

Appendix F

Environmental Noise Assessment



CONSULTING ENGINEERS
& SCIENTISTS

FINAL REPORT

ENVIRONMENTAL NOISE ASSESSMENT TRENT RIVER CROSSING CAMPBELLFORD, ONTARIO

Project Number: # W08-5292A

June 3, 2009

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1. INTRODUCTION

RWDI AIR Inc. (RWDI) was retained by AECOM to conduct an environmental noise impact assessment of the proposed river crossing, located in Campbellford, Ontario. This assessment has been conducted in accordance with the terms of reference outlined in RWDI Proposal No. W08-1875P, dated July 15, 2008.

The objective of the study is to predict future “build” and future “no-build” sound levels from road traffic noise sources in the area (i.e., noise levels with and without the proposed project taking place); to use these predictions to assess potential impacts according to the applicable guidelines; to specify mitigation measures where required; and to assess the potential for construction noise and provide a Code of Practice to minimize potential impacts.

Transportation Sound Basics can be found in **Appendix A**.

1.1 Project Description (Nature of the Undertaking)

The proposed improvements consist of the proposed addition of a 300 m (approximate) bridge crossing Trent River and connecting Second Street and Alma Street. The bridge will pass over Saskatoon Avenue. Access to Second Street from Frank Street will be restricted by modifying Frank Street to terminate as a cul-de-sac. The remainder of the roadway, and adjacent portions of cross streets, will be resurfaced. **Figure 1** illustrates the project limits and highlights the work to be conducted.

1.2 Study Area (Area of Investigation)

In accordance with Ministry of Transportation (MTO) and Ministry of the Environment (MOE) practices, the area of investigation for the project has been determined using screening level modelling to determine a distance from the project to where there is no anticipated increase above future ambient sound levels. The methodology for determining the Area of Investigation is described in **Appendix B**.

For this project, the Area of Investigation is 60 m on either side of the roadway (from edge of pavement). The Area of Investigation is illustrated in **Figure 1**.

2. ROAD TRAFFIC NOISE IMPACTS (OPERATIONAL NOISE)

For surface transportation projects, operation noise, relating to noise from operation of the facility following project completion, are of primary importance. This section of the report provides an evaluation of noise impacts from road traffic noise resulting from the undertaking.

2.1 Applicable Guidelines

There are several transportation noise guidelines that are applicable to this project. Ontario Provincial policies established by the MTO and MOE are directly applicable under the Municipal Class EA process for transportation projects, and are discussed in detail in this report.

2.1.1 Ontario Provincial Guidelines and Policies

Ontario has a number of guidelines and documents related to assessing road traffic noise impacts. The most applicable document which applies to municipal roadway construction and reconstruction projects is:

- Ontario MOE/MTO, “Joint Protocol”, A Protocol for Dealing With Noise concerns during the Preparation, Review and Evaluation of Provincial Highway’s Environmental Assessments (MTO & MOE, 1986).

In October 2006 the MTO adopted a new *Environmental Guide for Noise* which supersedes the Joint Protocol and previous MTO Quality and Standards Directive QST-A1 for Provincial highways and freeways (MTO 2006, 1992). It is our understanding that the updated MTO Guide has not been adopted by the MOE for municipal projects at the time of publication. Therefore, the Joint Protocol was used for this study.

The Joint Protocol sets out an Outdoor Objective sound level of 55 dBA L_{eq} , or the existing ambient, whichever is higher. The importance of changes from a noise impact perspective is based on the objective level and change from existing conditions. Cumulative sound levels are assessed. Assessments are based on a minimum 10-year future horizon year (i.e, on traffic volumes 10 years after the completion of the project). Accordingly, a design year of 2027 applies to this project, corresponding to the traffic forecasts provided by AECOM.

Noise mitigation is warranted when increases in sound level over the “no-build” ambient are greater than 5 dB. Mitigation measures can include noise barriers, noise reducing asphalts, and changes in vertical profiles and horizontal alignments. Noise mitigation where applied must be administratively, economically and technically feasible, and must provide at least 5 dB of reduction averaged over the first row of noise-sensitive receivers. Mitigation measures are restricted to within the roadway right-of-way. Off right-of-way noise mitigation, such as window upgrades and air conditioning, is not considered. Noise mitigation requirements are summarized below:

Table 2.1: Summary of Mitigation Efforts Under Ontario Road Traffic Noise Guidelines

Existing and Future Sound Levels	Change in Noise Level Above Future “No-Build” Ambient (dBA)	Mitigation Effort Required
< 55 dBA	0 to 5	<ul style="list-style-type: none"> None
	> 5	<ul style="list-style-type: none"> None. Sound levels still below 55 dBA Objective
> 55 dBA	0 to 5	<ul style="list-style-type: none"> None
	> 5	<ul style="list-style-type: none"> Investigate noise control measures within right-of-way Noise control measures where used must provide a minimum of 5 dBA of attenuation, averaged over the first row of receivers Mitigated to as close to ambient as possible, where technically, economically and administratively feasible

Notes: Values are L_{eq} (16h) levels for municipal and Provincial Highways, and L_{eq} (24h) for Freeways

Under MOE policies, daytime L_{eq} (16h) sound levels are used to assess impacts from Municipal roadways.

2.2 Location of Noise Sensitive Areas Within the Area of Investigation

2.2.1 Definition of Noise Sensitive Areas

Noise impacts from transportation projects are evaluated at noise sensitive receptors within the area of investigation. Noise receptors are called “Noise Sensitive Areas (NSAs)” in this report, in keeping with MTO and MOE practices for Municipal roadways. Under current MOE policies, NSAs include the following land uses, provided they have an Outdoor Living

Area (OLA) associated with them:

- Private homes (single family units and townhouses)
- Multiple unit buildings such as apartments, provided they have a communal OLA associated with them
- Hospitals and nursing homes for the aged, provided they have an OLA for use by patients
- Schools, educational facilities and daycare centres where there are OLAs for students
- Campgrounds that provide overnight accommodation
- Hotels and motels with outdoor communal OLAs (e.g., swimming pools) for visitors
- Churches and places of worship

The following land uses are generally not considered by MOE to qualify as NSAs:

- Apartment balconies
- Cemeteries
- Parks and picnic areas not part of a defined OLA
- All commercial
- All industrial

Land use zoning maps are included in **Appendix C**.

2.2.2 Location and Number of NSAs within the Area of Investigation

The general locations of NSAs within the Area of Investigation are indicated in **Figure 1**. There are approximately 35 NSAs within the Area of Investigation, meeting the MTO/MOE requirements discussed above, broken down as follows:

- 34 existing single family homes and town homes;
- 1 existing residential single family homes to be acquired;
- 6 existing residential single family homes potentially to be acquired; and
- 1 apartment building / townhouse complex.

Of the existing residential single family homes to be acquired, one (1) will be demolished to account for the realignment of Alma Street. The remaining six (6) houses potentially to be acquired may remain residential (or may become another noise sensitive land use). All of these

houses have been included in the analysis.

2.2.3 Representative NSAs for Analysis

A number of NSAs that are representative of potential noise impacts at the noise sensitive land uses in the area have been identified and used in the analysis. NSAs were grouped into areas with similar overall noise levels and similar changes in noise (“build” versus “no-build”). Receptors NR1 through NR7 were each used to represent a groupings of NSAs. These representative receptors were chosen to be characteristic of worst-case impacts for their respective areas. Both quantitative analysis and qualitative observations are used to assess whether an NSA can be represented by a particular receptor and thus fill the criteria to fall within a respective grouping. Some qualitative factors that are used to judge acoustic equivalence, and thus NSA grouping, include screening of OLAs by houses, geometrical changes (“build” versus “no-build”), and proximity to roadways. These NSA and modelled receptor locations are shown in **Figure 1** and described in the following table.

Table 2.2: Representative NSAs Considered in Analysis

Receptor Location	Description	Distance to Closest Edge of Pavement (m) ^[1]	Approx. No. of NSAs Represented
NR1	Residential House along Alma St	13	4
NR2	Residential House along Grand Street	50	8
NR3	Residential House along Grand Street	22	1
NR4	Residential Townhouse Complex along Saskatoon Ave	28	1
NR5	Residential House along Saskatoon Ave	27	13
NR6	Residential House along Second St S	10	6
NR7	Residential House along Second St S	12	5

Notes: [1] Distance to Alma Street, Proposed Bridge, or Second Street (i.e., not including cross-streets)

The point of reception for impact assessment is the Outdoor Living Area (OLA) of noise sensitive land uses. The OLA may be situated on any side of the receptor, but is generally taken to be the back yard. For assessment purposes, it is taken as a point 3 m from the façade of the receptor, and 1.5 m (approximate head-height) above the ground surface. Where the actual position of the OLA is unknown, the side with worst-case (minimum) “build” versus “no-build” screening effects has been assumed as conservatism. The locations of the points of reception used in the analysis are shown in **Figure 1**.

2.3 Road Traffic Data

Projected future “build” traffic volumes for the year 2027 design year were provided by AECOM for the proposed improvements, and for the surrounding roadway network. Future “no-build” traffic projections for the highway and roadway network were also provided. Traffic data was provided in the form of Annual Average Daily Traffic (AADT). Daytime traffic percentages were given from 5am to 9pm. This data was corrected assuming a 7am to 11pm daytime period using typical traffic distributions (VanDelden et al, 2008). The percentage of heavy trucks and medium trucks was provided by AECOM.

The traffic data used in the assessment are summarized in the following tables. Raw traffic data, typical distributions, and volume adjustment calculations can be found in **Appendix D**.

Table 2.3: Future Year 2027 “No-Build” Traffic Data

Road	2027 AADT	Day/Night Split ^[1]	Overall % Commercial Vehicles	Heavy / Medium Truck Split ^[2]	Posted Speed Limit (km/h)
Grand Road From Alma St to Canrobert St S	9,912	95.1 / 4.9	6	6 / 0	50
Grand Road From Albert Lane to Alma St	10,989	95.1 / 4.9	6	6 / 0	50
Alma St	1,846	95.1 / 4.9	5	5 / 0	50
Saskatoon Ave From River St to Second St	923	95.1 / 4.9	2	2 / 0	50
Saskatoon Ave From Second St to Trent Dr	3,044	95.1 / 4.9	2	2 / 0	50
Front St S	3,055	95.1 / 4.9	6	6 / 0	50
Second Street From Saskatoon Ave to Front St S	2,231	95.1 / 4.9	3	3 / 0	50
Second Street From Front St S to Doxee Ave S	3,330	95.1 / 4.9	3	3 / 0	50

Notes: [1] XX / YY is the percentage of vehicle traffic in the 16 daytime and 8 hour night-time respectively.
[2] HH / MM is the percentage of heavy trucks and medium trucks used in the analysis, respectively.

Table 2.4: Future Year 2027 “Build” Traffic Data

Road	2027 AADT	Day/Night Split ^[1]	Overall % Commercial Vehicles	Heavy / Medium Truck Split ^[2]	Posted Speed Limit (km/h)
Grand Road From Alma St to Canrobert St S	6,780	95.1 / 4.9	6	6 / 0	50
Grand Road From Albert Lane to Alma St	10,582	95.1 / 4.9	6	6 / 0	50
Alma St	6,187	95.1 / 4.9	5	5 / 0	50
Saskatoon Ave From River St to Second St	703	95.1 / 4.9	2	2 / 0	50
Saskatoon Ave From Second St to Trent Dr	703	95.1 / 4.9	2	2 / 0	50
Front St S	3,659	95.1 / 4.9	6	6 / 0	50
New Bridge Crossing	8,187	95.1 / 4.9	6	6 / 0	50
Second Street From Saskatoon Ave to Front St S	8,187	95.1 / 4.9	6	6 / 0	50
Second Street From Front St S to Doxee Ave S	7,220	95.1 / 4.9	3	3 / 0	50

Notes: [1] XX / YY is the percentage of vehicle traffic in the 16 daytime and 8 hour night-time respectively.

[2] HH / MM is the percentage of heavy trucks and medium trucks used in the analysis, respectively.

2.4 Noise Model Used

Road traffic noise levels were modelled using a computerized spreadsheet model of the “Ontario Road Noise Analysis Method for Environmental Transportation (ORNAMENT)” algorithms (MOE 1989). The algorithms in this spreadsheet form the basis of the STAMSON v5.03 computer program produced by the MOE (MOE 1996). Results from the ORNAMENT calculations and STAMSON are equivalent. Sound levels were predicted using the computerized spreadsheet for both the future “no-build” and future “build” cases. The ORNAMENT model was selected as road-receiver geometries and intervening terrain within the Area of Investigation are relatively “simple”, and the potential for impacts (sound level increases greater than 5 dBA) to result from the proposed undertaking is small.

The following factors were taken into account in the analysis:

- Horizontal and vertical road-receiver geometry;
- Intervening terrain types (ground absorption);
- Traffic volumes and percentage of trucks;

- Vehicle speeds;
- Screening provided by terrain, houses and existing sound barriers.

Distances, roadway heights and receptor locations were obtained from plan drawings and aerial photographs supplied by AECOM.

2.5 Determination of Potential Impacts

Under the Joint Protocol, the assessment of impact is conducted by comparing future “build” sound levels (with the project in place) versus future “no-build” sound levels. Table 2.5 presents a comparison of future “build” versus future “no-build” sound levels. Sample calculations can be found in **Appendix E**.

Table 2.5: Future Noise Levels With and Without the Undertaking - Unmitigated

Receptor Location	No. of NSAs Represented	Future “Build” L _{eq} (16h)	Future “No-Build” L _{eq} (16h)	Change (“Build” – “No-Build”)
NR1	4	59	54	5
NR2	8	55	50	4
NR3	1	58	52	6
NR4	5	60	56	4
NR5	13	54	50	4
NR6	6	64	57	7
NR7	5	62	59	3

- Notes:**
- All sound levels are in dBA
 - Apparent arithmetic discrepancies are due to rounding
 - If modelled impacts were less than 50 dBA, 50 dBA was assumed as ambient (class 2)

In keeping with MTO requirements, impacts are also ranked in terms of increasing future “build” sound level (in Table 2.6), and increasing change in sound level (in Table 2.7)

Table 2.6: Ranking of Absolute Future Noise Levels - Unmitigated

Future “Build” Sound Level	Receptors in Category	Total No. of Affected NSAs
45 to < 50 dBA	0	0
50 to < 55 dBA	2	21
55 to < 60 dBA	2	5
60 to < 65 dBA	3	16
65 < 70 dBA	0	0
70 dBA or greater	0	0

- Notes:**
- All sound levels are in dBA

Table 2.7: Ranking of Change in Sound Levels - Unmitigated

Future “Build” Sound Level		Receptors in Category	Total No. of Affected NSAs
Increase in Sound Level	> 15 dBA	0	0
	> 10 to 15 dBA	0	0
	> 5 to 10 dBA	3	11
	0 to 5 dBA	4	31
Decrease in Sound Level	-5 to < 0 dBA	0	0
	-10 to < -5 dBA	0	0
	-15 to < -10 dBA	0	0
	> -15 dBA	0	0

Notes: – All sound levels are in dBA

The results show that at representative NSA’s NR1, NR4, and NR6, changes in sound exposures resulting from the proposed project are greater than 5 dB. “Build” sound levels at these locations also exceed the Outdoor Objective sound level of 55 dBA L_{eq} as defined in the Joint Protocol. As a result, under the Joint Protocol, investigation of noise mitigation is required at NR1, NR4, and NR6.

2.7 Investigation of Noise Mitigation

Based on the projected increase in sound levels resulting from the project, an investigation of noise mitigation measures is required. Under the requirements of the Joint Protocol and previous MTO guidance:

- Noise mitigation should be investigated within the right-of-way (off- right-of-way noise mitigation measures such as window upgrades and air conditioning are not considered).
- Mitigation measures should achieve at least 5 dB of attenuation over the first row of affected receivers
- Mitigation should be implemented where administratively, technically and economically feasible.

2.7.1 Potential Noise Mitigation Measures

Noise mitigation measures that in general can feasibly be implemented within the right-of-way include:

- Changes to vertical and horizontal alignments
- Changes to pavement surface types.
- Acoustical barriers (noise walls and berms)

Horizontal and Vertical Alignments

Horizontal changes in alignment can result in increases or decreases in noise levels at noise sensitive receptors, through moving the roadway closer or further away. However, the changes that result are limited, since the distance to the roadway must be doubled for a 3 to 5 dB decrease in noise level to result. For this particular project, the alignment is constrained by the location and width of the right-of-way, and the location of noise sensitive receptors. Changes to the horizontal alignment within the right-of-way will result in negligible changes in sound levels at NSAs and therefore this mitigation method has not been investigated further.

Vertical changes in alignment can affect noise at NSAs by affecting the line-of-sight between the roadway sources and the receiver. This affects ground attenuation and barrier effects of the surrounding topography. For example, placing the roadway at the bottom of a shallow in-cut can create a natural barrier effect at the edge of the excavation. However, this may create drainage issues or other issues with highway construction and maintenance. Paradoxically, elevated roadways located on embankments or structures may also have reduced noise levels, as the structure/berm can act as a noise barrier for ground level receptors, blocking the line-of-sight for roadway lanes on the “far side” of the road from the receptor in question. For the project in question, the potential for changes in the vertical alignment are limited, and therefore any changes in vertical profile that can be accommodated will result in negligible acoustical changes off-site. Therefore, this mitigation method has not been investigated further.

Noise Barriers

Noise barriers reduce noise levels at protected receptors through blocking the path of sound waves emanating from the source towards the receiver, and by absorbing or reflecting the incident sound energy away. Therefore, a noise barrier must at least break the line-of-sight between the source (the roadway) and the receptor (the ground-level OLA of the NSA under

investigation). Such a barrier will provide at least 5 dB of attenuation. However, each of the roadways under investigation is intersected by multiple residential driveways, and installing adequate barriers on the proposed bridge is not technically feasible. Thus, barrier or berm installation is not feasible due to the requirements for breaks/interruptions in any installed barriers or berms, as the breaks would make the barriers ineffective in blocking noise. Thus barriers or berms are not feasible.

Pavement Type

Noise reducing asphalts may cost twice as much as conventional DFC mixes, and by themselves produce noise reductions of only 2.5 dB – half of the 5 dB minimum required for noise mitigation to be considered effective under the Joint Protocol. Other mitigation measures must therefore be employed in conjunction with noise-reducing pavements to meet the 5 dB requirements (e.g., barriers or alignment changes). As alignment changes and noise barriers have already been ruled out as effective mitigation measures for this project, noise reducing asphalts will not lead to the required 5 dB reduction in noise level.

2.7.2 Mitigation Measures To Be Installed

No feasible mitigation measures were identified.

3. CONSTRUCTION NOISE IMPACTS

Construction noise impacts are temporary in nature, and largely unavoidable. With adequate controls, impacts can be minimized. However, for some periods of time and types of work, construction noise will be noticeable. This section of the report provides an evaluation of noise impacts from construction resulting from the undertaking, and discusses guideline and Code of Practice requirements to minimize impacts.

3.1 Construction Noise Guidelines

3.1.1 Local Noise Control Bylaws

The proposed project lies within the local jurisdiction of the Municipality of Trent Hills.

Bylaws restricting noise generally and specifically noise from construction activity exist within this jurisdiction. The applicable by-law requirements are summarized below. Copies of the bylaws can be found in **Appendix F**.

Table 3.1: Applicable Local Noise Control Bylaws

Jurisdiction	Bylaw No.	Bylaw Provision
Municipality of Trent Hills	2005-36	Schedule B, Item 1 “Prohibitions by Time and Place 1. Construction or operation of any construction equipment whatsoever except in the case of urgent necessity and authorized by the Municipality between 9 p.m. and 6 a.m.”

The Contractor should seek any required exemptions and permits directly from the affected jurisdiction, in advance for any work to be performed outside of the allowable time periods listed above. If an exemption cannot be obtained, then construction will proceed in accordance with the Bylaw requirements.

3.1.2 MOE Model Municipal Noise Control Bylaw

The MOE stipulates limits on noise emissions from individual items of equipment, rather than for overall construction noise. In the presence of persistent noise complaints, sound emission standards for the various types of construction equipment used on the project should be checked to ensure that they meet the specified limits contained in MOE Publication NPC-115 – “Construction Equipment”, as follows (MOE 1977):

Table 3.1: NPC-115 Maximum Noise Emission Levels for Typical Construction Equipment

Type of Unit	Maximum Sound Level ^[1] (dBA)	Distance (m)	Power Rating (kW)
Excavation Equipment ^[2]	83	15	Less than 75 kW
	85	15	75 kW or Greater
Pneumatic Equipment ^[3]	85	7	-
Portable Compressors	76	7	-

- Notes:**
- [1] Maximum permissible sound levels presented here are for equipment manufactured after Jan. 1, 1981.
 - [2] Excavation equipment includes bulldozers, backhoes, front end loaders, graders, excavators, steam rollers and other equipment capable of being used for similar applications.
 - [3] Pneumatic equipment includes pavement breakers.

3.2 Anticipated Construction Activities

The following construction activities are anticipated as part of this project:

- Removing existing surface pavements
- Construction and rehabilitation of the base course
- Construction of a new bridge and related overpass structures (including pile driving)
- Paving (and repaving) of the roadway surface

3.3 Anticipated Construction Noise Levels

Construction activities will vary temporally and spatially as the project progresses. Noise levels from construction at a given receptor location will also vary over time as different activities take place, and as those activities change location within the right-of-way.

At this time, detailed construction noise plans are not available. An analysis of potential worst-case construction noise levels has been conducted based on generic data (equipment types and activities). The analysis, including anticipated construction sound levels, is described in **Appendix G**.

3.4 Construction Code of Practice Requirements (Mitigation)

To minimize the potential for construction noise impacts, it is recommended that provisions be written into the contract documentation for the contractor, as outlined below:

- Construction should be limited to the time periods allowed by the locally applicable bylaws (0600h to 2100h). If construction activities are required outside of these hours, the Contractor must seek permits / exemptions directly from the Town in advance.
- There should be explicit indication that Contractors are expected to comply with all applicable requirements of the contract and local noise by-laws. Enforcement of noise control by-laws is the responsibility of the Municipality for all work done by Contractors.

- All equipment should be properly maintained to limit noise emissions. As such, all construction equipment should be operated with effective muffling devices that are in good working order.
- The Contract documents should contain a provision that any initial noise complaint will trigger verification that the general noise control measures agreed to are in effect.
- In the presence of persistent noise complaints, all construction equipment should be verified to comply with MOE NPC-115 guidelines, as outlined in Section 3.
- In the presence of persistent complaints and subject to the results of a field investigation, alternative noise control measures may be required, where reasonably available. In selecting appropriate noise control and mitigation measures, consideration should be given to the technical, administrative and economic feasibility of the various alternatives.

4. CONCLUSIONS AND RECOMMENDATIONS

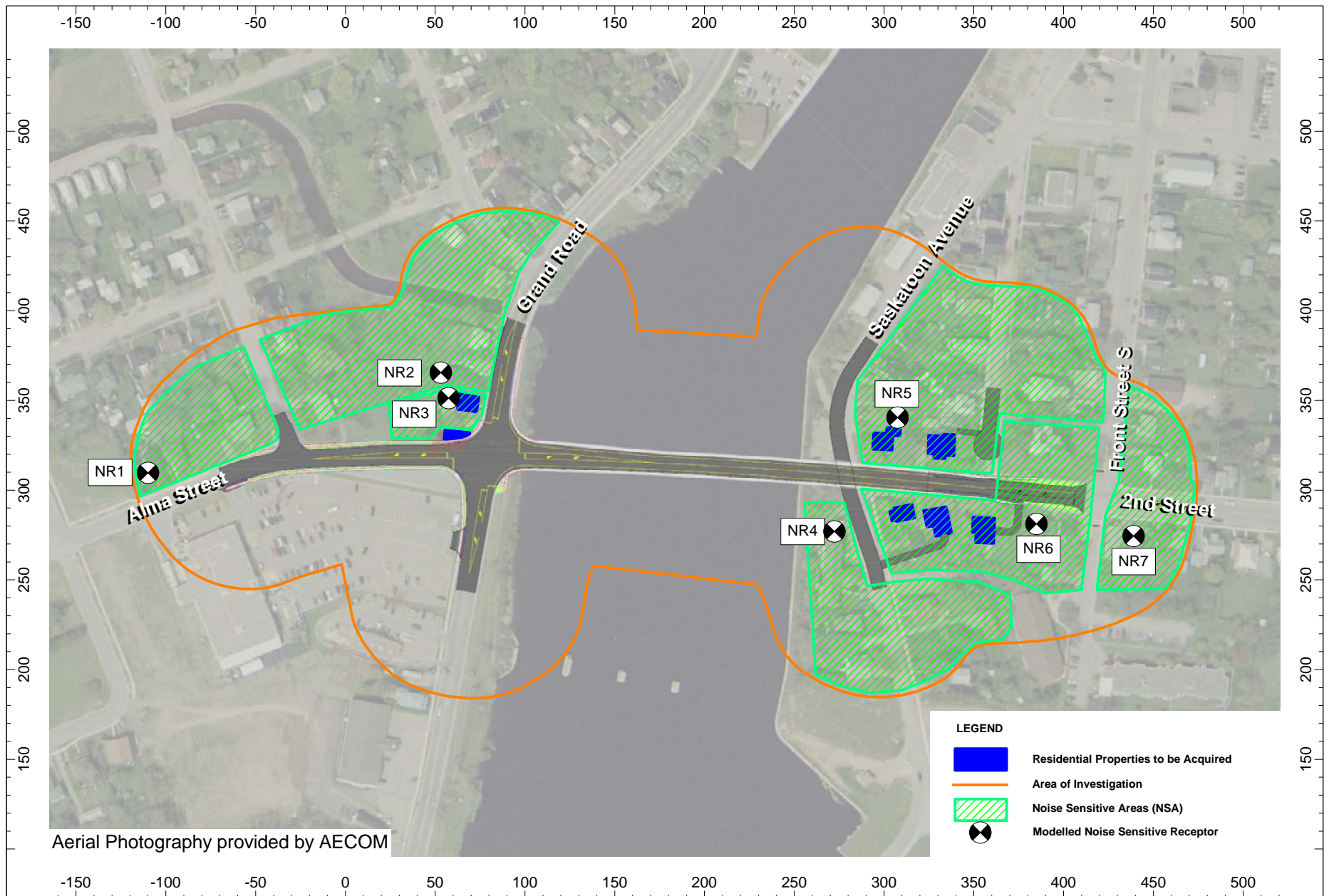
The potential environmental noise impacts of the proposed Trent River Crossing have been assessed. Both operational and construction noise impacts have been considered. The following conclusions and recommendations result:

- Unmitigated changes in sound levels at some receptors, resulting from the project, are greater than 5 dB at some noise sensitive receptors of concern. Additional noise mitigation at these locations has been investigated, in accordance with MTO/MOE Joint Protocol. Since no combination of investigated mitigation measures has the potential to lead to the required 5 dB reduction in noise level, no mitigation is feasible. Thus, no mitigation has been recommended.
- Construction noise impacts are temporary in nature but will be noticeable at times at residential NSAs. Noise related to pile driving activities associated with bridge construction will be substantial at some NSAs, and it is recommended that pile driving be restricted to daytime hours. Methods to minimize construction noise impacts should be included in the Construction Code of Practice, as outlined in the text.

5. REFERENCES

1. Ontario Ministry of the Environment (MOE), 1977, *Model Municipal Noise Control Bylaw*, which includes Publication NPC-115 – Construction Equipment
2. Ontario Ministry of the Environment (MOE), 1989, *Ontario Road Noise Analysis Method for Environment and Transportation (ORNAMENT)*
3. Ontario Ministry of the Environment (MOE), 1996, STAMSON v5.03: Road, Rail and Rapid Transit Noise Prediction Model
4. Ontario Ministry of the Environment (MOE) / Ontario Ministry of Transportation (MTO), 1986, “Joint Protocol”, *A Protocol for Dealing With Noise concerns during the Preparation, Review and Evaluation of Provincial Highway’s Environmental Assessments*
5. Ontario Ministry of Transportation (MTO), 1992, Quality and Standards Directive QST-A1, *Noise Policy and Acoustic Standards for Provincial Highways*
6. Peter VanDelden, Scott Penton, and Aaron Haniff, 2008, *Typical Hourly Traffic Distribution For Noise Modelling*

FIGURES



**Project Extents, Locations of Representative Noise Sensitive Receptors,
and Locations of Noise Sensitive Areas**

Trent River Crossing - Campbellford, Ontario

True North

 Project #W08-5292A

Drawn by: KAC	Figure: 1
Scale: 1:3000	
Date: June 2, 2009	



APPENDIX A

A. TRANSPORTATION SOUND BASICS

A.1 Sound Levels

Sound is, in its simplest form, a dynamic, fluctuating pressure, in a fluid medium. That medium can be air, other gases, or liquids such as water. These fluctuations are transmitted by pressure waves through the medium from the source to the receiver. For the majority of transportation engineering purposes, the primary interest is with sound waves in air, with human beings as the receptor. Noise is defined as unwanted sound. The standard practice within the acoustical industry is to use these two terms interchangeably.

A.1.1 Decibels

A decibel (dB) is a logarithmic ratio of a value to a reference level. The general mathematical format is:

$$\text{Level in dB} = 10 \log (\text{Value} / \text{Reference})$$

Any value can be expressed in decibels. Decibels are very, very useful in performing comparisons where there are huge ranges in levels. For example, an acoustical engineer can expect to deal with acoustical energy values ranging from 0.00001 W to 100 W (sound power), and pressures ranging from 0.002 Pa to 200 Pa (sound pressure).¹ For completeness, decibels should always be stated with their reference level (e.g., 20 dB re: 20 μ Pa). However, in practice the reference level is often left out.

A.1.2 Sound Pressure Level

Sound pressure level is what humans experience as sound. Sound waves create small fluctuations around the normal atmospheric pressure. These pressure fluctuations come into contact with eardrums and create the sensation of sound. Sound pressure is measured in decibels, according to the following equation:

$$\text{Sound Pressure Level, dB} = 10 \log (p^2 / p_o^2)$$

Where: p = root mean square (r.m.s.) sound pressure, in Pa
 p_o = reference sound pressure, 20 μ Pa

¹ Equivalent to Sound Power Levels ranging from 70 to 140 dB and Sound Pressure Levels ranging from 20 dB to 140 dB

The reference pressure represents the faintest sound that a “typical” human being can hear. The typical abbreviation for sound pressure level is SPL, although L_p is also often used in equations. “Sound level” or “noise level” are also sometimes used.

A.2 Octave Bands

Sounds are composed of varying frequencies or pitches. Human sensitivity to noise varies by frequency, with a greater sensitivity to higher frequency sounds. The propagation of sound also varies by frequency. The unit of frequency is Hertz (Hz), which refers the number of cycles per second (number of wave peaks per second of the propagating sound wave). The typical human hearing response runs from 20 Hz to 20,000 Hz. Frequencies below 20 Hz are generally inaudible, although response is variable, and some individuals may be able to hear or perceive them.

Sound is typically analysed in octave bands or 1/3-octave bands. An octave band is defined as a band or range of sound frequencies where the frequency range doubles for succeeding octave (alternately, the highest frequency in the range is twice the value of the lowest frequency). Octave band and 1/3-octave band frequencies of interest frequencies of interest are shown in the table on the following page. Road and rail transportation noise sources tend to be broadband in nature, having roughly equal sound energy in many octave bands. Heavy rail traffic and heavy truck traffic may produce significant noise in lower frequencies < 200 Hz.

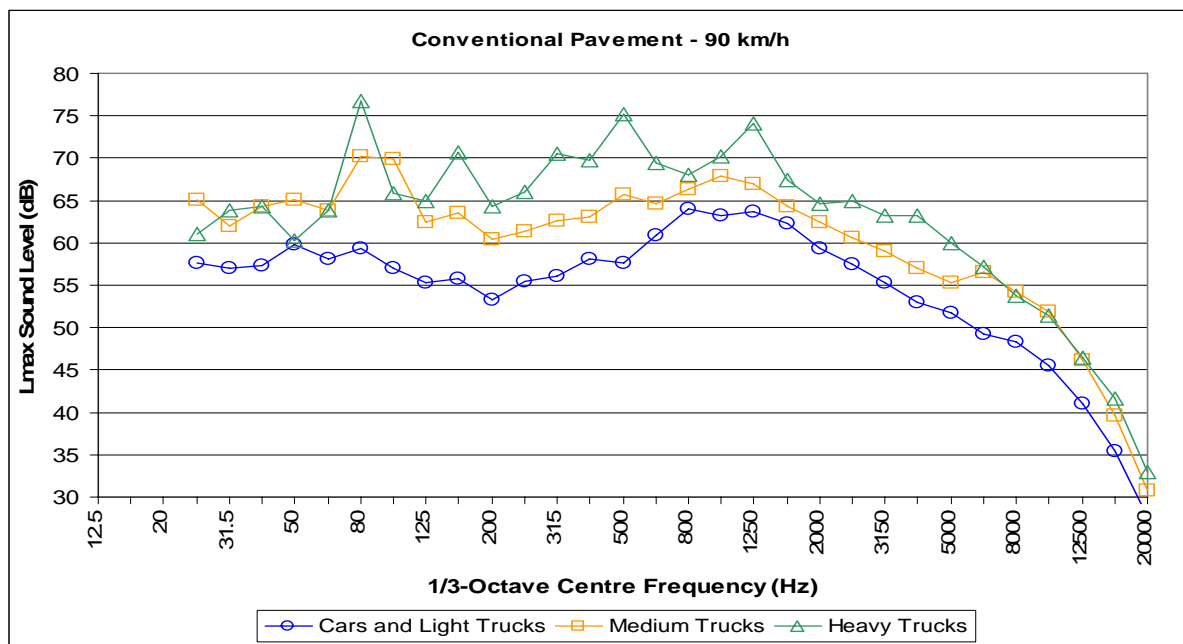
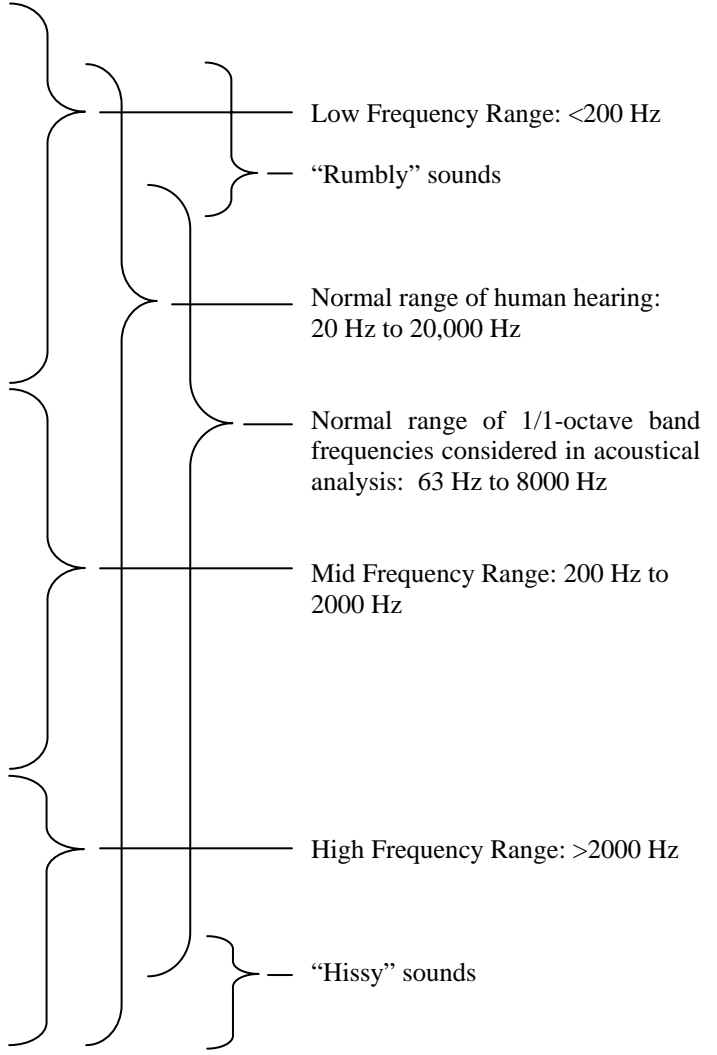


Figure 1: Typical Frequency Spectra of Traffic Noise - Vehicle Pass-bys at 90 km/h

Table 1: Octave Band Frequencies of Interest

Centre-Frequency (Hz)		Band No.	Frequency Range (Hz)	
1/3-Octave	1/1-Octave			
12.5	16	N/A	11 to 22	
16				
20				
25	31.5	0	22 to 45	
31.5				
40				
50	63	1	45 to 89	
63				
80				
100	125	2	89 to 177	
125				
160				
200	250	3	177 to 345	
250				
315				
400	500	4	345 to 707	
500				
630				
800	1,000	5	707 to 1,414	
1,000				
1,250				
1,600	2,000	6	1,414 to 2,828	
2,000				
2,500				
3,150	4,000	7	2,828 to 5,657	
4,000				
5,000				
6,300	8,000	8	5,657 to 11,314	
8,000				
10,000				
12,500	16,000	N/A	11,314 to 22,627	
16,000				
20,000				

Note: Per ISO 266-1975

A.3 A-Weighting

When the overall sound pressure level is expressed as a single value (i.e., not expressed in frequency band levels) the variation in human frequency response must be accounted for. People do not hear low frequency noise as well as noise in mid or high frequencies. To account for this, frequency-weighting networks have been developed to better account for human hearing response. The most frequently used networks are the A-Weighting and C-Weighting.

The A-Weighting network was developed to correspond to how humans hear low to medium levels of noise. The A-Weighting is the most frequently used scheme, and the majority of noise guidelines are expressed in A-Weighted decibel values, denoted as “dBA” levels. C-Weighted “dBC” values are sometimes used in assessing low-frequency noise impacts, which are generally not of concern in transportation noise impact assessment. The A-Weighting and C-Weighting values are shown in the following table and figure.

Table 2: A- and C-Weighting Values

1/1-Octave Frequency (Hz)	A-Weighting Value (dB)	C-Weighting Value (dB)
31.5	-39.4	-3.0
63	-26.2	-0.8
125	-16.1	-0.2
250	-8.6	0
500	-3.2	0
1,000	0	0
2,000	1.2	-0.2
4,000	1.0	-0.8
8,000	-1.1	-3.0

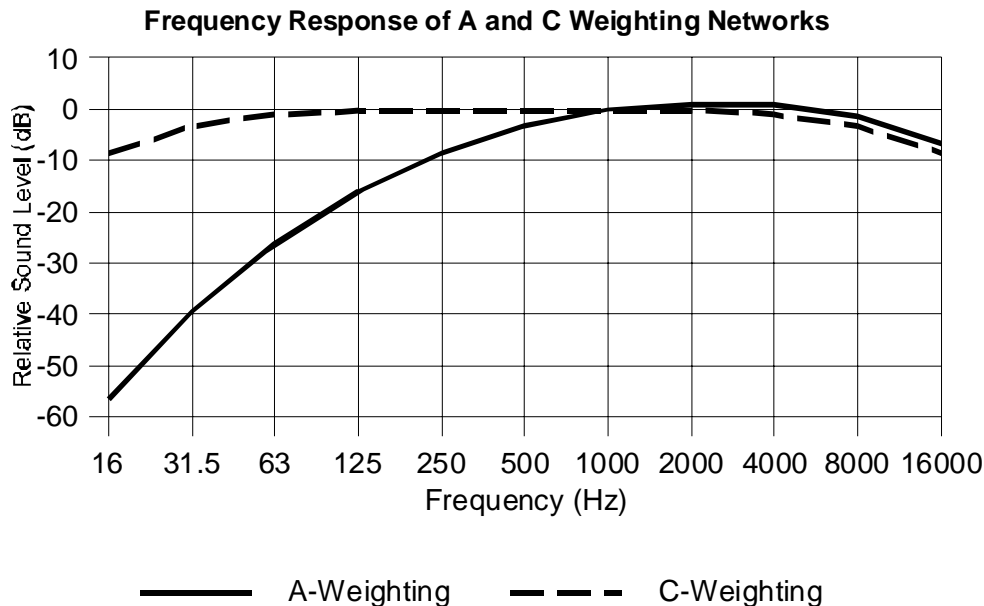


Figure 2: A-Weighting and C-Weighting Networks

A.4 Ranges of Sound Levels

People experience a wide range of sound levels in their daily activities. The table below presents a graphical comparison of “typical” noise levels which might be encountered, and the general human perception of the level.

Table 3: Ranges of Sound Levels

Sound Levels		Sources of Noise
Human Perception	SPL, in dBA	
Deafening	125	Sonic booms
	120	Threshold of Feeling / Pain
	115	Maximum level, hard rock band concert
	110	Accelerating Motorcycle at a few feet away
Very Loud	105	Loud auto horn at 3 m (10 ft) away
	100	Dance club / maximum human vocal output at 1 m (3 ft) distance
	95	Jack hammer at 15 m (50 ft) distance
	90	Indoors in a noisy factory
Loud	85	Heavy truck pass-by at 15 m (50 ft) distance
	80	School cafeteria / noisy bar; Vacuum Cleaner at 1.5 m (5 ft)
	75	Near edge of major Highway
	70	Inside automobile at 60 km/h
	65	Normal human speech (unraised voice) at 1 m (3 ft) distance
Moderate	60	Typical background noise levels in a large department store
	55	General objective for outdoor sound levels; typical urban sound level (24h)
	50	Typical suburban / semi-rural sound level (24h)
	45	Typical noise levels in an office due to HVAC; typical rural levels (24h)
Faint	40	Typical background noise levels in a library
	35	
	30	Broadcast Studio
	25	Average whisper
Very Faint	20	Deep woods on a very calm day
	15	
	10	
	5	Human breathing
	0	Quietest sound that can be heard

Sound levels from 40 to 65 dBA are in the faint to moderate range. The vast majority of the outdoor noise environment, even within the busiest city cores, will lie within this area. Sound levels from 65 to 90 are perceived as loud. This area includes very noisy commercial and industrial spaces. Sound levels greater than 90 dB are very loud to deafening, and may result in hearing damage.

Transportation noise events, which vary with time, can also be considered in terms of their maximum noise level (L_{max}) during a vehicle pass-by, as shown in the following table:

Table 4: Typical Pass-By Noise Levels at 15 m from Noise Source

Event	Range of Noise Levels (dBA) at 15 m
Semi-Trailer Trucks	75 - 85
Aircraft	69 – 85 ^[1]
Conventional Light Rapid Transit (Streetcars)	72 – 80 ^[2]
Large Trucks	71 - 78
Street Motorcycle	76
Diesel or Natural Gas Bus	70 - 78
Trolley Bus	69 - 73
Small Motorcycle	67
General Busy Auto Traffic	66 - 70
Individual Automobiles	63 - 69

Notes: Source: BKL Consultants Ltd.

[1] Aircraft flyover not at 15 m distance

[2] Based on data provided for the Calgary, Edmonton and Portland LRT systems.

A.5 Noise Descriptors – Leq Values

At this time, the best available research indicates that long-term human responses to noise are best evaluated using energy equivalent sound exposure levels (L_{eq} values), in A-Weighted decibels (L_{eq} values in dBA)^{2, 3} including adjustments to account for particularly annoying characteristics of the sounds being analyzed.

Sound levels in the ambient environment vary each instant. In a downtown urban environment, the background noise is formed by an “urban hum”, composed of noise from distant road traffic and from commercial sources. As traffic passes near a noise receptor, the instantaneous sound level may increase as a vehicle approaches, and then decrease as it passes and travels farther away. The energy equivalent sound exposure level L_{eq} is the average sound level over the same period of time with same acoustical energy as the actual environment (i.e., it

² Berglund and Lindvall, Community Noise, 1995.

³ ISO 1996:2003(E), *Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures*.

is the average of the sound energy measured over a time period T). As a time-average, all L_{eq} values must have a time period associated with them. This is typically placed in brackets beside the L_{eq} tag. For example, a thirty-minute L_{eq} measurement would be reported as an L_{eq} (30 min) value. The L_{eq} concept is illustrated in Figure 3, showing noise levels beside a small roadway, over a 100 second time period, with two vehicle pass-bys:

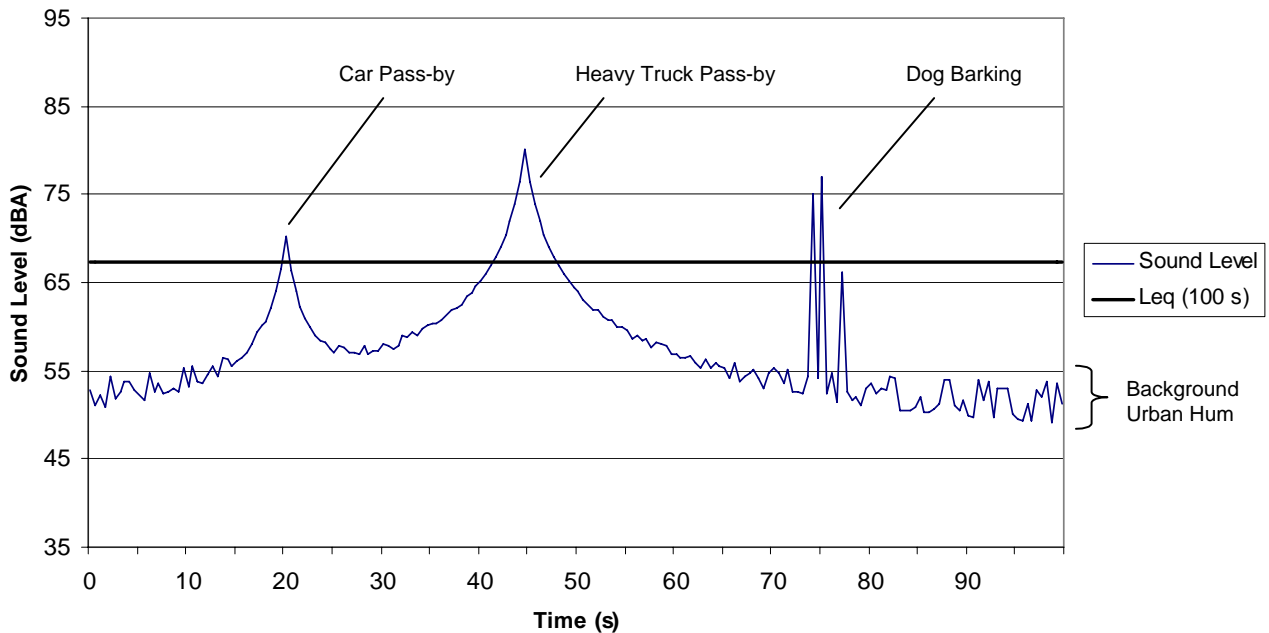


Figure 3: Example of the L_{eq} Concept

In this example, the background “urban hum” is between 47 and 53 dBA. A car passes by at 20 seconds. As it approaches, the noise level increases to a maximum, and then decreases as it speeds away. At 45 seconds, a heavy truck passes by. Near 75 seconds, a dog barks three times. The maximum sound level (L_{max}) over the period is 80 dBA and the minimum is 47 dBA. For almost 50% of the time, the sound level is lower than 55 dBA.

The L_{eq} (100s) for the above example is 67 dBA, which is much higher than the statistical mean sound level of 55 dBA. This illustrates that the L_{eq} value is very sensitive to loud noise events, which contain much more sound energy (as sound is ranked on a logarithmic scale) than the normal background. It is also sensitive to the number of events during the time period, and the duration of those events. If only the truck had passed by during the measurement (no car and no dog barks), the L_{eq} (100s) would be 66 dBA. If only the car and dog barks had occurred, the L_{eq} (100s) would have been 61 dBA. This shows that the truck pass-by is the dominant event in our example, due to its level and duration.

The ability of the L_{eq} metric to account for the three factors of level, duration and frequency of events makes it a robust predictor of human response to noise. It is for this reason that the vast majority of noise standards are based on L_{eq} values.

A.6 Typical Durations for Leq Analyses

For transportation noise impact analyses, the following durations are typically used:

L_{eq} (24h)	–	The sound exposure level over then entire 24-hour day
L_{eq} Day	–	Either: L_{eq} (15h), from 7am to 10 pm; or L_{eq} (16h), from 7am to 11 am
L_{eq} Night	–	Either: L_{eq} (9h), from 10 pm to 7 am; or L_{eq} (8h), from 11 pm to 7 am
L_{dn}	–	A special L_{eq} (24h) value with a 10 dB night-time penalty applied to overnight sound levels (10pm to 7am)
L_{eq} (1-h)	–	The sound exposure over a 1-hour time period

L_{eq} (24h) values are appropriate for examining impacts of transportation noise sources with small changes in sound exposure levels over the 24-hour day. For example, freeway noise levels are generally consistent over the 24-hour day. Therefore, for freeways, there is little difference between L_{eq} (24h) values and the corresponding L_{eq} Day and L_{eq} Night values.

L_{eq} Day values, covering off the AM-peak and PM-peak travel periods, are generally appropriate for examining the impacts of non-freeway highways and municipal arterial roadways. The vast majority of noise associated with these sources is concentrated in the daytime hours, where typically, 85% to 90% of the daily road traffic will occur.⁴ Thus, if reasonable sound levels occur during the daytime (and appropriate guideline limits are met), they will also occur (and be met) at night.

To account for increased annoyance with noise overnight in a single value, the U.S. Environmental Protection Agency (U.S. EPA) developed the L_{dn} metric. It is a special form of the L_{eq} (24h) with a +10 dB night-time penalty. L_{dn} values and a related metric, the day-evening-night level (L_{den}) are also used in some European guidelines. L_{dn} values are not used in Canadian

⁴ Based on research conducted by Ontario Ministry of Transportation, and provided in the *MTO Environmental Office Manual Technical Areas – Noise*. Daytime refers to a 16 hour day from 7am to 11 pm.

Provincial jurisdictions in evaluating transportation noise. Instead, guideline limits for separate L_{eq} Day and L_{eq} Night periods are generally used.

L_{eq} (1-h) values are the average sound levels over a one-hour time period. These tend to fluctuate more over the day, as traffic levels can fluctuate significantly hour to hour. L_{eq} (1-h) values are useful in assessing the impact of transportation sources which also vary hourly, and which may vary in a different manner than the background traffic. These values are often used to assess haul route noise impacts, for example.

Some transportation noise sources may have significant traffic levels occurring over-night. For example, freight rail traffic in heavily used corridors can be shifted to over-night periods, with daytime track use being reserved for freight switcher traffic and passenger traffic. In situations such as this, an assessment of both daytime and night-time noise impacts may be appropriate.

A.7 Decibel Addition

Decibels are logarithmic numbers, and therefore have special properties of addition. Decibel values must be added logarithmically. If two sources, each emitting the same amount of sound energy, are placed side-by-side, then the total increase in sound level will only be 3 dB. If the difference in sound energy emitted is greater than 10 dB, then effectively the sound level will be the same as for the loudest unit (i.e., the increase in noise will be less than a decibel). This is shown in Table 5:

Table 5: Decibel Addition Chart

dB Difference Of	dB Value to Add to Highest Number
0	3.0
1	2.5
2	2.1
3	1.8
4	1.5
5	1.2
6	1.0
7	0.8
8	0.6
9	0.5
10	0.4

This affects transportation noise from projects, as noise emission is logarithmically related to traffic volume. Doubling the traffic volume (essentially the same as adding a source with the same sound emission) will only result in a 3 dB increase over the original levels. The decibel increase in noise due to the increase in traffic volume, assuming all other factors remain the same, can be estimated by:

$$\text{dB increase} = 10 \log (\text{new volume} / \text{original volume}).$$

A.8 Human Response to Changes in Sound Levels

The human ear does not interpret changes in sound level in a linear manner. The general subjective human perception of changes in sound level is shown in the following table.

Table 6: Subjective Human Perception of Changes in Sound Level ^{5,6}

Change in Broadband Sound Level (dB)	Human Perception of Change
< 3	Imperceptible change
3	Just-perceptible change
4 to 5	Clearly noticeable change
6 to 9	Substantial change
> 10 and more	Very substantial change (half or twice as loud)
> 20 and more	Very substantial change (much quieter or louder)

Notes: Adapted from Bies and Hansen, p53, and MOE Noise Guidelines for Landfill Sites, 1998. Applies to changes in broadband noise sources only (i.e., increases or decreases in the same noise or same type of noise only). Changes in frequency content or the addition of tonal or temporal changes would affect the perception of the change.

The above table is directly applicable to changes in sound level where the noise sources are of the same general character. For example, existing road traffic noise levels can be directly compared to future road traffic noise levels, using the above relationships. In comparing road traffic noise to road plus rail traffic noise, the different frequency and temporal nature of the noise means that the rail noise may be more noticeable. Adjustments for the nature of the new sound can be applied to better account for temporal and frequency differences.

⁵ Bies, D.A., and C.H. Hansen 1988. *Engineering Noise Control – Theory and Practice*, 2nd Ed. E & FN Spon, London, p 53.

⁶ Ontario Ministry of the Environment 1998. Noise Guidelines for Landfill Sites. Queen’s Printer for Ontario.

For transportation noise sources, research conducted by the U.S. Environmental Protection Agency indicates that a 5 dB change in sound levels is required to trigger a change in large-scale community response to noise. This correlates to a clearly noticeable increase in noise levels.

A.9 Decay of Noise with Distance

Noise levels decrease with increasing distance from a source of noise. The rate of decay is partially dependent on the nature of the ground between the source: whether it is hard (acoustically reflective) or soft (acoustically absorptive). Transportation noise sources in general act as *line sources* of sound. For line sources, the rate of decay is approximately:

- Hard ground: 3 dB for each doubling of distance from the source
- Soft ground: 5 dB for each doubling of distance from the source

This is shown graphically in Figure 6, based on a reference distance of 15 m from the source:

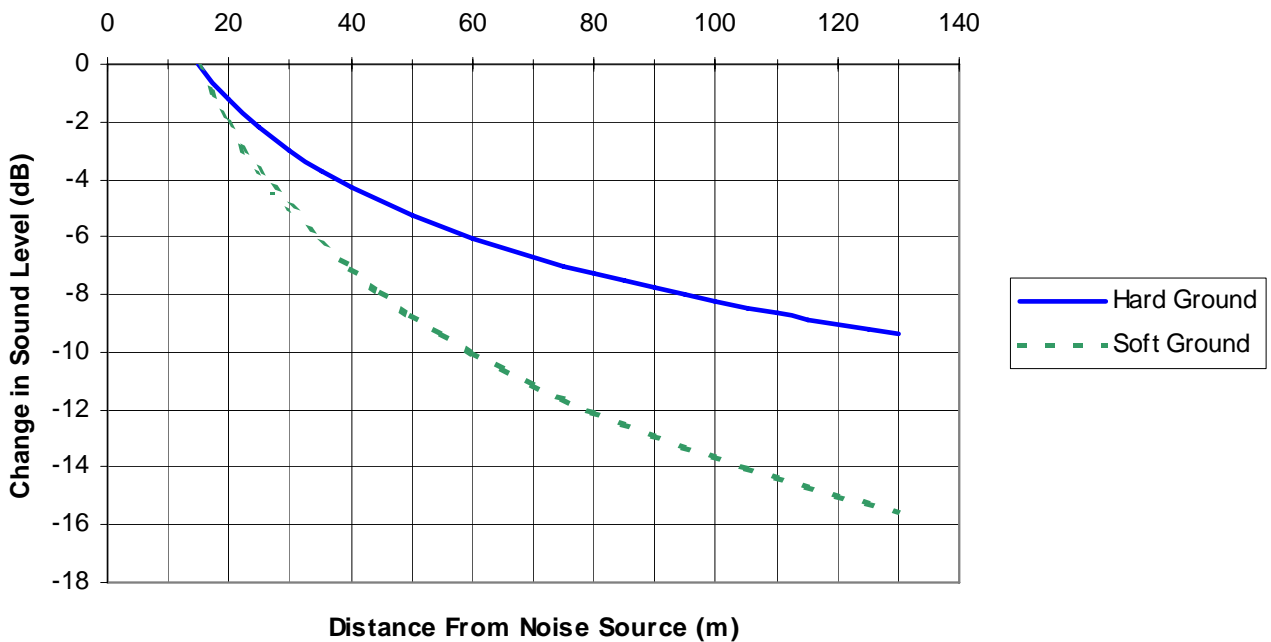


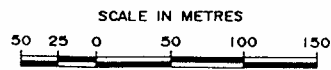
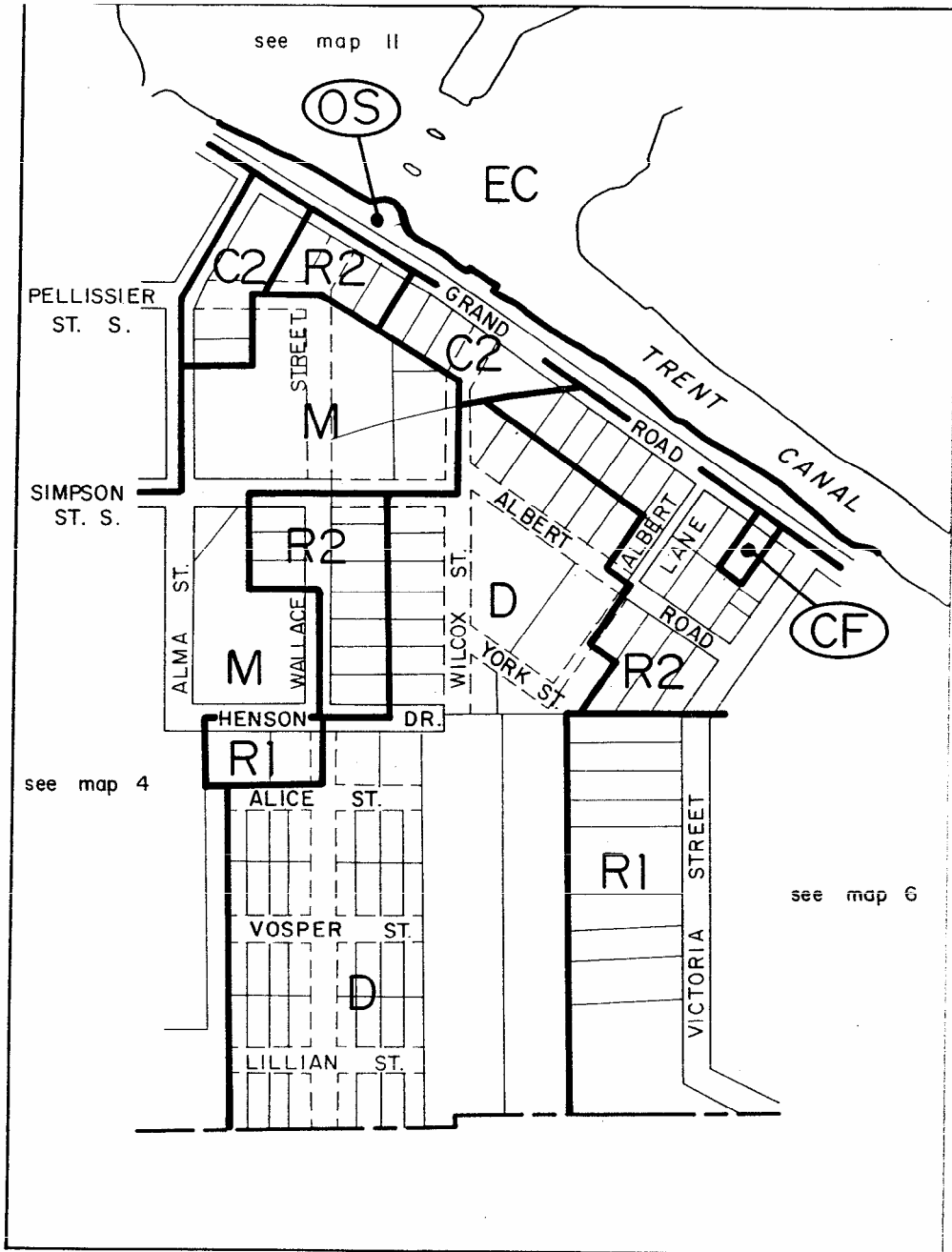
Figure 4: Decay of Noise Versus Distance for Line Sources

APPENDIX B

APPENDIX C

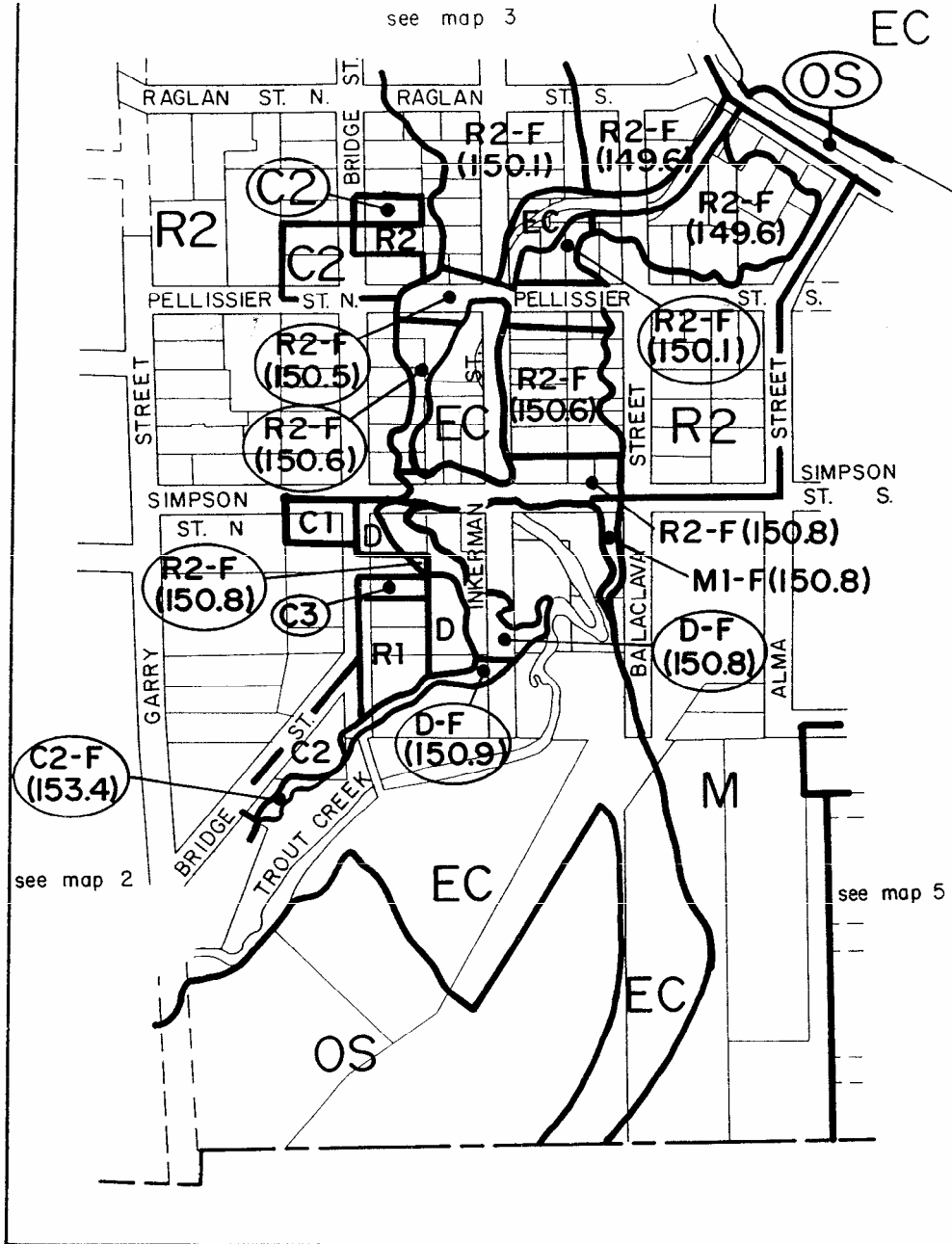
4. Z O N E P R O V I S I O N S

4.1	RESIDENTIAL 1 (R1) ZONE	4-1
4.2	RESIDENTIAL 2 (R2) ZONE	4-4
4.3	RESIDENTIAL 3 (R3) ZONE	4-7
4.4	RESIDENTIAL 4 (R4) ZONE	4-10
4.5	SPECIAL RESIDENTIAL (RS) ZONE	4-13
4.6	GENERAL COMMERCIAL (C1) ZONE	4-15
4.7	SERVICE COMMERCIAL (C2) ZONE	4-19
4.8	LOCAL COMMERCIAL (C3) ZONE	4-25
4.9	GENERAL INDUSTRIAL (M) ZONE	4-27
4.10	DISPOSAL INDUSTRIAL (MD) ZONE	4-33
4.11	COMMUNITY FACILITY (CF) ZONE	4-34
4.12	OPEN SPACE (OS) ZONE	4-36
4.13	RURAL (RU) ZONE	4-38
4.14	DEVELOPMENT (D) ZONE	4-41
4.15	ENVIRONMENTAL CONTROL (EC) ZONE	4-42



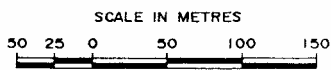
TOWN OF CAMPBELLFORD
ZONING BY-LAW No.
SCHEDULE 'A' MAP PART 5

see map 3

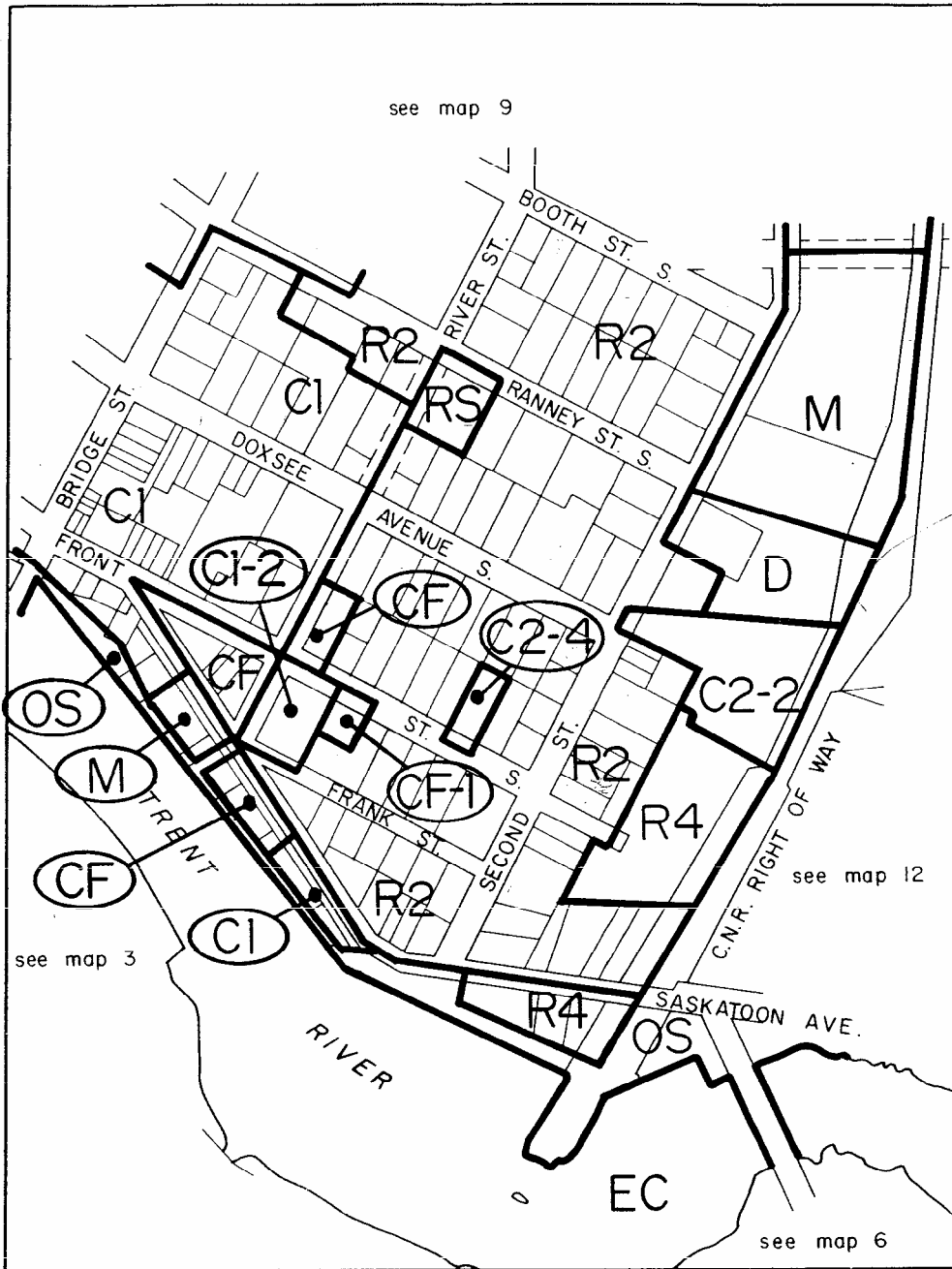


see map 2

see map 5



TOWN OF CAMPBELLFORD
ZONING BY-LAW No.
SCHEDULE 'A' MAP PART 4



TOWN OF CAMPBELLFORD
ZONING BY-LAW No.
SCHEDULE 'A' MAP PART II

APPENDIX D

Road	From	To	Spd Lim	16 Hr/8 Hr	%MV	%HV	2027 AADT - No Add. Crossing	2027 AADT - With Additional Crossing
Grand Road	Raglan Street S	Canrobert St S	50 km/h	93% / 7 %	0%	6%	9,912	6,780
Grand Road	Alma Street	Raglan Street S	50 km/h	93% / 7 %	0%	6%	9,912	6,780
Grand Road	Albert Lane	Alma Street	50 km/h	93% / 7 %	0%	6%	10,989	10,582
Alma Street	Pellissier Street S	Grand Road	50 km/h	93% / 7 %	0%	5%	1,846	6,187
Saskatoon Avenue	River Street	Second Street	50 km/h	93% / 7 %	0%	2%	923	703
Saskatoon Avenue	Second Street	Trent Drive	50 km/h	93% / 7 %	0%	2%	3,044	703
Frank Street	River Street	Second Street	50 km/h	93% / 7 %	0%	0%	Nominal	Nominal
Front Street S	River Street	Second Street	50 km/h	93% / 7 %	0%	6%	3,055	3,659
New Bridge Crossing	Grand Road	Front Street S	50 km/h	93% / 7 %	0%	6%	-	8,187
Second Street	Saskatoon Avenue	Frank Street	50 km/h	93% / 7 %	0%	3%	2,231	-
Second Street	Frank Street	Front Street S	50 km/h	93% / 7 %	0%	3%	2,231	-
Second Street	Front Street S	Doxee Avenue S	50 km/h	93% / 7 %	0%	3%	3,330	7,220

Notes:

- 16 hour split - 5 am - 9 pm
- 16/8 hr splits and AADTs based on AADT/PM 2-way vol ratios on bridge from Dillon report and confirmed with other Northumberland County count stations
- % MV/HV are based on peak 8-hour 2-way vols
- It is assumed that 16/8 hr splits and %MV/%HV for both future conditions would be the same as existing

TYPICAL HOURLY TRAFFIC DISTRIBUTION FOR NOISE MODELLING

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1. INTRODUCTION

A prominent feature of the environmental noise in our western world is the sound of vehicles travelling on our roads. Noise from vehicles is estimated using models that incorporate many factors, including traffic volume. However, the ability to characterize the variation in noise level is limited by the temporal resolution of the traffic volume that is available. This study provides input to evaluating the variation of noise level over the course of a day by examining variation in the number of vehicles.

Noise levels are usually represented on the basis of hourly, day/night, or 24-hour time periods. 24-hour time periods usually require no more than the Average Annual Daily Traffic (AADT) volume for a road segment. When breaking the evaluation period into daytime hours and night-time hours or further resolving it to a one hour time period, it becomes necessary to have information about how the traffic is distributed.

Traffic volumes distributed over one hour time periods are not always available for the specific road segments that are being modelled. Since traffic data is used primarily for transportation planning, the traffic volumes are frequently counted only during the morning peak and afternoon peak hours, or during an eight hour daytime period. Data for the evening and night-time periods is therefore missing.

The problem of determining how low the traffic volumes and sound levels fall during evening and night-time periods is particularly real in jurisdictions such as Ontario, where the lowest sound levels are used in determining the applicable limits for permitting of industrial noise. When the data is not available on an hourly basis for a desired road, a comparable road in the vicinity is often used as a proxy. This study addresses the situation where a suitable proxy is not available, by developing a typical hourly distribution.

2. DATA SET

2.1 Data Sources

The typical hourly traffic distribution presented in this study is empirically derived. Data was requested from the provincial and local levels of government across Ontario. Care was taken to represent the widest possible variety of roads by soliciting data from cities, towns, and municipalities in all regions of the province. Each was requested to send data sets reflecting the diversity of road types within the jurisdiction. Rural, collector, arterial, and controlled access roads are all represented.

Each of the data sets was accumulated using automated counters. A large number of the data sets included multiple days of counting. A few of the counts included complete breakdowns by vehicle type and size. However, the amount of this type of data was not sufficient to warrant further examination.

Traffic counting for the data sets obtained was conducted from March through November, with the majority occurring between April and October. One of the counts included hourly averages for each month of the year.

In general, the traffic distributions follow a common pattern. Between 6 am and 8 am there is a rapid rise in volume. The volume is drops somewhat, but rises through the late afternoon. After peaking at the end of the afternoon, it drops off into the evening and night-time hours. The lowest volume occurs between the hours of 2 am and 4 am.

2.2 Data Selection

Most of the data sets that were received were suitable for this analysis. Data sets that were significantly influenced by local features, had low traffic volumes, or were only part of a road segment are excluded in the analysis. Local features such as a dominant industry with shift changes or a nearby school, showed the ability to bias the hourly distribution on a road segment. While this is normal for certain road segments, this is clearly not universal. Data sets with low total volumes were also poorly behaved. They included hours where no vehicles were recorded, and showed comparatively large impacts for small changes in traffic volumes. Upon reviewing the distribution of traffic in the uni-directional data sets, it was apparent that they could not be considered together with the bi-directional data sets. These data sets were typically missing the rapid morning rise in traffic, or the large volumes of the late afternoon and early evening traffic. These data sets would skew the results away from normal conditions, and were therefore not included.

After removing the unsuitable data sets, just over 100 data sets remained for analysis. The distribution of AADT's is shown in Figure 1.

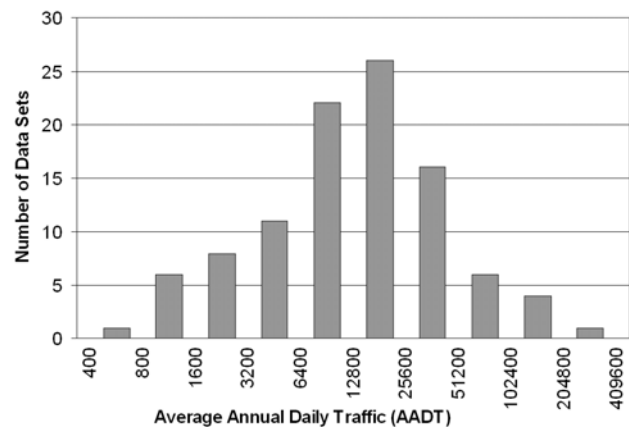


Figure 1. Distribution of AADTs in Data Set

3. ANALYSIS AND RESULTS

3.1 Hourly Traffic Volume

The accumulated suitable data sets were analyzed using the percentage of the AADT occurring in each hour of the day. A single data set was used for each road segment.

Where a number of days were counted for a segment, an average was calculated over the measurement period. The typical distribution was calculated as the mean of each hour over the data set, as shown in Figure 2. The range of values and standard deviation are shown in Table 1.



Figure 2: Typical Hourly Traffic Distribution in Percent AADT

Table 1. Range of Values and Standard Deviation for the Supporting Data Set (in Percent)

Hour Beginning	Typical	Maximum	Minimum	Standard Deviation
0:00	0.87	1.88	0.18	0.44
1:00	0.49	1.21	0.09	0.27
2:00	0.36	0.86	0.07	0.21
3:00	0.30	0.76	0.05	0.17
4:00	0.36	0.87	0.07	0.21
5:00	0.95	2.68	0.37	0.54
6:00	2.75	5.18	1.19	1.43
7:00	5.05	8.59	2.13	2.30
8:00	6.55	11.08	3.30	2.81
9:00	5.62	7.70	3.96	2.24
10:00	5.50	7.73	3.81	2.21
11:00	6.04	9.76	4.19	2.48
12:00	6.48	9.78	4.45	2.65
13:00	6.26	9.75	4.24	2.56
14:00	6.60	9.62	4.44	2.63
15:00	7.41	10.40	5.51	2.91
16:00	7.82	10.34	5.83	3.06
17:00	7.65	9.30	5.58	3.01
18:00	6.27	8.72	4.42	2.50
19:00	5.12	7.44	3.52	2.06
20:00	4.09	6.30	2.18	1.69
21:00	3.41	5.21	1.30	1.44
22:00	2.41	4.09	0.78	1.08
23:00	1.67	3.79	0.46	0.86

The significance of the statistical data becomes apparent when the hourly distribution is translated into sound levels. For illustration purposes an $L_{eq}(24 \text{ hour})$ of 60 dBA was used for comparison with the $L_{eq}(1 \text{ hour})$ sound levels as shown in Table 2. The respective increase or decrease due one standard deviation increase or decrease in traffic volume is also presented.

Table 2. Hourly Sound Levels and Variation Based on an $L_{eq}(24hr)$ of 60 dBA.

Hour Beginning	Sound Level (dBA)	+1 std. dev.	-1 std. dev.
0:00	53	+2	-3
1:00	51	+2	-3
2:00	49	+2	-4
3:00	49	+2	-4
4:00	49	+2	-4
5:00	54	+2	-4
6:00	58	+2	-3
7:00	61	+2	-3
8:00	62	+2	-2
9:00	61	+1	-2
10:00	61	+1	-2
11:00	62	+1	-2
12:00	62	+1	-2
13:00	62	+1	-2
14:00	62	+1	-2
15:00	62	+1	-2
16:00	63	+1	-2
17:00	63	+1	-2
18:00	62	+1	-2
19:00	61	+1	-2
20:00	60	+1	-2
21:00	59	+2	-2
22:00	58	+2	-3
23:00	56	+2	-3

3.2 Day/Night Split

The amount of traffic occurring in each part of the 16/8 and 15/9 hour splits was calculated for each distribution. Table 3 presents the average and range of these values.

Table 3. Day/Night Split Ratios

	16:8 hr	15:9 hr
Mean	92:8	90:10
Maximum Range	97:3	96:4
Minimum Range	87:13	83:17

4. DISCUSSION

To understand the value of this typical traffic distribution, it is necessary to know its limitations. The first indication of limitations is derived from the input data. Low volume roads, unidirectional roads, or those with significant local influences are not covered in this typical hourly traffic distribution.

Regulatory parameters put a practical lower limit on the AADT values where this distribution can be applied. Conditions, including AADT, that are sufficient to generate $L_{eq}(24 \text{ hour})$ values of 57 dBA and 52 dBA would be needed to raise the lowest hourly sound levels above the minimum limit values of 45 dBA and 40 dBA respectively. More significantly, the models that use this data also provide limitations. For example, the algorithms currently used in Ontario set a minimum limit of 40 vehicles per hour. An AADT of over 13,000 would be necessary to satisfy this criterion during the early morning hours.

This study proposes a typical hourly traffic distribution together with some indication of its range of variability. It provides a method of estimating minimum hourly sound levels when actual data is missing or incomplete and good proxy data is not available.

correction factors - day = 5am to 9pm to day = 7am to 11pm

numbers from PV's paper on traffic distributions

time	percentile
5-6am	3.7%
9-10pm	5.8%

given

day (5am-9pm)	93.0%
night (9pm-5am)	7.0%
	100.0%

calculated

day (7am-11pm)	95.1%
night (11pm-7am)	4.9%
	100.0%

APPENDIX E

APPENDIX F

FAX TRANSMITTAL SHEET

MUNICIPALITY OF CAMPBELLFORD/SEYMOUR

P.O. Box 1030
66 Front Street South
Campbellford, Ontario
K0L 1L0

Phone: (705) 653-1900
Fax: (705) 653-5203

NAME: Kevin Carr

SERVICE/BRANCH:

CITY: Peterborough

FAX: 519-823-1316

of PAGES (incl cover page): 7

SENDER'S NAME: Susan Gordon/David Rogers

DATE: July 22, 2008

REMARKS

THE CORPORATION OF THE MUNICIPALITY OF TRENT HILLS

BY-LAW 2005-36

BEING A BY-LAW TO PROHIBIT AND REGULATE CERTAIN
NOISES WITHIN THE MUNICIPALITY OF TRENT HILLS

WHEREAS Section 129 of the Municipal Act, 2001 permits a local municipality to prohibit and regulate noise and vibrations;

AND WHEREAS the Council deems it appropriate to enact restrictions of certain noises or vibrations within the municipality;

NOW THEREFORE the Council of the Corporation of the Municipality of Trent Hills enacts as follows;

DEFINITIONS

1. **Municipality** means the Council of the Corporation of the Municipality of Trent Hills or its designated staff.
2. **Noise** includes sound and vibrations.
3. **Construction** includes erection, alteration, repair, demolition, dismantling, structural maintenance, painting, moving, land clearing, earth moving, grading, excavating, the laying of pipe or conduit whether above or below ground level, street and highway building, concreting equipment installation and alteration, and the structural installation of construction components and materials in any form or for any purpose and includes any work in connection therewith.
4. **Construction equipment** means any equipment or device designed or intended for use in construction or material handling, including air compressors, pile drivers, pneumatic or hydraulic tools, bulldozers, tractors, scrapers, pavers, generators, off-highway haul trucks, ditchers, compactors and rollers, pumps, concrete mixers, graders or other material handling equipment.
5. **Point of reception** means any point on premises where noise is received, which noise originates from any other premises.
6. **Conveyance** includes a vehicle and any other device employed to transport a person or persons or goods from place to place but does not include any such device or vehicle that is operated only within a building.

GENERAL PROHIBITIONS

7. No person shall generate any unnecessary noise in the vicinity of a hospital, nursing home, seniors' home or like facilities.
8. No person shall generate any noise from any commercial use that is clearly audible at a distance of 15 metres from any property line of the property upon which the building, structure or equipment from which the noise is emanating is located.
9. No person shall emit, or cause or permit the emission of noise which is clearly audible at a point of reception, resulting from an act or emanating from a device listed in Schedule "A".
10. No person shall, within a prohibited time shown in Schedule B, emit, or cause or permit the emission of a noise that is clearly audible at a point of reception, resulting from a corresponding act listed in Schedule "B".

GENERAL EXEMPTIONS

11. It shall be lawful during an emergency to emit or cause or permit the emission of noise in connection with emergency measures for the immediate health, safety or welfare of the general public or for the preservation or restoration of property, unless such noise is clearly of a longer duration or its nature more disturbing than is necessary for the accomplishment of such emergency purpose.
12. None of the provisions of this by-law shall apply to incidental noise from any sporting, recreational or musical entertainment event authorized by the Municipality or permitted on Municipal-owned lands.
13. The provisions of this by-law shall not apply to:
 - (a) the reasonable use of any apparatus or mechanism for the amplification of the human voice or of music in a public park provided permission has been obtained from the Municipality and the duration is less than four (4) hours;
 - (b) any band or any parade provided permission has been obtained from the Municipality;
 - (c) any vehicle of any emergency service or to any public service while answering a call;
 - (d) the ringing of bells in connections with any church, chapel, meeting house or religious service;
 - (e) the ringing of fire alarms or burglar alarms;
 - (f) noise arising from commercial or industrial uses already existing on the date this by-law is passed;
 - (g) the operation of snow ploughing or snow removal equipment;
 - (h) sounds emitted as a result of municipal refuse and/or recycling clearing operations;
 - (i) any noise generating from or caused by the operation of municipal owned or leased equipment or machinery for municipal operations;
 - (j) sound emitted in connection with the operation of a farm including farm animals, farm equipment or machinery while conducting normal farm practices as that term is defined in the Farming and Food Production Protection Act, 1998 and when conducted within the appropriate zone.

GRANT OF EXEMPTION BY COUNCIL

14. (a) Notwithstanding anything contained in this By-law, any person may make application to the Council of the Corporation of the Municipality of Trent Hills to be granted an exemption from any of the provisions of this By-law for a period of up to six months with respect to any noise prohibited by this By-law. Council, by resolution, may grant or refuse to grant any exemption, or may grant an exemption on terms other than those sought by the applicant. Any exemption granted by Council shall specify the time period and date during which it is effective and may contain such terms and conditions as Council sees fit.
- (b) The application shall be made in writing and shall contain:
 - (i) the name and address of the applicant;
 - (ii) a description of the noise in respect of which the exemption is sought; and
 - (iii) the period of time and date for which the exemption is sought.

OFFENCES AND PENALTIES

- 15. Every person who contravenes any provision of this By-law is guilty of an offence and shall be subject to a penalty in accordance with the Provincial Offences Act.
- 16. Every person who is guilty of an offence under this By-law may, if permitted under the Provincial Offences Act, pay a set fine, and the Chief Justice of the Ontario Court, Provincial Division, shall be requested to establish set fines as set out in Schedule C attached to this By-law.
- 17. All noise by-laws for the former Town of Campbellford, Township of Seymour, Township of Percy and the Village of Hastings are hereby repealed.

By-law 2005 -36 introduced and deemed to be read a first, second and third time, passed and properly signed and sealed this 9th day of May, 2005.



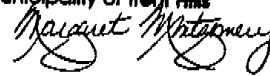
 Hector Macmillan (Mayor)



 Margaret Montgomery (Clerk)

Certified to be a true and correct copy of the original document. Dated at Campbellford, Ontario

this 16th day of MAY., 2005
Margaret Montgomery, Clerk
Municipality of Trent Hills



THE CORPORATION OF THE MUNICIPALITY OF TRENT HILLS
BY-LAW 2005-36
SCHEDULE A

Prohibited Acts and Devices

1. A radio, phonograph, television, public address system, car stereo, sound equipment, loud speaker, musical or sound producing instrument and all similar devices.
2. An auditory signalling device including but not limited to ringing of bells, gongs, sirens, horns, whistles, and the productions or reproduction of any similar sound by electronic means except where authorized or required by law.
3. The detonation of explosive devices except when used in construction or approved by the Municipality.
4. Persistent noise-making by any domestic pet, which is likely to disturb the peace and quiet of any individual.
5. Yelling, shouting, hooting or other similar noise made by a human.
6. The use or operation of any drum, horn, bell, radio or mechanical loudspeaker other instrument or device or apparatus for the purpose of advertising or attracting attention to any performance, show, sale of goods, wares or merchandise.
7. The operation of an engine or motor in, or on, any motor vehicle or item of attached auxiliary equipment for a continuous period exceeding 15 minutes while such vehicle is stationary, unless:
 - (a) the vehicle is in an enclosed structure so as to effectively prevent excessive noise emission;
 - (b) the original equipment manufacturer specifically recommends a longer idling period for normal and efficient operation in which case such recommended period shall not be exceeded;
 - (c) the operation of such engine or motor is essential to a basic function of the equipment including but not limited to, operation of read-mix concrete trucks, lift platforms, refuse compactors, heat exchange systems, compressors or generators;
 - (d) extreme weather conditions justifying the use of heating or refrigerating systems powered by the motor or engine for the safety and welfare of the operator, passengers or animals or the preservation of perishable cargo;
 - (e) prevailing low temperatures make longer idling periods necessary, immediately after starting the motor or engine; or
 - (f) idling is for the purpose of cleaning and flushing the radiator and associated circulation system, seasonal change of antifreeze, cleaning of the fuel system or the like, when such work is performed other than for profit.

THE CORPORATION OF THE MUNICIPALITY OF TRENT HILLS
By-law 2005-36
SCHEDULE B

Prohibitions by Time and Place

1. Construction or operation of any construction equipment whatsoever except in the case of urgent necessity and authorized by the Municipality between 9 p.m. and 6 a.m.
2. The operation or use of any power tool, non-power tool or equipment for domestic purposes other than for snow removal between 9 p.m. and 6 a.m. Monday through Saturday unless a holiday; and between 9 p.m. and 9 a.m. Sundays and holidays.
3. The operation of a commercial car wash with air-drying equipment between 9 p.m. and 6 a.m. Monday through Saturday unless a holiday; and between 9 p.m. to 9 a.m. Sundays and Holidays.
4. The operation of a combustion engine which, is, or is intended for use in, a toy or a model or a replica which has no function other than amusement and which is not a conveyance between 9 p.m. and 6 a.m.
5. The venting, release or pressure relief of air, steam or other gaseous material, product or compounds from any autoclave, boiler, pressure vessel, pipe, valve, machine, device or system between 9 p.m. and 6 a.m.

Part 1 Provincial Offences Act
The Corporation of the Municipality of Trent Hills
SCHEDULE C TO BY-LAW 2005-36

Item	COLUMN 1 Short Form Wording	COLUMN 2 Provision Creating Or Defining Offence	COLUMN 3 Set Fines (including costs)
1.	Generating unnecessary noise in the vicinity of a hospital, nursing home or like facility	Section 7	\$105.00
2.	Generating noise from any commercial use which is audible 15 metres from the property line upon which the use is located	Section 8	\$105.00
3.	Emitting or permitting noise by electronic devices which is audible at a point of reception	Section 9 and Schedule A, section 1	\$105.00
4.	Emitting or permitting noise by auditory signalling device which is audible at a point of reception	Section 9 and Schedule A, section 2	\$105.00
5.	Emitting or permitting noise from unauthorized detonation of explosive devices which is audible at a point of reception	Section 9 and Schedule A, section 3	\$105.00
6.	Permitting noise by any domestic pet likely to disturb the peace and quiet of an individual	Section 9 and Schedule A, section 4	\$105.00
7.	Yelling, shouting or hooting or permitting same which is audible at a point of reception	Section 9 and Schedule A, section 5	\$105.00
8.	Emitting or permitting noise by the operation of an instrument or device for advertising purposes which is audible at a point of reception	Section 9 and Schedule A, section 6	\$105.00
9.	Emitting or permitting noise by the operation of an engine or motor in, or on a motor vehicle or attached auxiliary equipment which is audible at a point of reception for a period exceeding 15 minutes	Section 9 and Schedule A, section 7	\$105.00
10.	Emitting or permitting noise from construction or by operating construction equipment during prohibited hours	Section 10 and Schedule B, section 1	\$105.00
11.	Emitting or permitting noise from operation of tools other than snow removal equipment during prohibited hours	Section 10 and Schedule B, section 2	\$105.00
12.	Emitting or permitting noise from operation of a commercial car wash with air drying equipment during prohibited hours	Section 10 and Schedule B, section 3	\$105.00
13.	Emitting or permitting noise from operation of a combustion engine used for amusement during prohibited hours.	Section 10 and Schedule B, section 4	\$105.00
14.	Emitting or permitting noise from pressure relief of air, steam or other gaseous material during prohibited hours.	Section 10 and Schedule B, section 5	\$105.00

Note: The penalty provision for the offences indicated above is Section 15 of By-law Number 2005-36, a certified copy of which has been filed.

APPENDIX G



Highway Construction Noise Assessment - Roadway Construction

Job No: W08-5292A
 Job Name: Trent River Crossing

2. Compaction of Subgrade

Type	Amt	Act. PWL ¹	Max. SPL ²	Equipment
5	2	111	83	Compactor
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
TOTAL	2	111		

4. Compaction of Base Course

Type	Amt	Act. PWL ¹	Max. SPL ²	Equipment
5	1	108	83	Compactor
11	1	108	80	Graders
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
TOTAL	2	111		

5. Surface Course

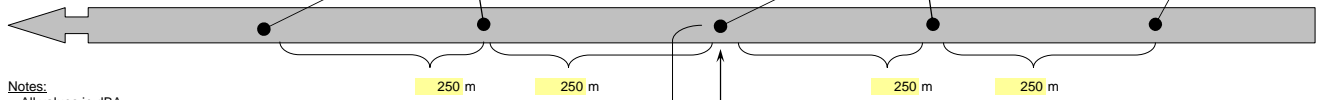
Type	Amt	Act. PWL ¹	Max. SPL ²	Equipment
1	2	110	79	Backhoes / Wheeled Loaders
14	3	108	76	Haul truck (Typical 3-axle)
12	1	105	77	Asphalt Spreader
6	1	98	73	Road Roller
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
TOTAL	7	113		

1. Removal of Overburden

Type	Amt	Act. PWL ¹	Max. SPL ²	Equipment
2	1	109	81	Excavators
14	3	108	76	Haul truck (Typical 3-axle)
3	1	110	82	Bulldozers
4	1	112	84	Scrapers
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
TOTAL	6	116		

3. Base Course

Type	Amt	Act. PWL ¹	Max. SPL ²	Equipment
1	2	110	79	Backhoes / Wheeled Loaders
3	1	110	82	Bulldozers
14	4	110	76	Haul truck (Typical 3-axle)
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
TOTAL	7	114		



- Notes:
- All values in dBA
 - 1. Equivalent Activity PWL, including duty cycle and penalty adjustments
 - 2. Maximum SPL at 15 m produced by the equipment

- Construction Hours
- 7 am start time
 - 10 pm end time
 - 1 h lunch and or dinner breaks

- 14 Total hours
- 14 Daytime hours (7 am to 10 pm) (assumes all breaks in daytime)
- 0 Night-time hours (10pm to 7am)

Predicted Construction Noise Levels

Receptor No.	Description	Distance to Centre-line R (m)	Approximate Screening (dBA)	L _{eq} (1h) ¹	L _{max} ²	L ₁₀ ³	L _{dn} ⁴
NR1	House	20	0	80	80	83	78
NR2	House	30	0	77	77	80	75
NR3	House	53	0	72	72	75	70
NR4	Apartment	32	0	76	76	79	74
NR5	House	34	0	76	76	79	73
NR6	House	74	10	59	59	62	57
NR7	House	17	0	82	82	85	79
NR8	House	19	3	78	78	81	75

- Notes:
- All values are in dBA unless otherwise noted
 - 1. Equivalent Activity PWL for the group (includes duty cycle, penalties and no of vehicle adjustments) + 10 log (2 / (4*3.14* S-R dist²))
 - 2. Higher of L_{eq} (1 h) or (Max of (Max SPL for each group + 20 log (15 / SR- dist))
 - 3. L_{eq} (1 h) + 3 dB, based on typical construction sites, per RCNM



Highway Construction Noise Assessment - Roadway Resurfacing

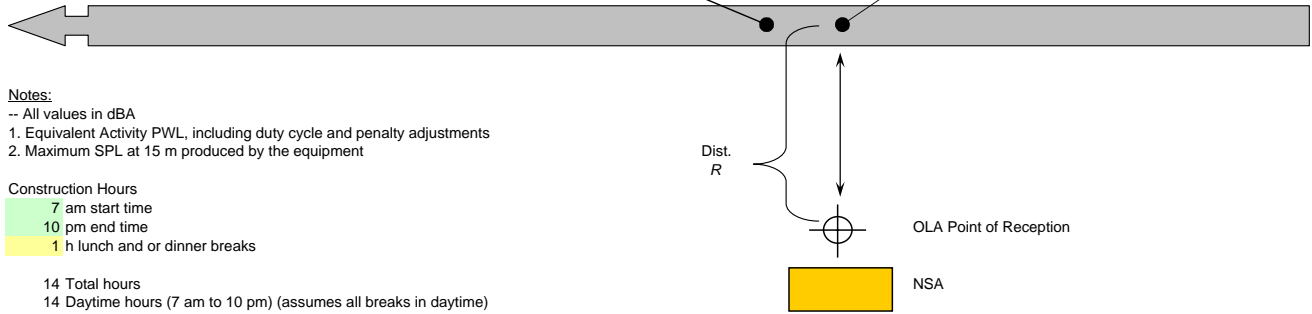
Job No: W08-5292A
 Job Name: Trent River Crossing

1. Removal of Original Surface

Type	Amt	Act. PWL ¹	Max. SPL ²	Equipment
13	1	120	90	Pavement Milling Machines (scarafier)
1	1	107	79	Backhoes / Wheeled Loaders
14	3	108	76	Haul truck (Typical 3-axle)
16	1	120	90	Hoe Ram / Pavement Breaker
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
TOTAL	6	123		

2. Resurfacing

Type	Amt	Act. PWL ¹	Max. SPL ²	Equipment
1	2	110	79	Backhoes / Wheeled Loaders
14	3	108	76	Haul truck (Typical 3-axle)
12	1	105	77	Asphalt Spreader
6	1	98	73	Road Roller
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
TOTAL	7	113		



Notes:

- All values in dBA
- 1. Equivalent Activity PWL, including duty cycle and penalty adjustments
- 2. Maximum SPL at 15 m produced by the equipment

Construction Hours

- 7 am start time
- 10 pm end time
- 1 h lunch and/or dinner breaks

- 14 Total hours
- 14 Daytime hours (7 am to 10 pm) (assumes all breaks in daytime)
- 0 Night-time hours (10pm to 7am)

Predicted Construction Noise Levels - Removal of Original Surface

Receptor No.	Description	Distance to Centre-line R (m)	Approximate Screening (dBA)	L _{eq} (1h) ¹	L _{max} ²	L ₁₀ ³	L _{dn} ⁴
NR1	House	20	0	89	89	92	86
NR2	House	30	0	85	85	88	83
NR3	House	53	0	80	80	83	78
NR4	Apartment	32	0	85	85	88	82
NR5	House	34	0	84	84	87	82
NR6	House	74	10	77	77	80	75
NR7	House	17	0	90	90	93	88
NR8	House	19	3	89	89	92	87

Predicted Construction Noise Levels - Resurfacing

Receptor No.	Description	Distance to Centre-line R (m)	Approximate Screening	L _{eq} (1h) ¹	L _{max} ²	L ₁₀ ³	L _{dn} ⁴
NR1	House	20	0	79	79	82	77
NR2	House	30	0	75	84	78	73
NR3	House	53	0	71	79	74	68
NR4	Apartment	32	0	75	83	78	73
NR5	House	34	0	74	83	77	72
NR6	House	74	10	68	76	71	65
NR7	House	17	0	80	89	83	78
NR8	House	19	3	79	88	82	77
...							
...							
...							
...							

Notes:

- All values are in dBA unless otherwise noted
- 1. Equivalent Activity PWL for the group (includes duty cycle, penalties and no of vehicle adjustments) + 10 log (2 / (4*3.14* S-R dist²))
- 2. Higher of L_{eq} (1 h) or (Max of (Max SPL for each group + 20 log (15 / SR - dist))
- 3. L_{eq} (1 h) + 3 dB, based on typical construction sites, per RCNM
- 4. Based on L_{eq} (1 h) values and construction hours, includes a 10 dB penalty for night-time operations (10 pm to 7 am)



Highway Construction Noise Assessment - Bridges and Embankments

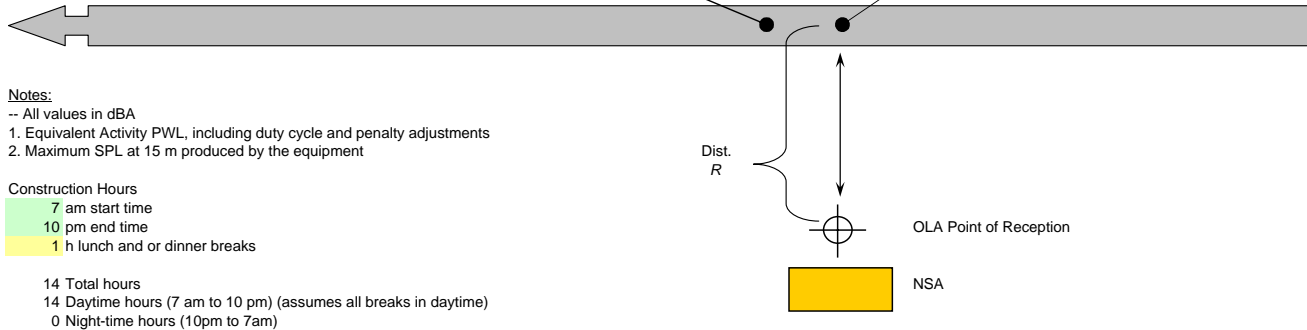
Job No: W08-5292A
 Job Name: Trent River Crossing

1. Construction of Embankments

Type	Amt	Act. PWL ¹	Max. SPL ²	Equipment
1	1	107	79	Backhoes / Wheeled Loaders
14	3	108	76	Haul truck (Typical 3-axle)
2	1	109	81	Excavators
3	1	110	82	Bulldozers
4	1	112	84	Scrapers
5	1	108	83	Compactor
		0	0	
		0	0	
TOTAL	8	117		

2. Bridge Construction

Type	Amt	Act. PWL ¹	Max. SPL ²	Equipment
1	1	107	79	Backhoes / Wheeled Loaders
8	1	104	76	Boom (Hoist) Trucks
14	3	108	76	Haul truck (Typical 3-axle)
18	1	127	97	Pile Driver - Diesel Hammer
7	1	105	81	Cranes
9	1	107	79	Concrete trucks
10	1	106	81	Concrete pumps
		0	0	
TOTAL	9	127		



Notes:

- All values in dBA
- 1. Equivalent Activity PWL, including duty cycle and penalty adjustments
- 2. Maximum SPL at 15 m produced by the equipment

Construction Hours

- 7 am start time
- 10 pm end time
- 1 h lunch and/or dinner breaks

- 14 Total hours
- 14 Daytime hours (7 am to 10 pm) (assumes all breaks in daytime)
- 0 Night-time hours (10pm to 7am)

Predicted Construction Noise Levels - Construction of Embankments

Receptor No.	Description	Distance to Centre-line R (m)	Approximate Screening (dBA)	L _{eq} (1h) ¹	L _{max} ²	L ₁₀ ³	L _{dn} ⁴
NR1	House	20	0	83	83	86	80
NR2	House	30	0	79	91	82	77
NR3	House	53	0	74	86	77	72
NR4	Apartment	32	0	79	90	82	76
NR5	House	34	0	78	90	81	76
NR6	House	74	10	71	83	74	69
NR7	House	17	0	84	96	87	82
NR8	House	19	3	83	95	86	81

Predicted Construction Noise Levels - Bridge Construction

Receptor No.	Description	Distance to Centre-line R (m)	Approximate Screening	L _{eq} (1h) ¹	L _{max} ²	L ₁₀ ³	L _{dn} ⁴
NR1	House	20	0	93	95	96	90
NR2	House	30	0	89	89	92	87
NR3	House	53	0	84	84	87	82
NR4	Apartment	32	0	89	89	92	86
NR5	House	34	0	88	88	91	86
NR6	House	74	10	81	81	84	79
NR7	House	17	0	94	94	97	92
NR8	House	19	3	93	93	96	91
...							
...							
...							
...							

Notes:

- All values are in dBA unless otherwise noted
- 1. Equivalent Activity PWL for the group (includes duty cycle, penalties and no of vehicle adjustments) + 10 log (2 / (4*3.14* S-R dist²))
- 2. Higher of L_{eq} (1 h) or (Max of (Max SPL for each group + 20 log (15 / SR- dist))
- 3. L_{eq} (1 h) + 3 dB, based on typical construction sites, per RCNM
- 4. Based on L_{eq} (1 h) values and construction hours, includes a 10 dB penalty for night-time operations (10 pm to 7 am)

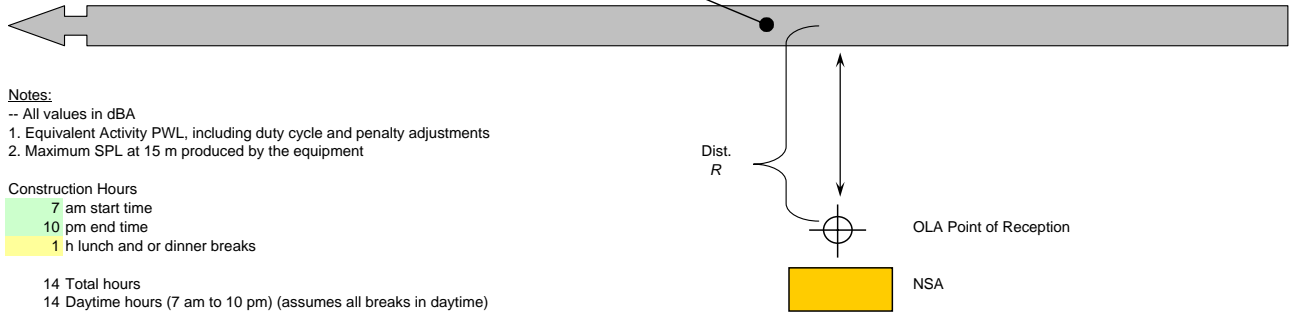


Highway Construction Noise Assessment - Rock Drilling

Job No: W08-5292A
 Job Name: Trent River Crossing

1. Rock Drilling

Type	Amt	Act. PWL ¹	Max. SPL ²	Equipment
25	1	119	89	Rock Drill - Average
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
		0	0	
TOTAL	1	119		



Notes:

-- All values in dBA

1. Equivalent Activity PWL, including duty cycle and penalty adjustments
2. Maximum SPL at 15 m produced by the equipment

Construction Hours

- 7 am start time
- 10 pm end time
- 1 h lunch and/or dinner breaks

14 Total hours

14 Daytime hours (7 am to 10 pm) (assumes all breaks in daytime)

0 Night-time hours (10pm to 7am)

Predicted Construction Noise Levels - Rock drilling

Receptor No.	Description	Distance to Centre-line R (m)	Approximate Screening (dBA)	$L_{eq}(1h)$ ^{1.}	L_{max} ^{2.}	L_{10} ^{3.}	L_{dn} ^{4.}
NR1	House	20	0	85	87	88	82
NR2	House	30	0	81	81	84	79
NR3	House	53	0	76	76	79	74
NR4	Apartment	32	0	80	80	83	78
NR5	House	34	0	80	80	83	78
NR6	House	74	10	73	73	76	71
NR7	House	17	0	86	86	89	84
NR8	House	19	3	85	85	88	83

Notes:

- All values are in dBA unless otherwise noted

1. Equivalent Activity PWL for the group (includes duty cycle, penalties and no of vehicle adjustments) + $10 \log(2 / (4 * 3.14 * S * R \text{ dist}^2))$
2. Higher of $L_{eq}(1h)$ or (Max of (Max SPL for each group + $20 \log(15 / SR \cdot \text{dist})$)
3. $L_{eq}(1h) + 3 \text{ dB}$, based on typical construction sites, per RCNM
4. Based on $L_{eq}(1h)$ values and construction hours, includes a 10 dB penalty for night-time operations (10 pm to 7 am)