TRAFFIC SOUND STUDY FOR DISCOVERY RIDGE: SOUTHWEST CALGARY RING ROAD

PREDICTED VS. MEASURED SOUND LEVELS

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1. Purpose and Scope

This study was commissioned by residents of Discovery Ridge who have detailed familiarity with the issues facing them regarding the imminent Southwest Calgary Ring Road. With recently acquired data and standards, it was decided that a short, concise, but still comprehensive sound study was possible. The study focuses on the North Boundary of Discovery Ridge, and uses architectural design practice to predict the noise levels using known design basis such as traffic volumes, distance, and vehicle speeds.

This data is then supplemented with field measurements at three roadside locations that were specifically chosen for their comparability to the anticipated roadway. Berm and barrier height and positioning is then addressed. The results are intended to provide practical and economic solutions to Alberta Transportation (AT) regarding the overall protection of Discovery Ridge from the adjacent on/off-ramps and the main Eastbound lanes. Quoting from Adam Johnson, AT Communications Advisor: “The concerns you and your neighbors have are important to us and minimizing any impact this project may have on you is a priority”

The purpose of the study is then summarized as follows:

I) To provide a measureable basis of validation to data from studies performed by AT
II) To document anticipated peak sound measurements both quantitative and qualitative
III) To comment on the validity of AT’s criterion
IV) To provide reasonable and economic solutions for sound protection
2. Executive Summary

Traffic-generated sound levels are easily predictable and readily anticipated, even to the novice sound student.

Predicted sound levels were estimated using a simple nomograph that gives Leq, which accounts for variables such as traffic volume, type, velocity and distance from the observer. A sound meter was employed to take peak hour readings at three Key locations: Glenmore west of Elbow Dr., Deerfoot Trail at Ikea, Stony Trail at Crowchild.

Predicted sustained sound levels averaging 73 dBA to 75dBA were obtained, with peak readings of up to 90 dBA. Average measured vs. predicted readings correlated within 1.4 dBA. Constant exposure of these noise levels for several hours is known to be disturbing and lead to deterioration in overall human efficiency. Protective measures, therefore, are undoubtedly required.

Funnel Ravine is prime example of “channelizing” amplification of sound. Average Readings varied from 45dBA at the quietest time to 62 dBA, when a notable amplification of the sound due to truck traffic could be heard. Narrowing of the right-of-way would make “berming” or a sound wall more feasible and save hundreds of tons of grade.

A berm and wall combination was measured to have 22dBA of noise decay at 100m vs. 10dbA at 100m setback for the sound wall alone, hence proving that earthen berms are more effective than man-made walls.

Preliminary line-of-site analysis shows that, for most profiles, berms of 4 to 5m in height, correctly positioned, should be adequate. The on/off-ramps are noted to be generally too close to residences for proper berming; hence berm-and- wall method is favored where practical.

It was shown from examination of data from a previous sound study, that trees can attenuate as much as 10dBA, and additionally provide esthetic relief with earthen berms. Indeed this substantiates complaints of increased noise since clearing.

The action of AT to protect Discovery Ridge is driven solely by their sound study results, which require a simple 24 average. Note, there is a provision, however, to adopt the more stringent City (peak hour average), and residents continue to press the City on this point.
3. Criterion and Inputs

3.1 General Psychological Effects of Different Sounds

Continuous Exposure to excessive levels of sound is known to disturb human sleep and communication, leading to an overall deterioration in human efficiency. (Refer to Section 3.2 in the design document) Further, intermittent and high frequency and/or high amplitude sounds, such as squealing brakes or revving engines are known to be especially disturbing.

3.2 Limits of Acceptability and Provincial Criterion

The Design Document (per section 4.1) delineates levels of Sound acceptability as follows:

Below 45dBA: Acceptable Level

45 – 55 dBA: Normally Acceptable

55 – 75 dBA: Normally Unacceptable

Above 75 dBA: Unacceptable.

The graphic below effectively puts noise into common prospective:
Note that the Provincial standard of **65 dBA –Leq24** is in the **Normally Unacceptable** range! It will be shown that that peak daytime averages will far exceed this. The City of Calgary’s standard has been suggested, as this is a City residential area, and the City policy averages over Peak traffic hours. The Provincial standard is likely a “grandfather” standard that was developed for rural areas and not populated urban areas.

So one may conclude, then, the provincial standard is NOT stringent enough, and therefore not appropriate for this segment of the project at hand. Nevertheless, discussion of data for this report will, for the sake of consistency, compare to the Provincial Criterion.

For comparison, the City of Calgary averages noise data over peak 10 hour (Leq 10) intervals, and has other limitations of peak sound. The reader is encouraged
to review in Appendix VII. Additionally, there is a provision in the Provincial standard to adopt the more stringent city standard.

The predicted sound levels are based on Alberta Transportation Technical Requirements, Section 18, for the Southwest Calgary Ring Road. Key design basis are simplified as follows:

- 65 dBA maximum permissible Leq-24hours
- 167,000 vehicles-per-hour (vph) – main travel lanes
- 1500 vph-ramp
- AT Alignment Plans and X-Section as transmitted by Rizwan Hussain, AT Project Manager, SWCRR
- Limits of acceptability

Supplemental Criterion:

- Proximity of occupied residences
- Terrain and drainage ditches
- Special areas, such as Funnel Ravine
- Quality and intermittency of sound

4. Methodology;

4.1 Sound Level Prediction

The sound levels are estimated using the methods outlined in “Time Saver Standards for Landscape Architecture, Section 660-Sound Control”, Appendix I, hereafter referred to as “The Design Document”. A full copy is available in the Appendix, as are the nomo-graphs for prediction of Equivalent Noise Levels (Leq). [Note, that although Day-Night Equivalent noise levels (Ldn) may be deemed more relevant, the measurements are kept in Leq for consistency and comparability.]

Other methods provided by the above document are simple addition of noise levels (in dBA), and documented, real-life effects of noise on real human beings.
4.2 Field Measurements

Field measurements were taken and documented to supplement the predicted sound levels.

A 30 to 130 dBA digital hand held sound meter and data logger was selected for the field work. The meter was purchased for this study and came pre-calibrated for dBA measurements. Note the “A” is the weighting which corresponds to the human ear. Specifications are found in the Appendix.

Three locations within the City of Calgary were selected, based on comparable traffic volumes to that proposed near Discovery, as well as accessibility, (e.g. Glenmore-Lakeview sound wall with access gap.) These are labelled “SMP”’s, or Sound Measurement Points.

**SMP-1: Glenmore-Lakeview**
**SMP-2: Deerfoot Trail-Ikea**

![Map of SMP-2: Deerfoot Trail-Ikea](image)

**SMP-3: Stoney Trail-Arbor Lake**

![Map of SMP-3: Stoney Trail-Arbor Lake](image)
4.2.1 Sound Measurement Procedure

For each location; the following times and durations were:

- Peak hours; Weekdays 4pm to 6pm or Weekends 2 – 3 pm

All of the major roadways studied are assumed to fail the 65 Leq24 average, and therefore require sound protection where communities are present. The predicted data for the SWCRR in Discovery Ridge was therefore compared with data measured accordingly. Sound walls and/or berms can be seen along all major arteries in Calgary. Measured data is then compared to the predicted data.

4.3 Berm Design; Required heights

Berm design was chosen according to the following criterion:

- Minimize the distance from the roadway/or homes as practical
- Blockage of Line-of-Site to nearby homes
- Use of available grade material (spoil)
- Use of available land in the TUC
- Avoidance of ditches or other obstacles

Berms are thought to be the preferable solution, as compared to sound walls, as the earth is always the best insulator, acoustically, thermally, etc. The berms can easily be formed from discarded grade spoil and topsoil. This eliminates the need for expensive engineering and installation of a special sound wall. Berms would provide a natural appearance, and trees could then be planted on them for added esthetic value, as well as sound insulation.

4.3.1 Funnel Ravine / Jackson Coulee

There is a large Ravine, located 750m west of 69 Street, and is approximately 160m wide at its widest and highest point. It is aptly named by local residences, because of the way the ravine captures sound from the roadway and “funnels” it down and into the nearby residences. This is a common effect seen in valleys and ravines.
adjacent to high sources of noise. Special readings were therefore taken and documented at this location and tabled accordingly in the results.

5 Results and Data

Table 1: Predicted Sound levels at Fence-lines for Various Cross-Sections as Provided by AT

<table>
<thead>
<tr>
<th>Profile No.</th>
<th>E-Dist. to EB Lane (m)</th>
<th>E-SL (dBA)</th>
<th>W-Dist. to WB Lane (m)</th>
<th>W-SL (dBA)</th>
<th>R-Dist. to On-Ramp (m)</th>
<th>R-SL (dBA)</th>
<th>Combined Predicted SL (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>189m</td>
<td>69</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2</td>
<td>225m</td>
<td>69</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>3</td>
<td>168m</td>
<td>70</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>4</td>
<td>145m</td>
<td>73</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>5</td>
<td>75m</td>
<td>73</td>
<td>130m</td>
<td>70</td>
<td>N/A</td>
<td>N/A</td>
<td>75</td>
</tr>
<tr>
<td>6</td>
<td>71m</td>
<td>74</td>
<td>145m</td>
<td>70</td>
<td>N/A</td>
<td>N/A</td>
<td>75</td>
</tr>
<tr>
<td>7</td>
<td>73m</td>
<td>74</td>
<td>145m</td>
<td>71</td>
<td>N/A</td>
<td>N/A</td>
<td>76</td>
</tr>
<tr>
<td>8</td>
<td>74m</td>
<td>74</td>
<td>145m</td>
<td>72</td>
<td>N/A</td>
<td>N/A</td>
<td>76</td>
</tr>
<tr>
<td>9</td>
<td>70m</td>
<td>74</td>
<td>150m</td>
<td>72</td>
<td>N/A</td>
<td>N/A</td>
<td>76</td>
</tr>
<tr>
<td>10</td>
<td>80m</td>
<td>74</td>
<td>155m</td>
<td>70</td>
<td>67</td>
<td>65</td>
<td>75</td>
</tr>
<tr>
<td>11</td>
<td>88m</td>
<td>73</td>
<td>170m</td>
<td>70</td>
<td>58</td>
<td>65</td>
<td>75</td>
</tr>
<tr>
<td>12</td>
<td>100m</td>
<td>73</td>
<td>180m</td>
<td>70</td>
<td>38</td>
<td>66</td>
<td>75</td>
</tr>
<tr>
<td>13</td>
<td>146m</td>
<td>71</td>
<td>N/G</td>
<td>69</td>
<td>38</td>
<td>65</td>
<td>73</td>
</tr>
<tr>
<td>14</td>
<td>185m</td>
<td>70</td>
<td>N/G</td>
<td>69</td>
<td>61</td>
<td>65</td>
<td>73</td>
</tr>
<tr>
<td>15</td>
<td>130m</td>
<td>72</td>
<td>N/G</td>
<td>69</td>
<td>52</td>
<td>65</td>
<td>74</td>
</tr>
<tr>
<td>16</td>
<td>95m</td>
<td>74</td>
<td>N/G</td>
<td>69</td>
<td>64</td>
<td>65</td>
<td>75</td>
</tr>
</tbody>
</table>

The nomographs for the above table are filed in Appendix II
Table 2: Measured Sound Levels at Designated Points

<table>
<thead>
<tr>
<th>Measurement Location</th>
<th>Min SL (dBA)</th>
<th>Max SL (dBA)</th>
<th>Average SL (dBA)</th>
<th>Date</th>
<th>Time</th>
<th>Wind Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMP-1 Glenmore West of Elbow Dr.</td>
<td>61.1</td>
<td>88.9</td>
<td><strong>77</strong></td>
<td>Sept. 19</td>
<td>5 - 7 pm</td>
<td>W26km/hr/G45km/hr</td>
</tr>
<tr>
<td>SMP-2 Deerfoot-Ikea</td>
<td>58.1</td>
<td>82.9</td>
<td><strong>72</strong></td>
<td>Sept. 26</td>
<td>5 – 7 pm</td>
<td></td>
</tr>
<tr>
<td>SMP-3 Stoney Scenic Acres</td>
<td>42.7</td>
<td>86.1</td>
<td><strong>71.8</strong></td>
<td>Oct 7</td>
<td>2 – 3pm</td>
<td></td>
</tr>
<tr>
<td><strong>Average Over Locations</strong></td>
<td></td>
<td></td>
<td><strong>73.6</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: Detailed sound data in filed in Appendix III

Sound level prediction table results indicate an average combined impact of 75 dBA, and is within 1.4 dBA of measured results.

From the manual for 75 dBA and above: "**Noise Exposure is so severe that sound insulation costs [for houses] would be prohibitive and outdoor environment would be excessively noisy**". In addition, developers will not obtain financing if the sound levels will be above 55dBA.

For comparison, the excavators and dozers are producing 75 to 80 dBA sound levels, and they can clearly be heard from inside nearby houses. In addition, the vibrations transmitted can be keenly felt.
5.1 Traffic Sound Characteristics

Multi-lane traffic makes a shrill, sporadic roar as the vehicles cruise by. Large trucks make an additional deafening growl, peaking the sound levels in excess of 80dBA even at a setback of 100m. It is a hectic, dangerous and stressful environment, which presents a hazard to human hearing, rest, and overall health.

5.2 Sound Wall Effectiveness Measurement-Glenmore/Lakeview

Sound walls are widely used throughout the City of Calgary, typically in locations where residential communities would otherwise be exposed to multi-lane roadways. A sound wall was studied at the following location, labelled “SMP-4“:
Here, a gap in the wall made it possible to measure the sound levels on both sides. On the inside of the wall, a consistent 60 to 63 dBA was measured. This was perceived as cyclic, rapid “swish”s, but normal conversation was possible. Outside the wall, near the eight-lane roadway, 80 to 85 dBA was measured, which was very loud, and it was necessary to shout to be heard. The sound attenuation of the wall, then, was over 20 dBA.

To measure sound level drop off (“decay”) with distance, sound level measurements were then taken at three key landmarks walking south away from the wall:

<table>
<thead>
<tr>
<th>Landmark</th>
<th>Distance from Wall</th>
<th>Approx. Sound Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fence Gate</td>
<td>10m</td>
<td>60 dBA</td>
</tr>
<tr>
<td>Power Tower</td>
<td>65m</td>
<td>55dBA</td>
</tr>
<tr>
<td><strong>Interpolated</strong></td>
<td><strong>100m</strong></td>
<td><strong>53dBA</strong></td>
</tr>
<tr>
<td>Residential Road</td>
<td>150m</td>
<td>50dBA</td>
</tr>
</tbody>
</table>

Table 3. Sound Level with Setback Distance-Sound wall

Note a 10dBA drop over 150m in setback. 50dBA is comparable to Highway 8 under quiet traffic conditions, and is therefore reasonable for a community to live with. Effective sound attenuation is therefore an optimum combination of setback and sound attenuation. Where space in urban developments does not permit; the sound wall is the only remaining option, although they are often used in combination with berms to maximize effectiveness and save cost.

It was noted that the pathway opening had an “overlap” of several meters. Readings at the approach of the opening increased 5dBA and up to the full 20 dBA as we walked through the overlap segment.

Gaps in a sound barrier, then, significantly degrade, and even nullify the effectiveness of the barrier system. This would lead to significant re-work in construction if not properly designed initially.
5.3 **Sound Wall/Berm Combo Effectiveness Measurement-Glenmore**

The objective was to compare the effectiveness of a berm/wall combination with the simple wall structure that was analyzed in Lakeview, east of this location.

The sound protection in this area is comprised of a berm/brick wall combination. The berm is about 3.5m high on the north (Glenmore) side, and a little under 3m high on the south side. The wall is about 2m high.

Ambient temperature was 10° C. Moderate to very light winds (25 – 5 Km/hr) variable from the south and east.

Glenmore trail is slightly down cut so the north facing berm is higher than the south facing berm. The wall is 2m high. The south facing berm is open and used as an off-leash area.

Sound measurements were taken from the base of the wall facing north towards Glenmore (location “A”), from a height of 1.5m 25m south of the sound wall (location “B”), and from a height of 1.5m at 100m south of the sound wall (location “C”) as shown on the diagram below.
Table 4. Sound Level with Setback Distance-Sound wall + Berm

<table>
<thead>
<tr>
<th>Landmark</th>
<th>Distance from Wall</th>
<th>Avg. Sound Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>A – Top of Wall</td>
<td>0m</td>
<td>80 dBA</td>
</tr>
<tr>
<td>A1-Base of wall-Traffic Side</td>
<td>0m</td>
<td>73 dBA</td>
</tr>
<tr>
<td>B</td>
<td>25m</td>
<td>63 dBA</td>
</tr>
<tr>
<td>C</td>
<td>100m</td>
<td>51 dBA</td>
</tr>
</tbody>
</table>

Table 4 shows a 22 dBA drop in a 100m distance, dramatically higher than a 10 dBA drop in Table 3. The results show then, that the added value of the earthen berm is considerably more effective than just a wall structure.
5.4 The Value of Trees

Trees add not only natural oxygen and visual relief, but also provide a degree of acoustic shielding as well. A 2015 study of predicted average sound levels along Discovery Ridge was completed for AT, (leq. 24/65dBA Avg) at a time before clearing of the trees occurred.

See Appendix IV.

Note two key areas:

1) Funnel Ravine (DR Villas and DR Way)

<table>
<thead>
<tr>
<th>POINT 28</th>
<th>59.2 dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>POINT 29</td>
<td>66.8 dBA</td>
</tr>
<tr>
<td>POINT 30</td>
<td>61.5 dBA</td>
</tr>
</tbody>
</table>

Note the sudden jump of 7.6 dBA from point 28 to 29, and that this exceeds the 65 dBA allowable average.

2) East Discovery Ridge (DR Heights and 300 Place)

<table>
<thead>
<tr>
<th>POINT 44</th>
<th>56.1 dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>POINT 45</td>
<td>57.6 dBA</td>
</tr>
<tr>
<td>POINT 49</td>
<td>67.9 dBA</td>
</tr>
</tbody>
</table>

Note we have consistent readings until Point 48, and then a 10.3 dBA increase at Point 49. Examination of the surface features at the time reveals that the trees were present, and indeed both areas (1) and (2) presented gaps in the trees where the sound level average significantly increased 8 and 10 dBA, respectively. Adding trees, then, is an economical way of improvising on sound berms, and add pleasing and natural esthetic value.
5.5 Funnel Ravine Measurements and Recommendations

Readings were taken from the deck of a nearby residence in DR Villas, at a distance of approximately 200m from the existing roadway.

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Max SL (dBA)</th>
<th>Min SL (dBA)</th>
<th>Average SL (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sun, Sept. 24</td>
<td>6 - 8 pm</td>
<td>65.2</td>
<td>35.6</td>
<td>45.3</td>
</tr>
<tr>
<td>Thurs, Sept. 28</td>
<td>7 – 8am</td>
<td>71</td>
<td>52.4</td>
<td>62.1</td>
</tr>
</tbody>
</table>

Note the dramatic difference in the results, given the peak times, mostly from truck traffic. From the sound measurement point, an amplification resonance effect was evident, making the road seem louder and closer because of the walls of the valley. This is a commonly known effect for comparable locations. It was also noted that the terrain drops off steeply on the south side of the roadway, such that moving the eastbound lanes further north would not only help sound attenuation, but would substantially save several tons of grade fill required for this segment. As berming may not be practical, a suitable wall may be the only practical solution here.

6 Recommendations

Sound mitigation features are clearly required to protect existing residences along the SWCRR, due to the traffic speed and density, combined with the proximity of residential homes. Planning of land space, wall and/or berm height is Critical to achieve proper effectiveness, visual relief, and optimal project economy. Soft materials, such as simple grassed soil are more effective than hard surfaces. Topsoil berms are readily formed, (and some exist at the date of this writing) as the earth is the best insulator for sound. Berms are preferred, as they present a more natural appearance, can be used to plant trees, and would form excellent sound attenuation, while minimizing harmful psychological effects.
6.1 Profile Section Preliminary Berm Designs

Plan and Profile sections were sent by AT for comment. See Appendix V. Proposed berm and grade comments were sketched and sent back to AT for consideration. A summary of the key points are as follows:

Sections 1 and 2: Short berms are proposed at the toe of the existing slope. As these will not be effective, it is recommended to move them to the top, near the proposed road.

Sections 3, 4 and 5: Moving the proposed berms closer to the road and/or increasing the height from 3m to 4m would improve line-of-sight protection.

Sections 6 and 7: The existing slope near the houses and proposed berm may provide adequate protection.

Section 7B: Funnel Ravine; As noted in 5.5 a sound wall may be the only alternative, and tightening the alignment would save hundreds of tons of fill

Sections 8, 9 and 10: Berms of 5m are suggested and are easily made with existing grade. A lower grade cut is already suggested by AT.

Sections 11, 12 and 13. Berms are possible, but a wall may be the only alternative, as the off-ramp comes very close to the houses. *This indicates the road is too close to the houses and the alignment should be moved further north.*

Sections 14, 15, and 16. Lower grade is favorable for noise attenuation and berms. However, *no berms are proposed on the original AT plan.* Shallow berms, combined with a sound wall may be the only alternative, as again, *the road is too close to the houses.*

The above observations demonstrate that a critical criterion, Planning, has not been done. The alignment should be adjusted such that the houses closest to the on-ramp are an acceptable distance away. The current alignment will be more challenging, *but by no means impossible,* for sound attenuation, and require additional cost to the project to correct. This cost would have been saved if proper consultation had been completed and incorporated.
APPENDICIES

The Appendices can be viewed with the following link:

https://drive.google.com/drive/folders/0B47rELpLsN2VQUZxU3ctUVVoT0U?usp=sharing