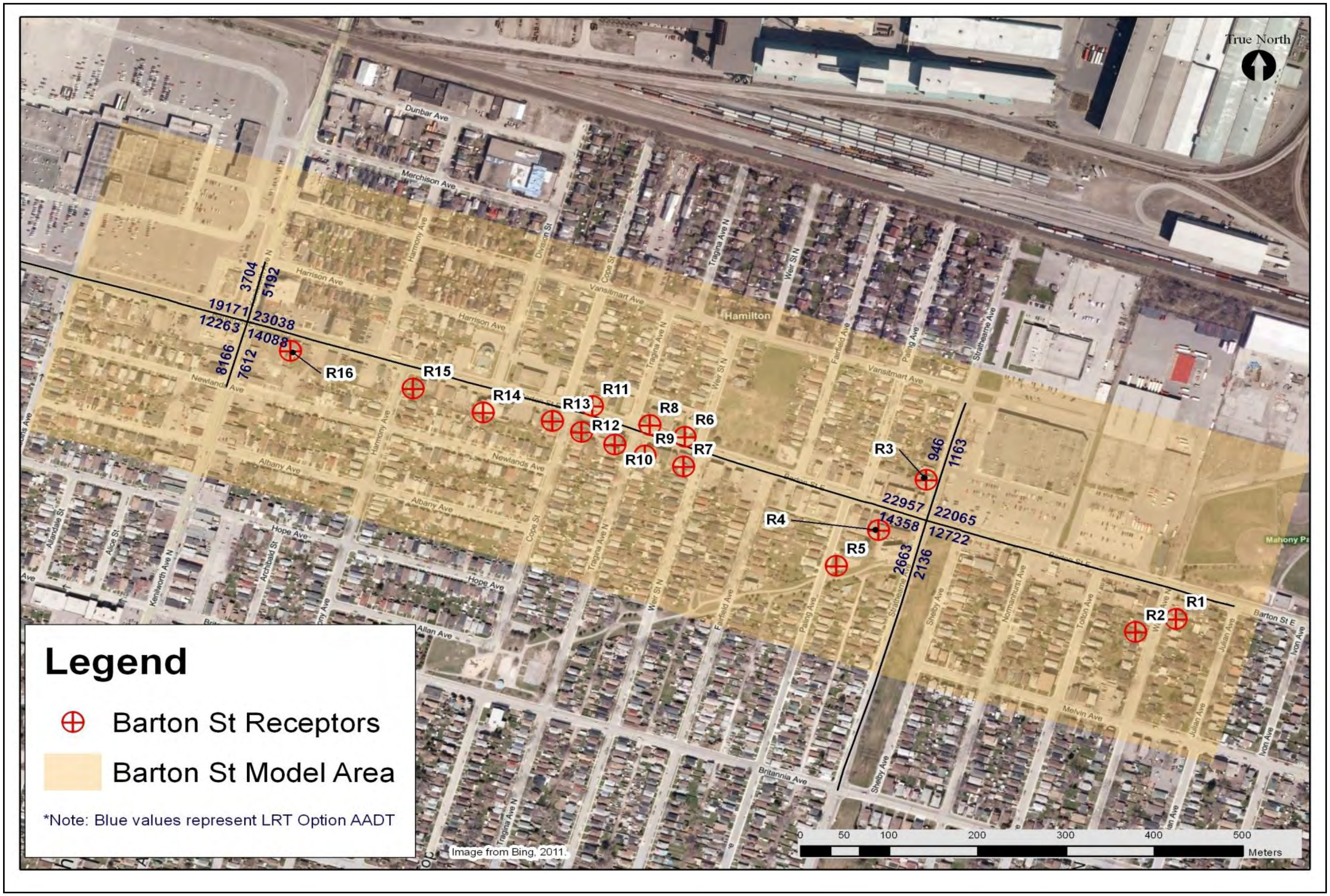


Figure 4: York Boulevard Model Area

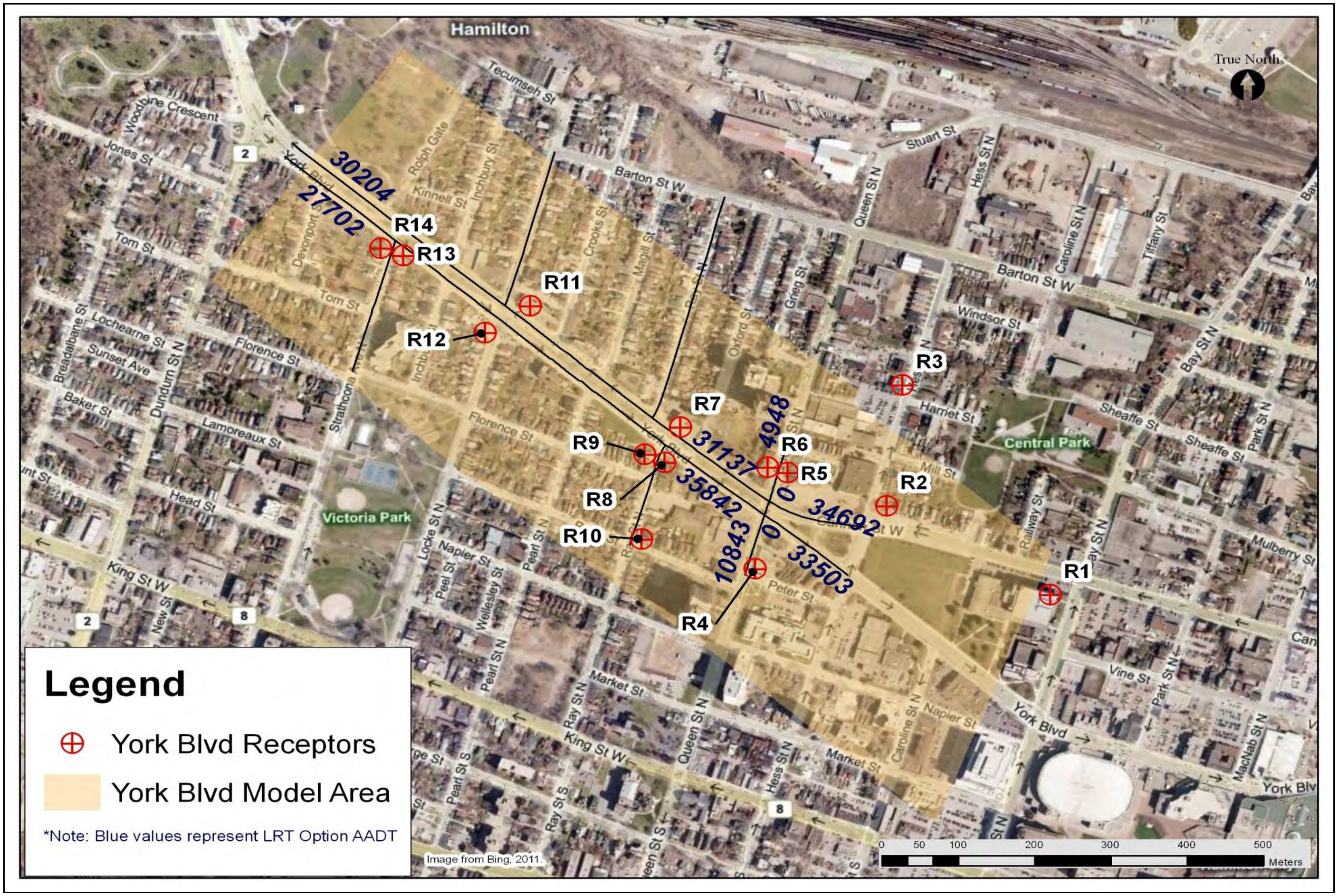
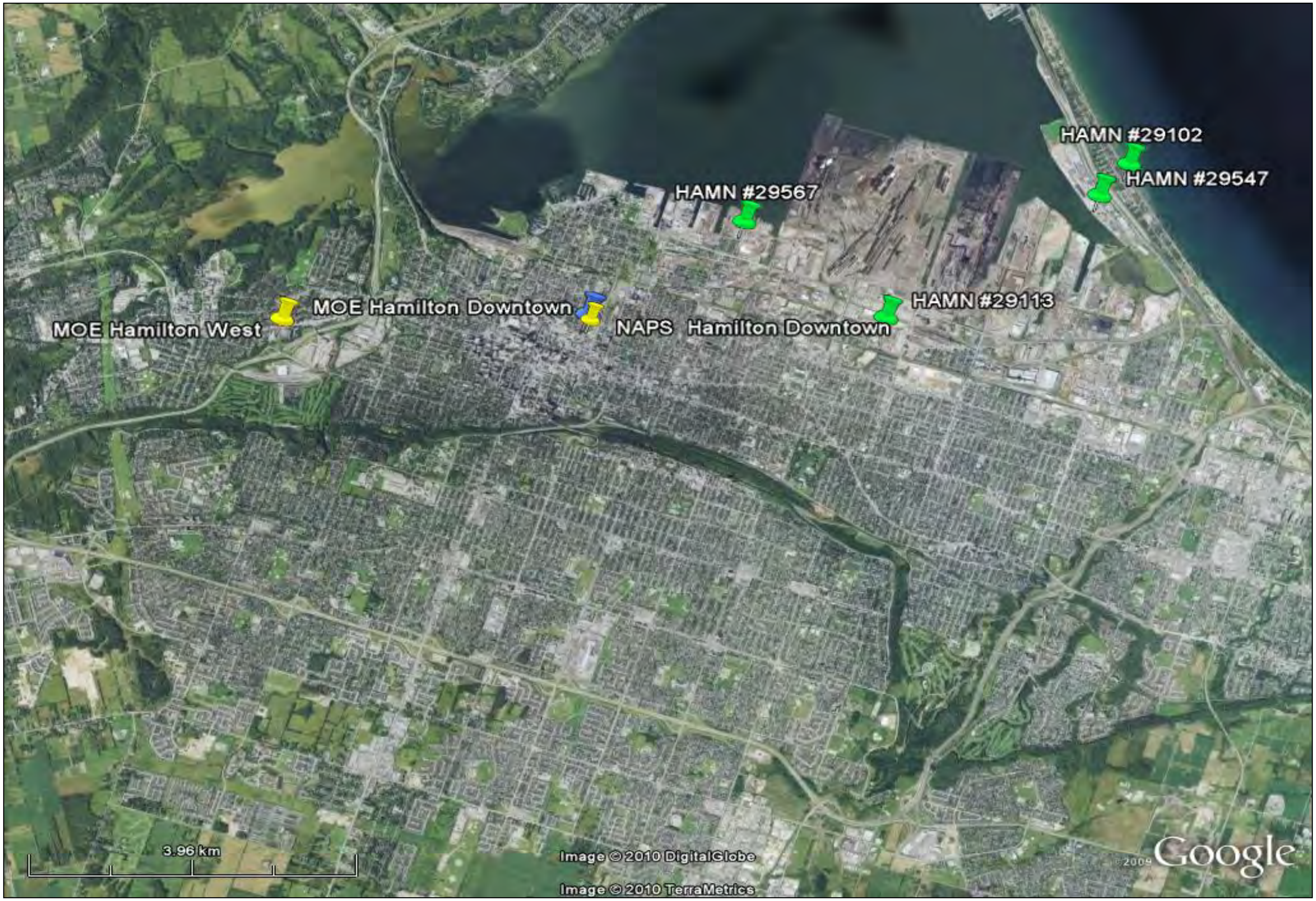
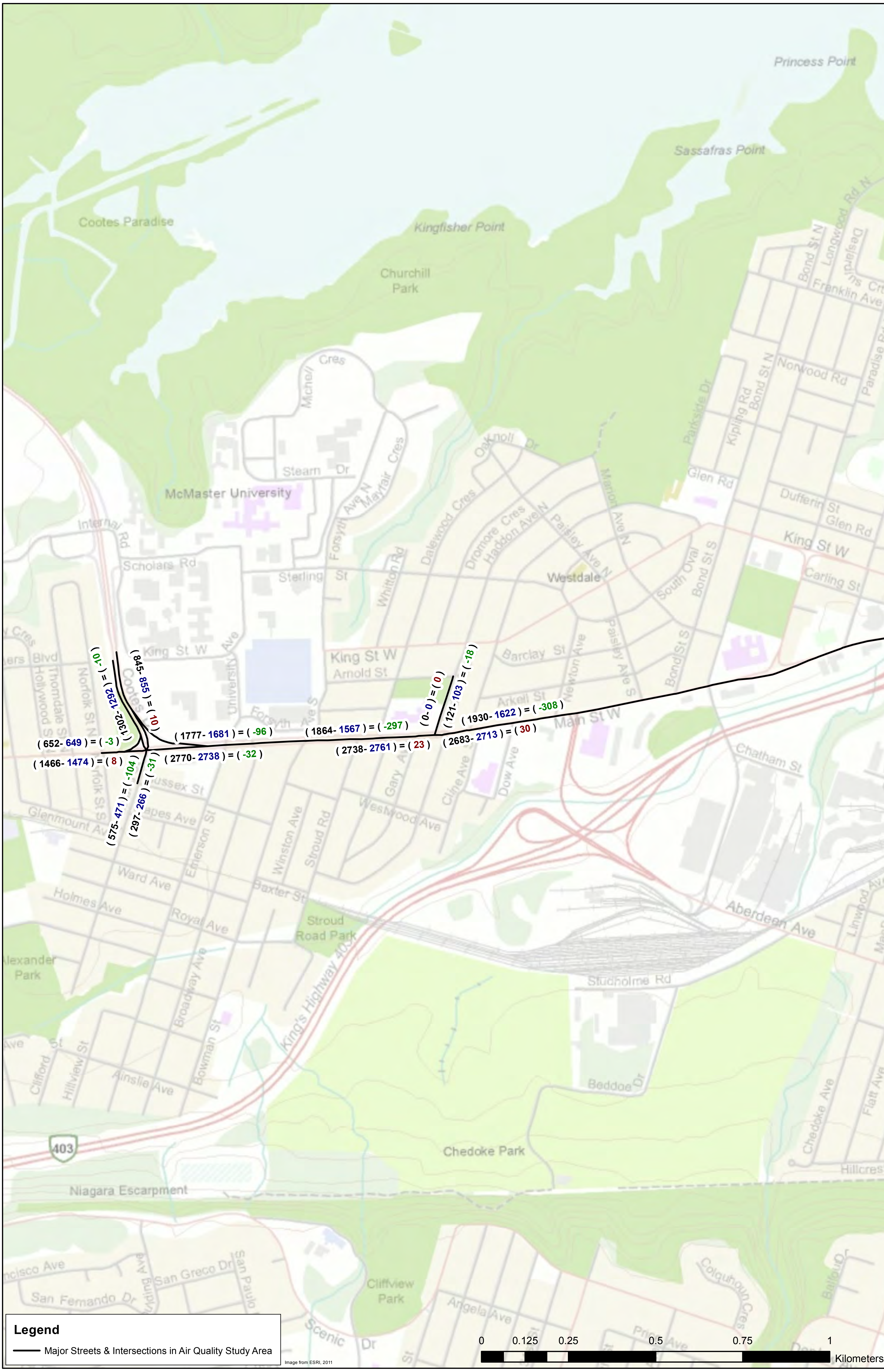


Figure 5: Location of Hamilton-Area Ambient Monitoring Stations – B-Line Study



APPENDIX A



Hamilton LRT - AM Peak Traffic Volume: Without LRT (2021) vs. LRT Option (2021)

Hamilton LRT EA - Hamilton, Ontario

Note:
- **Black** values represent Without LRT Scenario traffic volumes
- **Blue** values represent LRT Option Scenario traffic volumes
- **Red** values represent an increase in volumes from Without LRT to LRT Option
- **Green** values represent a decrease in volumes from Without LRT to LRT Option

True North

Project #1011063

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Approx. Scale:	1:10,000	
Date Revised:	Jun 2, 2011	

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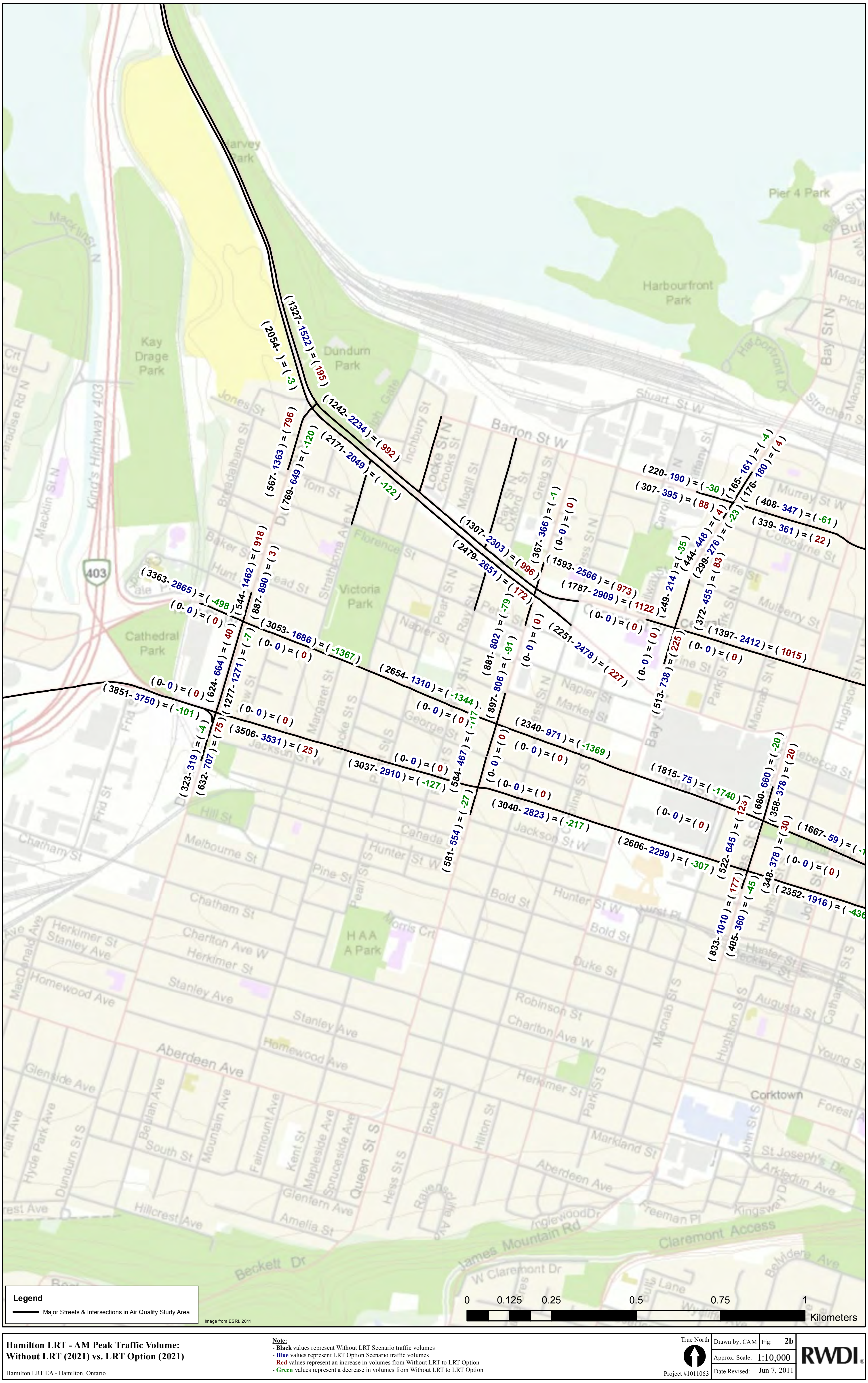

Hamilton LRT - AM Peak Traffic Volume:
Without LRT (2021) vs. LRT Option (2021)

Hamilton LRT EA - Hamilton, Ontario

Note:
- **Black** values represent Without LRT Scenario traffic volumes
- **Blue** values represent LRT Option Scenario traffic volumes
- **Red** values represent an increase in volumes from Without LRT to LRT Option
- **Green** values represent a decrease in volumes from Without LRT to LRT Option

True North

Project #1011063

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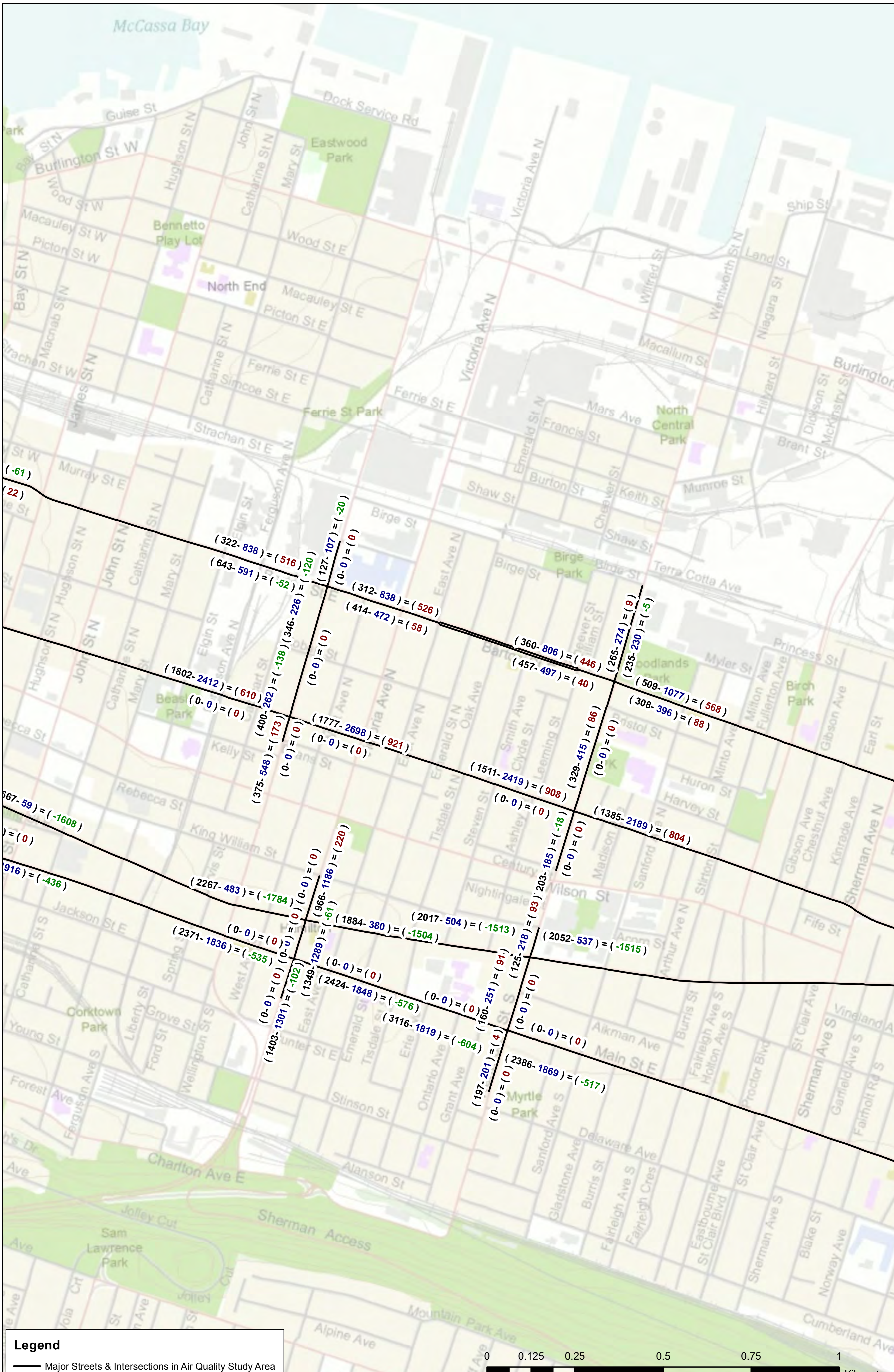

Hamilton LRT - AM Peak Traffic Volume: Without LRT (2021) vs. LRT Option (2021)

Hamilton LRT EA - Hamilton, Ontario

Note:
- **Black** values represent Without LRT Scenario traffic volumes
- **Blue** values represent LRT Option Scenario traffic volumes
- **Red** values represent an increase in volumes from Without LRT to LRT Option
- **Green** values represent a decrease in volumes from Without LRT to LRT Option

True North

Project #1011063

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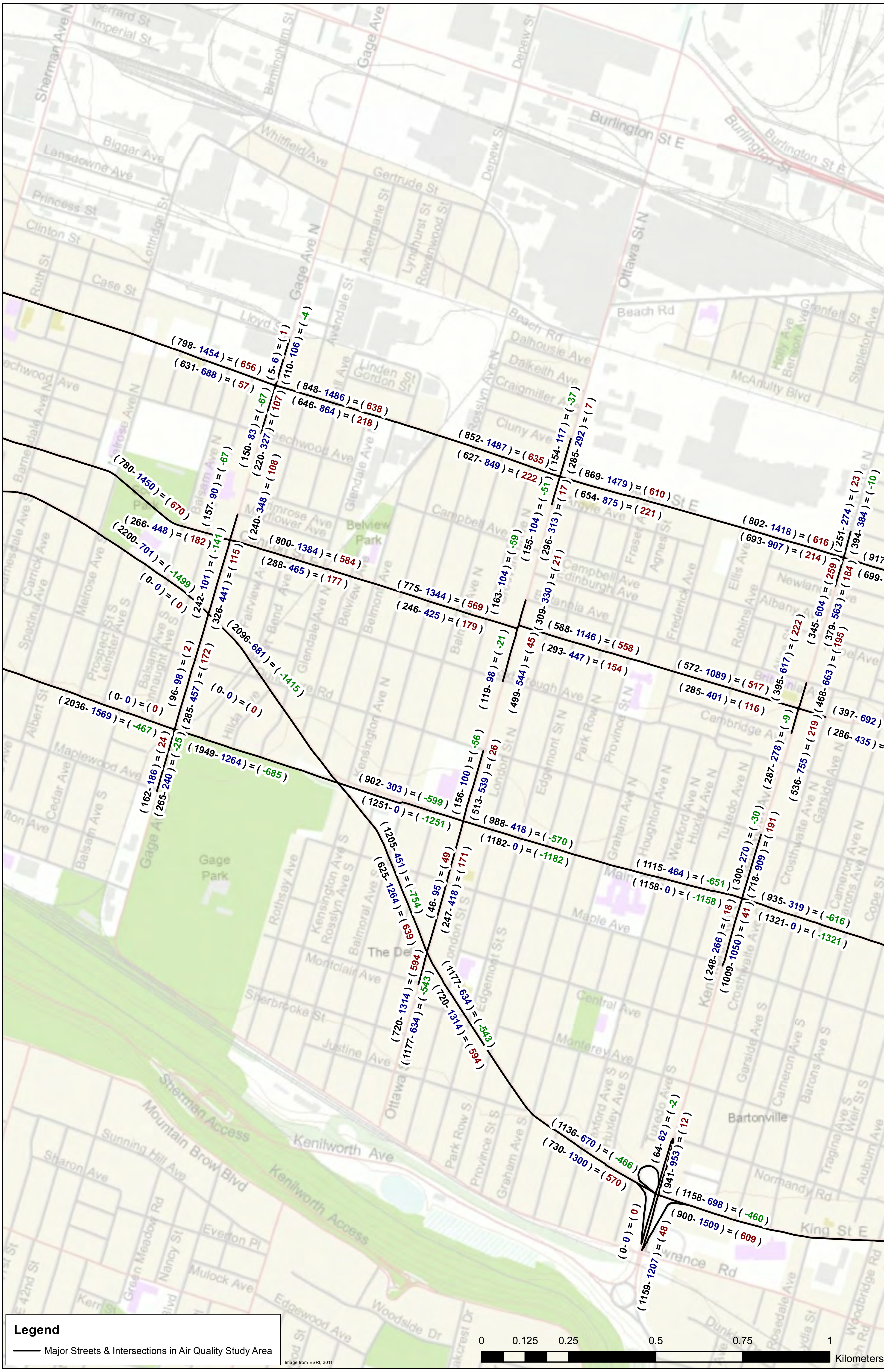


Hamilton LRT - AM Peak Traffic Volume: Without LRT (2021) vs. LRT Option (2021)

Hamilton LRT EA - Hamilton, Ontario

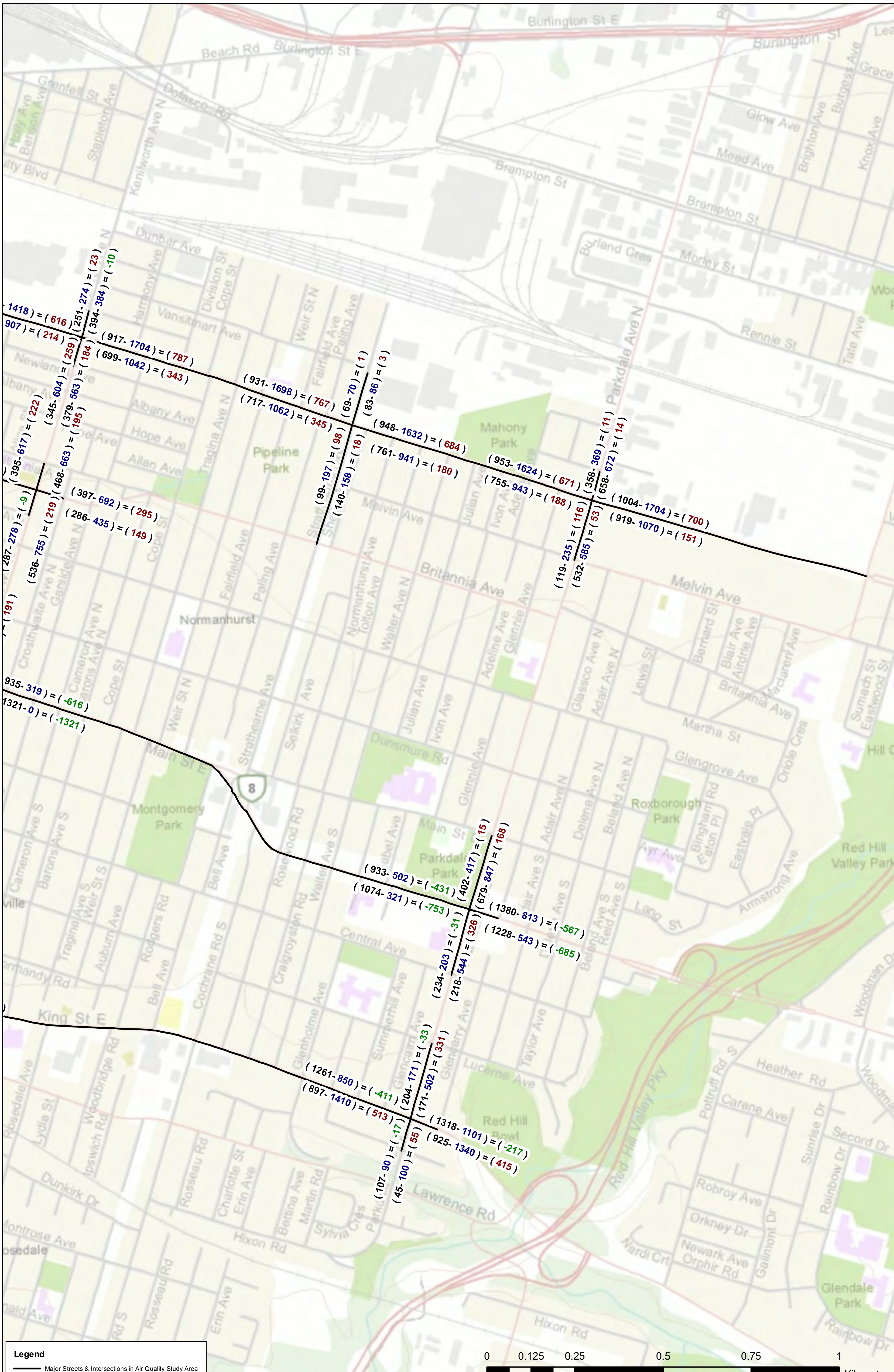
Note:
- **Black** values represent Without LRT Scenario traffic volumes
- **Blue** values represent LRT Option Scenario traffic volumes
- **Red** values represent an increase in volumes from Without LRT to LRT Option
- **Green** values represent a decrease in volumes from Without LRT to LRT Option

True North

Project #1011063

Drawn by: CAM	Fig: 2d
Approx. Scale:	1:10,000
Date Revised:	Jun 2, 2011

RWDI



Hamilton LRT - AM Peak Traffic Volume: Without LRT (2021) vs. LRT Option (2021)

Hamilton LRT EA - Hamilton, Ontario

Note:
- **Black** values represent Without LRT Scenario traffic volumes
- **Blue** values represent LRT Option Scenario traffic volumes
- **Red** values represent an increase in volumes from Without LRT to LRT Option
- **Green** values represent a decrease in volumes from Without LRT to LRT Option

True North

Project #1011063

Drawn by: CAM	Fig: 2e
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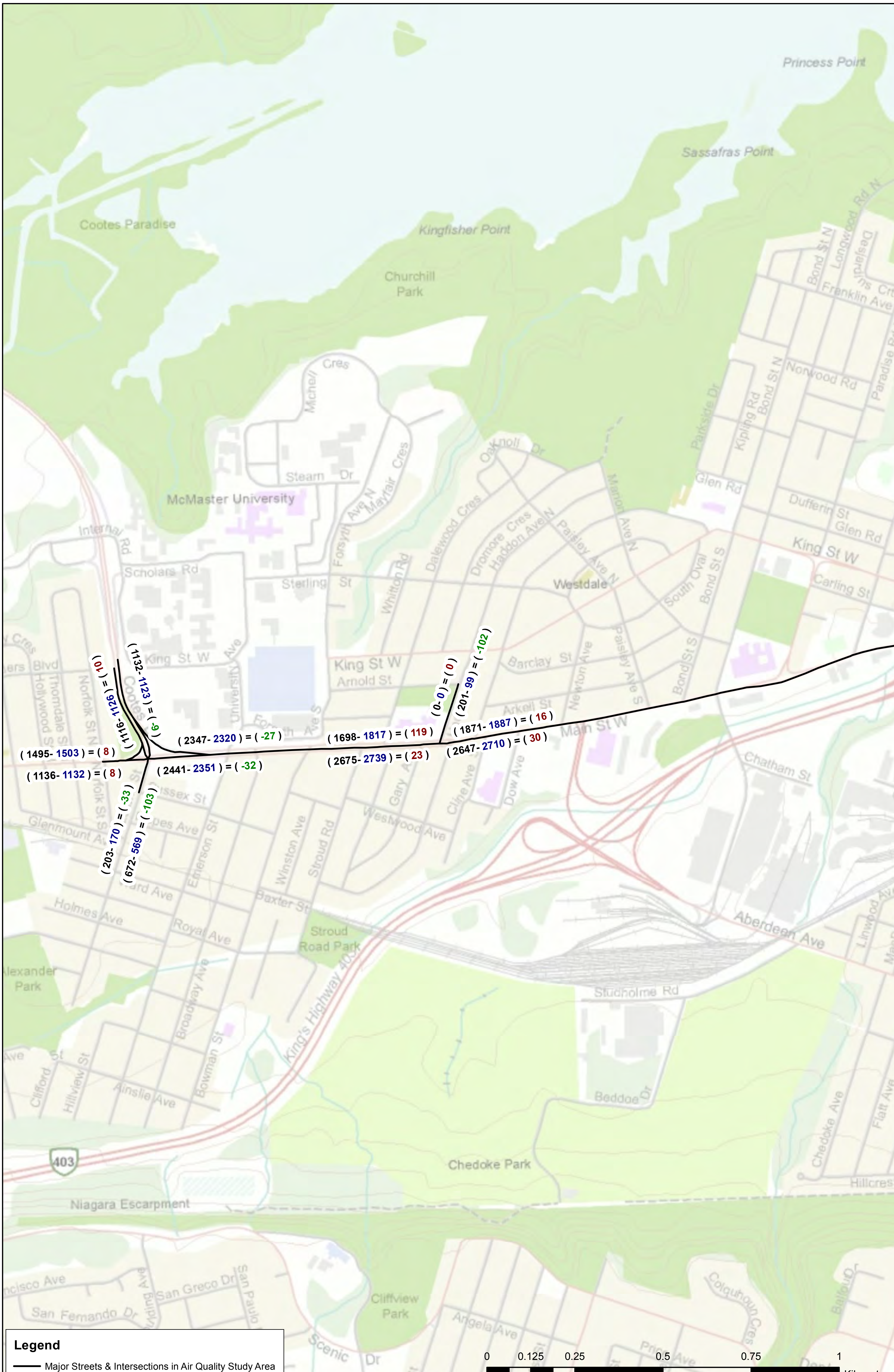
Date Revised:	Jun 7, 2011

RWDI



Hamilton LRT - PM Peak Traffic Volume:
Without LRT (2021) vs. LRT Option (2021)

Hamilton LRT EA - Hamilton, Ontario

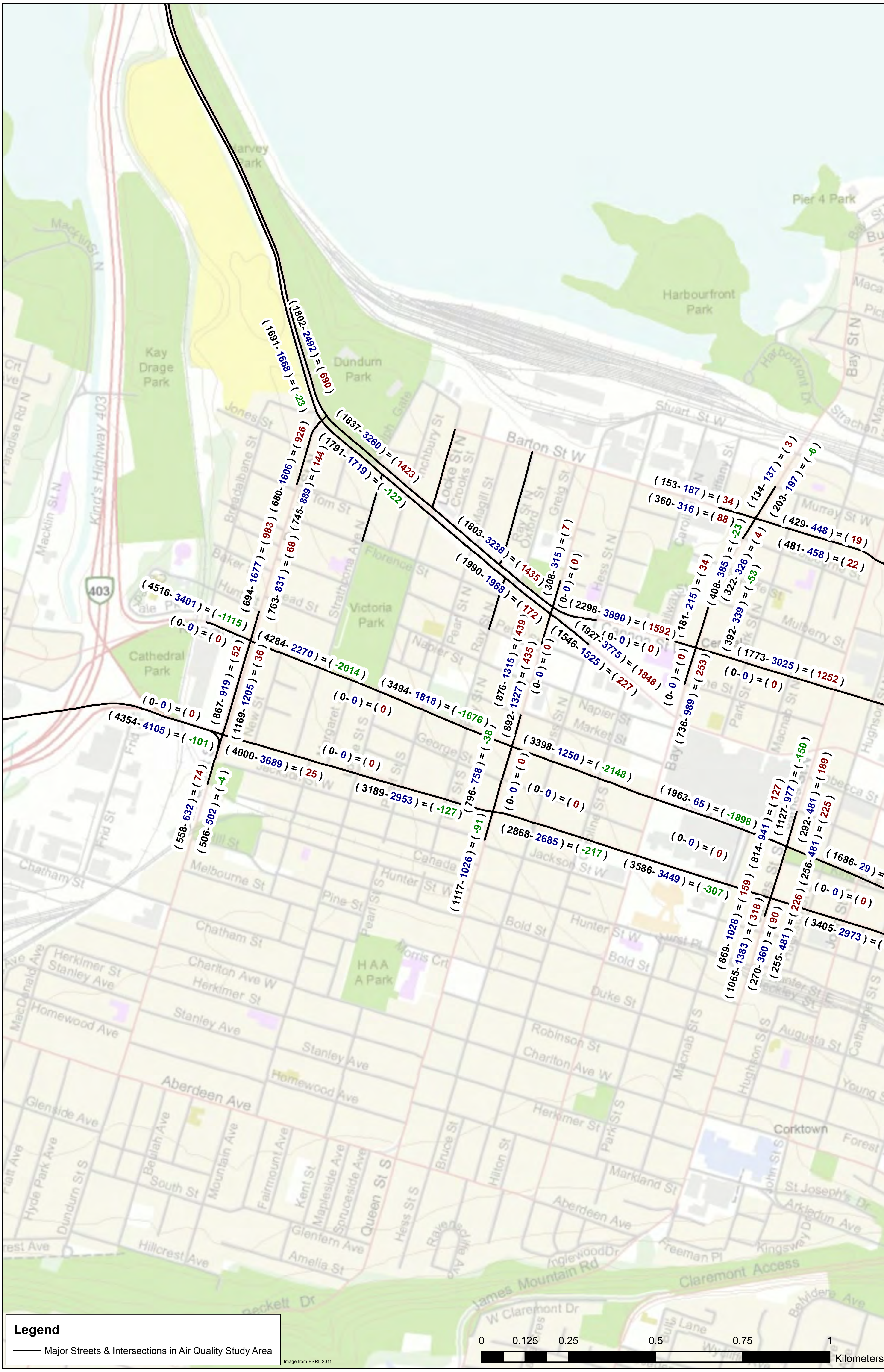
Note:
- **Black** values represent Without LRT Scenario traffic volumes
- **Blue** values represent LRT Option Scenario traffic volumes
- **Red** values represent an increase in volumes from Without LRT to LRT Option
- **Green** values represent a decrease in volumes from Without LRT to LRT Option

True North

Project #1011063

Drawn by: CAM | Fig: 3a
Approx. Scale: 1:10,000
Date Revised: Jun 2, 2011

RWDI



Hamilton LRT - PM Peak Traffic Volume: Without LRT (2021) vs. LRT Option (2021)

Hamilton LRT EA - Hamilton, Ontario

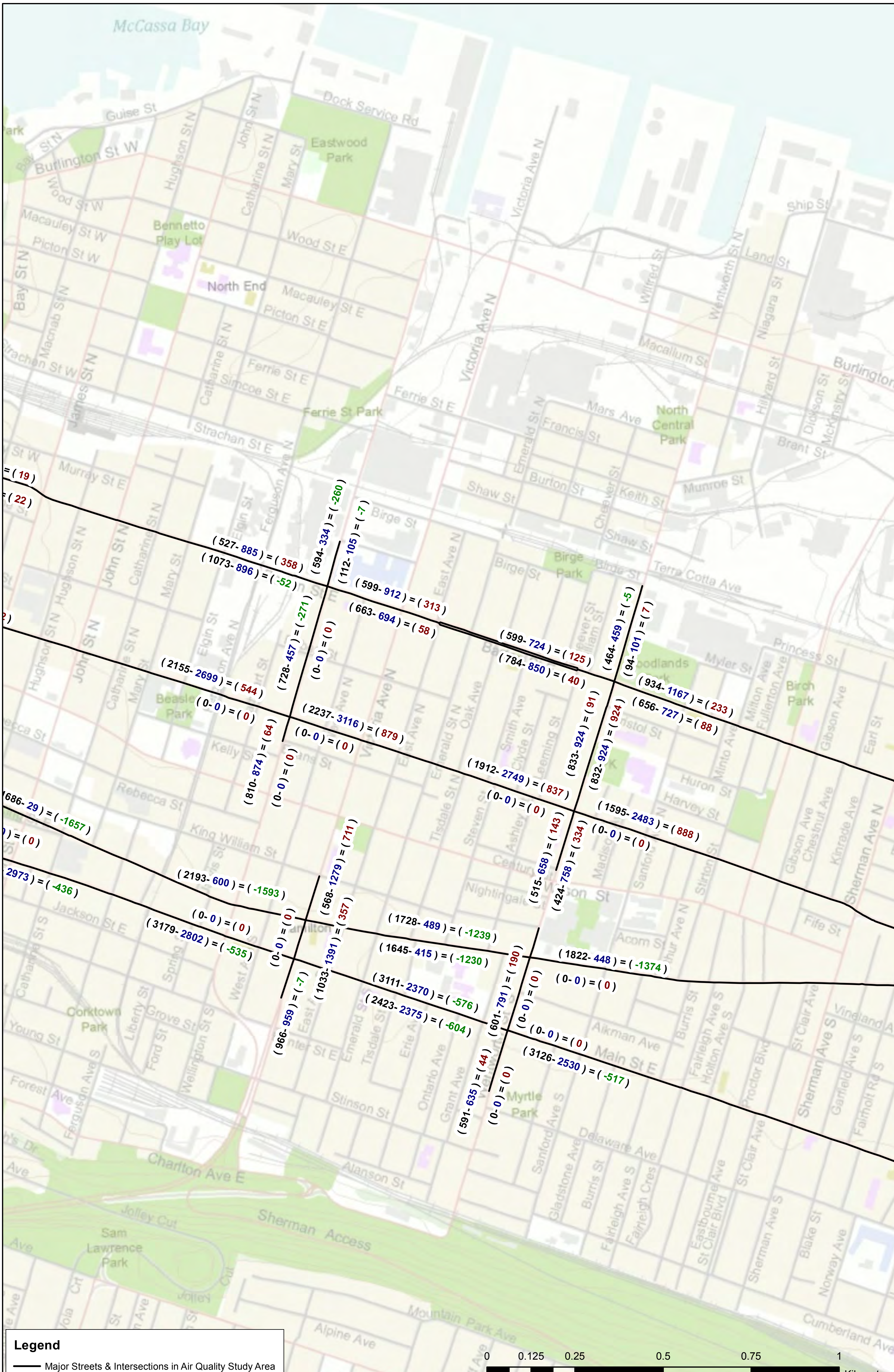
Note:
- **Black** values represent Without LRT Scenario traffic volumes
- **Blue** values represent LRT Option Scenario traffic volumes
- **Red** values represent an increase in volumes from Without LRT to LRT Option
- **Green** values represent a decrease in volumes from Without LRT to LRT Option

True North

Project #1011063

Drawn by: CAM	Fig: 3b
Approx. Scale: 1:10,000	
Date Revised: Jun 7, 2011	

RWDI



Hamilton LRT - PM Peak Traffic Volume: Without LRT (2021) vs. LRT Option (2021)

Hamilton LRT EA - Hamilton, Ontario

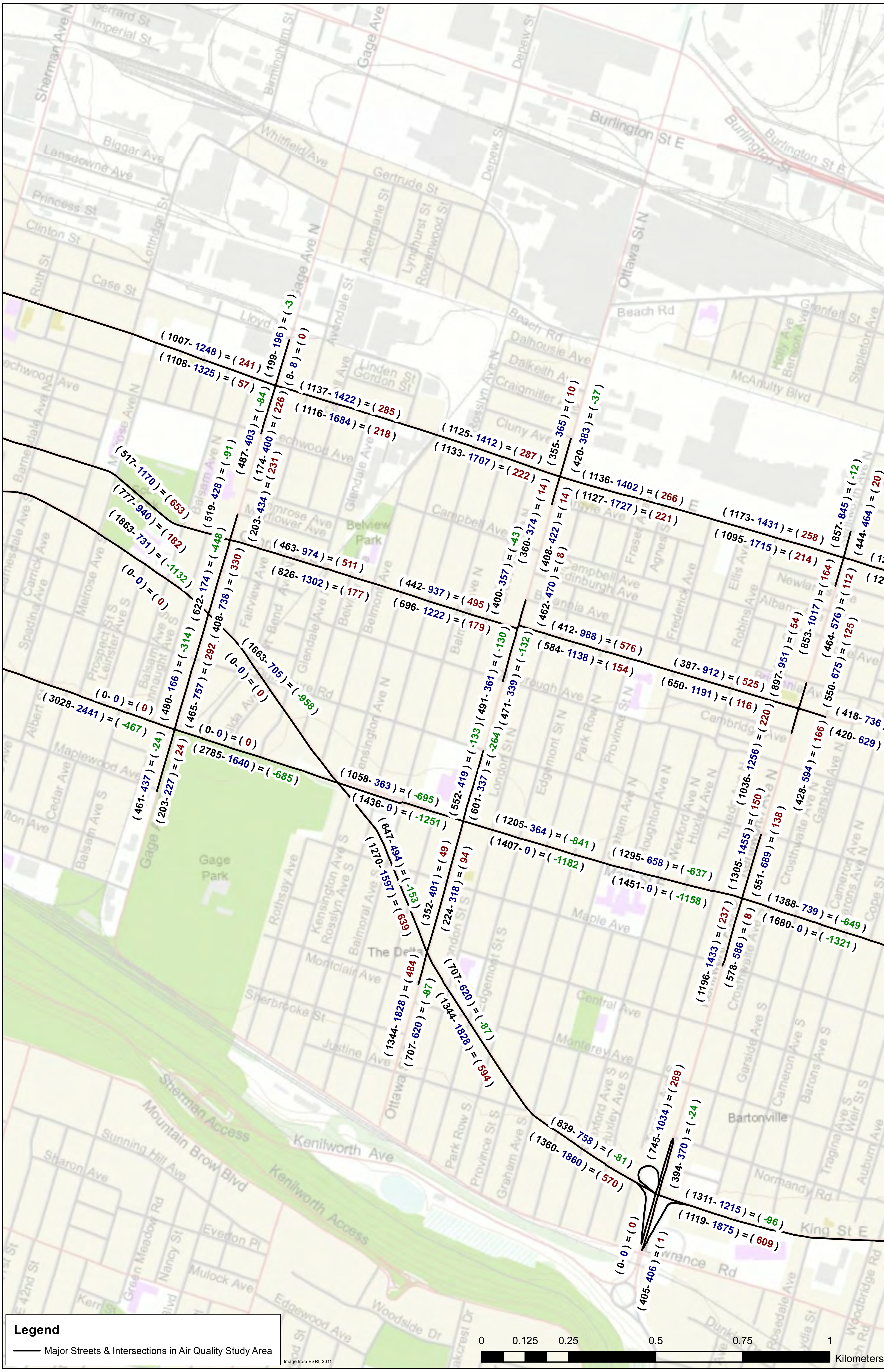
Note:
- **Black** values represent Without LRT Scenario traffic volumes
- **Blue** values represent LRT Option Scenario traffic volumes
- **Red** values represent an increase in volumes from Without LRT to LRT Option
- **Green** values represent a decrease in volumes from Without LRT to LRT Option

True North

Project #1011063

Drawn by: CAM	Fig: 3c
Approx. Scale: 1:10,000	
Date Revised: Jun 2, 2011	

RWDI



Hamilton LRT - PM Peak Traffic Volume: Without LRT (2021) vs. LRT Option (2021)

Hamilton LRT EA - Hamilton, Ontario

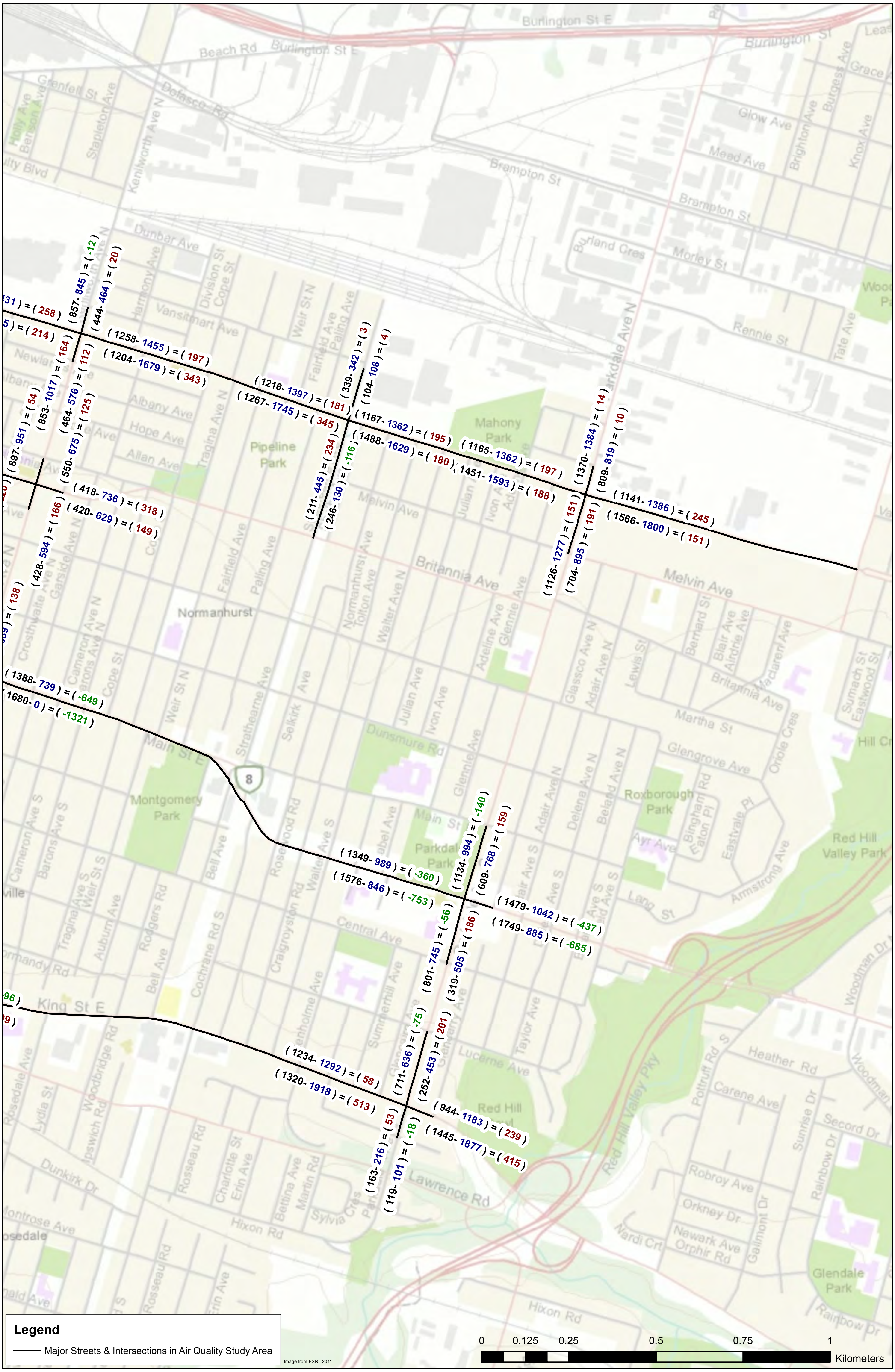
Note:
- **Black** values represent Without LRT Scenario traffic volumes
- **Blue** values represent LRT Option Scenario traffic volumes
- **Red** values represent an increase in volumes from Without LRT to LRT Option
- **Green** values represent a decrease in volumes from Without LRT to LRT Option

True North

Project #1011063

Drawn by: CAM	Fig: 3d
Approx. Scale: 1:10,000	
Date Revised: Jun 2, 2011	

RWDI



Hamilton LRT - PM Peak Traffic Volume: Without LRT (2021) vs. LRT Option (2021)

Hamilton LRT EA - Hamilton, Ontario

Note:
- **Black** values represent Without LRT Scenario traffic volumes
- **Blue** values represent LRT Option Scenario traffic volumes
- **Red** values represent an increase in volumes from Without LRT to LRT Option
- **Green** values represent a decrease in volumes from Without LRT to LRT Option

True North

Project #1011063

Drawn by: CAM	Fig: 3e
Approx. Scale: 1:10,000	
Date Revised: Jun 7, 2011	

RWDI

APPENDIX B

Table B1: MOBILE6.2 Key Model Input Parameters [1]

Parameter	Input
Pollutants	CO, NO_X, PM_{10}, $PM_{2.5}$, Acetaldehyde, Formaldehyde, 1,3-Butadiene, Benzene, and Acrolein.
Operating Year	2021
Evaluation Month	January
Ambient Temperature	Minimum Daily Temperature = 14.54 °F (-9.7°C) Maximum Daily Temperature = 28.04 °F (-2.2 °C) (Canadian Climate Normal, Hamilton Airport, ON – WMO ID: 71624; Climate ID: 71263)
Altitude	Low
Absolute Humidity	20 Grains /lb
Fuel Volatility	Reid Vapor Pressure (RVP) = 9 psi
Fuel Program	Conventional Gasoline East
Vehicle Speed	60km/h, 50 km/h, 40 km/h, 30 km/h and 4 km/hr for arterial roads

Note: [1] The idle condition is represented by a speed of 4km/hr since this is the lowest speed MOBILE6.2 can model

Table B2: Comparison of MOBILE6.2 and MOBILE6.2C Results for Default Conditions. [1]

	Description	LDGV	LDGT12	LDGT34	HDGV	LDDV	LDDT	HDDV	MC	All Vehicles
VMT Distribution:	MOBILE6.2C	0.279	0.44	0.15	0.0363	0.0003	0.0022	0.0872	0.005	1
	MOBILE6.2	0.279	0.44	0.15	0.0363	0.0003	0.0022	0.0872	0.005	1
Composite THC :	MOBILE6.2C	0.316	0.4	0.576	0.107	0.035	0.081	0.153	0.92	0.373
	MOBILE6.2	0.319	0.403	0.58	0.11	0.035	0.081	0.153	2.05	0.381
Composite CO :	MOBILE6.2C	16.89	16.08	19.29	8.49	0.512	0.3	0.169	22.07	15.114
	MOBILE6.2	17.5	16.49	19.68	9.05	0.512	0.3	0.169	21.47	15.54
Composite NOX :	MOBILE6.2C	0.322	0.463	0.739	0.23	0.04	0.179	0.824	0.99	0.49
	MOBILE6.2	0.333	0.472	0.75	0.24	0.04	0.179	0.824	2.79	0.508

Note: [1] These emission factors are based on a vehicle speed of 100 km/hr for the target year 2031, and are presented in grams/mile.

Table B3: CAL3QHCR Key Input Parameters

Parameter	Input
Meteorological Data	Year 2009 hourly surface data are from Hamilton Airport (71263) and upper air data are from Buffalo, USA (14733)
Traffic Volumes	Provided by SDG, and adopted from Statistics Canada Canadian Vehicle Summary: Annual Report 2009
Hourly Traffic Volume Distribution	ITE distributions based on AM Peak volumes provided by SDG were used.
Deposition Velocity	PM_{10} = 0.5 cm/s $PM_{2.5}$ = 0.1 cm/s
Settling Velocity	PM_{10} = 0.3 cm/s $PM_{2.5}$ = 0.02 cm/s
Surface Roughness	108 cm – representative of the urban landuse (commercial, residential, industrial) present in the study area.
Dispersion Coefficient (Urban or Rural)	Urban

B4: Summary of MOBILE6.2 Output according to vehicle class for VOCs (hydrocarbons)

2021

Contaminant	Vehicle Category	Emission Factors (**mg**/vmt)						
		Arterial						
		4 km/hr	10 km/hr	20 km/hr	30 km/hr	40 km/hr	50 km/hr	60 km/hr
Benzene	LDV	62.43	32.63	19.61	14.32	11.62	10.35	9.64
	HDV	13.01	10.00	7.17	5.36	4.18	3.38	2.86
1,3-Butadiene	LDV	5.69	3.09	1.91	1.41	1.14	1.01	0.93
	MDV	5.46	4.36	3.27	2.54	2.03	1.67	1.43
Formaldehyde	LDV	18.53	11.57	7.77	5.87	4.73	4.05	3.61
	HDV	67.60	54.24	40.94	31.85	25.56	21.13	18.10
Acetaldehyde	LDV	6.97	4.33	2.90	2.19	1.77	1.51	1.35
	HDV	24.77	19.89	15.02	11.70	9.39	7.77	6.65
Acrolein	LDV	0.99	0.60	0.39	0.30	0.24	0.21	0.18
	HDV	3.04	2.44	1.84	1.43	1.15	0.95	0.81

B5: Summary of MOBILE6.2 Output according to vehicle class for CO and NOx

2021

Contaminant	Vehicle Category	Emission Factors (g/vmt)						
		Arterial						
		4 km/hr	10 km/hr	20 km/hr	30 km/hr	40 km/hr	50 km/hr	60 km/hr
CO	LDV	29.01	14.33	9.34	7.66	6.84	6.56	6.77
	HDV	5.99	4.20	2.69	1.84	1.36	1.09	0.94
NOx	LDV	0.84	0.67	0.54	0.47	0.44	0.42	0.42
	HDV	2.43	2.05	1.69	1.46	1.33	1.27	1.28

B6: Summary of MOBILE6.2 Output according to vehicle class for PM

2021

Contaminant	Vehicle Category	Emission	Idle EF (g/hr)
PM10	LDV	0.0254	0.0634
	HDV	0.0781	0.0875
PM2.5	LDV	0.0118	0.0295
	HDV	0.0474	0.0805

Notes:

1. MOBILE6.2 emission factors for PM10 and PM2.5 emission factors for tailpipe emissions remain almost unchanged relative to the change in speed.

B7a: Summary of Re-entrained Road Dust Emission Factors for Barton Section

	k (g/VMT)
PM2.5	0.25
PM10	1

	1	2	3	4	5	6	7	8
Index	Percent LDV	Percent HDV	sL (g/m2)	HDV W (tons)	LDV W (tons)	Average W (tons)	PM2.5	PM10
1	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
2	94.0%	6.0%	0.12	20.2	1.8	2.9	0.0305	0.1220
3	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
4	94.0%	6.0%	0.03	20.2	1.8	2.9	0.1077	0.4308
5	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
6	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
7	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
8	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
9	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
10	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
11	94.0%	6.0%	0.12	20.2	1.8	2.9	0.0305	0.1220
12	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
13	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
14	94.0%	6.0%	0.6	20.2	1.8	2.9	0.1077	0.4308
15	94.0%	6.0%	0.12	20.2	1.8	2.9	0.4659	1.8637
16	94.0%	6.0%	0.6	20.2	1.8	2.9	0.1077	0.4308
17	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
18	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
19	94.0%	6.0%	0.03	20.2	1.8	2.9	0.4659	1.8637
20	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
21	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
22	94.0%	6.0%	0.6	20.2	1.8	2.9	0.0305	0.1220
23	94.0%	6.0%	0.03	20.2	1.8	2.9	0.4659	1.8637
24	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
25	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
26	94.0%	6.0%	0.12	20.2	1.8	2.9	0.0305	0.1220
27	94.0%	6.0%	0.6	20.2	1.8	2.9	0.1077	0.4308
28	94.0%	6.0%	0.03	20.2	1.8	2.9	0.4659	1.8637
29	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
30	94.0%	6.0%	2.4	20.2	1.8	2.9	0.0305	0.1220
31	94.0%	6.0%	2.4	20.2	1.8	2.9	1.6451	6.5803
32	94.0%	6.0%	0.03	20.2	1.8	2.9	1.6451	6.5803
33	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
34	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
35	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
36	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
37	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
38	94.0%	6.0%	2.4	20.2	1.8	2.9	0.0305	0.1220
39	94.0%	6.0%	2.4	20.2	1.8	2.9	1.6451	6.5803
40	94.0%	6.0%	2.4	20.2	1.8	2.9	1.6451	6.5803
41	94.0%	6.0%	2.4	20.2	1.8	2.9	1.6451	6.5803
42	94.0%	6.0%	2.4	20.2	1.8	2.9	1.6451	6.5803
43	94.0%	6.0%	2.4	20.2	1.8	2.9	1.6451	6.5803
44	94.0%	6.0%	2.4	20.2	1.8	2.9	1.6451	6.5803
45	94.0%	6.0%	2.4	20.2	1.8	2.9	1.6451	6.5803
46	94.0%	6.0%	2.4	20.2	1.8	2.9	1.6451	6.5803
47	94.0%	6.0%	0.03	20.2	1.8	2.9	1.6451	6.5803
48	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220

Index	Percent LDV	Percent HDV	sL (g/m2)	HDV W (tons)	LDV W (tons)	Average W (tons)	PM2.5	PM10
49	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
50	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
51	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
52	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
53	94.0%	6.0%	2.4	20.2	1.8	2.9	0.0305	0.1220
54	94.0%	6.0%	2.4	20.2	1.8	2.9	1.6451	6.5803
55	94.0%	6.0%	0.03	20.2	1.8	2.9	1.6451	6.5803
56	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
57	94.0%	6.0%	0.6	20.2	1.8	2.9	0.0305	0.1220
58	94.0%	6.0%	0.03	20.2	1.8	2.9	0.4659	1.8637
59	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
60	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
61	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
62	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
63	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
64	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
65	94.0%	6.0%	0.6	20.2	1.8	2.9	0.0305	0.1220
66	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
67	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
68	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
69	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
70	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
71	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
72	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
73	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
74	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
75	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
76	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
77	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
78	94.0%	6.0%	0.03	20.2	1.8	2.9	0.4659	1.8637
79	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
80	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
81	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
82	94.0%	6.0%	0.6	20.2	1.8	2.9	0.0305	0.1220
83	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
84	94.0%	6.0%	0.03	20.2	1.8	2.9	0.4659	1.8637
85	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
86	94.0%	6.0%	0.6	20.2	1.8	2.9	0.0305	0.1220
87	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
88	94.0%	6.0%	0.03	20.2	1.8	2.9	0.4659	1.8637
89	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
90	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
91	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
92	94.0%	6.0%	0.6	20.2	1.8	2.9	0.0305	0.1220
93	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
94	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
95	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
96	94.0%	6.0%	0.03	20.2	1.8	2.9	0.4659	1.8637
97	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
98	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
99	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
100	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
101	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
102	94.0%	6.0%	0	20.2	1.8	2.9	0.0305	0.1220

B7b: Summary of Re-entrained Road Dust Emission Factors for King/Main Section

	k (g/VMT)
PM2.5	0.25
PM10	1

	1	2	3	4	5	6	7	8
Index	Percent LDV	Percent HDV	sL (g/m2)	HDV W (tons)	LDV W (tons)	Average W (tons)	PM2.5	PM10
1	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
2	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
3	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
4	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
5	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
6	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
7	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
8	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
9	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
10	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
11	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
12	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
13	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
14	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
15	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
16	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
17	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
18	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
19	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
20	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
21	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
22	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
23	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
24	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
25	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
26	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
27	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
28	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
29	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
30	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
31	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
32	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
33	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
34	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
35	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
36	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
37	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
38	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
39	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
40	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
41	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
42	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
43	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
44	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
45	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
46	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
47	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
48	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308

Index	Percent LDV	Percent HDV	sL (g/m2)	HDV W (tons)	LDV W (tons)	Average W (tons)	PM2.5	PM10
49	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
50	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
51	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
52	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
53	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
54	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
55	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
56	94.0%	6.0%	2.4	20.2	1.8	2.9	1.6451	6.5803
57	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
58	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
59	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
60	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
61	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
62	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
63	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
64	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
65	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
66	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
67	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
68	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
69	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
70	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
71	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
72	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
73	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
74	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
75	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
76	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
77	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
78	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
79	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
80	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
81	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
82	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
83	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
84	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
85	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
86	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
87	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
88	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
89	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
90	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
91	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
92	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
93	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
94	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
95	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
96	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308
97	94.0%	6.0%	0.12	20.2	1.8	2.9	0.1077	0.4308

B7c: Summary of Re-entrained Road Dust Emission Factors for York Section

	k (g/VMT)
PM2.5	0.25
PM10	1

	1	2	3	4	5	6	7	8
Index	Percent LDV	Percent HDV	sL (g/m2)	HDV W (tons)	LDV W (tons)	Average W (tons)	PM2.5	PM10
1	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
2	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
3	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
4	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
5	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
6	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
7	94.0%	6.0%	2.4	20.2	1.8	2.9	1.6451	6.5803
8	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
9	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
10	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
11	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
12	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
13	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
14	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
15	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
16	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
17	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
18	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
19	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
20	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
21	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
22	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
23	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
24	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
25	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
26	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
27	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
28	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
29	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
30	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
31	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
32	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
33	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
34	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
35	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
36	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
37	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
38	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
39	94.0%	6.0%	2.4	20.2	1.8	2.9	1.6451	6.5803
40	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
41	94.0%	6.0%	2.4	20.2	1.8	2.9	1.6451	6.5803
42	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
43	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
44	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
45	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
46	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
47	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
48	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220

Index	Percent LDV	Percent HDV	sL (g/m2)	HDV W (tons)	LDV W (tons)	Average W (tons)	PM2.5	PM10
49	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
50	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
51	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
52	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
53	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
54	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
55	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
56	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
57	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
58	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
59	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
60	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
61	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
62	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
63	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
64	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
65	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
66	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
67	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
68	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
69	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
70	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
71	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
72	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
73	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
74	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
75	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
76	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
77	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
78	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
79	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
80	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
81	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
82	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
83	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
84	94.0%	6.0%	0.6	20.2	1.8	2.9	0.4659	1.8637
85	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
86	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
87	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220
88	94.0%	6.0%	0.03	20.2	1.8	2.9	0.0305	0.1220

APPENDIX C

Table C.1: Maximum Predicted 24-Hour Average PM_{10} Concentrations (µg/m^3)

Receptor No.	PM10			
	Barton	York	King	Background
R1	37.6	37.3	38.8	34
R2	36.1	46.5	40.1	34
R3	37.0	38.5	41.5	34
R4	38.7	38.6	38.9	34
R5	35.8	50.6	40.7	34
R6	40.1	41.8	41.8	34
R7	37.5	46.2	39.3	34
R8	40.2	41.0	37.5	34
R9	37.2	40.3	37.6	34
R10	37.4	36.9	37.5	34
R11	40.6	48.8	36.7	34
R12	37.9	46.0	39.4	34
R13	39.2	45.7	36.9	34
R14	36.8	43.3	38.9	34
R15	37.2	N/A	38.6	34
R16	38.2	N/A	40.8	34

Notes:
[1] The 24-Hour AAQC for PM_{10} is 50 µg/m³.

Table C.2: Maximum Predicted 24-Hour Average $PM_{2.5}$ Concentrations (µg/m³)

Receptor No.	PM2.5 (24-hr)			
	Barton	**York**	**King**	**Background**
R01	19.2	19.03	19.7	18
R02	18.7	21.46	20.4	18
R03	19.1	19.32	20.5	18
R04	19.6	19.36	19.5	18
R05	18.7	22.5	20.2	18
R06	19.8	20.19	21.1	18
R07	19.1	21.45	19.6	18
R08	19.9	20.03	19.1	18
R09	19.0	19.84	19.1	18
R10	19.1	18.93	19.1	18
R11	20.2	22.14	18.9	18
R12	19.2	21.29	19.6	18
R13	19.7	21.17	18.9	18
R14	18.9	20.6	19.5	18
R15	19.0	N/A	19.6	18
R16	19.3	N/A	20.2	18

Notes:

[1] The 24-Hour AAQC for $PM_{2.5}$ is 30 µg/m³.

Table C.3: Maximum Predicted 1-Hour and 24-Hour Average NO_2 Concentrations ($\mu g/m^3$)

Receptor No.	NO2 (1-hr)				NO2 (24-hr)			
	Barton	York	King	Background	Barton	York	King	Background
R01	97	88	74	40	47	44	41	34
R02	68	102	88	40	40	53	47	34
R03	69	65	73	40	42	40	45	34
R04	112	101	73	40	49	47	42	34
R05	62	101	88	40	39	55	45	34
R06	112	109	82	40	55	52	47	34
R07	104	138	57	40	47	71	39	34
R08	113	135	54	40	55	55	37	34
R09	99	125	52	40	46	52	37	34
R10	102	80	58	40	47	42	40	34
R11	111	135	57	40	56	71	39	34
R12	106	114	62	40	48	52	41	34
R13	119	134	57	40	51	55	37	34
R14	89	117	64	40	44	51	41	34
R15	97	N/A	69	40	46	N/A	40	34
R16	106	N/A	67	40	48	N/A	42	34

Notes:

[1] The 1-Hour AAQC for NO_2 is 400 µg/m³.

[2] The 24-Hour AAQC for NO_2 is 200 µg/m³.

Table C.4: Maximum Predicted 1-Hour and 8-Hour Average CO Concentrations (µg/m^3)

Receptor No.	CO (1-hr)				CO (8-hr)			
	Barton	York	King	Background	Barton	York	King	Background
R01	1578	1410	1405	747	1211	1118	1114	747
R02	1131	1839	1753	747	961	1357	1309	747
R03	1177	1121	1375	747	987	956	1098	747
R04	1849	1582	1187	747	1363	1213	993	747
R05	1074	1815	1599	747	929	1344	1223	747
R06	1750	1974	1576	747	1307	1432	1210	747
R07	1622	2449	982	747	1236	1698	878	747
R08	1779	2182	945	747	1324	1549	858	747
R09	1547	1949	908	747	1194	1418	837	747
R10	1591	1329	994	747	1218	1072	885	747
R11	1776	2366	981	747	1322	1652	878	747
R12	1650	1857	1073	747	1251	1367	929	747
R13	1879	2068	1012	747	1379	1485	895	747
R14	1462	1845	1182	747	1146	1361	990	747
R15	1543	N/A	1360	747	1191	N/A	1090	747
R16	1689	N/A	1213	747	1273	N/A	1007	747

Notes:

[1] The 1-Hour AAQC for CO is 36200 µg/m³.

[2] The 24-Hour AAQC for CO is 15700 µg/m³.

Table C.5: Maximum Predicted 24-Hour and Annual Average 1,3-Butadiene Concentrations (μg/m³)

Receptor No.	1,3-Butadiene (24-hr)				1,3-Butadiene (Annual)			
	Barton	York	King	Background	Barton	York	King	Background
R01	0.33	0.32	0.31	0.29	0.14	0.14	0.14	0.13
R02	0.31	0.35	0.34	0.29	0.13	0.15	0.14	0.13
R03	0.31	0.31	0.32	0.29	0.14	0.14	0.14	0.13
R04	0.33	0.33	0.31	0.29	0.14	0.14	0.14	0.13
R05	0.30	0.35	0.32	0.29	0.13	0.15	0.14	0.13
R06	0.35	0.34	0.34	0.29	0.14	0.15	0.14	0.13
R07	0.32	0.39	0.30	0.29	0.14	0.15	0.13	0.13
R08	0.35	0.35	0.30	0.29	0.14	0.14	0.13	0.13
R09	0.32	0.34	0.30	0.29	0.14	0.14	0.13	0.13
R10	0.32	0.31	0.30	0.29	0.14	0.13	0.13	0.13
R11	0.36	0.41	0.30	0.29	0.15	0.16	0.13	0.13
R12	0.33	0.34	0.31	0.29	0.14	0.14	0.13	0.13
R13	0.34	0.35	0.30	0.29	0.14	0.15	0.13	0.13
R14	0.32	0.34	0.31	0.29	0.14	0.14	0.14	0.13
R15	0.32	N/A	0.32	0.29	0.14	N/A	0.14	0.13
R16	0.33	N/A	0.31	0.29	0.14	N/A	0.14	0.13

Notes:
[1] The MOE's 24-Hour proposed AAQC for 1,3-butadiene is 10 μg/m³.
[2] The MOE's Annual proposed AAQC for 1,3-butadiene is 2 μg/m³.

Table C.6: Maximum Predicted 24-Hour and 1-Hour Average Acrolein Concentrations (µg/m^3)

Receptor No.	Acrolein (24-hr)				Acrolein (1-hr)			
	Barton	York	King	Background	Barton	York	King	Background
R01	0.23	0.23	0.23	0.22	0.26	0.25	0.25	0.22
R02	0.22	0.23	0.23	0.22	0.24	0.27	0.26	0.22
R03	0.23	0.22	0.23	0.22	0.24	0.24	0.25	0.22
R04	0.23	0.23	0.23	0.22	0.27	0.26	0.24	0.22
R05	0.22	0.24	0.23	0.22	0.23	0.27	0.26	0.22
R06	0.23	0.23	0.23	0.22	0.27	0.27	0.26	0.22
R07	0.23	0.24	0.22	0.22	0.26	0.30	0.23	0.22
R08	0.23	0.23	0.22	0.22	0.27	0.29	0.23	0.22
R09	0.23	0.23	0.22	0.22	0.26	0.28	0.23	0.22
R10	0.23	0.23	0.22	0.22	0.26	0.25	0.23	0.22
R11	0.24	0.25	0.22	0.22	0.27	0.29	0.23	0.22
R12	0.23	0.23	0.22	0.22	0.26	0.27	0.23	0.22
R13	0.23	0.23	0.22	0.22	0.27	0.29	0.23	0.22
R14	0.23	0.23	0.22	0.22	0.25	0.27	0.24	0.22
R15	0.23	N/A	0.23	0.22	0.26	N/A	0.25	0.22
R16	0.23	N/A	0.23	0.22	0.26	N/A	0.24	0.22

Notes:
[1] The MOE's 24-Hour AAQC for Acrolein is 0.4 µg/m³.
[2] The MOE's 1-Hour AAQC for Acrolein is 4.5 µg/m³.

Table C.7: Maximum Predicted 24-Hour and Annual Average Benzene Concentrations (µg/m³)

Receptor No.	Benzene (24-hr)				Benzene (Annual)			
	Barton	York	King	Background	Barton	York	King	Background
R01	3.97	3.84	3.84	4.0	1.50	1.49	1.46	1.0
R02	3.77	4.14	4.07	4.0	1.45	1.56	1.51	1.0
R03	3.81	3.77	3.93	4.0	1.46	1.45	1.48	1.0
R04	4.02	3.96	3.80	4.0	1.50	1.51	1.45	1.0
R05	3.73	4.22	3.93	4.0	1.43	1.58	1.48	1.0
R06	4.15	4.09	4.08	4.0	1.52	1.55	1.50	1.0
R07	3.92	4.50	3.72	4.0	1.48	1.63	1.43	1.0
R08	4.16	4.16	3.67	4.0	1.52	1.51	1.43	1.0
R09	3.89	4.06	3.68	4.0	1.48	1.49	1.42	1.0
R10	3.92	3.81	3.73	4.0	1.49	1.44	1.43	1.0
R11	4.23	4.72	3.72	4.0	1.55	1.70	1.43	1.0
R12	4.00	4.11	3.78	4.0	1.51	1.51	1.45	1.0
R13	4.12	4.13	3.69	4.0	1.53	1.55	1.43	1.0
R14	3.87	4.05	3.81	4.0	1.47	1.49	1.46	1.0
R15	3.89	N/A	3.85	4.0	1.48	N/A	1.47	1.0
R16	3.95	N/A	3.84	4.0	1.51	N/A	1.46	1.0

Notes:
[1] The MOE's 24-Hour proposed AAQC for Benzene is 2.3 µg/m³.
[2] The MOE's Annual proposed AAQC for Benzene is 0.45 µg/m³.

Table C.8: Maximum Predicted 24-Hour Acetaldehyde and Formaldehyde Concentrations (µg/m³)

Receptor No.	Acetaldehyde (24-hr)				Formaldehyde (24-hr)			
	Barton	York	King	Background	Barton	York	King	Background
R01	2.77	2.75	2.74	2.7	4.79	4.72	4.70	4.6
R02	2.73	2.80	2.77	2.7	4.69	4.87	4.79	4.6
R03	2.74	2.73	2.76	2.7	4.71	4.69	4.75	4.6
R04	2.78	2.77	2.74	2.7	4.81	4.78	4.70	4.6
R05	2.73	2.81	2.76	2.7	4.67	4.91	4.75	4.6
R06	2.81	2.79	2.78	2.7	4.89	4.84	4.81	4.6
R07	2.76	2.88	2.72	2.7	4.77	5.08	4.66	4.6
R08	2.81	2.81	2.71	2.7	4.89	4.89	4.63	4.6
R09	2.76	2.79	2.71	2.7	4.76	4.84	4.64	4.6
R10	2.76	2.74	2.73	2.7	4.77	4.71	4.67	4.6
R11	2.82	2.90	2.72	2.7	4.91	5.13	4.66	4.6
R12	2.77	2.79	2.73	2.7	4.80	4.85	4.69	4.6
R13	2.79	2.80	2.72	2.7	4.85	4.88	4.64	4.6
R14	2.75	2.79	2.74	2.7	4.74	4.83	4.69	4.6
R15	2.76	N/A	2.74	2.7	4.76	N/A	4.70	4.6
R16	2.77	N/A	2.74	2.7	4.78	N/A	4.71	4.6

Notes:
[1] The MOE's 24-Hour AAQC for Formaldehyde is 65 µg/m³.
[2] The MOE's 24-Hour AAQC for Acetaldehyde is 500 µg/m³.