APPENDIX C

AIR QUALITY EVALUATION

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City of Woodstock

Downtown Transit Terminal
Environmental Assessment

Air Quality Study

September 2009

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1.0 Introduction

This Air Quality Assessment addresses the potential impacts associated with a proposal to relocate the City of Woodstock's Municipal Transit system's central transfer point. The existing transfer point is located on-street adjacent to the corner of Wellington St. and Dundas St., the busiest intersection in the downtown core. This location requires some users to cross the intersection to transfer to other vehicles. The proposed new location is north of Dundas Street, the main east-west route in the city, on a section of York Street that will be closed to all but transit vehicles. Buses will enter into the new transfer location mainly from Dundas Street, although one route's vehicle will enter and leave the north end of the facility using York Street. The new transfer location will be sized to accommodate 8 buses, although currently the city only operate six bus routes, each with a single vehicle. Currently the system operates with routes taking approximately 30 minutes to cover, so two trips for each route pass any given point each hour between 6:30 am and 6:00 pm Monday to Saturday.

The adjustment to the operation of the transit system will have several impacts in the surrounding area:

- the Route 3 bus will no longer run along Princess Street, north on York Street, and east on George to get to Huron Street;
- both the Route 1 and Route 2 buses will no longer turn left onto Young Street south of Dundas and along Peel St to Wellington to the transfer point; and,
- the Route 4, Route 5 and Route 6 buses will run along Dundas to York to get to the new transfer point, and return along Dundas to their respective routes.

The net effect of these changes would be to:

- take 2 west bound buses off Peel St. between Young and Wellington;
- take 1 east bound bus off Princess St. between York and Wellington;
- add 1 east bound bus on Dundas between Wellington and York;
- add 2 west bound buses on Dundas between York and Wellington;
- add 1 bus in each direction on York between Adelaide and Princess;
- add 1 bus southbound on York from George;
- add 1 bus west bound on George;
- remove 1 north and 1 south bound bus on Kent between George and Dundas; and,
- add 1 north bound bus on Huron Street between Dundas and George.

In addition, buses would no longer be idling at the curb on Wellington and Dundas, but they would be idling at the transfer station.

Due to the closure of York Street between Dundas and Adelaide, traffic currently using that route will disperse to other routes in the vicinity. The traffic evaluation identified potential re-routing for this traffic. That study[1] notes that all intersections examined were expected to operate at an acceptable level of service in the AM peak period and signalized intersections would, at worst, drop to a C level of service in the afternoon due mainly to the diversion of PM traffic from York Street. Furthermore, the study notes that vehicles entering Dundas from the unsignalized cross streets could experience additional delays. Left turns both north and south bound at Beale, and north bound at York, and south bound at Kent will all experience excessive delays with the new arrangement, whereas only south bound at Kent is currently in that state.

2.0 Evaluation Procedure

With delays in traffic flow comes the potential for increases pollutant concentrations at receptors around those locations. Since the project will induce some changes in traffic flow patterns, but there will be no significant additions to traffic as a result of the project, there will be no regional changes in air quality.

With conventional point sources, changes in emissions are usually modelled to ascertain their impacts. In those cases the changes in emission characteristics can be well quantified, the temperature and flow rate of the stack gases is known and the contaminant emission rate can be readily quantified for the new case. The changes to emissions from traffic changes are more difficult to quantify because they depend upon the nature of the traffic at any time. Different types of vehicles have different emission rates. These emission rates can vary with the speed of the vehicles and thus the energy being produced by their engines. How the emissions may disperse is a function of the wind speed and direction in the vicinity of the source and in downtown situations the wind can be influenced by building structures. Assembling and applying all the data necessary to characterise potential changes in local air quality as a function of changes in traffic patterns thus can become a very time consuming challenge. This leads to questions about the effectiveness of expending such efforts particularly because, in many cases, such an analysis would show little if any effect of the changes.

Recognizing the need to conserve resources while still being able to identify the potential for significant changes induced by transportation related projects, environmental agencies in the United States have developed screening procedures to assess the impact of traffic induced changes in air quality. These methods are included in US EPA regulations related to conformance with state implementation plans. These regulations include lists of potential changes that are exempt from such considerations, examples of situations that can be addressed with qualitative assessments, and situations that could lead to significant changes that must be addressed with quantitative assessments. An outline of these procedures is provided in Appendix A. A slightly modified version of the recommended approach was applied for this assessment.

Mobile sources, cars, trucks and buses emit a range of air pollutants including:

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[1] IBI Group, 2009. Downtown Transit Terminal Environmental Assessment - Transportation Impact Assessment. A report for the City of Woodstock issued in draft September 11.

- carbon monoxide;
- oxides of nitrogen;
- particulate matter; and,
- air toxics.

Carbon monoxide, oxides of nitrogen and particulate matter are criteria contaminants that are usually associated with any combustion source. As regulators have set new standards for emissions from internal combustion engines there have been reductions in the levels of the criteria contaminants measured in urban areas. Indeed, carbon monoxide levels measured in Ontario have declined 90 - 95% since the mid 1970s. This should not be surprising since it is estimated that 85% of all CO emitted in the province originates from vehicles and emission standards have lowered emission rates from all vehicles. Similarly, NO_x concentrations of which 68% are related for vehicles, have decreased 36% over the same period. Long term trends in $PM_{2.5}$ levels are not available, but with only 24% of their emissions being associated with vehicular traffic, they would not be expected to have decreased at the same rate as the other criteria contaminants. Overall, it is appropriate to suggest that as emission rates from vehicle drop, air quality will improve. This trend is one of the reasons given by the US EPA for employing screening methods to identify the major changes that could be induced by traffic projects, and recommending qualitatively assessment for the minor changes.

Air Toxics, known formally as Mobile Source Air Toxics [MSATs] in the US, are a subset of the 188 air toxics defined by the US Clean Air Act. As the name suggests these are Air Toxics released from highway vehicles and non-road equipment. Some toxic compounds are present in fuel and are emitted to the air when the fuel evaporates or passes through the engine unburned. Other toxics are emitted when there is incomplete combustion of fuels and others are formed as secondary combustion products. Metal air toxics could also be included but since they are the result from engine wear or from impurities in oil or gasoline they are difficult to quantify for mobile sources and are ignored at this time. Currently the US EPA are targeting of 6 priority MSATs:

- Benzene - characterized as a known human carcinogen;
- Acrolein - the potential carcinogenicity of acrolein cannot be determined because the existing data are inadequate for an assessment of human carcinogenic potential for either the oral or inhalation route of exposure;
- Formaldehyde - a probable human carcinogen, based on limited evidence in humans, and sufficient evidence in animals;
- 1,3-butadiene - characterized as carcinogenic to humans by inhalation;
- Acetaldehyde - a probable human carcinogen based on increased incidence of nasal tumors in male and female rats and laryngeal tumors in male and female hamsters after inhalation exposure;
- Diesel exhaust (DE) - likely to be carcinogenic to humans by inhalation from environmental exposures. Diesel exhaust is the combination of diesel particulate matter and diesel exhaust organic gases. Diesel exhaust also represents chronic respiratory effects, possibly the primary non-cancer hazard from MSATs. Prolonged exposures may impair pulmonary function and could produce symptoms, such as cough, phlegm, and chronic bronchitis.

In the US, the EPA is the lead Federal Agency for administering the Clean Air Act and has certain responsibilities regarding the health effects of MSATs. Studies suggest that between 2000 and 2020, the programs that the US EPA has currently adopted to reduce vehicular emissions will result in the reduction of on-highway emissions of benzene, formaldehyde, 1,3-butadiene, and acetaldehyde by 57 percent to 65 percent, and will reduce on-highway diesel PM emissions by 87 percent. The Federal Highway Agency [FHWA] projects that even with a 64 percent increase in the number of vehicle miles travelled [VMT] the effect of these reductions will be realised.

In the evaluation that follows emissions of the various contaminants are addressed, where appropriate these are modelled by various methods drawing largely upon guidance developed at UC Davis for the California Department of Transportation[2], and the FHWA[3] for MSAT assessments.

3.0 Air Quality Impacts from the New Transfer Point

The assessment has been divided by contaminant to facilitate the review as the various guidance documents utilise different criteria for ranking the severity of traffic changes along with different approaches to quantifying the effect of the traffic on different aspects of air quality.

3.1 Carbon Monoxide

Assuming that there are no current issues with CO levels in Woodstock, the impacts of the project can be assessed following the Conformance Guidance for CO outlined in Appendix A. The activity of building a new transfer point is exempted from Regional Emissions Analysis, but should be addressed for the local situation. As such there is a need to look at both the transfer point, and changes that are induced in the traffic patterns around that point. Those changes, as outlined in the introduction, and detailed in the Transportation Impact Assessment [TIA] referenced earlier, include both signalized and un-signalized intersections. The screening criteria for acceptability of the changes are:

- No greater than a 2% increase in the percentage of vehicles operating in cold start mode. This project will not generate new traffic in the downtown core, rather it results in a change in traffic patterns some associated with buses, but most with passenger vehicles that seek different routes. With respect to cold start vehicles, it would be anticipated that with the exception of vehicles leaving the residences on Princess and Adelaide, few, if any, vehicles associated with the morning peak would be cold start. The slight change of route for the residents leaving in the morning is not judged to increase the cold start vehicles at any local intersections. The largest change in cold start traffic would be expect to be the vehicles leaving the Foodland West Driveway in the afternoon. Currently 11 vehicles turn south on York and they would be anticipated to go west on

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[2] http://www.dot.ca.gov/hq/env/air/pages/coprot.htm

[3] http://www.fhwa.dot.gov/environment/airtoxic/020306guidmem.htm

Adelaide. However, the closing of York is anticipated to result in a decrease in traffic on southbound York, to the extent that no change in cold start percentages are anticipated around this area.

- A second criteria suggests that increases in traffic volumes in excess of 5% would be anticipated to be potentially significant. Table 1 summarises the changes in traffic volumes at the 11 intersections considered in the TIA. In 3 intersections the project induces a decrease in traffic volume ranging between 7 and 43%. In 6 intersections the project causes less than a 2% change in volumes. At Dundas and Beale, the volume is anticipated to rise 8% whereas at Adelaide and Beale it is predicted to rise by 5%, basically due to the re-routing of traffic off of York. These two intersections should be reviewed quantitatively to determine the potential impact of these changes.

- Another criteria is the effect that the project might have on traffic flow. Removing the bus transfer zone from the corner of Wellington and Dundas should improve the traffic flow at this location, and reduce total emissions as measured on an hourly basis because the buses will no longer idle for extended periods in this location.

- Essentially the project results in moving the transfer point from Wellington and Dundas, where buses idle mainly along the east side of Wellington, south of Dundas. The centroid of this location is approximately 60 m from the nearest residential dwelling, located on Peel Street. The establishment of the transfer station on York Street will essentially move the centroid to a location approximately the same distance from a different set of residential dwellings around the new site. Since the transfer point needs to be considered for CO, a quantitative evaluation will address the potential that the project will increase CO levels at residential properties located around the transfer point.

Screening procedures can be used to assess CO concentrations in certain circumstances. California provides one such procedure[4]. Such procedures incorporate a set of tables and figures that can be used to determine concentrations in the vicinity of intersections. The procedure incorporates assumptions that result in conservative estimates. The procedures do not require detailed evaluation of the fleet mix, nor detailed modelling of the emissions; however, they do reflect California emission standards which are in some cases more severe than those applied in Ontario. To the extent that this would produce a low bias in estimates, it is likely overshadowed by the fact that the approach generally assumes much higher traffic volumes than seen at some of the intersections in Woodstock and the minimum adjustment factor is a conservative assumption.

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[4] California Department of Transportation, 1997. Transportation Project-Level Carbon Monoxide Protocol. Prepared by the Institute of Transportation Studies, UCDavis. Available at http://www.dot.ca.gov/hq/env/air/pages/coprot.htm

Table 1 Summary of Woodstock Traffic Volume Changes PM Peak

Intersection	Year	EBL	EBT	EBR	NBL	NBT	NBR	WBL	WBT	WBR	SBL	SBT	SBR	Total	% Increase		Traffic Volume Totals [v/h]			
															Growth	Project	East	West	North	South
Dundas Wellington	2009	30	397	25	54	219	84	28	400	44	88	181	53	1603			452	472	357	322
	B 2014	30	438	25	54	242	84	44	442	28	88	200	53	1728	8		493	514	380	341
	P 2014	30	441	25	54	242	88	46	444	30	88	200	53	1741	9	1	496	520	384	341
	B 2019	30	484	25	54	267	84	44	488	28	88	221	53	1866	16		539	560	405	362
	P 2019	30	488	25	54	267	88	46	492	30	88	221	53	1882	17	1	543	568	409	362
Dundas Victoria	2009	4	557	8	4	8	12	16	464	28	0	8	4	1113			569	508	24	12
	B 2014	4	615	8	4	8	12	16	512	28	0	8	4	1219	10		627	556	24	12
	P 2014	4	621	8	4	8	12	16	520	28	0	8	4	1233	11	1	633	564	24	12
	B 2019	4	679	8	4	8	12	16	566	28	0	8	4	1337	20		691	610	24	12
	P 2019	4	687	8	4	8	12	16	575	28	0	8	4	1354	22	2	699	619	24	12
Dundas Beale	2009	20	499	8	12	12	12	20	506	8	8	8	16	1129			527	534	36	32
	B 2014	20	551	8	12	12	12	20	559	8	8	8	16	1234	9		579	587	36	32
	P 2014	44	534	8	12	12	12	19	568	38	35	26	15	1323	17	8	586	625	36	76
	B 2019	20	609	8	12	12	12	20	617	8	8	8	16	1350	20		637	645	36	32
	P 2019	44	593	8	12	12	12	19	628	38	35	26	15	1442	28	8	645	685	36	76
Dundas York	2009	24	482	13	4	11	18	26	510	19	27	10	20	1164			519	555	33	57
	B 2014	24	532	13	4	11	18	28	563	19	27	10	20	1269	9		569	610	33	57
	P 2014	13	559	6	15	0	18	39	604	4	4	0	6	1268	9	0	578	647	33	10
	B 2019	24	588	13	4	11	18	28	622	19	27	10	20	1384	19		625	669	33	57
	P 2019	8	615	13	15	0	18	39	662	6	6	0	8	1390	19	1	636	707	33	14
Dundas Kent	2009	23	501	12	5	4	17	20	508	16	20	12	19	1157			536	544	26	51
	B 2014	23	553	12	5	4	17	20	561	16	20	12	19	1262	9		588	597	26	51
	P 2014	23	558	11	5	4	17	20	565	16	20	12	19	1270	10	1	592	601	26	51
	B 2019	23	611	12	5	4	17	20	619	16	20	12	19	1378	19		646	655	26	51
	P 2019	23	617	11	5	4	17	20	625	16	20	12	19	1389	20	1	651	661	26	51
Adelaide Wellington	2009	19	0	54	16	229	32	47	28	47	13	252	13	750			73	122	277	278
	B 2014	19	0	54	16	253	32	47	28	47	13	279	13	801	7		73	122	301	305
	P 2014	19	0	54	16	255	32	47	28	47	13	279	13	803	7	0	73	122	303	305
	B 2019	19	0	54	16	279	32	47	28	47	13	308	13	856	14		73	122	327	334
	P 2019	19	0	54	16	281	32	47	28	47	13	308	13	858	14	0	73	122	329	334

Table 1 Summary of Woodstock Traffic Volume Changes PM Peak

Intersection	Year	EBL	EBT	EBR	NBL	NBT	NBR	WBL	WBT	WBR	SBL	SBT	SBR	Total	% Increase		Traffic Volume Totals [v/h]			
															Growth	Project	East	West	North	South
Adelaide Beale	2009	13	71	6	6	28	6	12	84	12	37	19	0	294			90	108	40	56
	B 2014	13	71	6	6	28	6	12	84	12	37	19	0	294	0		90	108	40	56
	P 2014	13	53	24	28	60	6	5	33	5	28	54	0	309	5	5	90	43	94	82
	B 2019	13	71	6	6	28	6	12	84	12	37	19	0	294	0		90	108	40	56
	P 2019	13	53	24	28	60	6	5	33	5	28	54	0	309	5	5	90	43	94	82
Adelaide York	2009	36	50	27	41	14	0	23	43	43	24	16	24	341			113	109	55	64
	B 2014	36	50	27	41	14	0	23	43	43	24	16	24	341	0		113	109	55	64
	P 2014	36	50	0	0	2	0	0	33	43	24	2	5	195	-43	-43	86	76	2	31
	B 2019	36	50	27	41	14	0	23	43	43	24	16	24	341	0		113	109	55	64
	P 2019	36	50	0	0	2	0	0	33	43	24	2	5	195	-43	-43	86	76	2	31
Princess Wellington	2009	27	50	91	50	200	19	18	25	9	15	170	31	705			168	52	269	216
	B 2014	27	50	91	50	221	19	18	25	9	15	188	31	744	6		168	52	290	234
	P 2014	27	50	91	52	221	19	18	25	9	15	188	31	746	6	0	168	52	292	234
	B 2019	27	50	91	50	244	19	18	25	9	15	207	31	786	11		168	52	313	253
	P 2019	27	50	91	52	244	19	18	25	9	15	207	31	788	12	0	168	52	315	253
Princess York	2009	33		38	16	66						27	5	185			71	0	82	32
	B 2014	33		38	16	66						27	5	185	0		71	0	82	32
	P 2014	19		33	13	57						23	5	150	-19	-19	52	0	70	28
	B 2019	33		38	16	66						27	5	185	0		71	0	82	32
	P 2019	13		33	13	57						23	5	144	-22	-22	46	0	70	28
George York	2009	21	75	74		25	11	59						265			170	59	36	0
	B 2014	21	75	74		25	11	59						265	0		170	59	36	0
	P 2014	11	75	66		24	6	65						247	-7	-7	152	65	30	0
	B 2019	21	75	74		25	11	59						265	0		170	59	36	0
	P 2019	11	75	66		24	6	65						247	-7	-7	152	65	30	0

Detailed quantitative evaluations require emission factors from the fleet of vehicles typically found in the area, and more detailed information on the operation of those vehicles. This data is combined with meteorological data from the region to predict impacts. The major limitation with this approach is the availability of fleet data, age of the vehicles, type of vehicle (heavy duty diesel vehicles [HDDV] vs gasoline powered trucks, private cars etc.), state of tune, and VMT per type and age of vehicle. The screening procedure simply assumes a reasonable mix, and adjusts the anticipated releases for changes in the year of the evaluation to reflect potentially lower emission rates.

Screening procedures will be used to provide a comparison between existing situations and those that could result from the implementation of the project. These will follow the information outlined in Appendix A of the California protocol referenced above. One limitation on this approach is that the protocol recommends that it not be used when the mean minimum temperature for January is less than 2^{O}C. Clearly, this condition is not realistic for Ontario, however since the main function of this approach is to compare situations, this limitation is not considered a major concern.

Receptor locations used in the California protocol are set at either 3 m or 7 m depending upon whether a 1 hour or an 8 hour exposure are of interest. In this study it will be assumed that the receptor is located on the northeast corner of the intersection, 3 m from both the arriving and departing lanes. Eight hour predicted values are defined by applying a persistence factor to the 1 hour average values. The estimated concentrations are added to the background concentrations to determine if they exceed the appropriate standard.

In Ontario, the 1 hour standard for CO is 30 ppm and the 8 hour standard is 13 ppm. Background 1 hour maximum CO values in Ontario in smaller communities range from 2.03 ppm in Chatham to 1.29 ppm in Ottawa, 1.2 ppm in London and 0.59 ppm in Kingston. An average for these maximum 1 hour values, 1.5 ppm, will be used for this study.

For the purposes of this evaluation the intersections at Dundas and Wellington, Dundas and Beale and Adelaide and Beale will be evaluated. All three intersections have two lane streets in each direction. The area can be characterised as a comparable to the central valley area of California, ie. flat with limited terrain impacts on air flow and turbulence in the region.

The posted speed limit in the area is 50 km/h and it can be assumed that the average traffic speed along the stretch under consideration would not be more than 40 km/h or 25 mph to allow use of the charts from the California protocol.

The Protocol references a US EPA determination that the range of vehicles operating in cold start mode for PM Peak hours in the Central Business District is 25 - 40%. Since the 3 intersections are located in the Central Business District this was considered appropriate, and to be conservative, the upper end of this range was used.

Dundas and Wellington is a signal controlled intersection with Dundas having a red light time of 28 s whereas Wellington has an effective red time of 30 s. A red light time of 50% was used for this intersection in both directions.

Adelaide and Beale is controlled by a stop sign in the N/S direction. The average delay time in that direction is 10.8 s. In the E/W direction the control delay time is estimated at 1 s. Since the red light time minimum in the tables is 30% and will therefore be used for this evaluation.

Dundas and Beale is controlled by a stop sign in the N/S direction. The average delay time in that direction is 25.3 s. In the E/W direction the control delay time is estimated at 0.6 s. The red light time minimum in the tables is 30% and will therefore be used for this evaluation.

Traffic volumes on the E/W and N/S portions of the various intersections for the various years are shown in Table 1.

The analysis years from the California protocol are 2008 for present conditions and 2012 to represent future conditions.

The Concentration Contributions for a receptor on the NE corner of the intersection, 3 m from both the E/W and N/S road essentially results in values from the table for 3 m and 10 m depending upon which lanes are being considered. The evaluation and results are listed in Table 2. The protocol was used to assess both the influence of growth in the "no-build" and the "build" conditions.

The quantitative evaluation shows that, for all alternatives considered, the level of CO for both 1 hour and 8 hours is well below the applicable ambient air quality standard. There are slight differences in the Dundas and Wellington situation related to the growth in traffic flow over the period, but not due to the changes induced by moving the transfer location. The other difference is a slight drop in 2014 with the existing case for Dundas and Beale due to the improvement in emission performance of vehicles in 2012. This effect is lost when the project is included, but the level is not greater than the 2009 base case.

Since the intersections do not appear to be a concern, the potential impact of the buses idling in the transfer location on CO levels needs to be addressed. Buses can stay at the transfer location for up to 5 minutes since the operating policy is that all buses wait until the last one arrives at the transfer point. Buses can arrive at various times, and a finite amount of time must be allowed for the last bus to off-load passengers and re-load transfers. For this analysis the worst case situation would be that all 8 buses were present at the transfer location for 5 minutes out of every 30 minutes.

Diesel engines release products of combustion during operation. The quantity of contaminants released is a function of the load on the diesel engine and thus the fuel feed rate during operation. Typically diesel engine emission factors are expressed as g/bhp-hr, that is an emission rate that is a function of the horsepower being generated by the engine at any time. Such an emission factor suggests that emissions would vary directly relative to the load on the engine.

Table 2 CO Protocol Evaluation

Base Case Existing

	East West		North South		Total
	Approach	Departure	Approach	Departure	
Distance [m]	3	10	10	3	
Dundas Wellington					
Concentration Contribution	48	15.2	18.8	23	
Base Traffic Volume [v/h]	472	452	322	357	
Correction Factor	0.58	0.58	0.47	0.47	
Adjusted Contribution	27.84	8.82	8.84	10.81	
% Red Time	50	50	50	50	
Intersection Correction	0.39	0.16	0.35	0.17	
Adjusted Contribution	10.86	1.41	3.09	1.84	17.20
Worst Case Wind Correction [assume minimum 0.5 m/s]					1
Cold Start and Analysis Year [assume 40% - 2008]					0.3
Adjusted Contribution					5.16
		Highest	Lowest	Ratio	
Traffic Volume Ratio/Receptor Correction		472	322	1.47	0.94
Adjusted Contribution					4.85
Background 1 Hour Maximum [ppm]					1.50
Estimated 1 Hour Concentration [ppm]					6
Estimated 8 Hour Concentration [ppm] (assume 0.8 persistence urban value)					5
Dundas Beale					
Concentration Contribution	48	15.2	18.8	23	
Base Traffic Volume [v/h]	534	527	32	36	
Correction Factor	0.67	0.67	0.27	0.27	
Adjusted Contribution	32.16	10.18	5.08	6.21	
% Red Time	30	30	70	70	
Intersection Correction	0.24	0.14	0.45	0.62	
Adjusted Contribution	7.72	1.43	2.28	3.85	15.28
Worst Case Wind Correction [assume minimum 0.5 m/s]					1
Cold Start and Analysis Year [assume 40% - 2008]					0.3
Adjusted Contribution					4.58
		Highest	Lowest	Ratio	
Traffic Volume Ratio/Receptor Correction		534	32	16.69	1
Adjusted Contribution					4.58
Background 1 Hour Maximum [ppm]					1.50
Estimated 1 Hour Concentration [ppm]					6
Estimated 8 Hour Concentration [ppm] (assume 0.8 persistence urban value)					5
Adelaide Beale					
Concentration Contribution	48	15.2	18.8	23	
Base Traffic Volume [v/h]	108	90	56	40	
Correction Factor	0.27	0.27	0.27	0.27	
Adjusted Contribution	12.96	4.10	5.08	6.21	
% Red Time	30	30	70	70	
Intersection Correction	0.21	0.14	0.45	0.62	
Adjusted Contribution	2.72	0.57	2.28	3.85	9.43
Worst Case Wind Correction [assume minimum 0.5 m/s]					1
Cold Start and Analysis Year [assume 40% - 2008]					0.3
Adjusted Contribution					2.83
		Highest	Lowest	Ratio	
Traffic Volume Ratio/Receptor Correction		108	40	2.70	0.98
Adjusted Contribution					2.77
Background 1 Hour Maximum [ppm]					1.50
Estimated 1 Hour Concentration [ppm]					4
Estimated 8 Hour Concentration [ppm] (assume 0.8 persistence urban value)					3

Table 2 (cont) CO Protocol Evaluation

2014 Case Existing

	East West		North South		Total
	Approach	Departure	Approach	Departure	
Distance [m]	3	10	10	3	
Dundas Wellington					
Concentration Contribution	48	15.2	18.8	23	
Base Traffic Volume [v/h]	514	493	341	380	
Correction Factor	0.67	0.58	0.47	0.47	
Adjusted Contribution	32.16	8.82	8.84	10.81	
% Red Time	50	50	50	50	
Intersection Correction	0.45	0.16	0.35	0.17	
Adjusted Contribution	14.47	1.41	3.09	1.84	20.81
Worst Case Wind Correction [assume minimum 0.5 m/s]					1
Cold Start and Analysis Year [assume 40% - 2012]					0.25
Adjusted Contribution					5.20
		Highest	Lowest	Ratio	
Traffic Volume Ratio/Receptor Correction		514	341	1.51	0.94
Adjusted Contribution					4.89
Background 1 Hour Maximum [ppm]					1.50
Estimated 1 Hour Concentration [ppm]					6
Estimated 8 Hour Concentration [ppm] (assume 0.8 persistence urban value)					5
Dundas Beale					
Concentration Contribution	48	15.2	18.8	23	
Base Traffic Volume [v/h]	587	579	36	32	
Correction Factor	0.67	0.67	0.27	0.27	
Adjusted Contribution	32.16	10.18	5.08	6.21	
% Red Time	30	30	70	70	
Intersection Correction	0.24	0.14	0.45	0.62	
Adjusted Contribution	7.72	1.43	2.28	3.85	15.28
Worst Case Wind Correction [assume minimum 0.5 m/s]					1
Cold Start and Analysis Year [assume 40% - 2012]					0.25
Adjusted Contribution					3.82
		Highest	Lowest	Ratio	
Traffic Volume Ratio/Receptor Correction		587	32	18.34	1
Adjusted Contribution					3.82
Background 1 Hour Maximum [ppm]					1.50
Estimated 1 Hour Concentration [ppm]					5
Estimated 8 Hour Concentration [ppm] (assume 0.8 persistence urban value)					4
Adelaide Beale					
Concentration Contribution	48	15.2	18.8	23	
Base Traffic Volume [v/h]	108	90	56	40	
Correction Factor	0.27	0.27	0.27	0.27	
Adjusted Contribution	12.96	4.10	5.08	6.21	
% Red Time	30	30	70	70	
Intersection Correction	0.21	0.14	0.45	0.62	
Adjusted Contribution	2.72	0.57	2.28	3.85	9.43
Worst Case Wind Correction [assume minimum 0.5 m/s]					1
Cold Start and Analysis Year [assume 40% - 2012]					0.25
Adjusted Contribution					2.36
		Highest	Lowest	Ratio	
Traffic Volume Ratio/Receptor Correction		108	40	2.70	0.98
Adjusted Contribution					2.31
Background 1 Hour Maximum [ppm]					1.50
Estimated 1 Hour Concentration [ppm]					4
Estimated 8 Hour Concentration [ppm] (assume 0.8 persistence urban value)					3

Table 2 (cont) CO Protocol Evaluation

2014 Case Project Build

	East West		North South		Total
	Approach	Departure	Approach	Departure	
Distance [m]	3	10	10	3	
Dundas Wellington					
Concentration Contribution	48	15.2	18.8	23	
Base Traffic Volume [v/h]	520	496	341	384	
Correction Factor	0.67	0.58	0.47	0.47	
Adjusted Contribution	32.16	8.82	8.84	10.81	
% Red Time	50	50	50	50	
Intersection Correction	0.45	0.16	0.35	0.17	
Adjusted Contribution	14.47	1.41	3.09	1.84	20.81
Worst Case Wind Correction [assume minimum 0.5 m/s]					1
Cold Start and Analysis Year [assume 40% - 2012]					0.25
Adjusted Contribution					5.20
		Highest	Lowest	Ratio	
Traffic Volume Ratio/Receptor Correction		520	341	1.52	0.94
Adjusted Contribution					4.89
Background 1 Hour Maximum [ppm]					1.50
Estimated 1 Hour Concentration [ppm]					6
Estimated 8 Hour Concentration [ppm] (assume 0.8 persistence urban value)					5
Dundas Beale					
Concentration Contribution	48	15.2	18.8	23	
Base Traffic Volume [v/h]	625	586	76	32	
Correction Factor	0.76	0.67	0.27	0.27	
Adjusted Contribution	36.48	10.18	5.08	6.21	
% Red Time	30	30	70	70	
Intersection Correction	0.29	0.14	0.45	0.62	
Adjusted Contribution	10.58	1.43	2.28	3.85	18.14
Worst Case Wind Correction [assume minimum 0.5 m/s]					1
Cold Start and Analysis Year [assume 40% - 2012]					0.25
Adjusted Contribution					4.53
		Highest	Lowest	Ratio	
Traffic Volume Ratio/Receptor Correction		625	32	19.53	1
Adjusted Contribution					4.53
Background 1 Hour Maximum [ppm]					1.50
Estimated 1 Hour Concentration [ppm]					6
Estimated 8 Hour Concentration [ppm] (assume 0.8 persistence urban value)					5
Adelaide Beale					
Concentration Contribution	48	15.2	18.8	23	
Base Traffic Volume [v/h]	43	90	82	94	
Correction Factor	0.27	0.27	0.27	0.27	
Adjusted Contribution	12.96	4.10	5.08	6.21	
% Red Time	30	30	70	70	
Intersection Correction	0.21	0.14	0.45	0.62	
Adjusted Contribution	2.72	0.57	2.28	3.85	9.43
Worst Case Wind Correction [assume minimum 0.5 m/s]					1
Cold Start and Analysis Year [assume 40% - 2012]					0.25
Adjusted Contribution					2.36
		Highest	Lowest	Ratio	
Traffic Volume Ratio/Receptor Correction		94	43	2.19	0.98
Adjusted Contribution					2.31
Background 1 Hour Maximum [ppm]					1.50
Estimated 1 Hour Concentration [ppm]					4
Estimated 8 Hour Concentration [ppm] (assume 0.8 persistence urban value)					3

Table 2 (cont) CO Protocol Evaluation

2019 Case Existing

	East West		North South		Total
	Approach	Departure	Approach	Departure	
Distance [m]	3	10	10	3	
Dundas Wellington					
Concentration Contribution	48	15.2	18.8	23	
Base Traffic Volume [v/h]	560	539	362	405	
Correction Factor	0.67	0.67	0.47	0.58	
Adjusted Contribution	32.16	10.18	8.84	13.34	
% Red Time	50	50	50	50	
Intersection Correction	0.45	0.17	0.35	0.16	
Adjusted Contribution	14.47	1.73	3.09	2.13	21.43
Worst Case Wind Correction [assume minimum 0.5 m/s]					1
Cold Start and Analysis Year [assume 40% - 2012]					0.25
Adjusted Contribution					5.36
		Highest	Lowest	Ratio	
Traffic Volume Ratio/Receptor Correction		560	362	1.55	0.94
Adjusted Contribution					5.04
Background 1 Hour Maximum [ppm]					1.50
Estimated 1 Hour Concentration [ppm]					7
Estimated 8 Hour Concentration [ppm] (assume 0.8 persistence urban value)					5
Dundas Beale					
Concentration Contribution	48	15.2	18.8	23	
Base Traffic Volume [v/h]	645	637	36	32	
Correction Factor	0.76	0.76	0.27	0.27	
Adjusted Contribution	36.48	11.55	5.08	6.21	
% Red Time	30	30	70	70	
Intersection Correction	0.29	0.14	0.45	0.62	
Adjusted Contribution	10.58	1.62	2.28	3.85	18.33
Worst Case Wind Correction [assume minimum 0.5 m/s]					1
Cold Start and Analysis Year [assume 40% - 2012]					0.25
Adjusted Contribution					4.58
		Highest	Lowest	Ratio	
Traffic Volume Ratio/Receptor Correction		645	32	20.16	1
Adjusted Contribution					4.58
Background 1 Hour Maximum [ppm]					1.50
Estimated 1 Hour Concentration [ppm]					6
Estimated 8 Hour Concentration [ppm] (assume 0.8 persistence urban value)					5
Adelaide Beale					
Concentration Contribution	48	15.2	18.8	23	
Base Traffic Volume [v/h]	108	90	56	40	
Correction Factor	0.27	0.27	0.27	0.27	
Adjusted Contribution	12.96	4.10	5.08	6.21	
% Red Time	30	30	70	70	
Intersection Correction	0.21	0.14	0.45	0.62	
Adjusted Contribution	2.72	0.57	2.28	3.85	9.43
Worst Case Wind Correction [assume minimum 0.5 m/s]					1
Cold Start and Analysis Year [assume 40% - 2012]					0.25
Adjusted Contribution					2.36
		Highest	Lowest	Ratio	
Traffic Volume Ratio/Receptor Correction		108	40	2.70	0.98
Adjusted Contribution					2.31
Background 1 Hour Maximum [ppm]					1.50
Estimated 1 Hour Concentration [ppm]					4
Estimated 8 Hour Concentration [ppm] (assume 0.8 persistence urban value)					3

Table 2 (cont) CO Protocol Evaluation
2019 Case Project Build

	East West		North South		Total
	Approach	Departure	Approach	Departure	
Distance [m]	3	10	10	3	
Dundas Wellington					
Concentration Contribution	48	15.2	18.8	23	
Base Traffic Volume [v/h]	568	543	362	409	
Correction Factor	0.67	0.67	0.47	0.58	
Adjusted Contribution	32.16	10.18	8.84	13.34	
% Red Time	50	50	50	50	
Intersection Correction	0.45	0.17	0.35	0.16	
Adjusted Contribution	14.47	1.73	3.09	2.13	21.43
Worst Case Wind Correction [assume minimum 0.5 m/s]					1
Cold Start and Analysis Year [assume 40% - 2012]					0.25
Adjusted Contribution					5.36
		Highest	Lowest	Ratio	
Traffic Volume Ratio/Receptor Correction		568	362	1.57	0.94
Adjusted Contribution					5.04
Background 1 Hour Maximum [ppm]					1.50
Estimated 1 Hour Concentration [ppm]					7
Estimated 8 Hour Concentration [ppm] (assume 0.8 persistence urban value)					5
Dundas Beale					
Concentration Contribution	48	15.2	18.8	23	
Base Traffic Volume [v/h]	685	645	76	32	
Correction Factor	0.76	0.76	0.27	0.27	
Adjusted Contribution	36.48	11.55	5.08	6.21	
% Red Time	30	30	70	70	
Intersection Correction	0.29	0.14	0.45	0.62	
Adjusted Contribution	10.58	1.62	2.28	3.85	18.33
Worst Case Wind Correction [assume minimum 0.5 m/s]					1
Cold Start and Analysis Year [assume 40% - 2012]					0.25
Adjusted Contribution					4.58
		Highest	Lowest	Ratio	
Traffic Volume Ratio/Receptor Correction		685	32	21.41	1
Adjusted Contribution					4.58
Background 1 Hour Maximum [ppm]					1.50
Estimated 1 Hour Concentration [ppm]					6
Estimated 8 Hour Concentration [ppm] (assume 0.8 persistence urban value)					5
Adelaide Beale					
Concentration Contribution	48	15.2	18.8	23	
Base Traffic Volume [v/h]	43	90	82	94	
Correction Factor	0.27	0.27	0.27	0.27	
Adjusted Contribution	12.96	4.10	5.08	6.21	
% Red Time	30	30	70	70	
Intersection Correction	0.21	0.14	0.45	0.62	
Adjusted Contribution	2.72	0.57	2.28	3.85	9.43
Worst Case Wind Correction [assume minimum 0.5 m/s]					1
Cold Start and Analysis Year [assume 40% - 2012]					0.25
Adjusted Contribution					2.36
		Highest	Lowest	Ratio	
Traffic Volume Ratio/Receptor Correction		94	43	2.19	0.98
Adjusted Contribution					2.31
Background 1 Hour Maximum [ppm]					1.50
Estimated 1 Hour Concentration [ppm]					4
Estimated 8 Hour Concentration [ppm] (assume 0.8 persistence urban value)					3

There is only limited data on idling emissions from diesel vehicles, and even more limited data on emissions during cold start periods. It is known that NO_x emissions from internal combustion engines are affected by temperature in the combustion chamber[5] and many idling studies are done only after the engine had reached operating temperatures. The main contaminants that are measured in most studies are the regulated species, CO, PM, and NO_x.

McCormick[6] notes that there was little difference between emission results for engines hot started, or cold started at $10^{O}C$. Since the buses in this study will have been operating for some time before arriving at the transfer station, it can be assumed that the emissions in the published literature will be representative.

Bradley[7] undertook a study on inter-city coaches that provide idling data from buses with and without air conditioning operating. The average CO emission rate was 8.3 mg/s without the air conditioning and it rose to 14.5 mg/s with AC operating. These data deal with undefined engines in 6 buses.

McCormick's data was collected from engines installed in buses. McCormick's testing was done within 20 minutes of the vehicle being tested on a chassis dynamometer, meaning that any auxiliary equipment typically used on buses would have been operational for the testing. The data collected by these authors produced g/minute emission rates for a range of contaminants as shown in Table 3. The details provided in the paper include the manufacturing year of the engine along with its manufacturer and specifications.

Given all the data provided, the emissions data from McCormick provides representative values that can be used for this study.

The basic emission data, provided in grams per minute, suggests a relationship to the power of the engine, larger engines produce more emissions. This is in line with the emission factor expression of g/HP-hr. The problem is, how does one translate the idling emission data to the conventional emission factor so it can be used for the Woodstock fleet?

Emissions from diesel bus engines for PM and NO_x have decreased over the last 10 years in response to regulatory reductions in the allowable emissions promulgated by the US EPA, although the CO emission regulations have remained constant. For instance, engines manufactured prior to 1991 were designed to operate with a not to exceed a PM emission rate of 0.6 g/bhp-hr. Engines for the 1991 to

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[5] Internal Combustion Engine Fundamentals, Heywood, J.B. Published by McGraw-Hill Ltd. OSSBN:978-0-07-028637-5. 1988.

[6] McCormick, R.L., M.S. Graboski, T.L. Alleman, J. Yanowitz, 2000. Idle Emissions from Heavy-Duty Diesel and Natural Gas Vehicles at High Altitude. JAWMA 50:1992-1998

[7] M.J. Bradley and Associates, Inc., 2006. Commercial Bus Emissions Characterization & Idle Reduction Idle & Urban Cycle Test Results. A report prepared for the U.S. Federal Highway Administration (FHWA), the Environmental Protection Agency, the Department of Energy, and the American Bus Association (ABA). http://www.buses.org/files/download/motorcoach_idling_study.pdf

Table 3 Emission Data for Buses under Idling Conditions from McCormick, 2000

Vehicle	Model Year	Engine	HP	Engine Family	THC, g/min	CO, g/min	NO x , g/min	PM, g/min	VOF, % of PM	Aldehyde, g/min
Bus 5054	1993	DDC S50, 8.5 L	250	P00085FZK7	0.038	1.740	1.979	0.106	8.2	0.0128
Bus 5021	1993	DDC S50, 8.5 L	250	P00085FZK7	0.030	1.238	2.109	0.047	7.3	0.0092
Bus 1710	1991	DDC 6V92, 9.0 L	330	8067–7B28	0.161	0.785	2.165	0.047	21	0.0064
Bus 1717	1991	DDC 6V92, 9.0 L	330	8067–7B28	0.318	2.156	2.406	0.173	18	0.0053
Bus 1510	1987	DDC 8V92, 12.1 L	370	8067–7AV0	0.181	1.624	2.738	0.031	14	0.0066
Bus 1501	1987	DDC 8V92, 12.1 L	370	8067–7AV0	0.215	0.967	2.767	0.037	2.8	0.0075
Bus 1936	1998	DDC S60, 12.7 L	430	6067GK2B	0.108	0.930	2.698	0.060	7.4	0.0068
Bus 1937	1998	DDC S60, 12.7 L	430	6067GK2B	0.130	1.733	2.352	0.019	35	0.0080
Bus 1009	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	0.222	2.345	1.147	0.021	32	0.0072
Bus 1010	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	0.070	0.763	1.030	0.006	–	–
Bus 1011	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	0.094	1.143	1.743	0.017	32	0.0003
Bus 1012	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	0.078	0.491	1.051	0.007	–	–
Bus Average					**0.137**	**1.326**	**2.015**	**0.048**	**19**	**0.006**

Emissions as a Function of Maximum Emission Rate according to US Regulations

					g/bhp/h	g/bhp/h	g/bhp/h
Bus 5054	1993	DDC S50, 8.5 L	250	P00085FZK7	15.5	6	0.25
Bus 5021	1993	DDC S50, 8.5 L	250	P00085FZK7	15.5	6	0.25
Bus 1710	1991	DDC 6V92, 9.0 L	330	8067–7B28	15.5	6	0.25
Bus 1717	1991	DDC 6V92, 9.0 L	330	8067–7B28	15.5	6	0.25
Bus 1510	1987	DDC 8V92, 12.1 L	370	8067–7AV0	15.5	6	0.6
Bus 1501	1987	DDC 8V92, 12.1 L	370	8067–7AV0	15.5	6	0.6
Bus 1936	1998	DDC S60, 12.7 L	430	6067GK2B	15.5	4	0.1
Bus 1937	1998	DDC S60, 12.7 L	430	6067GK2B	15.5	4	0.1
Bus 1009	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	15.5	6	0.1
Bus 1010	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	15.5	6	0.1
Bus 1011	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	15.5	6	0.1
Bus 1012	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	15.5	6	0.1
Bus Average					15.50	5.67	0.23

Maximum Hourly Emissions per Standard

					g/minute	g/minute	g/minute
Bus 5054	1993	DDC S50, 8.5 L	250	P00085FZK7	64.6	25.0	1.0
Bus 5021	1993	DDC S50, 8.5 L	250	P00085FZK7	64.6	25.0	1.0
Bus 1710	1991	DDC 6V92, 9.0 L	330	8067–7B28	85.3	33.0	1.4
Bus 1717	1991	DDC 6V92, 9.0 L	330	8067–7B28	85.3	33.0	1.4
Bus 1510	1987	DDC 8V92, 12.1 L	370	8067–7AV0	95.6	37.0	3.7
Bus 1501	1987	DDC 8V92, 12.1 L	370	8067–7AV0	95.6	37.0	3.7
Bus 1936	1998	DDC S60, 12.7 L	430	6067GK2B	111.1	28.7	0.7
Bus 1937	1998	DDC S60, 12.7 L	430	6067GK2B	111.1	28.7	0.7
Bus 1009	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	45.2	17.5	0.3
Bus 1010	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	45.2	17.5	0.3
Bus 1011	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	45.2	17.5	0.3
Bus 1012	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	45.2	17.5	0.3
Bus Average					74.49	26.44	1.24

Idling Emissions as Percentage of Maximum Allowable Emissions

					% of Max.	% of Max.	% of Max.
Bus 5054	1993	DDC S50, 8.5 L	250	P00085FZK7	2.69	7.92	10.18
Bus 5021	1993	DDC S50, 8.5 L	250	P00085FZK7	1.92	8.44	4.51
Bus 1710	1991	DDC 6V92, 9.0 L	330	8067–7B28	0.92	6.56	3.42
Bus 1717	1991	DDC 6V92, 9.0 L	330	8067–7B28	2.53	7.29	12.58
Bus 1510	1987	DDC 8V92, 12.1 L	370	8067–7AV0	1.70	7.40	0.84
Bus 1501	1987	DDC 8V92, 12.1 L	370	8067–7AV0	1.01	7.48	1.00
Bus 1936	1998	DDC S60, 12.7 L	430	6067GK2B	0.84	9.41	8.37
Bus 1937	1998	DDC S60, 12.7 L	430	6067GK2B	1.56	8.20	2.65
Bus 1009	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	5.19	6.55	7.20
Bus 1010	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	1.69	5.89	2.06
Bus 1011	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	2.53	9.96	5.83
Bus 1012	1997	Cum. ISB, 5.9 L	175	VCE359DJDARA	1.09	6.01	2.40
Bus Average					1.97	7.59	5.09

1994 model years were restricted to 0.25 g PM/bhp-hr while those manufactured in 1994 to 1997 had to meet a limit of 0.1 g PM/bhp-hr. This standard was further lowered to 0.01 g PM/bhp-hr in 2007.

Table 3 shows the regulatory emission limit for the year of manufacture and this value can be used to determine the emission rate at full horsepower. From this data, the individual data for idle emissions for each engine can be used to determine the emission rate for each engine as a percentage of the permitted maximum emission rate that the engine was certified to meet.

The results of these calculations are shown in the last section of Table 3 for CO, NO_x, and PM. The average idle emission rates as a function of allowable emissions range from 2 to 8%. There are some differences evident in the table where the four 1997 engines tested showed lower emissions. These engines, Cummins ISB 5.9 L engines are more typical of those installed in newer buses and, as noted in various references, newer engines produce less emissions than some older engines.

Assuming that the average emission rate at idle as a function of the maximum permissible emission rates is representative for all engines in a given fleet, the weighted average emission rate for the fleet can be calculated by taking the permissible rate for each bus, multiplying it by the average rate shown in Table 3, summing these values and then dividing by the total number of vehicles in the fleet. However, since the permitted CO emission rate has not changed over the period represented by the Woodstock buses, the calculation is simpler for that contaminant. Essentially the total HP represented by all the buses engines, can be multiplied by 15.5 g/bhp/h and the idling emission percentage 1.97% and divided by the total number of vehicles to yield a emission factor per bus. Since HP for the various engines are not known, an assumed HP of 300 was used for the calculation.

The result of this calculation is that the 11 buses in the fleet represent 3300 HP, which at 15.5 g CO/bhp/hr generates a potential 51,150 g CO/h of emissions, but at idle this emission rate is reduced to 1,008 g CO/h, or 0.0254 g CO/s/bus. Weighted average calculations for PM and NO_x are presented later in this document.

To evaluate the impact of the CO emissions at the transfer station, they were modelled using ISC-Prime. Each bus was treated as a separate structure and the exhaust was assumed to be released vertically above the bus. The model used 5 years of meteorological data from London and hourly concentrations were determined for each hour of the day. Note, because the buses start at 6:30 am and finish at 6 pm, emissions were assumed to be only 50% of the total for 6 am, and no emissions were released between 7 pm and 6 am. The maximum 1 hour value returned by the modelling was 90 ug/m^3 or 0.08 ppm. The model also determined the maximum 8 hour value, 0.06 ppm. The pattern of the concentrations around the transfer point are shown in Figures 1 and 2.

Given the maximum hourly value for London in 2007 was 1.2 ppm, the addition of the transfer station operation will not raise the maximum hourly level above the 30 ppm standard. Similarly, the maximum 8 hour value was 0.65 ppm and the 0.06 ppm will not raise the total about the 8 hour AAQS of 13 ppm. While the actual background values for Woodstock are not available, it would appear that the bus transfer point will not add significantly to levels in the community.

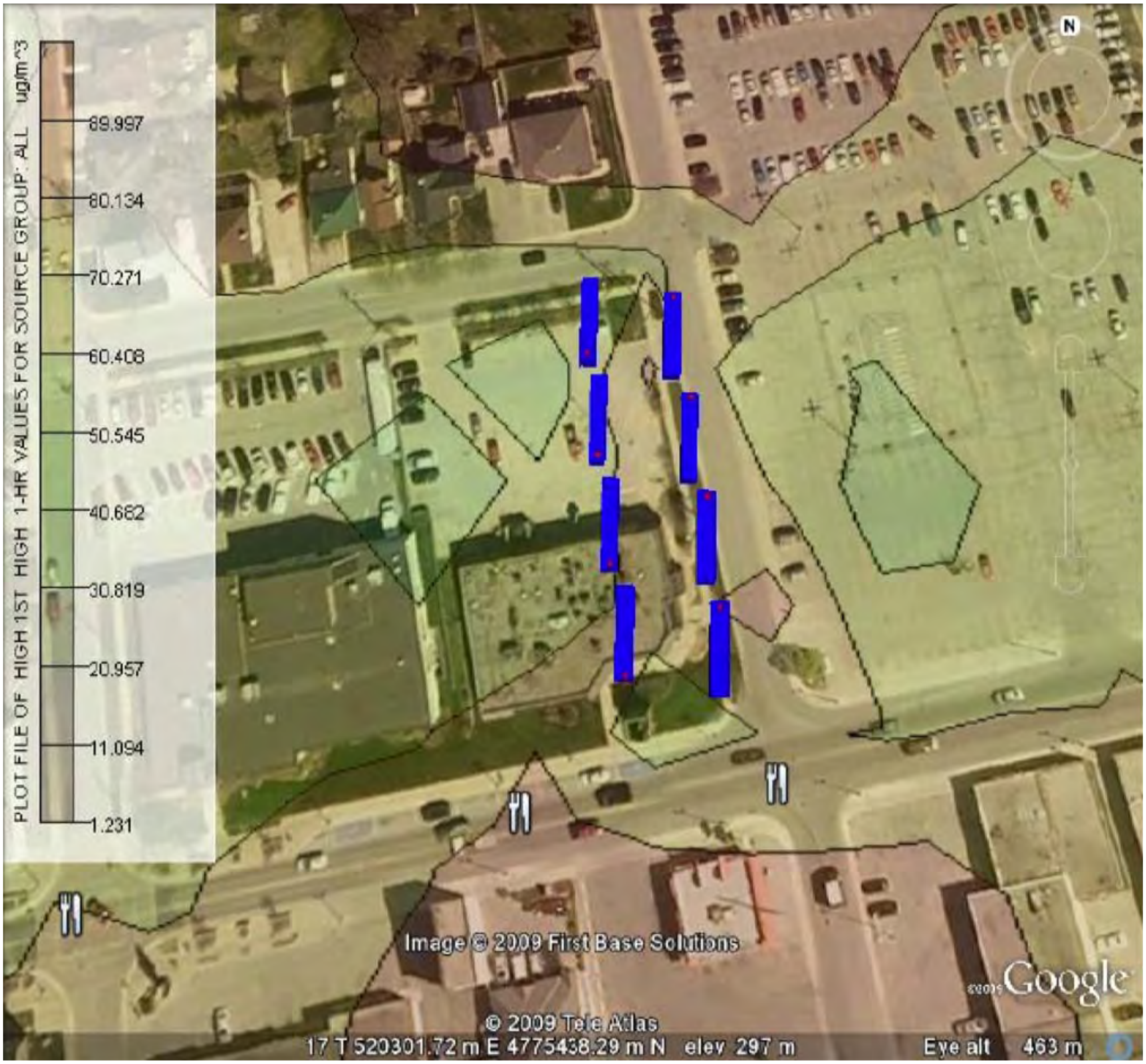

Figure 1 1 Hour Maximum Concentration Isopleth for Carbon Monoxide

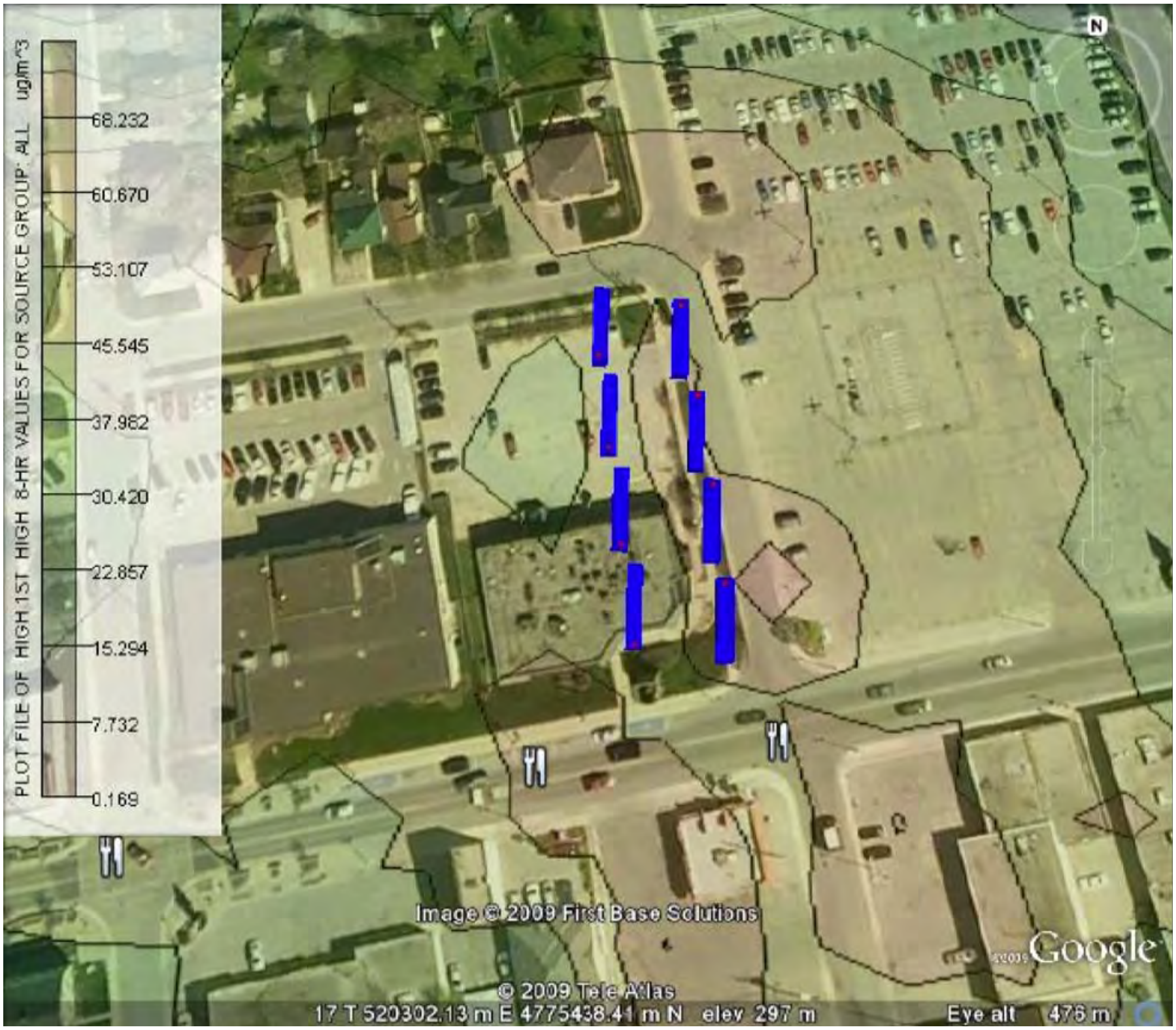

Figure 2 8 Hour Maximum Concentration Isopleths for Carbon Monoxide

In conclusion, the quantitative evaluation has shown that even though there are increases in the traffic volume at some intersections that are above the de minimis levels that would exempt to project from quantitative evaluation, there should be no concerns about CO levels increasing as a result of the new transfer station.

3.2 PM_{10} and $PM_{2.5}$ Evaluation

Conformance evaluation protocols for particulate matter emissions are similar to those for CO, however the exemption levels are different. The major criteria are:

- Projects affecting intersections that are at Level of Service D, E, or F with a significant number of diesel vehicles, or those that will change to Level of Service D, E, or F because of increased traffic volumes from a significant number of diesel vehicles related to the project;
- New bus and rail terminals and transfer points that have a significant number of diesel vehicles congregating at a single location; and,
- Expanded bus and rail terminals and transfer points that significantly increase the number of diesel vehicles congregating at a single location.

Note however that the criteria exempt transfer points that satisfy the following criteria:

- A new or expanded bus terminal that is serviced by non-diesel vehicles (e.g., compressed natural gas) or hybrid-electric vehicles; and,
- A 50% increase in daily arrivals at a small terminal (e.g., a facility with 10 buses in the peak hour).

Since the intersections that will experience a decrease in level of service are simply taking private vehicle traffic diverted from other streets in the community, and there will be no significant increase in diesel vehicles at those intersections, all intersections are anticipated to have no significant increase in PM emissions. As such the consideration of intersections can be considered exempt from any requirements to examine impacts.

Since the existing bus fleet is diesel powered, the exemption for new or expanded terminals does not apply, and since the Woodstock transfer point will result in a total of 8 buses arriving at the location every 30 minutes, the facility would not qualify as being exempt under the small facility classification. Thus, PM emissions and their impacts should be quantitatively evaluated for the transfer facility.

There are no facilities that would allow comparison of the new facility to existing facilities to ascertain impacts. The potential emissions from the buses must thus be determined and the impacts on the surrounding area modelled. To do this emissions were determined from the McCormick data in Table 3, as described above and then the fleet weighted average was determined. The estimated emissions were then used in the ISC Prime model to ascertain 1 hour and 24 hour maximum concentrations.

Woodstock Transit provided a list of existing equipment which is summarized in Table 4, but HP was not listed. For the purposes of estimating idling emissions, the full power emissions were assumed to be generated from a 300 HP diesel engine. This is the typical size of engine offered for urban buses by Cummins in the ISB, ISC and ISL model engines. Using the regulated value and the horsepower, the weighted averaged full power emissions for the fleet was determined by multiplying the number of vehicles by the emission rate, and dividing the sum of this by the number of buses in the fleet. That weighted average emission rate is then adjusted to estimate idling emissions on a gram per second emission rate.

The Woodstock Transit fleet list shows that as of July 2009, they expect delivery of 1 new bus in November, 2009. It is presumed that this will replace the oldest vehicle in the fleet. As the number of 2007-2009 vehicles increases the fleet is assumed to be new vehicles added for 2011 and built to the 2010 emission specification. The procedures in the preceding paragraph were used to estimate average emissions for the 2014 fleet in the second part of Table 4.

While there is little information to estimate the situation for 2019, it has been presumed that the 20 year old vehicles have been replaced and the emission standard of all replacement and additional vehicles reflect the 2010 emission standard. This is the approach used to calculate emissions in the 3rd part of Table 4. Clearly, as the older vehicles are replaced the average emission rate in g/s at idle in the facility decreases.

Having developed a gram per second emission rate, the operating time on site can be used to determine the total emissions in a given time period. The model assumes constant emissions over the 1 hour period. Information from Woodstock Transit suggests that the operators might wait for up to 5 minutes to allow all the routes to exchange passengers. In reality it is likely that this is the longest period for any one bus, and the shortest period for the last bus in could be on the order of 1 minute.

Table 4 summarizes the PM emissions per vehicle under idle for three periods, the 2009 fleet, the 2014 fleet and 2019 fleet. Emissions go down as the fleet is replaced.

To evaluate the impact of the PM emissions at the transfer stop they were modelled using ISC-Prime. Each bus was treated as a separate structure and the exhaust was assumed to be released vertically above the bus. The model used 5 years of meteorological data from London and hourly concentrations were determined for each hour of the day. Note, because the buses start at 6:30 am and finish at 6 pm, emissions were assumed to be only 50% of the total for 6 am, and no emissions were released between 7 pm and 6 am. The model also determined 24 hour average values, and the 6th highest of these values was determined based upon the fact that the standard for $PM_{2.5}$ is the 98th percentile of the 24 hour average values.

The mean hourly $PM_{2.5}$ concentration recorded in London in 2007[8] was 6.5 ug/m^3, while the maximum was 48 ug/m^3. The maximum 24 hour average from 2007 in London was 32 ug/m^3. The 3 year 98th

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[8] http://www.ene.gov.on.ca/publications/6930e.pdf

Table 4 Summary of PM Emissions from Woodstock Transit Vehicle Fleet by Year

a) Existing June 2009

Vehicle Manufactured Year	PM Emission Rate Standard [g/HP-hr]	Number of Vehicles	Total Emission Rate [g/HP-hr]
pre-1991	0.6	7	4.2
1991-1994	0.25	0	0
1994-2007	0.1	2	0.2
2007-10	0.01	2	0.02
Total		11	4.42
Weighted Average Emission [g/HP-hr]			0.40
Average Assumed HP for Fleet			300
Estimated Maximum PM Emission Rate for Average Engine in Fleet [g/hr/vehicle]			120.55
Estimated Idling PM Emission Rate for Average Engine in Fleet [g/hr/vehicle] 0.51 x max.			6.14
Estimated Emission Rate for Modelling [g/s/vehicle operating]			1.70e-03

b) 2014 Operating

Vehicle Manufactured Year	Emission Rate Standard [g/HP-hr]	Number of Vehicles	Total Emission Rate [g/HP-hr]
pre-1991	0.6	4	2.4
1991-1994	0.25	0	0
1994-2007	0.1	2	0.2
2007-10	0.01	2	0.02
2010	0.01	3	0.03
Total		11	2.65
Weighted Average Emission [g/HP-hr]			0.24
Average Assumed HP for Fleet			300
Estimated Maximum PM Emission Rate for Average Engine in Fleet [g/hr/vehicle]			72.27
Estimated Idling PM Emission Rate for Average Engine in Fleet [g/hr/vehicle] 0.51 x max.			3.68
Estimated Emission Rate for Modelling [g/s/vehicle operating]			1.02e-03

b) Anticipated 2019 Operating

Vehicle Manufactured Year	Emission Rate Standard [g/HP-hr]	Number of Vehicles	Total Emission Rate [g/HP-hr]
1994-2007	0.1	2	0.2
2007-10	0.01	2	0.02
2010	0.01	7	0.07
Total		11	0.29
Weighted Average Emission [g/HP-hr]			0.03
Average Assumed HP for Fleet			300
Estimated Maximum PM Emission Rate for Average Engine in Fleet [g/hr/vehicle]			7.91
Estimated Idling PM Emission Rate for Average Engine in Fleet [g/hr/vehicle] 0.51 x max.			0.40
Estimated Emission Rate for Modelling [g/s/vehicle operating]			1.12e-04

percentile value was 28 ug/m^3. The CWS standard for $PM_{2.5}$ is 30 ug/m^3 being the 98th percentile of 3 years of data.

In contrast, the model suggests that the buses idling at the transfer stop will result in a maximum 1 hour value of 6 ug/m^3 and the 3 year 24 hour 98th percentile value will be 2.1 ug/m^3. The actual background values for Woodstock are not available, however it would appear that the bus transfer point will not add significantly to levels in the community. The concentration patterns around the transfer station for the two periods are shown in Figures 3 and 4.

3.3 MSAT Evaluation

The FHWA[9] developed a tiered approach for analyzing MSATs. Depending on the specific project circumstances, FHWA identified three levels of analysis:

- No analysis for projects with no potential for meaningful MSAT effects;
- Qualitative analysis for projects with low potential MSAT effects; or
- Quantitative analysis to differentiate alternatives for projects with higher potential MSAT effects.

As suggested elsewhere in this document, US EPA and FHWA anticipate that the improvement in vehicle emission standards will result in a decline in MSATs unless the VMT travelled on a particular section of roadway doubles by 2020. Indeed, the FHWA suggests that the threshold in meaningful increases in MSATs is the addition of a new highway with capacity for over 114,000 AADT.

The traffic analyses for this project show that in the worst case the increase is only 8% suggesting that there would be a continual decrease in emissions over the project life.

On the other hand, the new transfer stop will generate additional MSAT emissions in the vicinity of the residential properties on Adelaide because these sources are not presently in that location. However, it should also be noted that this is merely a relocation of the facility from a location less than 400 m away, suggesting that there will be little change of overall impacts in the downtown core.

The FHWA guidance focuses on the six MSAT pollutants identified by the United States Environmental Protection Agency (USEPA) as being the highest priority. The six pollutants are diesel particulate matter (DPM), acrolein, acetaldehyde, formaldehyde, benzene, and 1,3-butadiene.

This report includes a basic analysis of the likely MSAT emission impacts of this project. However, the US EPA has determined that while the potential for these emissions exists, the currently available technical tools do not enable the prediction of project-specific health impacts of the emission changes associated with such projects. To address these deficiencies, the US EPA and the FHWA recommend

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[9] FHWA, Interim Guidance on Air Toxic Analysis in NEPA Documents, February 3, 2006.

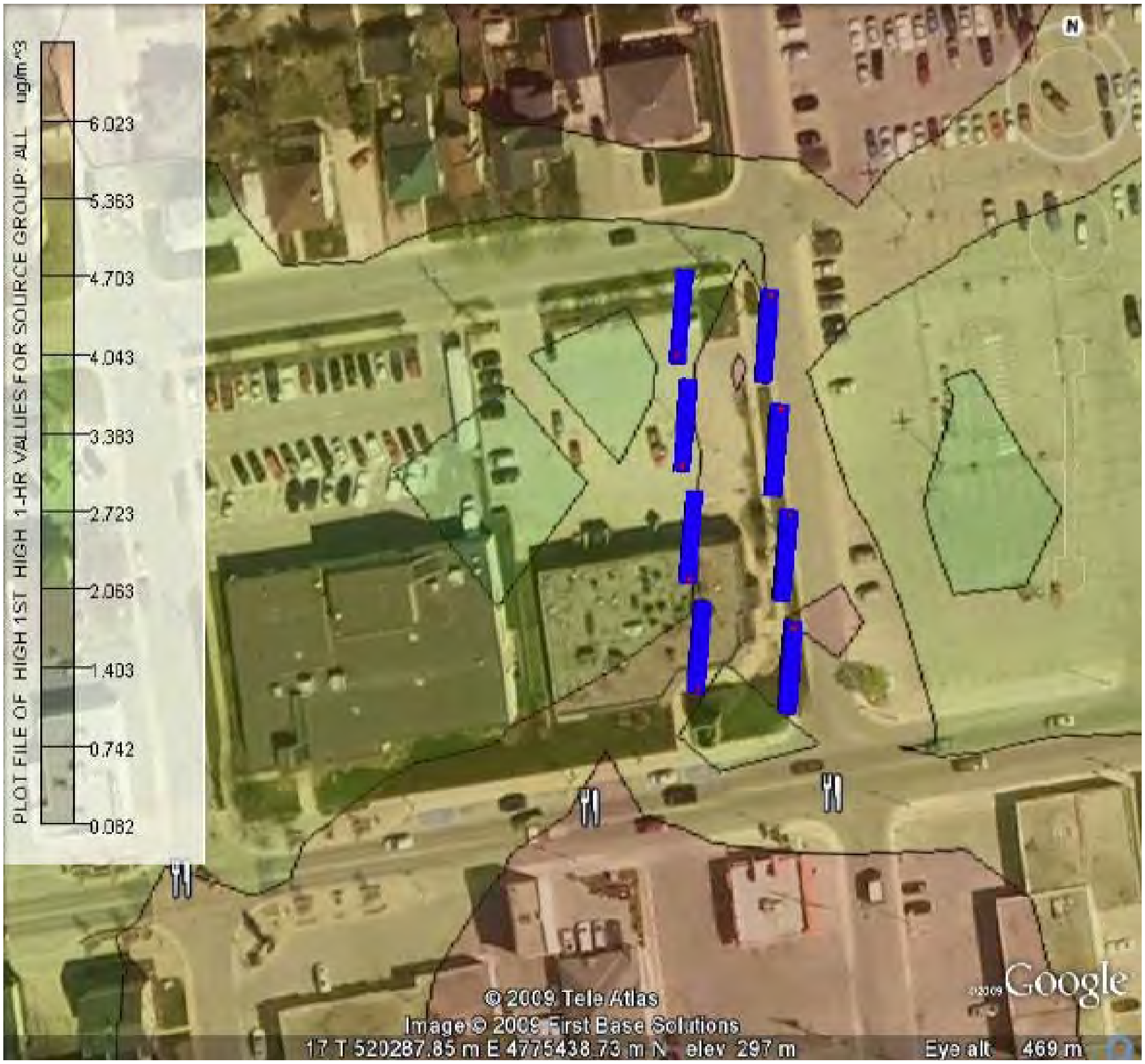

Figure 3 1 Hour Maximum Concentration Isopleth for Particulate Matter

Figure 4 24 Hour 98% Maximum Concentration Isopleth for Particulate Matter that a general discussion of the issues associated with MSAT emissions be included and this discussion specifically addresses incomplete or unavailable information.

1. Information that is Unavailable or Incomplete

Evaluating the environmental and health impacts from MSATs on a proposed project would involve several key elements, including emissions modelling, dispersion modelling in order to estimate ambient concentrations resulting from the estimated emissions, exposure modelling in order to estimate human exposure to the estimated concentrations, and then a final determination of health impacts based on the estimated exposure. Each of these steps is encumbered by technical shortcomings or uncertain science that prevents a more complete determination of the MSAT health impacts.

<u>Emissions</u> The US EPA tools to estimate MSAT emissions from motor vehicles are not sensitive to key variables that can influence emissions of MSATs in the context of this project, particularly with respect to local effects. This is because the method used to predict vehicle emissions, while valuable for assessments at a regional level, has limited applicability at the project level. The procedure is based upon modelling trips typically about 10 km in duration at some average speed. This approach does not allow the researcher to predict emission factors for a specific vehicle operating condition at a specific location at a specific time. For particulate matter, the model results are not sensitive to average trip speed, although for the other MSATs, emission rates do change with changes in average speed. Maybe most importantly, the emissions rates used in emission factors approach are based on a limited number of tests of mostly older-technology vehicles. In summary, the US EPA and FHWA have concluded that while the model is an adequate tool for projecting emissions trends and performing relative analyses between alternatives for very large projects, it is not sensitive enough to capture the effects of travel changes tied to smaller projects or to predict emissions near specific roadside locations.

<u>Dispersion</u> The tools to predict how MSATs disperse are also limited. The US EPA's current regulatory models, CALINE3 and CAL3QHC, were developed and validated more than a decade ago for the purpose of predicting episodic concentrations of carbon monoxide to determine compliance with the NAAQS. The performance of such dispersion models is more accurate for predicting maximum concentrations that can occur at some time at some location within a geographic area. This limitation makes it difficult to predict accurate exposure patterns at specific times at specific project locations across an urban area to assess potential health risks. Research was underway in 2006 to determine best practices for applying models and other technical methods in the analysis of MSATs. Those results have not been published to the present time. Moreover, investigations are also faced with a lack of monitoring data in most areas which limits the ability for the researcher to establish project specific MSAT background concentrations.

<u>Exposure Levels and Health Effects</u> Finally, even if emission levels and concentrations of MSATs could be accurately predicted, shortcomings in current techniques for exposure assessment and risk analysis do not allow one to reach meaningful conclusions about project-specific health

impacts. Exposure assessments are difficult because they require an accurate calculation of annual concentrations of MSATs near roadways coupled with a good understanding of how much time in a year people are actually exposed to those concentrations at a specific location. These difficulties are magnified for 70-year cancer assessments, particularly because unsupportable assumptions would have to be made regarding changes in travel patterns and vehicle technology (which affects emissions rates) over a 70-year period. There are also considerable uncertainties associated with the existing estimates of toxicity of the various MSATs because of factors such as low-dose extrapolation and translation of occupational exposure data to the general population. Any calculated difference in health impacts between alternatives would likely be much smaller than the uncertainties associated with the calculation of the impacts. Therefore, the results of such assessments would not be useful to decision makers, who need to weigh that information against other project impacts that are better suited for quantitative analysis.

2. Summary of Existing Credible Scientific Evidence Relevant to Evaluating the Impacts of MSATs

Research into the health impacts of MSATs is ongoing. For different emission types, scientific studies show that MSATs are statistically associated with adverse health outcomes through epidemiological studies (frequently based on emissions levels found in occupational settings) or that animals demonstrate adverse health outcomes when exposed to large doses. These studies do not examine the low or chronic doses expected to occur in the environmental setting. The effects of exposure to toxics has been a focus of a number of US EPA efforts. Most notably, the US EPA conducted the National Air Toxics Assessment (NATA) in 1996 to evaluate modelled estimates of human exposure applicable to the county level. While not intended for use as a measure of or benchmark for local exposure, those estimates best illustrate the levels of various toxics when aggregated to a national or State level.

The US EPA is in the process of assessing the risks of various kinds of exposures to these pollutants. The US EPA Integrated Risk Information System (IRIS) is a database of human health effects that may result from exposure to various substances found in the environment. The IRIS database is located at http://www.epa.gov/iris. Data from that database is included in the discussion of MSATs in Appendix A.

3. Relevance of Unavailable or Incomplete Information to Evaluating Reasonably Foreseeable Significant Adverse Impacts on the Environment, and Evaluation of impacts Based upon Theoretical Approaches or Research Methods Generally Accepted in the Scientific Community Analysis

Because of the uncertainties outlined above, a quantitative assessment of the effects of air toxic emissions impacts on human health cannot be made at the project level. While available tools do allow us to reasonably predict relative emissions changes between alternatives for larger projects, the amount of MSAT emissions from each of the project alternatives and MSA

> The concentrations or exposures created by each of the project alternatives cannot be predicted with enough accuracy to be useful in estimating health impacts. Therefore, the relevance of the unavailable or incomplete information is that it is not possible to make a determination of whether any of the alternatives would have "significant adverse impacts on the human environment. "

Within these limitations, this document will merely provide a qualitative analysis of MSAT emissions relative to the proposed project.

The project may result in increased exposure to MSAT emissions in certain locations, although the concentrations and duration of exposures are uncertain. Because of this uncertainty, the health effects from these emissions cannot be estimated.

For the Build and No-Build Alternatives, the amount of MSATs emitted would be proportional to the VMT, assuming that other variables, such as fleet mix, are the same for both alternatives. Newer buses will have lower emissions, but adding additional routes to the transfer point will increase emissions both at that location and along the routes. Thus more miles would be travelled for the Build Alternative with the new routes and emissions would increase from those of the No-Build Alternative. This increase in VMT would lead to higher MSAT emissions for the Build Alternative along the routes. The emissions increase may be offset somewhat by having a more efficient transfer operation as passengers will not have to wait to cross the main roads to get to their next bus. The extent of these emissions decreases cannot be reliably projected due to the inherent deficiencies of technical models.

The new transfer point will alter the exposure pattern in the community, but, as noted above is unlikely to result in a large increase in MSATs in the community. Properties previously located close to the existing transfer point will no longer be in close proximity to these emissions. Moreover, removing the bus transfer location from the street will likely alleviate some congestion at that location therefore further reducing MSAT emissions. While the new transfer location will not cause traffic congestion, and waiting times may be reduced, the proposed project will have the effect of moving emissions closer to the nearby properties. Therefore, there may be localized areas associated with the transfer point where ambient concentrations of MSATs could be higher under the Build Alternative than the No-Build Alternative.

However, as discussed above, the magnitude and the duration of these potential increases compared to the No-Build Alternative cannot be accurately quantified due to the inherent deficiencies of current models. In summary, when a project such as that proposed proceeds emissions can move closer to some receptors, and the localized level of MSAT emissions for the Build Alternative could be higher relative to the No-Build Alternative. Other receptors will likely see lower localized levels of MSATs when traffic shifts away from them. Thus, on a regional basis, as the vehicle and fuel regulations and fleet turnover take effect, over time substantial reductions in MSATs will occur.

3.4 Oxides of Nitrogen

While not addressed in conformance legislation, NO_x emissions will result from the operation of buses, and the changes in traffic patterns at the various intersections in town. As with the CO emissions, it is anticipated that the effect of moving the transfer point will have little impact on NO_x levels around the intersections along Adelaide or Dundas. The one area that should be considered are effects around the new transfer point.

Using the McCormick data for bus engine idling emissions referenced earlier, it is possible to undertake a similar emissions evaluation to that completed for CO and PM. The average idling emissions as a percentage of the maximum engine emissions is shown in Table 3 as 7.59%.

The idling emission rate as a function of the maximum emission rate was applied to the fleet mix in Table 5, resulting in a per vehicle emission rate for the existing fleet of 0.0284 g NO_x /s/vehicle. This value was applied in the ISC Prime model to predict concentrations for both 1 hour and 24 hours.

The maximum 1 hour value predicted by the model was 101 ug/m^3 comparable to the 400 ug/m^3 POI standard applied to new sources in the province. The 24 hour maximum value was 38 ug/m^3 which can be compared to the 200 ug/m^3 health based limit for 24 hour NO_x values. The pattern of the NO_x levels around the transfer point are shown in Figures 5 and 6.

Since Table 5 shows lower emissions for 2014 and 2019, the model was not re-run for these years as the numbers above are representative of the worst case situation.

Table 5 Summary of NO_x Emissions from the Woodstock Transit Vehicle Fleet by Year

a) Existing June 2009

Vehicle Manufactured Year	PM Emission Rate Standard [g/HP-hr]	Number of Vehicles	Total Emission Rate [g/HP-hr]
pre-1998	6	7	42
1998-2004	4	0	0
2004-2007	2.5	2	5
2007-10	1.2	2	2.4
2010	0.2	0	0
Total		11	49.4
Weighted Average Emission [g/HP-hr]			4.49
Average Assumed HP for Fleet			300
Estimated Maximum NO_x Emission Rate for Average Engine in Fleet [g/hr/vehicle]			1347.27
Estimated Idling NO_x Emission Rate for Average Engine in Fleet [g/hr/vehicle] 0.0759 x max.			102.26
Estimated Emission Rate for Modelling [g/s/vehicle operating]			2.84e-02

b) 2014 Operating

Vehicle Manufactured Year	Emission Rate Standard [g/HP-hr]	Number of Vehicles	Total Emission Rate [g/HP-hr]
pre-1991	6	4	24
1991-1994	4	0	0
1994-2007	2.5	2	5
2007-10	1.2	2	2.4
2010	0.2	3	0.6
Total		11	32
Weighted Average Emission [g/HP-hr]			2.91
Average Assumed HP for Fleet			300
Estimated Maximum NO_x Emission Rate for Average Engine in Fleet [g/hr/vehicle]			872.73
Estimated Idling NO_x Emission Rate for Average Engine in Fleet [g/hr/vehicle] 0.0759 x max.			66.24
Estimated Emission Rate for Modelling [g/s/vehicle operating]			1.84e-02

b) Anticipated 2019 Operating

Vehicle Manufactured Year	Emission Rate Standard [g/HP-hr]	Number of Vehicles	Total Emission Rate [g/HP-hr]
1994-2007	2.5	2	5
2007-10	1.2	2	2.4
2010	0.2	7	1.4
Total		11	8.8
Weighted Average Emission [g/HP-hr]			0.80
Average Assumed HP for Fleet			300
Estimated Maximum NO_x Emission Rate for Average Engine in Fleet [g/hr/vehicle]			240.00
Estimated Idling NO_x Emission Rate for Average Engine in Fleet [g/hr/vehicle] 0.0759 x max.			18.22
Estimated Emission Rate for Modelling [g/s/vehicle operating]			5.06e-03

Figure 5 1 Hour Maximum Concentration Isopleth for Oxides of Nitrogen

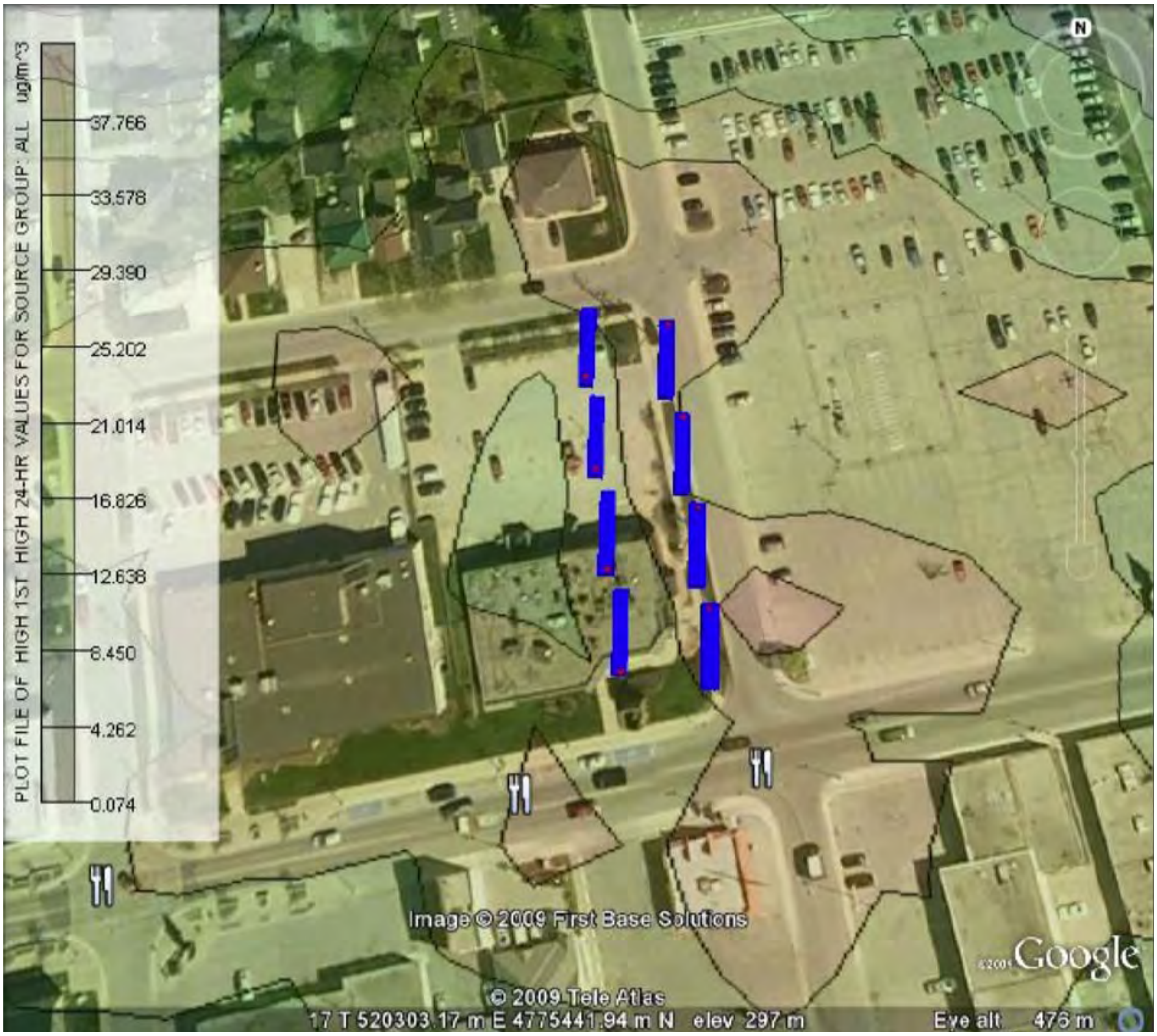

Figure 6 24 Hour Maximum Concentration Isopleth for Oxides of Nitrogen

4.0 Conclusions

Moving the Woodstock Transfer Point in downtown Woodstock to an off-road location on York Street will cause changes to the traffic patterns in the immediate vicinity of the new transfer point largely because a portion of York Street is required to close as a result of this project. The impact of the changes in vehicle traffic patterns in the vicinity of the new location, and emissions that will be generated by the buses when they idle at the new location were considered in this study.

Quantitative evaluations of CO impacts at intersections and at the transfer point were carried out. These concluded that there would be minimal changes in CO levels in the areas of town considered.

A quantitative evaluation of both PM and NO_x emissions from the new transfer point location were undertaken. In the case of these two contaminants, data suggested that, while there may be some shifts in traffic, none would be significant enough to induce measurable changes in PM or NO_x levels in the vicinity of the intersections. Modelling of the emissions from the buses showed that while there would be minor increases in both contaminants in the vicinity of the new transfer station, these would not result in exceedances of the existing targets for air quality.

While it is recognized that diesel buses are one of the more prolific sources of mobile source air toxics, these contaminants are also released from cars, gasoline trucks and diesel powered trucks. Following the guidance of the US EPA on this subject it was concluded that while the location of the emissions of these contaminants from the buses would be altered, it was unlikely that this would induce a significant increase in MSATs in downtown Woodstock. Even the addition of two new bus routes would not increase the levels signficantly as newer vehicles will have lower levels of these emissions.

In summary, the air quality study has not identified any significant increase in air contaminants in downtown Woodstock.

Appendix A

Review of Conformance Protocols used in the United States

City of Woodstock
Downtown Transit Terminal
Environmental Assessment

Air Quality Study

September 2009

APPENDIX A

Summary of Conformance Determinations according to US EPA

The US regulations require that transportation related projects obtaining state or federal funding must be analysed to ensure that it will not have deleterious effects on air quality. This is called a conformance evaluation. The principles behind these evaluations assist with identifying what aspects of a project should be evaluated.

US regulations identify conformance evaluation procedures for:

- carbon monoxide;
- PM_{10} and $PM_{2.5}$; and,
- MSATs.

Typically, Carbon Monoxide conformance evaluations involve evaluating all links associated with the proposed project along with signalized intersections for the existing year, the first year of operation and the design year. The evaluation determines the worst case one-hour and eight hour average ambient CO concentrations using theoretical worst case inputs. Initial screening however, can be used to identify projects that have relatively insignificant impacts. The screening is conducted based upon the type of change and traffic volumes to determine if there is a need to perform a detailed assessment.

Some categories of projects are exempt from the CO conformance requirements. These are listed in the regulations. All safety related projects are exempt from CO emissions analyses. For mass transit projects, projects such as the construction of small passenger shelters are also exempt. A second level of CO related exemptions defines whether projects need to be considered on a regional basis or can simply be considered for “hot spot” analysis, the assessment of local effects. In this second category, bus terminals and transfer points are exempt from regional emissions analysis.

Projects can be further screened to determine if they are likely to worsen air quality. Criteria include:

- Does the project result in a significant increase in vehicles operating in cold start mode? Increases of 2% are typically considered significant.
- Does the project significantly increase traffic volumes? Increases in traffic volumes in excess of 5% should be considered to be potentially significant. Increases that are smaller than 5% can also be significant if there is a reduction in average speeds.
- Does the project worsen traffic flow?

If there is a reason to suspect that worsening traffic flow will result in higher emissions the next level of the screening analysis is to look for signalized intersections where the level of service is D, E or F. For intersections with an LOS of E or F, increased traffic is likely to result in increased emissions that should be evaluated using screening procedures. If an intersection moves from D to E or F clearly that intersection should be evaluated.

For PM_{10} and $PM_{2.5}$ the US EPA specified in 40 CFR 93.123(b)(1) of the final rule that projects of air quality concern are certain highway and transit projects that involve significant levels of diesel vehicle traffic, or any other project that is identified in the $PM_{2.5}$ or PM_{10} state implementation plan as a localized air quality concern. For the purposes of this report, the final rule defines the projects of air quality concern that require a $PM_{2.5}$ or PM_{10} hot-spot analysis in 40 CFR 93.123(b)(1) as:

> "(ii) Projects affecting intersections that are at Level-of-Service D, E, or F with a significant number of diesel vehicles, or those that will change to Level-of-Service D, E, or F because of increased traffic volumes from a significant number of diesel vehicles related to the project;
> (iii) New bus and rail terminals and transfer points that have a significant number of diesel vehicles congregating at a single location;
> (iv) Expanded bus and rail terminals and transfer points that significantly increase the number of diesel vehicles congregating at a single location;"

The following are examples of projects that are not an air quality concern for $PM_{2.5}$ or PM_{10} under 40 CFR 93.123(b)(1)(i) and (ii):

- Any new or expanded highway project that primarily services gasoline vehicle traffic (i.e., does not involve a significant number or increase in the number of diesel vehicles), including such projects involving congested intersections operating at Level-of-Service D, E, or F;
- An intersection channelization project or interchange configuration project that involves either turn lanes or slots, or lanes or movements that are physically separated. These kinds of projects improve freeway operations by smoothing traffic flow and vehicle speeds by improving weave and merge operations, which would not be expected to create or worsen $PM_{2.5}$ or PM_{10} violations; and,
- Intersection channelization projects, traffic circles or roundabouts, intersection signalization projects at individual intersections, and interchange re-configuration projects that are designed to improve traffic flow and vehicle speeds, and do not involve any increases in idling. Thus, they would be expected to have a neutral or positive influence on $PM_{2.5}$ or PM_{10} emissions.

Examples of projects that are not an air quality concern for $PM_{2.5}$ or PM_{10} under 40 CFR 93.123(b)(1)(iii) and (iv) would be:

- A new or expanded bus terminal that is serviced by non-diesel vehicles (e.g., compressed natural gas) or hybrid-electric vehicles; and,
- A 50% increase in daily arrivals at a small terminal (e.g., a facility with 10 buses in the peak hour).

For MSATs there are another set of criteria used to define whether there needs to be a hot spot analysis. The FHWA developed a tiered approach for analyzing MSATs. Depending on the specific project circumstances, FHWA identified three levels of analysis:

- No analysis for projects with no potential for meaningful MSAT effects;
- Qualitative analysis for projects with low potential MSAT effects; or

- Quantitative analysis to differentiate alternatives for projects with higher potential MSAT effects.

Some examples of qualitative MSAT analyses are provided below. Each project is different, and some projects may contain elements covered in more than one of the examples below. The following factors should be considered when crafting a qualitative analysis:

- For projects on an existing alignment, MSATs are expected to decline unless VMT more than doubles by 2020 (due to the effect of new EPA engine and fuel standards).
- Projects that result in increased travel speeds will reduce emissions of the VOC-based MSATs (acetaldehyde, benzene, formaldehyde, acrolein, and 1, 3 butadiene); the effect of speed changes on diesel particulate matter is unknown. This speed benefit may be offset somewhat by increased VMT if the more efficient facility attracts additional vehicle trips.
- Projects that facilitate new development may generate additional MSAT emissions from new trips, truck deliveries, and parked vehicles (due to evaporative emissions). However, these may also be activities that are attracted from elsewhere in the community (thus, on a regional scale there may be no net change in emissions).
- Projects that create new travel lanes, relocate lanes or relocate economic activity closer to homes, schools, businesses and other sensitive receptors may increase concentrations of MSATs at those locations relative to the No Action alternative.

Projects that have the potential for meaningful differences in MSATs include those that:

- Create or significantly alter a major intermodal freight facility that has the potential to concentrate high levels of diesel particulate matter in a single location; or
- Create new or add significant capacity to urban highways such as interstates, urban arterials, or urban collector-distributor routes with traffic volumes where the AADT is projected to be in the range of 140,000 to 150,000 or greater, by the design year;
  and,
- The project is proposed to be located in proximity to populated areas or in rural areas, in proximity to concentrations of vulnerable populations (i.e., schools, nursing homes, hospitals).

The changes in Woodstock due to the new transfer facility can be characterised according to the Conformance criteria outlined in the previous paragraphs.