NOISE STUDY - Project: 18315.00

Colborne Street W. Noise Study
Brantford, ON

Prepared for:

The City of Brantford
P.O. Box 818
Brantford, ON N3T 5R7

Attn: Robert Smith

Prepared by:

[Signature]
Nicholas Sylvestre-Williams, P.Eng.

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Executive Summary

Aercoustics Engineering Limited was retained by The City of Brantford to complete a noise study of current noise levels in the study area at the intersection of Colborne Street West and Oakhill Drive in Brantford, Ontario. The scope of the noise study includes an acoustical investigation into the background noise levels, above average noise disturbances, and sound sources in the study area. The purpose of the noise study is to provide The City of Brantford with information that can be used to help them respond to noise-related complaints from the residential community to the north of Colborne Street West in the study area and to gain a deeper understanding of noise sources in the study area.

Multiple long-term sound monitors were deployed near the residential communities on Colborne Street West. The primary purpose of the monitor locations was to establish sound levels in all areas of the study area from possible different sources.

The results from noise monitoring indicate that the dominant noise source in the area is traffic noise from Colborne Street West. Measured background noise levels agree with background noise levels calculated from measured traffic volumes in the study area.

Short term noise disturbances significantly higher than background level occur and were investigated and determined to be primarily from loud vehicles or from emergency vehicle sirens travelling on Colborne Street West.

Existing levels were compared with potentially relevant guidelines (as applicable) to determine further recommendations to the City. Based on the results of the monitoring, the measured noise is at levels Aercoustics recommends investigating mitigation.

A computer model was developed to assist in considering various mitigation models. Initially, road-side barriers are the suggested mitigation recommendation. The model was used to demonstrate the potential noise reduction for various barrier heights.
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1 Introduction

Aercoustics Engineering Limited (Aercoustics) was retained by The City of Brantford to complete a noise study of current noise levels in the study area at the intersection of Colborne Street West and Oakhill Drive in Brantford, Ontario.

The scope of the noise study includes an acoustical investigation into the background noise levels, above average noise disturbances, and sound sources in the study area. The purpose of the noise study is to provide The City of Brantford with information that can be used to help them respond to noise-related complaints from the residential community to the north of Colborne Street West in the study area and to gain a deeper understanding of noise sources in the study area. The study also concludes with suggestions and recommendations to mitigate the noise experienced by the impacted houses.

2 Background Theory

To provide context for the report, this section provides a background on the technical acoustical terms used throughout the report and on the human perception of sound.

2.1 Descriptors

“A” Weighting: The frequency weighting characteristic intended to approximate the sensitivity of the typical human ear to different frequencies (pitches) of sound.

A-Weighted Sound Pressure Level (dBA): The sound pressure level modified by the application of the A-weighting. It is measured in decibels, A-weighted, and denoted dBA.

Decibel (dB): stands for decibel and is a unit of sound measurement. This unit measures the amplitude of a sound.

Frequency (Hz): the number of times in one second that a wave oscillates (or the number of periods). For sound, the frequency range has been analysed from 20 Hz to 20,000 Hz, which corresponds to the typical audible range of the human ear. This matters as humans perceive low-frequency sound differently from high-frequency.

Insertion Loss (dB): The reduction in sound pressure at the receiver due to a device (barrier) being placed between the source and receiver.

Level: In acoustics, the logarithm of the ratio of a kind of quantity to a reference quantity of the same kind.

$L_{eq}$ (dB or dBA): The $L_{eq}$ is a single number, continuous energy-equivalent sound pressure level during a time period. $L_{eq}$ is often described as the average noise level during a noise measurement, which although not technically correct, is the easiest way to think of $L_{eq}$. The $L_{Aeq}$ would be the A-weighted sound level.
**L\text{max/min} (dB or dBA):** The \( L_{\text{max}} \) and \( L_{\min} \) are the maximum and minimum sound level, respectively, measured over a time-period. While this information is useful, a single (non-related) loud incident will skew measurements. As such, it’s typical to look at the statistical data instead.

**\( L_{10} \) (dB or dBA):** The \( L_{10} \) parameter is based on a statistical analysis of all sound measured within a time period and indicates that 10% of the sound measured was either at or above the specified level. E.g. a \( L_{10} \) level of 79 dBA means that 10% of the sound was over 79 dBA and 90% of the sound was below 79 dBA, over the period measured.

**\( L_{90} \) (dB or dBA):** The \( L_{90} \) parameter is based on a statistical analysis of all sound measured within a time period and indicates that 90% of the sound measured was either at or above the specified level. E.g. a \( L_{90} \) level of 45 dBA means that 90% of the sound was over 45 dBA and 10% of the sound was below 45 dBA, over the period measured.

**Loudness:** The attribute of auditory sensation in terms of which sounds can be ordered on a scale extending from quiet to loud.

### 2.2 \( L_{\text{eq}} \) – Energy Average Sound Level

As defined, the \( L_{\text{eq}} \) is a single number, continuous energy-equivalent sound pressure level during a time period of sounds and frequencies. Sounds are typically varying continuously in time and duration (e.g. cars pass by, a dog barks, someone talks). To put context to these values, the energy average is used to compare unequal-in-time sounds.

The benefit of this approach is a clear comparison i.e. an apples-to-apples comparison. The downside of this approach is that short-duration loud sounds e.g. a loud vehicle speeding by for a few seconds, would be averaged out if the sound were considered over a whole hour.

Most acoustic metrics provide noise limits in \( L_{\text{eq}} \), with most being a 1-hour average, an 8-hour average or a 16-hour average.

### 2.3 Perception of Sound

Human perception of sound is complicated. The human ear is sensitive to a wide range of sounds and frequencies. Our response to changes in sound levels also varies depending on the amplitude of the sound as well as our sensitivity to the offending noise. E.g. loud music may be considered non-intrusive while the same sound level coming from a transport truck could be loud and intrusive. Perception can also be affected by the background (or ambient) sound level people are exposed to.

### 2.3.1 Change in Sound Level

In general, the following relationship between a quantitative change in sound pressure level and qualitative rating of the increase/decrease perceived is shown in Table 1 below, for frequencies in the mid-band (i.e. typically between 200Hz – 5000H)
Table 1 Relationship Between Change in Sound Level & Human Perception

<table>
<thead>
<tr>
<th>Sound Level Change (dBA)</th>
<th>Qualitative Rating of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>Insignificant</td>
</tr>
<tr>
<td>3-5</td>
<td>Noticeable Change</td>
</tr>
<tr>
<td>5-9</td>
<td>Significant Change</td>
</tr>
<tr>
<td>10+</td>
<td>Very Significant Change</td>
</tr>
</tbody>
</table>

2.3.2 Loudness

Objective measurements of the sound pressure level are often confused with “loudness”. Loudness is a subjective term describing the strength of the ear’s perception of a sound.

Table 2 below shows the relationship between the change in sound pressure level, change in acoustic energy, and loudness. It is generally accepted that a change in sound level of 10 dB is perceived as a doubling of loudness¹.

Table 2 Loudness Relationship with Change in Sound Pressure Level

<table>
<thead>
<tr>
<th>Change in Sound Level (dBA)</th>
<th>Acoustic Sound Energy</th>
<th>Perceived Loudness</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2x (Double)</td>
<td>1.23x</td>
</tr>
<tr>
<td>6</td>
<td>4x</td>
<td>1.52x</td>
</tr>
<tr>
<td>10</td>
<td>10x</td>
<td>2x (Double)</td>
</tr>
<tr>
<td>20</td>
<td>100x</td>
<td>4x</td>
</tr>
</tbody>
</table>

¹ The perception of change in loudness is frequency dependent.
3 Monitoring Methodology

3.1 Objectives
The objective of sound monitoring was to determine the study area’s background sound levels, the level and frequency of above average noise disturbances, and to determine typical sound source(s).

A total of four (4) sound monitors were deployed - three (3) along the north side of Colborne Street West and one (1) in the vacant lot west of and adjacent to the Tim Hortons restaurant. See Figure 1 below for monitor locations.

![Figure 1 Study Area and Sound Monitor Locations](image)

3.2 Noise Monitoring Timeline
The noise monitoring term began on August 22, 2018 and the monitors were retrieved on September 6, 2018. A total of ten (10) weekdays, four (4) weekends and 1 long-weekend were captured during the monitoring period.

3.3 Noise Monitor Types
Two (2) different types of sound level monitors were deployed:

- The first type of monitor recorded audio files as well as average sound levels in 1-minute intervals for the duration of the measurement. The 1-minute time resolution was to be able to capture short-duration events that may occur within the study area. This type of monitor was deployed at Monitor location #2.
• The second type of noise monitor recorded average sound levels in 10-minute intervals for the duration of the measurement term. This type of monitor was deployed at Monitor #1, #3, and #4 locations.

Table 3 provides a summary of monitor locations and recorded data type.

Table 3: Equipment Details

<table>
<thead>
<tr>
<th>Monitor Type</th>
<th>Location</th>
<th>Recorded Data Type(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>Sound Monitor 2</td>
<td><strong>Audio Files</strong>: Saved in 1-minute intervals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-minute $L_{eq}$: The energy-average sound over a 1-minute period, recorded every 1-minute</td>
</tr>
<tr>
<td>Type 2</td>
<td>Sound Monitor 1</td>
<td>10-minute $L_{eq}$: The energy-average sound over a 10-minute period, recorded every 10-minutes</td>
</tr>
<tr>
<td></td>
<td>Sound Monitor 3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sound Monitor 4</td>
<td></td>
</tr>
</tbody>
</table>

3.3.1 Additional information on Monitors
The data from noise monitor #4 was corrupted due to tampering from an unknown person. The microphone cable was found to be broken upon retrieval by Aercoastics technicians and had to be replaced. Data for the first two (2) days was not captured.

3.3.2 Time-Lapse Video Monitoring
A video monitor was deployed to record time-lapse video of the Time Horton’s parking lot in the study area for the duration of the measurement period using a GoPro camera. The purpose of recording time-lapse video was to determine the cause of noise sources in the area. Unfortunately, high outside temperatures during the measurement term and the camera’s protective casing caused the camera to overheat and stop recording. The 8 hours of footage that was recorded did not indicate a noise source in the area beyond traffic sources, and the data was not used further in the report.

3.4 Traffic Data
The City carried out traffic counts for the intersection of Colborne St. W. and Oakhill Dr. This data was completed for the date of August 22, 2018. The traffic counts considered the types of vehicles, general size (car, medium truck, large truck, etc.) and turning counts. Data was broken down into 15-minute intervals.
4 Guidelines

This study considered the impact of noise on existing residential developments. There are no explicit guides or regulations for existing residential developments being impacted from existing roadways.

There are several Ontario relevant guidelines that provide context to expected sound levels at receptors. There are also international guidelines by the World Health Organization (WHO) on noise.

4.1 World Health Organization (WHO) Guidelines

The two (2) WHO guidelines Aercoustics references are:

- World Health Organization – *Guidelines for community noise*, dated 1999; and

The 2009 WHO guideline is a very comprehensive document listing the degree of noise exposure in various parts of Europe. There is also detailed information the health impacts of noise. This information is well beyond the scope of this project.

The more recent WHO guideline established health-protective guidelines of 55 dBA outdoors ($L_{eq}$ 16 hours) for daytime and evening exposures and night-noise exposure guidelines of 40 dBA outdoors ($L_{eq}$ 8 hours). Given that 40 dBA is often difficult to achieve in urban centres, the WHO indicated an interim nighttime limit of 55 dBA.

4.2 Ontario Ministry Guidelines

The two (2) Ministry guidelines Aercoustics references are:

- Ministry of Transportation (MTO) – *Environmental Guide for Noise*, dated October 2006 [updated July 2008]; and

4.2.1 Environmental Guide for Noise - MTO

The “Environmental Guide for Noise” (Noise Guide) was developed to provide guidance for MTO personnel and consultants in the analysis of highway noise and its effects. The primary purpose of the guide is to provide the requirements for noise assessment and mitigation relating to the construction of new or the expansion of existing Provincial Highways.

It is important to note that the MTO noise guide is applicable to new or expanding highways and roadways. As such, the limits stated in the guide are not directly applicable in this study, however it has been included to provide context to the results of the noise monitoring. Table 4 below is summarized from Table 2.1 of the MTO guide and contains
a summary of the typical mitigation efforts that would be required for a new or expanded roadway, based on sound levels.

Table 4: Mitigation Efforts required for the Projected Noise level

<table>
<thead>
<tr>
<th>Change in Noise level above Ambient</th>
<th>Mitigation effort Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5 dBA change and &lt; 65 dBA</td>
<td>None</td>
</tr>
<tr>
<td>≥ 5 dBA change OR ≥ 65 dBA</td>
<td>- Investigate noise control measures</td>
</tr>
<tr>
<td></td>
<td>- Introduce noise control measures [...] and mitigate to ambient if technically, economically and administratively feasible.</td>
</tr>
<tr>
<td></td>
<td>- Noise control measures, where introduced, should achieve a minimum of 5 dBA attenuation, over first row of receivers.</td>
</tr>
</tbody>
</table>

As can be seen in the table above, if there were a new roadway being built or expanded, an assessment would first be carried out to determine if the sound level would be predicted to exceed 65 dBA. If the level were exceeded, then noise controls would need to be investigated if feasible and economical.

4.2.2 Environmental Noise Guideline - MECP

The “Environmental Noise Guideline” (NPC-300) was developed by the MECP to serve four purposes, summarized as follows:

1. to provide sound level limits stationary sources, such as industrial and commercial establishments and auxiliary transportation facilities;
2. to provide advice, sound level limits and guidance that may be used when land use planning decisions are made under the Planning Act;
3. To provide sound level limits that may be incorporated into noise control by-laws; and
4. To provide sound level limits that may be applied under the provisions of the Aggregate Resources Act, Reference.

The relevant purpose of the guideline, for this study, is expanded from point #2 above. The guide further states:

“This guidance is for land use planning authorities (such as municipalities, planning boards and other ministries), developers and consultants. It is intended to minimize the potential conflict between proposed noise sensitive land uses and sources of noise emissions and is intended to be supportive of the Provincial Policy Statement. Specifically, it may be applied in planning decisions concerning noise sensitive land uses that are proposed adjacent
to facilities such as, but not limited to, airports, road and rail transportation corridors, industrial facilities, railway yards, aggregate facilities, major commercial facilities, water and sewage treatment facilities and waste sites. In order to achieve effective and economic planning, the principles described should be implemented in a proactive manner in the earliest stages of the land use planning process.”

It is important to note that the MECP guide as a resource for municipalities and would only be applicable to new developments that are adjacent to existing roadways. As such, the limits stated in the guide are not directly applicable in this study, however it has been included to provide context to the results of the noise monitoring and calculations. Table 5 and Table 9 below is summarized from Table C-1 and Section C7.1.1 of the MECP guide, respectively.

Table 5: Sound Level limit for Outdoor Living Areas (Road)

<table>
<thead>
<tr>
<th>Time Period</th>
<th>( L_{eq} (16) ) (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-hour, 07:00 – 23:00</td>
<td>55</td>
</tr>
</tbody>
</table>

Further, Section C7.1.1 provides details on potential mitigation and could be summarized as follows:

Table 6: Summary of Mitigation due to Road noise

<table>
<thead>
<tr>
<th>Change in Noise level above Ambient</th>
<th>Mitigation effort Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \leq 55 ) dBA</td>
<td>None</td>
</tr>
<tr>
<td>( &gt; 55 ) dBA and ( \leq 60 ) dBA</td>
<td>- Noise control measures may be applied to reduce the sound level to 55 dBA.</td>
</tr>
<tr>
<td></td>
<td>- If measures are not provided, buyers or tenants should be informed of potential noise problems.</td>
</tr>
<tr>
<td>( &gt; 60 ) dBA</td>
<td>- Noise control measures should be implemented to reduce the level to 55 dBA</td>
</tr>
<tr>
<td></td>
<td>- Only in cases where the noise control measures are not feasible for technical, economic or administrative reasons would an excess above the limit (55 dBA) be acceptable.</td>
</tr>
</tbody>
</table>

4.2.3 Stationary Noise

As there are a number of stationary noise sources in proximity to the houses along Colborne St., the MECP noise guide also provides recommended limits for these businesses. These noise limits are applicable to the commercial facilities and this area
can be considered a Class 1 area with respect to the MECP limits. Table 7 and Table 8 below are summarized from Table B-1 and Table B-2 of the MECP guide, respectively.

Table 7: Minimum Outdoor Sound Levels Limits from Stationary Sources

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Sound Level Limits (1-hr $L_{eq}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>07:00 – 19:00</td>
<td>50</td>
</tr>
<tr>
<td>19:00 – 23:00</td>
<td>50</td>
</tr>
</tbody>
</table>

Table 8: Minimum Plane of Window Sound Levels Limits from Stationary Sources

<table>
<thead>
<tr>
<th>Time of Day</th>
<th>Sound Level Limits (1-hr $L_{eq}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>07:00 – 19:00</td>
<td>50</td>
</tr>
<tr>
<td>19:00 – 23:00</td>
<td>50</td>
</tr>
<tr>
<td>23:00 – 07:00</td>
<td>45</td>
</tr>
</tbody>
</table>

The MECP noise guide does state: “For sound from a stationary source […] the sound level limit at a point of reception […] is the higher of the applicable exclusion limit value given in Table B-1 or Table B-2, or the background sound level for that point of reception.” Based on this, the road noise establishes the general ambient sound level at the houses.

4.3 Reasonable Sound Level Criteria

The WHO guideline recommends not exceeding 55 dBA for urban areas. The Ministry guidelines, while not directly applicable to the situation in this study (as this study considers the impact of noise on existing residential developments from existing roads), recommends either 60 dBA or 65 dBA (depending on the document referenced).
5 Data Analysis

During the measurement term, depending on the monitor type, acoustic data was logged in 1-minute or 10-minute average sound level intervals. Data was captured at this high resolution in order to capture short-duration events. Raw signal recordings were also stored for listening and post-processing.

5.1 Equivalent Continuous Sound Levels

Establishing the equivalent sound energy average ($L_{eq}$) over different time periods presents the data with different levels of smoothness for ease of visual understanding (however, it does remove the short-duration loud events).

For each monitor, the total equivalent sound energy averaged over a rolling 1-hour and 10-minute time-period was calculated. This data calculation is illustrated in the Figure 2.

5.2 Background Sound Level from Monitor Data

To obtain background noise levels loud transient noise disturbances, or “noise spikes” were removed. An example of cleaned data from Monitor #2 is shown for August 24th in Figure 2.

A summary of all cleaned data and removed noise data is included in Appendix B.

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2 Data was removed using a rolling median filter. The filter calculates the median of the previous 1-hour of sound data and replaces noise levels that are 12 dB or greater than the median with the median value.
Figure 2 1-Hour, 10-Min, and 1-Min Equivalent Continuous Sound Energy Examples
Figure 3 Example of Sound Data with Transient Noise Disturbances Removed
5.3 Background Sound Level from Traffic Count

Traffic counts for the intersection of Colborne St. W. and Oakhill Dr. were completed on August 22, 2018. The traffic count results and the Ministry of Transportation of Ontario’s STAMSON software were used to calculate the background sound levels caused by traffic noise at each monitor location for each hour of the day.

Table 9 Calculated Noise Monitor Sound Levels from Colborne St. W. Traffic

<table>
<thead>
<tr>
<th>Time</th>
<th>Sound Level (dBA) Monitor #1</th>
<th>Sound Level (dBA) Monitor #2</th>
<th>Sound Level (dBA) Monitor #3</th>
<th>Sound Level (dBA) Monitor #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>07:30 - 08:30</td>
<td>66</td>
<td>66</td>
<td>66</td>
<td>63</td>
</tr>
<tr>
<td>08:30 - 09:30</td>
<td>68</td>
<td>68</td>
<td>68</td>
<td>65</td>
</tr>
<tr>
<td>09:30 - 10:30</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>63</td>
</tr>
<tr>
<td>11:30 - 12:30</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>62</td>
</tr>
<tr>
<td>12:30 - 13:30</td>
<td>63</td>
<td>63</td>
<td>63</td>
<td>63</td>
</tr>
<tr>
<td>15:00 - 16:00</td>
<td>66</td>
<td>66</td>
<td>66</td>
<td>63</td>
</tr>
<tr>
<td>16:00 - 17:00</td>
<td>66</td>
<td>66</td>
<td>66</td>
<td>64</td>
</tr>
<tr>
<td>17:00 - 18:00</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>62</td>
</tr>
</tbody>
</table>

A summary of detailed STAMSON noise level calculations are included in Appendix C.

5.4 Computer Simulation

With the measured data and traffic counts, a separate computer simulation was developed in order to assist in the predictions of any mitigation that may be considered. Data from the measured road noise (Section 5.2) as well as the calculations of road noise based on vehicular volume (Section 5.3) was used to calibrate a virtual "road" within the software. Once the model was calibrated and validated against the measured data, various mitigation strategies could be developed and considered.
6 Noise Measurement Results

The results from the measured data and the calculated background noise levels in the study area were compared. Instances of transient noise disturbances above the background level are examined for frequency and type.

6.1 Background Noise Levels from Monitor Data

Human behaviour patterns and human produced noise levels are typically different on weekends, weekdays, and holidays\(^3\). Therefore, to examine background sound levels in further detail, the noise data was divided into weekends, weekdays, and holiday categories.

A sample of the background sound levels from Monitor #2 data is shown in Figure 4 below. There are day-to-day variations, however all the data follows this general trend. Some initial observations and trends are apparent:

- Weekday daytime noise levels reach 70 dBA at approximately 7am and stay in that range until approximately 5pm;
- Weekend daytime noise levels reach 65 dBA at approximately 9am and stay in that range until approximately 11pm;
- Noise levels drop to a minimum of 55 dBA in the night time hours;
- Nighttime noise levels are lowest between 4:00-5:00am and increase more quickly to peak levels on weekdays than on weekends and holidays, presumably due to morning commuter traffic and business-related traffic;
- Weekend nighttime levels are marginally higher than the same time period during the weekdays;
- The only time periods the sound level is below 65 dBA occur between midnight and 6am on weekdays, and 9am on weekends, respectively; and
- The holiday sound levels generally follow the weekend sound levels.

6.2 Calculated Road Noise

In Figure 4, incorporating the calculated background sound levels (STAMSON) into the measured background sound levels shows generally good agreement (within 3 dB) between the data sets. This would indicate that the background sound levels in the study area are primarily generated from traffic noise.

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\(^3\) The statutory holiday of Labour Day fell on September 3\(^{rd}\), 2018.
Figure 4 Sample Background Sound Level for Weekend, Weekday & Holiday
6.3 Transient Noise Disturbances above Background Levels
To determine the cause of above average noise in the area, a selection of the loudest noise disturbances over the two-week monitoring program were listened to and categorized by the type of noise disturbance. The distribution by noise disturbance type is shown in Figure 5, below.

Figure 5 Transient Noise Disturbance, by Subjective Type
Almost 65% of the noise disturbances are caused by loud vehicles passing by, with another approximately 16% being emergency vehicles with sirens passing by. These vehicles are assumed to be travelling on Colborne St. W. as Oakhill Drive would not generate the same pass-by noise type. Some noise disturbances were caused by music or people’s voices; however, these were quite uncommon and generally not loud.

The individual noise disturbance levels range from 73 dBA to 95 dBA. A breakdown of the sound levels of various disturbances is shown below in Figure 6. Referring to Table 1,

- sound levels 5 dB above the background (i.e. above approximately 75 dBA) will be noticeable;
- sound levels 10 dB above the background (i.e. above approximately around 80 dBA) will be significant; and
- sound levels in excess of 80 dBA will be considered by residents to be very significant.

- The median sound level is 79 dBA and mode is 78 dBA.

![Figure 6 Noise Disturbance Levels by Count](image)

Figure 6 Noise Disturbance Levels by Count

---

4 Blank values mean no incidents occurred at this level.
Figure 7 shows the data sorted by date and shows no distinct trend. It would appear that weekends generally produce more noise disturbances than holidays or weekdays, however this is not fully corroborated based on the Sept 1 & Sept 2 weekend. Further, there may have been an unknown event occurring in the area on Sept 5th, 2018 to cause the abnormally high number of noise disturbances (loud vehicle pass-bys) on that day.

Figure 7 Transient Noise Disturbances by Date
Figure 8 shows the data sorted by time of day and shows that most of the noise disturbances are occurring during the evening hours or early hours of the night. Lunchtime and mid-afternoon also appear to produce generally more noise disturbances than a typical hour.

Figure 8 Noise Disturbances by Time of Day
7 Recommendations

The results from the monitoring data in the study area are above the guidelines stated in Section 4. The guidelines (WHO & Ministry), while not a limit, do suggest that mitigation should be investigated for the study area.

7.1 Computer Model

To assess the feasibility of mitigation, Aeroustics developed a computer model of the subject area. The impact calculations were performed using the DataKustik CadnaA environmental noise prediction software. The calculations are based on established prediction methods: ISO 9613-2. The impact predictions take into account geometrical attenuation, barrier attenuation, atmospheric attenuation and ground attenuation. The computer model allows for the comparison of various mitigation layouts. Figure 9 shows an aerial view of the computer model.

The acoustic model prepared for this report utilizes the following information:

- Aerial layout of subject area;
- Topographic data;
- Ground Attenuation; and
- Additional Model Details.
Figure 9: Aerial of Subject Site

Colborne St. (in orange)
Paved road (in green)
Once the model was developed and calibrated, the impact at receptors along Colborne St. W. was predicted at a two (2) heights:

- Ground height at 1.5m, typical of a person standing outside in their back-yard; and
- Second floor height at 4.5m, typical of a 2nd storey bedroom window.

Figure 10 shows the predicted impact from the road traffic.

Table 10: Calculated impact from Road Noise (Computer Model)

<table>
<thead>
<tr>
<th>Location</th>
<th>Sound Level at 1.5m (typical backyard)</th>
<th>Sound Level at 4.5m (typical 2nd storey window)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East of Oakhill Dr. North of Colborne</td>
<td>66 dBA</td>
<td>68 dBA</td>
</tr>
<tr>
<td>West of Oakhill Dr. North of Colborne</td>
<td>66 dBA</td>
<td>68 dBA</td>
</tr>
<tr>
<td>West of Oakhill Dr. South of Colborne</td>
<td>66 dBA</td>
<td>68 dBA</td>
</tr>
</tbody>
</table>
Figure 10: Impact from Traffic Noise (shown in boxes, in dBA)
For the study area, the most feasible mitigation strategy is a road barrier. Since the road and the houses currently exist, little can be done to the source of the noise (road or vehicles) or to the houses. Barriers, which block line of sight to the road, offer the most practical mitigation strategy, provided it can be feasibly installed.

7.2 Barrier Layout
Barrier heights have a practical limit and as such, receptors having a line of sight to the source (above the barrier) will not experience any reduction in sound. Receptor heights above 4.5m (more than 2-storey buildings) were not assessed as the expected change in sound level will not be very significant.

The potential locations for barriers are indicated on Figure 11, as Barrier #1, Barrier #2 and Barrier #3.

Barrier #1 – North of Colborne St, west of Oakhill Dr., approximately 250 m;
Barrier #2 – North of Colborne St., east of Oakhill Dr., approximately 415 m; and
Barrier #3 – South of Colborne St., east of Oakville Dr., beyond commercial development, approximately 80 m.

Acoustic Barriers may consist of an acoustic fence, an earth berm, or a combination of an acoustic fence and earth berm.

Barriers can also be absorptive or reflective. When placing a barrier there may be the inadvertent effect of reflecting noise to other receptors, thus increasing the noise. As such, care should be taken to ensure that this scenario does not occur. Based on the layout shown in Figure 11, it is recommended that Barrier #3 is absorptive, and the remaining barriers are reflective. There may be consideration for portions of Barrier #2 to be absorptive (areas in proximity to Barrier #3).
Figure 11: Aerial showing Barrier Locations (in blue)
7.3 Barrier Effectiveness

To determine the barrier effectiveness, the reduction in sound with a barrier is compared without a barrier and changes presented in the following tables below. Four (4) scenarios were evaluated:

- Scenario 1 – Barrier height of 2m;
- Scenario 2 – Barrier height of 3m; and
- Scenario 3 – Barrier height of 4.5m.

The results of each scenario are presented in Table 11 below. Results are also presented in Figure 12 and Figure 13 showing a representative plot of the scenario of a 2m and 4.5m tall barrier, for receptor height of 4.5m.

Table 11: Predicted change in sound level, due to barrier

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Predicted reduction in sound (height of 1.5m)</th>
<th>Predicted reduction in sound (at height of 4.5m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barrier height: 2m</td>
<td>6 to 7 dB</td>
<td>3 to 4 dB</td>
</tr>
<tr>
<td>Barrier height: 3m</td>
<td>7 to 8 dB</td>
<td>5 to 7 dB</td>
</tr>
<tr>
<td>Barrier height: 4.5m</td>
<td>8 to 10 dB</td>
<td>7 to 10 dB</td>
</tr>
</tbody>
</table>

- As soon as the line of sight between the source and receptor is broken, there is a reduction in sound of at least 5 dBA for the outdoor height and approximately 3 dBA for the 2nd storey windows. This can be considered perceptible (but just barely).
- At a barrier height of 3m, the reduction is at a level that is noticeable.
- At a barrier height of 4.5m, the reduction is within the noticeable to significant range.

This demonstrates that a barrier’s effectiveness is, qualitatively, noticeable to significant when the road is shielded, per Table 1.
Figure 12: Reduction in Sound Level (shown) with a 2m Barrier
Figure 13: Reduction in Sound Level (shown) with a 4.5m Barrier
Note that the change in sound level is the more pertinent value as this will be the exactly level reduction for the complaints i.e. referring to Figure 6, a reduction of 10 dB would put half of the impacts below 70 dBA, and all but one (1) incident below 80 dBA.

The absolute value of the road noise impact on houses is less accurate due to the nature of computer modelling but has been provided in Table 12 to Table 14 below.

Table 12: Calculated Sound level with 2m tall Barrier

<table>
<thead>
<tr>
<th></th>
<th>Sound Level at 1.5m (typical backyard)</th>
<th>Sound Level at 4.5m (typical 2nd storey window)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East of Oakhill Dr.</td>
<td>60 dBA</td>
<td>65 dBA</td>
</tr>
<tr>
<td>North of Colborne St. W.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West of Oakhill Dr.</td>
<td>60 dBA</td>
<td>65 dBA</td>
</tr>
<tr>
<td>North of Colborne St. W.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West of Oakhill Dr.</td>
<td>60 dBA</td>
<td>65 dBA</td>
</tr>
<tr>
<td>South of Colborne St. W.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 13: Calculated Sound level with 3m tall Barrier

<table>
<thead>
<tr>
<th></th>
<th>Sound Level at 1.5m (typical backyard)</th>
<th>Sound Level at 4.5m (typical 2nd storey window)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East of Oakhill Dr.</td>
<td>59 dBA</td>
<td>62 dBA</td>
</tr>
<tr>
<td>North of Colborne St. W.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West of Oakhill Dr.</td>
<td>59 dBA</td>
<td>62 dBA</td>
</tr>
<tr>
<td>North of Colborne St. W.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West of Oakhill Dr.</td>
<td>59 dBA</td>
<td>62 dBA</td>
</tr>
<tr>
<td>South of Colborne St. W.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 14: Calculated Sound level with 4.5m tall Barrier

<table>
<thead>
<tr>
<th></th>
<th>Sound Level at 1.5m (typical backyard)</th>
<th>Sound Level at 4.5m (typical 2nd storey window)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East of Oakhill Dr.</td>
<td>57 dBA</td>
<td>60 dBA</td>
</tr>
<tr>
<td>North of Colborne St. W.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West of Oakhill Dr.</td>
<td>57 dBA</td>
<td>60 dBA</td>
</tr>
<tr>
<td>North of Colborne St. W.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>West of Oakhill Dr.</td>
<td>57 dBA</td>
<td>60 dBA</td>
</tr>
<tr>
<td>South of Colborne St. W.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7.4 Barrier Costs

Barrier costs vary, predominantly based on height and if they are absorptive or reflective. The major impact on cost is the amount of material, the height and the post spacing between panels. To provide estimated pricing, an approximate cost of $187.50 per square meter has been used for a reflective barrier, and an approximate cost of $237.50 per square meter has been used for an absorptive barrier. Based on these estimates, Table 15 and Table 16 below provide the approximate costs for each of barrier. Numbers have been rounded to nearest thousands (1000).

Table 15: Estimated Barrier Costs for Absorptive Barrier (including Construction)

<table>
<thead>
<tr>
<th>Barrier Height (m)</th>
<th>Barrier #1</th>
<th>Barrier #2</th>
<th>Barrier #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1m</td>
<td>$100,000</td>
<td>$170,000</td>
<td>$32,000</td>
</tr>
<tr>
<td>3m</td>
<td>$300,000</td>
<td>$503,000</td>
<td>$100,000</td>
</tr>
<tr>
<td>4.5m</td>
<td>$454,000</td>
<td>$754,000</td>
<td>$146,000</td>
</tr>
</tbody>
</table>
Table 16: Estimated Barrier Costs for Reflective Barrier

<table>
<thead>
<tr>
<th>Barrier Height (m)</th>
<th>Barrier #1</th>
<th>Barrier #2</th>
<th>Barrier #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1m</td>
<td>$80,000</td>
<td>$132,000</td>
<td>$26,000</td>
</tr>
<tr>
<td>3m</td>
<td>$240,000</td>
<td>$400,000</td>
<td>$77,000</td>
</tr>
<tr>
<td>4.5m</td>
<td>$360,000</td>
<td>$595,000</td>
<td>$115,000</td>
</tr>
</tbody>
</table>
8 Conclusion

Aercoustics Engineering Limited was retained by The City of Brantford to complete a noise study of current noise levels in the intersection of Colborne Street West and Oakhill Drive, to provide the city with information that can be used to help them respond to noise-related complaints from the residential community.

Multiple long-term sound monitors were deployed and the results from noise monitoring indicate that the dominant noise source in the area is traffic noise from Colborne Street West. Existing levels showed the measured noise is at levels Aercoustics recommends investigating mitigation.

A computer model was developed to assist in considering various mitigation models. Initially, road-side barriers are the suggested mitigation recommendation. The model was used to demonstrate the potential noise reduction for various barrier heights. The data shows the barriers, based on heights, will reduce the noise from the road between 3 and 10 dBA.
Appendix A
List of Noise Disturbance Sources
Table 1 Above Background Sound Level Noise Disturbance Sources

<table>
<thead>
<tr>
<th>Date</th>
<th>Timestamp</th>
<th>Disturbance Type</th>
<th>LAeq (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 23, 2018</td>
<td>00:59:09</td>
<td>Loud Vehicle Pass-by</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>08:24:01</td>
<td>Loud Vehicle Pass-by</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>08:48:01</td>
<td>Loud Vehicle Pass-by</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>19:58:01</td>
<td>Loud Vehicle Pass-by</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>21:54:01</td>
<td>Loud Vehicle Pass-by</td>
<td>79</td>
</tr>
<tr>
<td>August 24, 2018</td>
<td>08:47:00</td>
<td>Loud Vehicle Pass-by</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>10:28:00</td>
<td>Loud Vehicle Pass-by</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>16:06:18</td>
<td>Loud Vehicle Pass-by</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>19:15:22</td>
<td>Loud Vehicle Pass-by</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>19:16:22</td>
<td>Loud Vehicle Pass-by</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>20:42:22</td>
<td>Loud Vehicle Pass-by</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>22:19:22</td>
<td>Loud Vehicle Pass-by</td>
<td>78</td>
</tr>
<tr>
<td>August 25, 2018</td>
<td>08:30:00</td>
<td>Emergency Vehicle Siren</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>11:58:00</td>
<td>Loud Vehicle Pass-by</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>11:59:00</td>
<td>Loud Vehicle Pass-by</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>12:00:00</td>
<td>Loud Vehicle Pass-by</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>22:00:00</td>
<td>Loud Vehicle Racing</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>22:18:00</td>
<td>Loud Vehicle Racing</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>22:19:00</td>
<td>Loud Vehicle Pass-by</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>22:20:00</td>
<td>Emergency Vehicle Siren</td>
<td>64</td>
</tr>
<tr>
<td></td>
<td>22:21:00</td>
<td>Loud Vehicle Pass-by with Emergency Vehicle Siren</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>22:48:00</td>
<td>Loud Vehicle Racing</td>
<td>84</td>
</tr>
<tr>
<td>August 26, 2018</td>
<td>00:19:00</td>
<td>Loud Vehicle Pass-by</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>00:28:00</td>
<td>Loud Vehicle Pass-by</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>18:17:00</td>
<td>Emergency Vehicle Siren</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>18:18:00</td>
<td>Emergency Vehicle Siren</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>21:07:00</td>
<td>Loud Vehicle Pass-by with Emergency Vehicle Siren</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>21:08:00</td>
<td>Emergency Vehicle Siren</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>22:12:00</td>
<td>Loud Vehicle Pass-by</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>22:28:00</td>
<td>Loud Vehicle Pass-by</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>22:29:00</td>
<td>Loud Vehicle Pass-by</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>23:04:00</td>
<td>Loud Vehicle Pass-by</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>23:05:00</td>
<td>Loud Vehicle Pass-by</td>
<td>74</td>
</tr>
<tr>
<td>August 27, 2018</td>
<td>00:12:00</td>
<td>Loud Vehicle Pass-by</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>00:13:00</td>
<td>Loud Vehicle Pass-by</td>
<td>66</td>
</tr>
</tbody>
</table>
### APPENDIX C

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>August 28, 2018</strong></td>
<td>00:14:00</td>
<td>Loud Vehicle Pass-by</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>21:51:00</td>
<td>Loud Vehicle Pass-by</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>21:52:00</td>
<td>Loud Vehicle Pass-by</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>02:12:00</td>
<td>Loud Vehicle Pass-by</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>09:50:00</td>
<td>Loud Vehicle Pass-by</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>10:59:00</td>
<td>Emergency Vehicle Siren</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>17:46:00</td>
<td>Loud Vehicle Pass-by</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>18:34:00</td>
<td>Truck with Metal-on-Metal Screeching Sound</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>20:33:00</td>
<td>Loud Motorbike/Airplane pass-by</td>
<td>80</td>
</tr>
<tr>
<td><strong>August 29, 2018</strong></td>
<td>00:02:00</td>
<td>Loud Vehicle Pass-by</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>01:25:00</td>
<td>Loud Vehicle Pass-by</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>03:04:00</td>
<td>Loud Vehicle Pass-by with Person Screaming</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>03:05:00</td>
<td>Loud Vehicle Pass-by</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>14:50:00</td>
<td>Emergency Vehicle Siren</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>16:21:00</td>
<td>Loud Vehicle Pass-by</td>
<td>78</td>
</tr>
<tr>
<td></td>
<td>20:16:00</td>
<td>Loud Motorbike/Airplane pass-by</td>
<td>78</td>
</tr>
<tr>
<td><strong>August 30, 2018</strong></td>
<td>00:02:00</td>
<td>Loud Vehicle Pass-by with Emergency Vehicle Siren</td>
<td>87</td>
</tr>
<tr>
<td><strong>September 1, 2018</strong></td>
<td>11:36:00</td>
<td>Emergency Vehicle Siren</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>11:49:00</td>
<td>Loud Vehicle Pass-by</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>11:55:00</td>
<td>Loud Vehicle Pass-by</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>17:30:00</td>
<td>Loud Vehicle Pass-by</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>23:02:00</td>
<td>Loud Vehicle Pass-by</td>
<td>85</td>
</tr>
<tr>
<td><strong>September 2, 2018</strong></td>
<td>05:18:00</td>
<td>Loud Vehicle Pass-by with Loud Music</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>05:19:00</td>
<td>Crickets Near Microphone</td>
<td>70</td>
</tr>
<tr>
<td><strong>September 3, 2018</strong></td>
<td>15:20:00</td>
<td>Loud Vehicle Pass-by</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>17:24:00</td>
<td>Signal Interruption</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>22:27:00</td>
<td>Loud Vehicle Pass-by with Emergency Vehicle Siren</td>
<td>83</td>
</tr>
<tr>
<td><strong>September 4, 2018</strong></td>
<td>05:54:00</td>
<td>Loud Vehicle Pass-by</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>05:54:00</td>
<td>Loud Vehicle Pass-by</td>
<td>81</td>
</tr>
<tr>
<td><strong>September 5, 2018</strong></td>
<td>00:29:00</td>
<td>Loud Vehicle Pass-by</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>01:10:00</td>
<td>Emergency Vehicle Siren</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>01:11:00</td>
<td>Emergency Vehicle Siren</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>01:18:00</td>
<td>Loud Vehicle Pass-by</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>03:20:00</td>
<td>Signal Interruption</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>03:21:00</td>
<td>Signal Interruption</td>
<td>95</td>
</tr>
<tr>
<td></td>
<td>03:22:00</td>
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</tr>
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<td>88</td>
</tr>
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<td>--------------------------------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>03:24:00</td>
<td>Signal Interruption</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>11:54:00</td>
<td>Loud Vehicle Pass-by</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>20:23:00</td>
<td>Loud Vehicle Pass-by</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>22:18:00</td>
<td>Emergency Vehicle Siren</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>22:37:00</td>
<td>Emergency Vehicle Siren</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>23:33:00</td>
<td>Loud Vehicle Pass-by</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td>September 6, 2018</td>
<td>Loud Vehicle Pass-by</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>00:23:00</td>
<td>Crickets Near Microphone</td>
<td>77</td>
<td></td>
</tr>
</tbody>
</table>
Appendix B
Data Cleaned of Transient Noise Disturbances
APPENDIX C

18315.00 – The City of Brantford / Colborne Street West
Noise Study

Appendices

[Image of a chart showing sound pressure level over time with annotations for different data types: Original Data, Cleaned Data, and Removed Data. The chart is dated August 24, 2018.]
APPENDIX C

18315.00 – The City of Brantford / Colborne Street West
Noise Study

Appendices
APPENDIX C

18315.00 – The City of Brantford / Colborne Street West
Noise Study

Appendices
APPENDIX C

18315.00 – The City of Brantford / Colborne Street West
Noise Study

August-31-2018

Sound Pressure Level - 1 Minute LAeq (dBA)

Time (hh:mm)
APPENDIX C

18315.00 – The City of Brantford / Colborne Street West
Noise Study

Appendices
Appendix C

STAMSON noise level calculations
Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume : 668 veh/TimePeriod
Medium truck volume : 28 veh/TimePeriod
Heavy truck volume : 23 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1 Angle2 : -90.00 deg 90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 21.00 m
Receiver height : 2.50 m
Topography : 1 (Flat/gentle slope; no barrier)
Reference angle : 0.00

Results segment # 1: Colborne St
---------------------------------
Source height = 1.34 m

ROAD (0.00 + 63.90 + 0.00) = 63.90 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.63</td>
<td>67.70</td>
<td>0.00</td>
<td>-2.39</td>
<td>-1.41</td>
<td>0.00</td>
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<td>0.00</td>
<td>63.90</td>
</tr>
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</table>

Segment Leq : 63.90 dBA
Total Leq All Segments: 63.90 dBA
TOTAL Leq FROM ALL SOURCES: 63.90
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: hour2.te  Time Period: 1 hours
Description: Hour from 8:30 am - 9:30 am

Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume : 785 veh/TimePeriod
Medium truck volume : 39 veh/TimePeriod
Heavy truck volume : 43 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1  Angle2           : -90.00 deg   90.00 deg
Wood depth                :       0       (No woods.)
No of house rows          :       0
Surface                   :       1       (Absorptive ground surface)
Receiver source distance  : 21.00 m
Receiver height           :   2.50 m
Topography                :       1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: Colborne St
--------------------------------
Source height = 1.49 m
ROAD (0.00 + 65.88 + 0.00) = 65.88 dBA

---
-90     90   0.63  69.67   0.00  -2.38  -1.41   0.00   0.00   0.00  65.88
---

Segment Leq : 65.88 dBA
Total Leq All Segments: 65.88 dBA
TOTAL Leq FROM ALL SOURCES: 65.88
Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume : 635 veh/TimePeriod
Medium truck volume : 18 veh/TimePeriod
Heavy truck volume : 19 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1  Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  21.00 m
Receiver height           :   2.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: Colborne St
-------------------------------
Source height = 1.30 m

ROAD (0.00 + 63.09 + 0.00) = 63.09 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
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</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.64</td>
<td>66.90</td>
<td>0.00</td>
<td>-2.39</td>
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</table>

Segment Leq : 63.09 dBA

Total Leq All Segments: 63.09 dBA

TOTAL Leq FROM ALL SOURCES: 63.09
STAMSON 5.0       NORMAL REPORT        Date: 17-09-2018 14:56:13
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: hour2.te             Time Period: 1 hours
Description: Hour from 11:30 am - 12:30 pm

Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume :   792 veh/TimePeriod
Medium truck volume :    33 veh/TimePeriod
Heavy truck volume :     9 veh/TimePeriod
Posted speed limit :    60 km/h
Road gradient :      0 %
Road pavement :    1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  21.00 m
Receiver height           :   2.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: Colborne St
--------------------------------
Source height = 1.02 m
ROAD (0.00 + 62.75 + 0.00) = 62.75 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
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<td>0.64</td>
<td>66.58</td>
<td>0.00</td>
<td>-2.40</td>
<td>-1.43</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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</table>

Segment Leq : 62.75 dBA
Total Leq All Segments: 62.75 dBA
TOTAL Leq FROM ALL SOURCES: 62.75
Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume : 790 veh/TimePeriod
Medium truck volume : 28 veh/TimePeriod
Heavy truck volume  : 13 veh/TimePeriod
Posted speed limit  : 60 km/h
Road gradient      : 0 %
Road pavement      : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      1       (Absorptive ground surface)
Receiver source distance  :  21.00 m
Receiver height           :   2.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: Colborne St
--------------------------------
Source height = 1.12 m
ROAD (0.00 + 63.07 + 0.00) = 63.07 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
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</thead>
<tbody>
<tr>
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Segment Leq : 63.07 dBA
Total Leq All Segments: 63.07 dBA
TOTAL Leq FROM ALL SOURCES: 63.07
Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume : 1053 veh/TimePeriod
Medium truck volume : 29 veh/TimePeriod
Heavy truck volume : 13 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1  Angle2 : -90.00 deg  90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 21.00 m
Receiver height : 2.50 m
Topography : 1 (Flat/gentle slope; no barrier)
Reference angle : 0.00

Results segment # 1: Colborne St
----------------------------------
Source height = 1.04 m
ROAD (0.00 + 63.68 + 0.00) = 63.68 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
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<th>H.Adj</th>
<th>B.Adj</th>
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<tbody>
<tr>
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<td>0.64</td>
<td>67.51</td>
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<td>0.00</td>
<td>63.68</td>
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</tbody>
</table>

Segment Leq : 63.68 dBA
Total Leq All Segments: 63.68 dBA
TOTAL Leq FROM ALL SOURCES: 63.68
Road data, segment #1: Colborne St

Car traffic volume: 1376 veh/TimePeriod
Medium truck volume: 20 veh/TimePeriod
Heavy truck volume: 13 veh/TimePeriod
Posted speed limit: 60 km/h
Road gradient: 0%
Road pavement: 1 (Typical asphalt or concrete)

Data for Segment #1: Colborne St

Angle1 Angle2 Angle2: -90.00 deg 90.00 deg
Wood depth: 0 (No woods.)
No of house rows: 0
Surface: 1 (Absorptive ground surface)
Receiver source distance: 21.00 m
Receiver height: 2.50 m
Topography: 1 (Flat/gentle slope; no barrier)
Reference angle: 0.00

Results segment #1: Colborne St

Source height = 0.98 m

ROAD (0.00 + 64.08 + 0.00) = 64.08 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
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<td></td>
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<td>64.08</td>
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</table>

Segment Leq: 64.08 dBA

Total Leq All Segments: 64.08 dBA

TOTAL Leq FROM ALL SOURCES: 64.08
Road data, segment # 1: Colborne St

Car traffic volume : 1035 veh/TimePeriod
Medium truck volume : 9 veh/TimePeriod
Heavy truck volume : 7 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St

Angle1 Angle2 : -90.00 deg 90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0
Surface : 1 (Absorptive ground surface)
Receiver source distance : 21.00 m
Receiver height : 2.50 m
Topography : 1 (Flat/gentle slope; no barrier)
Reference angle : 0.00

Results segment # 1: Colborne St

Source height = 0.90 m

ROAD (0.00 + 62.24 + 0.00) = 62.24 dBA

Segment Leq : 62.24 dBA

Total Leq All Segments: 62.24 dBA

TOTAL Leq FROM ALL SOURCES: 62.24
Road data, segment # 1: Colborne St  
-----------------------------------
Car traffic volume : 668 veh/TimePeriod  
Medium truck volume : 28 veh/TimePeriod  
Heavy truck volume : 23 veh/TimePeriod  
Posted speed limit : 60 km/h  
Road gradient : 1 %  
Road pavement : 1 (Typical asphalt or concrete)  

Data for Segment # 1: Colborne St  
---------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg  
Wood depth                :      0       (No woods.)  
No of house rows          :      0  
Surface                   :      2       (Reflective ground surface)  
Receiver source distance  :  21.00 m  
Receiver height           :   2.50 m  
Topography                :      1       (Flat/gentle slope; no barrier)  
Reference angle           :   0.00  

Results segment # 1: Colborne St  
--------------------------------
Source height = 1.34 m  
ROAD (0.00 + 66.24 + 0.00) = 66.24 dBA  

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>67.70</td>
<td>0.00</td>
<td>-1.46</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>66.24</td>
</tr>
</tbody>
</table>

Segment Leq : 66.24 dBA  
Total Leq All Segments: 66.24 dBA  
TOTAL Leq FROM ALL SOURCES: 66.24
STAMSON 5.0        NORMAL REPORT        Date: 20-09-2018 12:11:12
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: m1h2.te              Time Period: 1 hours
Description: Monitor #1 (08:30-09:30)

Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume :  785 veh/TimePeriod
Medium truck volume : 39 veh/TimePeriod
Heavy truck volume  : 43 veh/TimePeriod
Posted speed limit  : 60 km/h
Road gradient      :  1 %
Road pavement       :  1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  21.00 m
Receiver height           :   2.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: Colborne St
--------------------------------
Source height = 1.49 m

ROAD (0.00 + 68.20 + 0.00) = 68.20 dBA

<table>
<thead>
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<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
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</thead>
<tbody>
<tr>
<td>-90</td>
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<td>0.00</td>
<td>69.67</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>68.20</td>
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Segment Leq : 68.20 dBA
Total Leq All Segments: 68.20 dBA

TOTAL Leq FROM ALL SOURCES: 68.20
STAMSON 5.0        NORMAL REPORT        Date: 20-09-2018 12:11:59
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: m1h3.te              Time Period: 1 hours
Description: Monitor #1 (09:30-10:30)

Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume :   635 veh/TimePeriod
Medium truck volume :    18 veh/TimePeriod
Heavy truck volume  :    19 veh/TimePeriod
Posted speed limit :  60 km/h
Road gradient       :     1 %
Road pavement       :     1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  21.00 m
Receiver height           :   2.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: Colborne St
--------------------------------
Source height = 1.30 m

ROAD (0.00 + 65.44 + 0.00) = 65.44 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>66.90</td>
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<td>-1.46</td>
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<td>0.00</td>
<td>65.44</td>
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</table>

Segment Leq : 65.44 dBA

Total Leq All Segments: 65.44 dBA

TOTAL Leq FROM ALL SOURCES: 65.44
ROAD data, segment #1: Colborne St

<table>
<thead>
<tr>
<th>Car traffic volume</th>
<th>70 veh/TimePeriod</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium truck volume</td>
<td>28 veh/TimePeriod</td>
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<tr>
<td>Heavy truck volume</td>
<td>13 veh/TimePeriod</td>
</tr>
<tr>
<td>Posted speed limit</td>
<td>60 km/h</td>
</tr>
<tr>
<td>Road gradient</td>
<td>1 %</td>
</tr>
<tr>
<td>Road pavement</td>
<td>1 (Typical asphalt or concrete)</td>
</tr>
</tbody>
</table>

Data for Segment #1: Colborne St

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>-90.00 deg</th>
<th>90.00 deg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood depth</td>
<td>0</td>
<td>(No woods.)</td>
<td></td>
</tr>
<tr>
<td>No of house rows</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Surface</td>
<td>2</td>
<td>(Reflective ground surface)</td>
<td></td>
</tr>
<tr>
<td>Receiver source distance</td>
<td>21.00 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiver height</td>
<td>2.50 m</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Topography</td>
<td>1</td>
<td>(Flat/gentle slope; no barrier)</td>
<td></td>
</tr>
<tr>
<td>Reference angle</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Results segment #1: Colborne St

Source height = 1.85 m

ROAD (0.00 + 63.23 + 0.00) = 63.23 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>64.69</td>
<td>0.00</td>
<td>-1.46</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>63.23</td>
</tr>
</tbody>
</table>

Total Leq All Segments: 63.23 dBA

TOTAL Leq FROM ALL SOURCES: 63.23 dBA
Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume : 1053 veh/TimePeriod
Medium truck volume : 29 veh/TimePeriod
Heavy truck volume : 13 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 1 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1   Angle2               : -90.00 deg   90.00 deg
Wood depth                : 0       (No woods.)
No of house rows          : 0
Surface                   : 2       (Reflective ground surface)
Receiver source distance  : 21.00 m
Receiver height           : 2.50 m
Topography                : 1       (Flat/gentle slope; no barrier)
Reference angle           : 0.00

Results segment # 1: Colborne St
---------------------------------
Source height = 1.04 m

ROAD (0.00 + 66.05 + 0.00) = 66.05 dBA

<table>
<thead>
<tr>
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<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
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<th>H.Adj</th>
<th>B.Adj</th>
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<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>67.51</td>
<td>0.00</td>
<td>-1.46</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<td>66.05</td>
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</tbody>
</table>

Segment Leq : 66.05 dBA

Total Leq All Segments: 66.05 dBA

TOTAL Leq FROM ALL SOURCES: 66.05
Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume : 1376 veh/TimePeriod
Medium truck volume : 20 veh/TimePeriod
Heavy truck volume : 13 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 1 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1 Angle2 : -90.00 deg  90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0
Surface : 2 (Reflective ground surface)
Receiver source distance : 21.00 m
Receiver height : 2.50 m
Topography : 1 (Flat/gentle slope; no barrier)
Reference angle : 0.00

Results segment # 1: Colborne St
--------------------------------
Source height = 0.98 m

ROAD (0.00 + 66.45 + 0.00) = 66.45 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
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<tbody>
<tr>
<td>-90</td>
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<td>67.91</td>
<td>0.00</td>
<td>-1.46</td>
<td>0.00</td>
<td>0.00</td>
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<td>0.00</td>
</tr>
</tbody>
</table>

Segment Leq : 66.45 dBA

Total Leq All Segments: 66.45 dBA

TOTAL Leq FROM ALL SOURCES: 66.45
Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume : 668 veh/TimePeriod
Medium truck volume : 28 veh/TimePeriod
Heavy truck volume  : 23 veh/TimePeriod
Posted speed limit  : 60 km/h
Road gradient      : 0 %
Road pavement      : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows           :      0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :   21.00 m
Receiver height           :   2.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: Colborne St
---------------------------------
Source height = 1.34 m
ROAD (0.00 + 66.24 + 0.00) = 66.24 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
</tr>
</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
<td>0.00</td>
<td>67.70</td>
<td>0.00</td>
<td>-1.46</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>66.24</td>
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</tbody>
</table>

Segment Leq : 66.24 dBA
Total Leq All Segments: 66.24 dBA
TOTAL Leq FROM ALL SOURCES: 66.24
Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume : 785 veh/TimePeriod
Medium truck volume : 39 veh/TimePeriod
Heavy truck volume : 43 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
----------------------------------
Angle1   Angle2           :  -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  21.00 m
Receiver height           :   2.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: Colborne St
--------------------------------
Source height = 1.49 m

ROAD (0.00 + 68.20 + 0.00) = 68.20 dBA

---
-90     90   0.00   69.67   0.00   -1.46   0.00   0.00   0.00   0.00   68.20
---

Segment Leq : 68.20 dBA

Total Leq All Segments: 68.20 dBA

TOTAL Leq FROM ALL SOURCES: 68.20
Road data, segment # 1: Colborne St  
-----------------------------------  
Car traffic volume :  635 veh/TimePeriod  
Medium truck volume :    18 veh/TimePeriod  
Heavy truck volume :    19 veh/TimePeriod  
Posted speed limit :    60 km/h  
Road gradient :    0 %  
Road pavement :    1 (Typical asphalt or concrete)  

Data for Segment # 1: Colborne St  
----------------------------------  
Angle1   Angle2           : -90.00 deg   90.00 deg  
Wood depth                :      0       (No woods.)  
No of house rows          :      0  
Surface                   :      2       (Reflective ground surface)  
Receiver source distance  :  21.00 m  
Receiver height           :   2.50 m  
Topography                :      1       (Flat/gentle slope; no barrier)  
Reference angle           :   0.00  

Results segment # 1: Colborne St  
--------------------------------  
Source height = 1.30 m  

ROAD (0.00 + 65.44 + 0.00) = 65.44 dBA  

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
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</thead>
<tbody>
<tr>
<td>-90</td>
<td>90</td>
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<td>66.90</td>
<td>0.00</td>
<td>-1.46</td>
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<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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</tbody>
</table>

Segment Leq : 65.44 dBA  
Total Leq All Segments: 65.44 dBA  
TOTAL Leq FROM ALL SOURCES: 65.44
STAMSON 5.0        NORMAL REPORT        Date: 20-09-2018 11:59:38
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: M2M3H4.te            Time Period: 1 hours
Description: Monitor #2 and Monitor #3 (11:30-12:30)

Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume :   792 veh/TimePeriod
Medium truck volume :    33 veh/TimePeriod
Heavy truck volume  :     9 veh/TimePeriod
Posted speed limit :    60 km/h
Road gradient :      0 %
Road pavement :      1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1    Angle2 : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  21.00 m
Receiver height           :   2.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: Colborne St
---------------------------------
Source height = 1.02 m

ROAD (0.00 + 65.12 + 0.00) = 65.12 dBA

<table>
<thead>
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<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>F.Adj</th>
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<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
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<tbody>
<tr>
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<td>66.58</td>
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</table>

Segment Leq : 65.12 dBA

Total Leq All Segments: 65.12 dBA

TOTAL Leq FROM ALL SOURCES: 65.12
Road data, segment #1: Colborne St
-----------------------------------
Car traffic volume: 70 veh/TimePeriod
Medium truck volume: 28 veh/TimePeriod
Heavy truck volume: 13 veh/TimePeriod
Posted speed limit: 60 km/h
Road gradient: 0 %
Road pavement: 1 (Typical asphalt or concrete)

Data for Segment #1: Colborne St
-----------------------------------
Angle1 Angle2 : -90.00 deg  90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0
Surface : 2 (Reflective ground surface)
Receiver source distance : 21.00 m
Receiver height : 2.50 m
Topography : 1 (Flat/gentle slope; no barrier)
Reference angle : 0.00

Results segment #1: Colborne St
-----------------------------------
Source height = 1.85 m

ROAD (0.00 + 63.23 + 0.00) = 63.23 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
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</thead>
<tbody>
<tr>
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</table>

Segment Leq: 63.23 dBA
Total Leq All Segments: 63.23 dBA
TOTAL Leq FROM ALL SOURCES: 63.23
Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume : 1053 veh/TimePeriod
Medium truck volume : 29 veh/TimePeriod
Heavy truck volume : 13 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  21.00 m
Receiver height           :   2.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: Colborne St
--------------------------------
Source height = 1.04 m

ROAD (0.00 + 66.05 + 0.00) = 66.05 dBA

---
-90  90  0.00  67.51  0.00  -1.46  0.00  0.00  0.00  0.00
66.05
---

Segment Leq : 66.05 dBA

Total Leq All Segments: 66.05 dBA

TOTAL Leq FROM ALL SOURCES: 66.05
Road data, segment # 1: Colborne St
---------------------------------------------
Car traffic volume : 1376 veh/TimePeriod
Medium truck volume : 20 veh/TimePeriod
Heavy truck volume : 13 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------------------
Angle1 Angle2 : -90.00 deg  90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0
Surface : 2 (Reflective ground surface)
Receiver source distance : 21.00 m
Receiver height : 2.50 m
Topography : 1 (Flat/gentle slope; no barrier)
Reference angle : 0.00

Results segment # 1: Colborne St
---------------------------------------------
Source height = 0.98 m
ROAD (0.00 + 66.45 + 0.00) = 66.45 dBA

---
  -90 90 0.00 67.91 0.00 -1.46 0.00 0.00 0.00 0.00
  66.45
---

Segment Leq : 66.45 dBA

Total Leq All Segments: 66.45 dBA

TOTAL Leq FROM ALL SOURCES: 66.45
Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume : 1035 veh/TimePeriod
Medium truck volume : 9 veh/TimePeriod
Heavy truck volume : 7 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1 Angle2 : -90.00 deg 90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0
Surface : 2 (Reflective ground surface)
Receiver source distance : 21.00 m
Receiver height : 2.50 m
Topography : 1 (Flat/gentle slope; no barrier)
Reference angle : 0.00

Results segment # 1: Colborne St
--------------------------------
Source height = 0.90 m

ROAD (0.00 + 64.63 + 0.00) = 64.63 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
<th>W.Adj</th>
<th>H.Adj</th>
<th>B.Adj</th>
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<tr>
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<td>66.09</td>
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<td>0.00</td>
<td>0.00</td>
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</tbody>
</table>

Segment Leq : 64.63 dBA

Total Leq All Segments: 64.63 dBA

TOTAL Leq FROM ALL SOURCES: 64.63
Road data, segment #1: Colborne St
-----------------------------------
Car traffic volume : 668 veh/TimePeriod
Medium truck volume : 28 veh/TimePeriod
Heavy truck volume : 23 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment #1: Colborne St
---------------------------------
Angle1 Angle2 : -90.00 deg 90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0
Surface : 2 (Reflective ground surface)
Receiver source distance : 40.00 m
Receiver height : 2.50 m
Topography : 1 (Flat/gentle slope; no barrier)
Reference angle : 0.00

Results segment #1: Colborne St
---------------------------------
Source height = 1.34 m
ROAD (0.00 + 63.44 + 0.00) = 63.44 dBA
Angle1 Angle2 Alpha RefLeq P.Adj D.Adj F.Adj W.Adj H.Adj B.Adj SubLeq
--------------------------------------------------------------------------------
--- -90 90 0.00 67.70 0.00 -4.26 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
63.44
-----------------------------------------------------------------------------------
---
Segment Leq : 63.44 dBA

Total Leq All Segments: 63.44 dBA

TOTAL Leq FROM ALL SOURCES: 63.44
Road data, segment #1: Colborne St
-----------------------------------
Car traffic volume: 785 veh/TimePeriod
Medium truck volume: 39 veh/TimePeriod
Heavy truck volume: 43 veh/TimePeriod
Posted speed limit: 60 km/h
Road gradient: 0 %
Road pavement: 1 (Typical asphalt or concrete)

Data for Segment #1: Colborne St
---------------------------------
Angle1 Angle2 : -90.00 deg 90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0
Surface : 2 (Reflective ground surface)
Receiver source distance : 40.00 m
Receiver height : 2.50 m
Topography : 1 (Flat/gentle slope; no barrier)
Reference angle : 0.00

Results segment #1: Colborne St
---------------------------------
Source height = 1.49 m

ROAD (0.00 + 65.41 + 0.00) = 65.41 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
<th>F.Adj</th>
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<th>H.Adj</th>
<th>B.Adj</th>
<th>SubLeq</th>
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<tr>
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</table>

Segment Leq: 65.41 dBA
Total Leq All Segments: 65.41 dBA

TOTAL Leq FROM ALL SOURCES: 65.41
Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume : 635 veh/TimePeriod
Medium truck volume : 18 veh/TimePeriod
Heavy truck volume : 19 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1 Angle2 : -90.00 deg 90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0
Surface : 2 (Reflective ground surface)
Receiver source distance : 40.00 m
Receiver height : 2.50 m
Topography : 1 (Flat/gentle slope; no barrier)
Reference angle : 0.00

Results segment # 1: Colborne St
--------------------------------
Source height = 1.30 m

ROAD (0.00 + 62.64 + 0.00) = 62.64 dBA

----------------------------------------
-90 90 0.00 66.90 0.00 -4.26 0.00 0.00 0.00 0.00
62.64
----------------------------------------

Segment Leq : 62.64 dBA

Total Leq All Segments: 62.64 dBA

TOTAL Leq FROM ALL SOURCES: 62.64
Road data, segment # 1: Colborne St

Car traffic volume : 792 veh/TimePeriod
Medium truck volume : 33 veh/TimePeriod
Heavy truck volume : 9 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 1 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St

Angle1 Angle2 : -90.00 deg  90.00 deg
Wood depth : 0  (No woods.)
No of house rows : 0
Surface : 2  (Reflective ground surface)
Receiver source distance : 21.00 m
Receiver height : 2.50 m
Topography : 1  (Flat/gentle slope; no barrier)
Reference angle : 0.00

Source height = 1.02 m

ROAD (0.00 + 65.12 + 0.00) = 65.12 dBA

SubLeq

---
-90 90 0.00 66.58 0.00 -1.46 0.00 0.00 0.00 0.00 65.12
---

Segment Leq : 65.12 dBA
Total Leq All Segments: 65.12 dBA
TOTAL Leq FROM ALL SOURCES: 65.12
Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume :  790 veh/TimePeriod
Medium truck volume : 28 veh/TimePeriod
Heavy truck volume : 13 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
--------------------------------- 
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  :  40.00 m
Receiver height           :   2.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: Colborne St
-------------------------------- 
Source height = 1.12 m

ROAD (0.00 + 62.64 + 0.00) = 62.64 dBA

---
-90    90  0.00  66.90  0.00  -4.26  0.00  0.00  0.00  0.00 
62.64  
---

Segment Leq : 62.64 dBA

Total Leq All Segments: 62.64 dBA

TOTAL Leq FROM ALL SOURCES: 62.64
STAMSON 5.0        NORMAL REPORT        Date: 20-09-2018 12:19:12
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: m4h6.te              Time Period: 1 hours
Description: Monitor #4 (15:00-16:00)

Road data, segment # 1: Colborne St
-----------------------------------
Car traffic volume : 1053 veh/TimePeriod
Medium truck volume : 29 veh/TimePeriod
Heavy truck volume : 13 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St
---------------------------------
Angle1   Angle2           : -90.00 deg   90.00 deg
Wood depth                :      0       (No woods.)
No of house rows          :      0
Surface                   :      2       (Reflective ground surface)
Receiver source distance  : 40.00 m
Receiver height           :   2.50 m
Topography                :      1       (Flat/gentle slope; no barrier)
Reference angle           :   0.00

Results segment # 1: Colborne St
--------------------------------
Source height = 1.04 m
ROAD (0.00 + 63.25 + 0.00) = 63.25 dBA

<table>
<thead>
<tr>
<th>Angle1</th>
<th>Angle2</th>
<th>Alpha</th>
<th>RefLeq</th>
<th>P.Adj</th>
<th>D.Adj</th>
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<th>B.Adj</th>
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</table>

Segment Leq : 63.25 dBA

Total Leq All Segments: 63.25 dBA

TOTAL Leq FROM ALL SOURCES: 63.25
Road data, segment # 1: Colborne St

-----------------------------------
Car traffic volume : 1376 veh/TimePeriod
Medium truck volume : 20 veh/TimePeriod
Heavy truck volume : 13 veh/TimePeriod
Posted speed limit : 60 km/h
Road gradient : 0 %
Road pavement : 1 (Typical asphalt or concrete)

Data for Segment # 1: Colborne St

---------------------------------
Angle1 Angle2 : -90.00 deg 90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0
Surface : 2 (Reflective ground surface)
Receiver source distance : 40.00 m
Receiver height : 2.50 m
Topography : 1 (Flat/gentle slope; no barrier)
Reference angle : 0.00

Results segment # 1: Colborne St

----------------------------------
Source height = 0.98 m

ROAD (0.00 + 63.65 + 0.00) = 63.65 dBA

---
-90 90 0.00 67.91 0.00 -4.26 0.00 0.00 0.00 0.00 63.65
---

Segment Leq : 63.65 dBA

Total Leq All Segments: 63.65 dBA

TOTAL Leq FROM ALL SOURCES: 63.65
APPENDIX C

STAMSON 5.0        NORMAL REPORT        Date: 20-09-2018 12:20:40
MINISTRY OF ENVIRONMENT AND ENERGY / NOISE ASSESSMENT

Filename: m4h8.te          Time Period: 1 hours
Description: Monitor #4 (17:00-18:00)

Road data, segment #1: Colborne St
-----------------------------------
Car traffic volume: 1035 veh/TimePeriod
Medium truck volume: 9 veh/TimePeriod
Heavy truck volume: 7 veh/TimePeriod
Posted speed limit: 60 km/h
Road gradient: 0 %
Road pavement: 1 (Typical asphalt or concrete)

Data for Segment #1: Colborne St
---------------------------------
Angle1 Angle2 : -90.00 deg 90.00 deg
Wood depth : 0 (No woods.)
No of house rows : 0
Surface : 2 (Reflective ground surface)
Receiver source distance : 40.00 m
Receiver height : 2.50 m
Topography : 1 (Flat/gentle slope; no barrier)
Reference angle : 0.00

Results segment #1: Colborne St
--------------------------------
Source height = 0.90 m

ROAD (0.00 + 61.83 + 0.00) = 61.83 dBA

---
-90 90 0.00 66.09 0.00 -4.26 0.00 0.00 0.00 0.00 61.83
---

Segment Leq: 61.83 dBA
Total Leq All Segments: 61.83 dBA
TOTAL Leq FROM ALL SOURCES: 61.83