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Environmental Noise Computer Modelling
For

Northeast Stoney Trail
In
Calgary, Alberta

Prepared for:
Alberta Transportation

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Executive Summary

aci Acoustical Consultants Inc., of Edmonton AB, was retained by Alberta Transportation (AT) to conduct an environmental noise assessment along the northeast and northwest sections of Stoney Trail in Calgary, Alberta. The purpose of the work was to conduct 24-hour environmental noise monitorings at various locations adjacent to the roadway and generate a computer noise model with current and future traffic conditions and compare the results to the AT noise guidelines. The results of the noise monitorings are provided in the reports entitled "*Environmental Noise Monitoring for Northeast Stoney Trail in Calgary, AB*" and "*Environmental Noise Monitoring for Northwest Stoney Trail in Calgary, AB*", by aci Acoustical Consultants Inc. This report details the computer noise modeling portion of the work for northeast Stoney Trail.

The results of the Current Conditions noise monitoring indicated noise levels which were below 65 dBA $L_{eq}24$[1]. It is important to note, however, that all of the noise monitoring locations were within the TUC and not on residential property and, as such, the results cannot be directly compared to the applicable criteria of 65 dBA $L_{eq}24$ since the noise monitoring results would be higher than at residential locations. In most locations, Stoney Trail was the dominant noise source. However there were locations at which other intersecting City streets either contributed a significant amount or were dominant.

The noise modeling results for Current Conditions matched well with the measurement results. The modeled noise levels did not exceeded the limit of 65 dBA $L_{eq}24$ at any of the residential outdoor receptor locations.

The noise modeling results for the Future Conditions (with projected traffic volumes for the 1.6 million population) indicated noise levels which were still below the limit of 65 dBA $L_{eq}24$ at most locations. The exceptions to this were locations northwest of the future interchange at Stoney Trail and 17 Avenue SE. The model indicated that some of the residential receptors at this location will have noise levels at or above 65 dBA $L_{eq}24$. It is important to note that most of the residential lots in this region have either no fence or rather, an acoustically ineffective fence (i.e. large gaps between the fence-boards). As such, fences were not included in the model at these locations.

A sensitivity analysis of the traffic volumes, traffic speeds, and % heavy trucks indicated that significant individual increases to each parameter or significant increases to all three combined, would result in additional locations with noise levels at or above 65 dBA $L_{eq}24$. Again, these were all locations at which fences were not included in the noise model because of the relative ineffectiveness of the existing fences to act as noise barriers.

[1] The term L_{eq} represents the energy equivalent sound level. This is a measure of the equivalent sound level for a specified period of time accounting for fluctuations.

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1.0 Introduction

aci Acoustical Consultants Inc., of Edmonton AB, was retained by Alberta Transportation to conduct an environmental noise assessment along the northeast and northwest sections of Stoney Trail in Calgary, Alberta. The purpose of the work was to conduct 24-hour environmental noise monitorings at various locations adjacent to the roadway and generate a computer noise model with current and future traffic conditions and compare the results to the AT noise guidelines. The results of the noise monitorings are provided in the reports entitled "*Environmental Noise Monitoring for Northeast Stoney Trail in Calgary, AB*" and "*Environmental Noise Monitoring for Northwest Stoney Trail in Calgary, AB*", by aci Acoustical Consultants Inc. This report details the computer noise modeling portion of the work for northeast Stoney Trail.

2.0 Location Description

The current sections of Stoney Trail span from 17 Avenue SE (on the east side of Calgary) to Highway 1 NW (on the west side of Calgary), as indicated in Figs. 1A & 1B. Throughout the entire span (approximately 45 km), Stoney Trail is a twinned road with at least 2-lanes in each direction and some sections with 3-lanes in each direction. The posted speed limit throughout is 100 km/hr. The current and future interchanges/intersections are as follows:

- 17 Avenue SE (a signalized light-controlled intersection at the time of the field monitoring. Scheduled to be an interchange in the near future).
- 16 Avenue NE (grade separated interchange).
- McKnight Blvd NE (grade separated interchange).
- Airport Trail NE (grade separated interchange not yet operational).
- Country Hills Blvd NE (grade separated interchange).
- Deerfoot Trail (grade separated interchange).
- 11 Street NE (currently no intersection. Future grade separated interchange).
- Harvest Hills Blvd NE (a signalized light-controlled intersection at the time of the field monitoring. Grade separated interchange under construction).
- 14 Street NW (currently no intersection. Future grade separated interchange).
- Beddington Trail NW (grade separated interchange).
- Shaganappi Trail NW (Fly-over with westbound Stoney Trail Access. Full interchange access under construction).
- Sarcee Trail NW (grade separated interchange).
- Country Hills Blvd NW (grade separated interchange).
- Crowchild Trail NW (a signalized light-controlled intersection at the time of the field monitoring. Grade separated interchange under construction).
- Scenic Acres Link (grade separated interchange with modifications related to the Crowchild Trail Interchange).

- Nose Hill Drive (a signalized light-controlled intersection at the time of the field monitoring. Scheduled to be an interchange in the near future).
- Highway 1 (grade separated interchange).

There will therefore be 18 grade separated interchanges within the study area for the future case noise modeling scenario[1].

The study area is primarily composed of single family detached residential areas with houses that back onto Stoney Trail. At some locations, there are houses that side or front onto Stoney Trail. There are also sections with multi-family 3 and 4 storey residential buildings adjacent to Stoney Trail. Finally, there are commercial areas and areas which have yet to be developed. In particular, there are no residential receptors adjacent to Stoney Trail between Airport Trail NE and 11 Street NE.

Topographically, the land in between Stoney Trail and the residential receptors for northeast Stoney Trail is relatively flat with no significant berms for shielding. Most of the residential lots have direct line-of-sight to Stoney Trail. For the northwest portion of Stoney Trail, there are sections with relatively flat ground in between the road and the adjacent houses and other sections with significant berms blocking the line-of-sight. In addition, for the northwest section, there are significant changes in elevation throughout. Because of this, topographical information provided by Alberta Transportation was incorporated into the noise model.

The vegetation in the areas between the residential locations and Stoney Trail consists mainly of field grasses with small sections of bushes and trees. Given the relative distances from the receptors to the roadways, the level of vegetative sound absorption is considered moderate. Vegetative sound absorption was incorporated into the noise model for calibration purposes (i.e. to ensure the modeled results matched with the monitored results).

[1] The Interchange at Metis Trail has been ignored because it is too far from the NE and NW residential study areas to have an impact on the noise climate.

3.0 Measurement & Modeling Methods

3.1. Environmental Noise Monitoring

As part of the study, a total of twenty five (25) 24-hour noise monitorings were conducted for the northeast and northwest Stoney Trail. The locations for each were selected based on consultation with personnel from AT as well as site specific observations and accessibility.

The measurements were conducted collecting broadband A-weighted as well as 1/3 octave band sound levels. This enabled a detailed analysis of the noise climate. The noise monitorings were conducted on weekdays under "typical" traffic conditions. In particular, measurements avoided any holidays, construction activity re-routing nearby, and other occurrences which would affect the normal traffic on the road. In addition, the monitorings were conducted in summer conditions (i.e. no snow cover) with dry road surfaces, no precipitation, and low wind-speeds. The monitorings were accompanied by a 24-hour digital audio recording for more detailed post process analysis. Finally, a portable weather monitor was used within the area to obtain local weather conditions. All noise measurement instrumentation was calibrated at the start of the measurements and then checked afterwards to ensure that there had been no calibration drift over the duration of the measurements. Refer to the reports entitled "*Environmental Noise Monitoring for Northeast Stoney Trail in Calgary, AB*" and "*Environmental Noise Monitoring for Northwest Stoney Trail in Calgary, AB*", by aci Acoustical Consultants Inc., for more detailed information on the measurement locations, start/stop times, and the equipment used.

3.2. Computer Noise Modeling

The computer noise modeling was conducted using the CADNA/A (version 4.1.137) software package. CADNA/A allows for the modeling of various noise sources such as road, rail, and various stationary sources. In addition, topographical features such as land contours, vegetation, and bodies of water can be included. Finally, meteorological conditions such as temperature, relative humidity, wind-speed and wind-direction can be included in the calculations.

The default calculation method for traffic noise in CADNA/A follows the German Standard RLS-90. It is aci's experience that this calculation method is accurate under the conditions present for this study, with a tendency to slightly over-predict potential noise levels (i.e. resulting in conservative values). The calculation method used for noise propagation follows the ISO standard 9613-2. All receiver locations

were assumed as being downwind from the source(s). In particular, as stated in Section 5 of the ISO document:

> *"Downwind propagation conditions for the method specified in this part of IS0 9613 are as specified in 5.4.3.3 of IS0 1996-2:1987, namely*
> - *wind direction within an angle of ± 45^0 of the direction connecting the centre of the dominant sound source and the centre of the specified receiver region, with the wind blowing from source to receiver, and*
> - *wind speed between approximately 1 m/s and 5 m/s, measured at a height of 3 m to 11 m above the ground.*
>
> *The equations for calculating the average downwind sound pressure level LAT(DW) in this part of IS0 9613, including the equations for attenuation given in clause 7, are the average for meteorological conditions within these limits. The term average here means the average over a short time interval, as defined in 3.1.*
> *These equations also hold, equivalently, for average propagation under a well-developed moderate ground-based temperature inversion, such as commonly occurs on clear, calm nights".*

Throughout the study area, the ground was given an absorption coefficient of 0.5. Trees and field grasses were added where appropriate to match existing conditions in addition to providing a calibration of the modeled results compared to the measured results at the various noise monitoring locations. Therefore, all sound level propagation calculations are considered conservatively representative of summertime conditions for all surrounding residents.

Note that not every commercial building and house in the area was modeled. Only the first row of buildings (in relation to the major roadways) were included, since these are the ones which will have the highest sound levels and will result in the greatest impact and level of shielding for structures further in.

As part of the study, various scenarios were modeled including:

1) Current conditions: This included existing road configurations and traffic volumes present during the noise monitoring traffic volumes. The baseline noise monitoring was used as a calibration method for the model.
2) Future conditions (approximately 30 years): This included final road configurations and interchanges with projected traffic volumes. The traffic volumes used in this scenario were indicative of projected traffic volumes for an approximate 1.6 million population.
3) Future conditions (as in item #2) with a sensitivity analysis:This involved modification of various traffic parameters (listed below) to determine their effect on noise levels.
    a. Traffic counts

b. Traffic speeds
c. Traffic composition (i.e. % heavy vehicles)

The computer noise modeling results were calculated in two ways. First, sound levels were calculated at specific receiver locations. This included the noise monitor locations as well as numerous representative residential locations. Next, the sound levels were calculated using a 5 m x 5 m grid over the entire study area for the Current and Future conditions. This provided color noise contours for easier visualization of the results.

Refer to Appendix I for a list of the computer noise modeling parameters.

4.0 Permissible Sound Levels

Environmental noise levels from road traffic are commonly described in terms of equivalent sound levels or L_{eq}. This is the level of a steady sound having the same acoustic energy, over a given time period, as the fluctuating sound. In addition, this energy averaged level is A–weighted to account for the reduced sensitivity of average human hearing to low frequency sounds. These L_{eq} in dBA, which are the most common environmental noise measure, are often given for day-time (07:00 to 22:00) L_{eq}Day and night-time (22:00 to 07:00) L_{eq}Night while other criteria use the entire 24-hour period as L_{eq}24.

The criterion used to evaluate the road noise in the study area is based on the document entitled "*Noise Attenuation Guidelines for Provincial Highways Under Provincial Jurisdiction Within Cities and Urban Areas"* by Alberta Transportation. The document specifies:

> "For construction or improvements of highways through cities and other urban areas, Alberta Transportation will adopt a noise level of 65 dBA L_{eq}24 measured 1.2 m above ground level and 2 meters inside the property line (outside the highway right-of-way). The measurements should be adjusted to the 10-year planning horizon, as a threshold to consider noise mitigation measures"

As such, the criterion used to assess the noise levels in the computer noise model will be **65 dBA L_{eq}24** for all current dwellings at a height of 1.2 m above grade. For typical residential lots that back or "side" onto the provincial roadway, the assessment will be taken at 2 m inside the residential property line in the back-yard amenity space. For typical residential lots that "front" onto the provincial highway, noise levels will be assessed at 2 m inside the residential property line in the front yard.

5.0 Monitoring Results

The noise monitoring results at all 25 measurement locations are shown in Table 1. The information shows the broadband A-weighted $L_{eq}24$, $L_{eq}Day$ and $L_{eq}Night$ sound levels. At most of the noise monitoring locations, traffic noise on Stoney Trail was the dominant noise source. There were some locations (Location 4 for example) at which the adjacent City of Calgary road was the dominant noise source due to the relative distances from the noise monitor to the City road and Stoney Trail. Note that, although all of the monitoring locations (except M18) resulted in noise levels below 65 dBA $L_{eq}24$, all but two of the monitoring locations (M10 & M13) were within the TUC and, as such, cannot be compared directly to the criteria of 65 dBA $L_{eq}24$. All comparisons to the criteria should be done with the modeled results at the residential locations presented in Section 6. The two monitoring location within residential property, however, were well below 65 dBA $L_{eq}24$.

More detailed information for the noise monitorings can be found in the reports entitled "*Environmental Noise Monitoring for Northeast Stoney Trail in Calgary, AB*" and "*Environmental Noise Monitoring for Northwest Stoney Trail in Calgary, AB*", by aci Acoustical Consultants Inc.

Table 1. Summary of Noise Monitoring Results

Monitor	$L_{eq}24$ (dBA)	$L_{eq}Day$ (dBA)	$L_{eq}Night$ (dBA)
M1	57.9	58.9	55.5
M2	60.0	60.8	57.9
M3	55.0	55.8	53.0
M4	55.5	56.5	52.9
M5	54.6	55.4	53.0
M6	60.2	61.2	57.6
M7	53.3	54.4	50.5
M8	55.1	56.1	52.9
M9	56.1	57.2	53.3
M10	56.5	57.4	54.5
M11	58.8	59.6	56.8
M12	57.0	58.4	52.7
M13	53.3	54.7	48.8
M14	60.1	61.5	55.6
M15	59.9	61.2	56.1
M16	51.6	52.9	47.6
M17	54.1	55.5	50.0
M18	67.6	69.0	63.3
M19	48.3	48.8	47.2
M20	51.9	52.7	50.2
M21	53.0	54.3	48.9
M22	50.2	51.2	47.8
M23	52.7	54.0	48.7
M24	49.1	49.7	48.1
M25	51.9	53.1	48.4

6.0 Modelling Results

6.1. Current Conditions

The results of the noise modeling under current conditions at the noise monitoring locations are presented in Table 2. The $L_{eq}24$, $L_{eq}Day$ and $L_{eq}Night$ sound levels are presented as well as the difference in the $L_{eq}24$ sound levels relative to the monitor results at each location. It can be seen that the modeled sound levels compare very well with the monitored results at each location. In all cases, the model calibration was such that the model gave slightly higher $L_{eq}24$ sound levels than the monitored results. In some cases, the relative differences are more than 1 dBA. This was done intentionally to account for noise monitored results that may have been slightly lower than anticipated due to wind conditions at the time of the monitoring. As such, all noise modeling results are considered conservative (i.e. slightly higher than actual).

Table 2. Noise Modeling Results Under Current Conditions at Monitor Locations

Monitor	$L_{eq}24$ (dBA)	Difference Relative to Monitor Results $L_{eq}24$ (dBA)	$L_{eq}Day$ (dBA)	$L_{eq}Night$ (dBA)
M1	58.4	0.5	60.0	52.7
M2	60.2	0.2	61.8	54.6
M3	56.4	1.4	58.0	50.7
M4	55.5	0.0	57.1	49.3
M5	55.7	1.1	57.2	50.0
M6	60.2	0.0	61.7	55.2
M7	54.0	0.7	55.5	49.0
M8	55.4	0.3	56.9	50.6
M9	56.1	0.0	57.5	51.3
M10	57.7	1.2	59.3	52.2
M11	59.4	0.6	60.9	54.4
M12	57.7	0.7	59.2	52.7
M13	54.7	1.4	56.3	49.0
M14	60.8	0.7	62.4	55.1
M15	60.2	0.3	61.8	54.5
M16	52.8	1.2	54.3	47.3
M17	54.6	0.5	56.2	49.3
M18	67.8	0.2	69.3	62.9
M19	49.6	1.3	51.1	44.6
M20	52.9	1.0	54.2	48.6
M21	54.3	1.3	55.7	49.9
M22	51.1	0.9	52.6	46.2
M23	53.2	0.5	54.6	48.3
M24	50.5	1.4	51.9	46.0
M25	52.8	0.9	54.3	47.5

The results of the Current Conditions noise modeling at the various residential property locations are presented in Tables 3A – 3C. The study area was divided into 3 separate sections, with the roadway interchanges as the dividers for each section. In addition to the information presented in Tables 3A – 3C, the $L_{eq}24$ color noise contours for the entire study area are shown in Figs. 2A – 2C. The color contours provide a very good representation of where the "hot" spots are and the relative contribution from each of the nearby roadways for the various receptor locations. In the event of a discrepancy between the results indicated in the color contours and the Tables, the Tables will be considered as correct. All of the current noise levels at residential property locations are under the limit of 65 dBA $L_{eq}24$.

Table 3A. Noise Modeling Results Under Current Conditions for Region 1

Receptor	$L_{eq}24$ (dBA)	L_{eq}Day (dBA)	L_{eq}Night (dBA)		Receptor	$L_{eq}24$ (dBA)	L_{eq}Day (dBA)	L_{eq}Night (dBA)
R1	54.7	56.3	49.0		R40	56.2	57.8	50.5
R2	54.3	55.9	48.6		R41	56.0	57.6	50.3
R3	54.2	55.7	48.5		R42	56.1	57.7	50.4
R4	54.8	56.4	49.1		R43	56.5	58.1	50.8
R5	55.5	57.1	49.8		R44	56.7	58.3	51.0
R6	56.5	58.1	50.9		R45	56.9	58.5	51.2
R7	57.9	59.5	52.2		R46	57.3	58.9	51.6
R8	58.6	60.2	52.9		R47	56.7	58.2	50.9
R9	59.0	60.6	53.3		R48	56.3	57.9	50.5
R10	59.4	61.0	53.8		R49	56.6	58.2	50.7
R11	59.1	60.7	53.5		R50	55.8	57.4	49.8
R12	58.4	59.9	52.7		R51	54.9	56.5	48.8
R13	58.9	60.4	53.2		R52	53.5	55.1	47.4
R14	59.2	60.8	53.6		R53	52.8	54.4	46.7
R15	59.4	61.0	53.8		R54	53.8	55.4	47.7
R16	60.0	61.5	54.3		R55	53.6	55.2	47.4
R17	59.4	61.0	53.8		R56	54.9	56.5	48.8
R18	59.3	60.8	53.6		R57	53.6	55.2	47.5
R19	59.0	60.6	53.4		R58	53.5	55.1	47.4
R20	59.0	60.6	53.4		R59	52.8	54.4	46.8
R21	58.7	60.3	53.1		R60	53.0	54.6	46.9
R22	59.2	60.7	53.5		R61	53.7	55.3	47.7
R23	58.4	60.0	52.7		R62	58.7	60.3	52.8
R24	57.9	59.5	52.3		R63	56.3	57.9	50.6
R25	57.6	59.2	51.9		R64	55.4	56.9	49.7
R26	57.5	59.1	51.9		R65	55.9	57.4	50.2
R27	56.6	58.2	51.0		R66	55.8	57.4	50.1
R28	56.1	57.7	50.5		R67	55.9	57.5	50.2
R29	54.6	56.1	48.9		R68	55.8	57.4	50.1
R30	52.5	54.0	46.8		R69	55.5	57.1	49.8
R31	51.8	53.4	46.1		R70	55.3	56.9	49.6
R32	52.0	53.6	46.3		R71	55.2	56.8	49.6
R33	52.6	54.2	47.0		R72	54.8	56.4	49.1
R34	53.2	54.7	47.5		R73	55.5	57.1	49.8
R35	54.0	55.6	48.3		R74	56.9	58.5	51.1
R36	55.4	57.0	49.7		R75	57.2	58.8	51.4
R37	56.5	58.1	50.8		R76	57.4	59.0	51.6
R38	56.3	57.9	50.7		R77	57.3	58.9	51.5
R39	56.3	57.9	50.7					

Table 3B. Noise Modeling Results Under Current Conditions for Region 2

Receptor	L_{eq}24 (dBA)	L_{eq}Day (dBA)	L_{eq}Night (dBA)		Receptor	L_{eq}24 (dBA)	L_{eq}Day (dBA)	L_{eq}Night (dBA)
R78	57.1	58.7	50.9		R112	54.2	55.7	48.6
R79	56.7	58.3	50.4		R113	52.8	54.4	47.4
R80	56.9	58.5	50.6		R114	51.7	53.2	46.3
R81	56.2	57.9	50.0		R115	52.2	53.7	47.0
R82	55.0	56.6	48.9		R116	51.6	53.1	46.6
R83	55.1	56.7	49.0		R117	51.5	53.0	46.5
R84	55.9	57.5	49.8		R118	50.3	51.8	45.2
R85	56.2	57.8	50.2		R119	51.5	53.0	46.5
R86	56.5	58.1	50.5		R120	54.1	55.6	49.1
R87	57.0	58.6	51.2		R121	53.7	55.2	48.7
R88	57.7	59.3	52.0		R122	53.6	55.1	48.7
R89	57.7	59.3	52.2		R123	54.1	55.5	49.1
R90	56.7	58.2	51.3		R124	53.9	55.4	48.9
R91	55.9	57.4	50.5		R125	54.1	55.5	49.1
R92	54.7	56.3	49.5		R126	53.9	55.4	48.9
R93	53.8	55.3	48.6		R127	54.0	55.5	48.9
R94	53.8	55.3	48.6		R128	53.9	55.4	48.8
R95	54.5	56.0	49.4		R129	53.5	55.0	48.4
R96	57.8	59.3	52.7		R130	53.5	55.0	48.4
R97	58.3	59.8	53.3		R131	53.0	54.5	47.9
R98	58.5	60.0	53.5		R132	53.2	54.7	48.0
R99	58.6	60.1	53.6		R133	53.4	54.9	48.2
R100	57.9	59.5	52.9		R134	53.1	54.6	47.9
R101	57.9	59.4	52.9		R135	54.3	55.9	48.9
R102	57.8	59.3	52.7		R136	52.2	53.8	46.9
R103	57.8	59.3	52.8		R137	52.4	54.0	47.1
R104	57.7	59.2	52.7		R138	53.8	55.3	48.2
R105	58.0	59.5	52.9		R139	52.4	54.0	46.9
R106	56.5	58.0	51.4		R140	52.7	54.3	47.2
R107	54.7	56.2	49.6		R141	54.5	56.1	48.8
R108	53.6	55.1	48.5		R142	53.5	55.1	47.9
R109	52.9	54.5	47.7		R143	53.8	55.3	48.1
R110	52.6	54.1	47.3		R144	55.0	56.6	49.3
R111	52.0	53.5	46.6		R145	58.4	59.9	52.6

Table 3C. Noise Modeling Results Under Current Conditions for Region 3

Receptor	L_{eq}24 (dBA)	L_{eq}Day (dBA)	L_{eq}Night (dBA)		Receptor	L_{eq}24 (dBA)	L_{eq}Day (dBA)	L_{eq}Night (dBA)
R146	58.2	59.8	52.5		R182	56.1	57.6	51.3
R147	53.3	54.9	47.7		R183	55.9	57.4	51.1
R148	51.9	53.5	46.4		R184	55.5	57.0	50.8
R149	52.2	53.8	46.7		R185	55.9	57.4	51.1
R150	55.1	56.6	49.7		R186	56.0	57.5	51.2
R151	54.5	56.0	49.1		R187	56.4	57.9	51.6
R152	54.4	55.9	49.2		R188	56.4	57.8	51.6
R153	54.6	56.1	49.5		R189	56.3	57.8	51.5
R154	53.3	54.8	48.3		R190	55.4	56.9	50.6
R155	53.3	54.8	48.3		R191	54.5	56.0	49.7
R156	54.1	55.6	49.1		R192	55.7	57.2	51.0
R157	54.8	56.3	50.0		R193	55.9	57.3	51.1
R158	54.8	56.2	49.9		R194	56.0	57.4	51.2
R159	54.9	56.4	50.1		R195	55.4	56.9	50.6
R160	55.0	56.5	50.2		R196	55.7	57.2	50.9
R161	55.1	56.5	50.3		R197	55.7	57.1	50.9
R162	55.2	56.6	50.4		R198	56.2	57.7	51.5
R163	55.7	57.2	50.9		R199	56.3	57.7	51.5
R164	56.1	57.5	51.3		R200	55.9	57.4	51.1
R165	55.0	56.5	50.2		R201	55.5	56.9	50.7
R166	54.7	56.2	50.0		R202	55.1	56.6	50.4
R167	53.3	54.7	48.4		R203	55.9	57.4	51.2
R168	52.0	53.5	47.1		R204	55.7	57.2	50.9
R169	51.5	53.0	46.5		R205	52.0	53.4	47.1
R170	50.7	52.2	45.6		R206	51.4	52.9	46.6
R171	50.5	52.0	45.3		R207	50.7	52.2	45.8
R172	52.1	53.6	46.8		R208	50.4	51.9	45.5
R173	52.1	53.7	46.8		R209	51.5	53.0	46.5
R174	50.6	52.1	45.5		R210	50.7	52.2	45.7
R175	50.7	52.2	45.6		R211	50.2	51.8	45.1
R176	49.7	51.2	44.7		R212	49.1	50.6	44.0
R177	51.4	52.9	46.4		R213	49.1	50.6	43.9
R178	52.9	54.4	48.1		R214	46.8	48.3	41.4
R179	53.4	54.9	48.7		R215	46.4	47.9	41.2
R180	54.4	55.9	49.6		R216	45.9	47.4	40.7
R181	55.9	57.4	51.1					

6.2. Future Conditions

The results of the noise modeling under future conditions (1.6 million population) at the residential receptor locations are presented in Tables 4A – 4C and shown in Figs. 3A – 3C. The $L_{eq}24$, $L_{eq}Day$ and $L_{eq}Night$ sound levels are presented in the Tables along with the relative increase in the $L_{eq}24$ compared to current conditions. Below each Table is a summary discussion of the results for that particular Region.

Table 4A. Noise Modeling Results Under Future Conditions for Region 1

Receptor	$L_{eq}24$ (dBA)	$L_{eq}24$ Increase Relative to Current Conditions (dBA)	L_{eq}Day (dBA)	L_{eq}Night (dBA)		Receptor	$L_{eq}24$ (dBA)	$L_{eq}24$ Increase Relative to Current Conditions (dBA)	L_{eq}Day (dBA)	L_{eq}Night (dBA)
R1	60.6	5.9	62.2	54.3		R40	62.2	6.0	63.7	56.4
R2	61.3	7.0	62.9	54.8		R41	62.1	6.1	63.6	56.3
R3	61.6	7.4	63.3	54.9		R42	62.2	6.1	63.8	56.5
R4	63.3	8.5	64.9	56.5		R43	62.7	6.2	64.3	56.9
R5	64.5	9.0	66.2	57.8		R44	62.9	6.2	64.5	57.1
R6	65.4	8.9	67.1	58.9		R45	63.1	6.2	64.7	57.3
R7	66.1	8.2	67.8	59.8		R46	63.5	6.2	65.1	57.7
R8	65.7	7.1	67.3	59.7		R47	62.8	6.1	64.4	57.0
R9	66.3	7.3	67.9	60.4		R48	62.4	6.1	64.0	56.5
R10	66.5	7.1	68.0	60.6		R49	62.7	6.1	64.3	56.6
R11	65.9	6.8	67.5	60.1		R50	61.8	6.0	63.4	55.7
R12	64.5	6.1	66.1	58.7		R51	60.9	6.0	62.5	54.7
R13	65.1	6.2	66.7	59.4		R52	59.5	6.0	61.1	53.3
R14	65.3	6.1	66.9	59.5		R53	58.8	6.0	60.4	52.6
R15	65.7	6.3	67.3	59.9		R54	59.9	6.1	61.5	53.7
R16	66.2	6.2	67.8	60.4		R55	59.7	6.1	61.4	53.5
R17	65.2	5.8	66.8	59.5		R56	61.1	6.2	62.7	54.8
R18	65.1	5.8	66.7	59.5		R57	59.5	5.9	61.1	53.3
R19	64.6	5.6	66.2	59.0		R58	59.3	5.8	61.0	53.2
R20	64.5	5.5	66.1	58.8		R59	58.5	5.7	60.1	52.3
R21	64.4	5.7	66.0	58.8		R60	58.5	5.5	60.1	52.4
R22	64.9	5.7	66.5	59.3		R61	58.6	4.9	60.2	52.5
R23	63.8	5.4	65.4	58.2		R62	62.0	3.3	63.6	56.0
R24	63.4	5.5	64.9	57.7		R63	62.5	6.2	64.0	56.8
R25	63.3	5.7	64.9	57.6		R64	61.5	6.1	63.1	55.8
R26	63.2	5.7	64.8	57.6		R65	62.0	6.1	63.6	56.3
R27	62.4	5.8	64.0	56.8		R66	61.9	6.1	63.5	56.2
R28	61.9	5.8	63.4	56.2		R67	62.0	6.1	63.5	56.3
R29	60.2	5.6	61.8	54.5		R68	61.9	6.1	63.4	56.1
R30	57.9	5.4	59.5	52.2		R69	61.5	6.0	63.1	55.8
R31	56.9	5.1	58.5	51.2		R70	61.3	6.0	62.9	55.6
R32	57.4	5.4	59.0	51.7		R71	61.2	6.0	62.8	55.5
R33	58.1	5.5	59.7	52.4		R72	60.7	5.9	62.3	55.0
R34	58.8	5.6	60.3	53.1		R73	61.3	5.8	62.9	55.6
R35	59.7	5.7	61.3	54.0		R74	62.4	5.5	64.0	56.7
R36	61.1	5.7	62.7	55.5		R75	62.5	5.3	64.1	56.8
R37	62.3	5.8	63.9	56.6		R76	62.5	5.1	64.1	56.7
R38	62.2	5.9	63.8	56.5		R77	62.3	5.0	63.9	56.5
R39	62.2	5.9	63.8	56.5						

The Future Conditions noise modeling for Region 1 indicated noise levels below 65 dBA $L_{eq}24$ at all locations with the exception of R6 – R11 and R15 – R18. It is important to note that most of the residential lots in this region have either no fence or an acoustically ineffective fence (i.e. large gaps between the fence-boards). As such, fences were not included in the model at these locations. The increases relative to the Current Conditions ranged from +3.3 to +9.0 dBA. At essentially all locations, these increases were due to the relatively significant projected increases in traffic volumes on Stoney Trail. In the case of the southern-most receptors, the larger increase was due to the proposed interchange at 17 Avenue SE and the associated ramps that will be significantly closer to the residential properties than the current roads.

Table 4B. Noise Modeling Results Under Future Conditions for Region 2

Receptor	L_{eq}24 (dBA)	L_{eq}24 Increase Relative to Current Conditions (dBA)	L_{eq}Day (dBA)	L_{eq}Night (dBA)		Receptor	L_{eq}24 (dBA)	L_{eq}24 Increase Relative to Current Conditions (dBA)	L_{eq}Day (dBA)	L_{eq}Night (dBA)
R78	62.5	5.4	64.1	56.3		R112	56.4	2.2	58.0	51.1
R79	62.6	5.9	64.2	56.4		R113	55.8	3.0	57.3	50.6
R80	62.9	6.0	64.5	56.7		R114	55.0	3.3	56.5	49.8
R81	62.2	6.0	63.8	56.1		R115	57.1	4.9	58.6	52.1
R82	60.8	5.8	62.4	54.8		R116	56.9	5.3	58.4	51.9
R83	60.8	5.7	62.4	54.8		R117	56.8	5.3	58.2	51.8
R84	61.5	5.6	63.1	55.6		R118	55.3	5.0	56.8	50.4
R85	61.5	5.3	63.1	55.7		R119	56.7	5.2	58.2	51.8
R86	61.6	5.1	63.2	55.9		R120	59.6	5.5	61.0	54.6
R87	62.1	5.1	63.7	56.5		R121	59.2	5.5	60.7	54.3
R88	62.8	5.1	64.4	57.4		R122	59.2	5.6	60.6	54.2
R89	62.9	5.2	64.5	57.6		R123	59.5	5.4	61.0	54.6
R90	62.0	5.3	63.5	56.7		R124	59.4	5.5	60.9	54.4
R91	61.2	5.3	62.7	56.0		R125	59.5	5.4	61.0	54.6
R92	60.0	5.3	61.5	54.8		R126	59.3	5.4	60.8	54.4
R93	59.2	5.4	60.7	54.1		R127	59.2	5.2	60.6	54.2
R94	59.2	5.4	60.7	54.1		R128	59.1	5.2	60.6	54.1
R95	60.0	5.5	61.5	54.9		R129	58.6	5.1	60.1	53.6
R96	63.3	5.5	64.8	58.3		R130	58.6	5.1	60.0	53.5
R97	63.9	5.6	65.4	58.9		R131	57.9	4.9	59.4	52.9
R98	64.1	5.6	65.5	59.1		R132	58.2	5.0	59.7	53.1
R99	64.1	5.5	65.6	59.1		R133	58.3	4.9	59.8	53.3
R100	63.2	5.3	64.7	58.2		R134	57.5	4.4	59.1	52.5
R101	63.2	5.3	64.7	58.2		R135	57.3	3.0	58.9	52.1
R102	63.1	5.3	64.6	58.1		R136	56.0	3.8	57.5	50.8
R103	63.2	5.4	64.7	58.2		R137	56.2	3.8	57.7	51.0
R104	63.1	5.4	64.6	58.2		R138	56.3	2.5	57.8	50.9
R105	63.3	5.3	64.8	58.3		R139	55.4	3.0	56.9	50.0
R106	61.9	5.4	63.4	56.9		R140	55.6	2.9	57.2	50.2
R107	59.9	5.2	61.4	54.9		R141	56.4	1.9	57.9	50.9
R108	58.5	4.9	60.0	53.5		R142	55.9	2.4	57.4	50.3
R109	57.4	4.5	58.9	52.3		R143	56.3	2.5	57.8	50.7
R110	56.5	3.9	58.0	51.4		R144	57.0	2.0	58.5	51.4
R111	55.5	3.5	57.0	50.3		R145	59.5	1.1	61.1	53.8

The Future Conditions noise modeling for Region 2 indicated noise levels below 65 dBA L_{eq}24 at all locations. The increases relative to the Current Conditions ranged from +1.1 to +6.0 dBA. At essentially all locations, these increases were due to the relatively significant projected increases in traffic volumes on Stoney Trail. Locations at which the noise climate was dominated more by intersecting City of Calgary roads (with lower projected increases in traffic volumes) than by Stoney Trail had lower a relative increase in noise level.

Table 4C. Noise Modeling Results Under Future Conditions for Region 3

Receptor	L_{eq}24 (dBA)	L_{eq}24 Increase Relative to Current Conditions (dBA)	L_{eq}Day (dBA)	L_{eq}Night (dBA)		Receptor	L_{eq}24 (dBA)	L_{eq}24 Increase Relative to Current Conditions (dBA)	L_{eq}Day (dBA)	L_{eq}Night (dBA)
R146	59.1	0.9	60.7	53.4		R182	61.1	5.0	62.6	56.3
R147	55.3	2.0	56.9	49.8		R183	60.9	5.0	62.4	56.2
R148	54.6	2.7	56.1	49.2		R184	60.7	5.2	62.1	55.9
R149	55.3	3.1	56.8	49.9		R185	61.1	5.2	62.5	56.3
R150	58.5	3.4	60.0	53.2		R186	61.1	5.1	62.6	56.4
R151	58.2	3.7	59.7	53.0		R187	61.6	5.2	63.0	56.8
R152	58.4	4.0	59.9	53.3		R188	61.4	5.0	62.9	56.7
R153	58.8	4.2	60.3	53.8		R189	61.4	5.1	62.8	56.6
R154	57.7	4.4	59.1	52.7		R190	60.4	5.0	61.9	55.6
R155	57.8	4.5	59.2	52.9		R191	59.4	4.9	60.9	54.7
R156	58.8	4.7	60.3	53.9		R192	60.8	5.1	62.3	56.1
R157	59.8	5.0	61.2	55.0		R193	61.0	5.1	62.5	56.2
R158	59.8	5.0	61.3	55.0		R194	61.1	5.1	62.6	56.3
R159	59.9	5.0	61.4	55.1		R195	60.5	5.1	62.0	55.8
R160	60.1	5.1	61.5	55.3		R196	60.9	5.2	62.3	56.1
R161	60.2	5.1	61.6	55.4		R197	60.8	5.1	62.3	56.0
R162	60.2	5.0	61.7	55.4		R198	61.4	5.2	62.8	56.6
R163	60.8	5.1	62.3	56.1		R199	61.4	5.1	62.9	56.6
R164	61.2	5.1	62.6	56.4		R200	61.1	5.2	62.5	56.3
R165	60.1	5.1	61.6	55.4		R201	60.7	5.2	62.1	55.9
R166	59.8	5.1	61.3	55.1		R202	60.3	5.2	61.8	55.5
R167	58.2	4.9	59.7	53.4		R203	61.1	5.2	62.6	56.3
R168	56.8	4.8	58.2	52.0		R204	60.9	5.2	62.4	56.1
R169	55.8	4.3	57.3	51.0		R205	58.1	6.1	59.6	52.9
R170	54.6	3.9	56.0	49.7		R206	57.9	6.5	59.4	52.6
R171	53.8	3.3	55.3	48.8		R207	57.1	6.4	58.7	51.9
R172	54.9	2.8	56.4	49.8		R208	57.0	6.6	58.5	51.7
R173	54.8	2.7	56.3	49.7		R209	59.2	7.7	60.8	53.7
R174	54.6	4.0	56.1	49.7		R210	59.1	8.4	60.7	53.4
R175	54.7	4.0	56.2	49.8		R211	58.2	8.0	59.8	52.5
R176	54.0	4.3	55.5	49.2		R212	58.9	9.8	60.5	53.0
R177	55.6	4.2	57.1	50.7		R213	63.7	14.6	65.3	57.5
R178	57.8	4.9	59.3	53.0		R214	60.9	14.1	62.5	54.7
R179	58.5	5.1	60.0	53.7		R215	61.3	14.9	62.9	55.1
R180	59.4	5.0	60.9	54.6		R216	62.0	16.1	63.6	55.8
R181	61.0	5.1	62.5	56.2						

The Future Conditions noise modeling for Region 3 indicated noise levels below 65 dBA L_{eq}24 at all locations. The increases relative to the Current Conditions ranged from +0.9 to +16.1 dBA. At essentially all locations, these increases were due to the projected increases in traffic volumes on Stoney Trail. Locations at which the noise climate was dominated more by intersecting City of Calgary roads (with lower projected increases in traffic volumes) than by Stoney Trail had a lower relative increase in noise levels. The highest increases (R209 – R216) were at locations adjacent to 96 Avenue NE which was not present for the Current Conditions.

6.3. Future Conditions Sensitivity Analysis

As part of the study, a sensitivity analysis was performed for the main traffic parameters associated with Stoney Trail. These included the overall traffic volumes, the traffic speeds, and the % heavy trucks. Each was evaluated with an increase and a decrease relative to the future conditions modeled. In addition, the cumulative impact of an increase in all three variables was assessed.

6.3.1. Traffic Volume Analysis

As with any noise source, the relative change in noise level with changing quantity is a simple logarithmic function as indicated below:

$$\Delta SPL = 10\log_{10}\left(relative\ change\right)$$

This means that if the traffic volumes, for example, are doubled, there will be a 3.0 dBA increase. **If there is a relative increase in traffic volumes of 25% (possible error in long term planning horizon), there will be a relative maximum 1.0 dBA increase for locations in which the noise climate is entirely dominated by Stoney Trail (i.e. relative to other City Roadways). Conversely, there is a maximum relative decrease of -1.3 dBA for a relative reduction in traffic volumes of 25%.** At locations in which the noise climate has a greater influence by City Roadways, changes in traffic volumes on Stoney Trail will have less of an impact. Tables 5A – 5C show the $L_{eq}24$ results for the ± 25% vehicles per day conditions as well as the relative change in noise levels at all modeled receptor locations. The relative increase in noise levels with a relative increase of 25% in traffic volumes would result in a small number of additional locations along northeast Stoney Trail to have noise levels at or above 65 dBA $L_{eq}24$.

As an aside, typical traffic volumes on typical urban roads only vary a few percent from day-to-day. This means that changes in noise levels from day-to-day are almost entirely dictated by environmental and meteorological conditions, and not by varying traffic volumes.

Table 5A. Effects of Changing Stoney Trail Traffic Volumes for Region 1

Receptor	$L_{eq}24$ with +25% Vehicles Per Day (dBA)	Increase Compared to Future Vehicles Per Day (dBA)		$L_{eq}24$ with -25% Vehicles Per Day (dBA)	Decrease Compared to Future Vehicles Per Day (dBA)		Receptor	$L_{eq}24$ with +25% Vehicles Per Day (dBA)	Increase Compared to Future Vehicles Per Day (dBA)		$L_{eq}24$ with -25% Vehicles Per Day (dBA)	Decrease Compared to Future Vehicles Per Day (dBA)
R1	60.8	0.2		60.4	-0.2		R40	63.0	0.8		61.1	-1.1
R2	61.5	0.2		61.0	-0.3		R41	62.9	0.8		61.0	-1.1
R3	61.9	0.3		61.3	-0.3		R42	63.1	0.9		61.3	-0.9
R4	63.6	0.3		62.9	-0.4		R43	63.4	0.7		61.7	-1.0
R5	64.9	0.4		64.1	-0.4		R44	63.7	0.8		62.0	-0.9
R6	65.9	0.5		64.9	-0.5		R45	63.9	0.8		62.2	-0.9
R7	66.7	0.6		65.4	-0.7		R46	64.3	0.8		62.7	-0.8
R8	66.4	0.7		64.9	-0.8		R47	63.6	0.8		62.0	-0.8
R9	67.0	0.7		65.3	-1.0		R48	63.1	0.7		61.6	-0.8
R10	67.3	0.8		65.5	-1.0		R49	63.3	0.6		61.9	-0.8
R11	66.7	0.8		64.9	-1.0		R50	62.3	0.5		61.1	-0.7
R12	65.3	0.8		63.5	-1.0		R51	61.3	0.4		60.4	-0.5
R13	66.0	0.9		64.1	-1.0		R52	59.8	0.3		59.1	-0.4
R14	66.1	0.8		64.3	-1.0		R53	59.1	0.3		58.5	-0.3
R15	66.6	0.9		64.7	-1.0		R54	60.1	0.2		59.7	-0.2
R16	67.1	0.9		65.2	-1.0		R55	59.9	0.2		59.5	-0.2
R17	66.1	0.9		64.1	-1.1		R56	61.2	0.1		61.0	-0.1
R18	66.1	1.0		64.0	-1.1		R57	59.7	0.2		59.3	-0.2
R19	65.6	1.0		63.5	-1.1		R58	59.5	0.2		59.2	-0.1
R20	65.4	0.9		63.3	-1.2		R59	58.6	0.1		58.3	-0.2
R21	65.4	1.0		63.2	-1.2		R60	58.6	0.1		58.3	-0.2
R22	65.9	1.0		63.7	-1.2		R61	58.7	0.1		58.5	-0.1
R23	64.8	1.0		62.7	-1.1		R62	62.1	0.1		62.0	0.0
R24	64.3	0.9		62.2	-1.2		R63	63.2	0.7		61.6	-0.9
R25	64.2	0.9		62.1	-1.2		R64	62.2	0.7		60.7	-0.8
R26	64.2	1.0		62.0	-1.2		R65	62.7	0.7		61.2	-0.8
R27	63.4	1.0		61.2	-1.2		R66	62.6	0.7		61.1	-0.8
R28	62.8	0.9		60.7	-1.2		R67	62.6	0.6		61.2	-0.8
R29	61.1	0.9		59.0	-1.2		R68	62.5	0.6		61.1	-0.8
R30	58.8	0.9		56.8	-1.1		R69	62.1	0.6		60.8	-0.7
R31	57.8	0.9		55.9	-1.0		R70	61.9	0.6		60.7	-0.6
R32	58.3	0.9		56.3	-1.1		R71	61.7	0.5		60.6	-0.6
R33	59.0	0.9		57.0	-1.1		R72	61.2	0.5		60.1	-0.6
R34	59.7	0.9		57.6	-1.2		R73	61.7	0.4		60.8	-0.5
R35	60.6	0.9		58.5	-1.2		R74	62.7	0.3		62.1	-0.3
R36	62.1	1.0		60.0	-1.1		R75	62.8	0.3		62.2	-0.3
R37	63.2	0.9		61.1	-1.2		R76	62.7	0.2		62.3	-0.2
R38	63.1	0.9		61.1	-1.1		R77	62.5	0.2		62.1	-0.2
R39	63.1	0.9		61.1	-1.1							

Table 5B. Effects of Changing Stoney Trail Traffic Volumes for Region 2

Receptor	L_{eq}24 with +25% Vehicles Per Day (dBA)	Increase Compared to Future Vehicles Per Day (dBA)		L_{eq}24 with -25% Vehicles Per Day (dBA)	Decrease Compared to Future Vehicles Per Day (dBA)		Receptor	L_{eq}24 with +25% Vehicles Per Day (dBA)	Increase Compared to Future Vehicles Per Day (dBA)		L_{eq}24 with -25% Vehicles Per Day (dBA)	Decrease Compared to Future Vehicles Per Day (dBA)
R78	62.5	0.0		62.4	-0.1		R112	57.0	0.6		55.8	-0.6
R79	62.7	0.1		62.5	-0.1		R113	56.5	0.7		55.1	-0.7
R80	63.0	0.1		62.8	-0.1		R114	55.7	0.7		54.2	-0.8
R81	62.3	0.1		62.0	-0.2		R115	58.0	0.9		56.0	-1.1
R82	61.0	0.2		60.6	-0.2		R116	57.8	0.9		55.8	-1.1
R83	61.0	0.2		60.5	-0.3		R117	57.7	0.9		55.6	-1.2
R84	61.8	0.3		61.2	-0.3		R118	56.2	0.9		54.2	-1.1
R85	61.9	0.4		61.1	-0.4		R119	57.6	0.9		55.6	-1.1
R86	62.1	0.5		61.1	-0.5		R120	60.5	0.9		58.4	-1.2
R87	62.7	0.6		61.5	-0.6		R121	60.2	1.0		58.0	-1.2
R88	63.5	0.7		62.1	-0.7		R122	60.1	0.9		58.0	-1.2
R89	63.6	0.7		62.1	-0.8		R123	60.5	1.0		58.3	-1.2
R90	62.7	0.7		61.1	-0.9		R124	60.3	0.9		58.2	-1.2
R91	62.0	0.8		60.3	-0.9		R125	60.4	0.9		58.3	-1.2
R92	60.7	0.7		59.1	-0.9		R126	60.2	0.9		58.2	-1.1
R93	60.0	0.8		58.3	-0.9		R127	60.0	0.8		58.0	-1.2
R94	60.1	0.9		58.2	-1.0		R128	59.9	0.8		58.0	-1.1
R95	60.8	0.8		58.9	-1.1		R129	59.5	0.9		57.5	-1.1
R96	64.2	0.9		62.2	-1.1		R130	59.4	0.8		57.5	-1.1
R97	64.8	0.9		62.7	-1.2		R131	58.8	0.9		56.9	-1.0
R98	65.0	0.9		62.9	-1.2		R132	59.0	0.8		57.1	-1.1
R99	65.0	0.9		62.9	-1.2		R133	59.1	0.8		57.3	-1.0
R100	64.1	0.9		62.0	-1.2		R134	58.3	0.8		56.7	-0.8
R101	64.1	0.9		62.0	-1.2		R135	57.9	0.6		56.7	-0.6
R102	64.0	0.9		62.0	-1.1		R136	56.6	0.6		55.3	-0.7
R103	64.1	0.9		62.0	-1.2		R137	56.8	0.6		55.5	-0.7
R104	64.1	1.0		62.0	-1.1		R138	56.6	0.3		55.9	-0.4
R105	64.2	0.9		62.1	-1.2		R139	55.7	0.3		55.0	-0.4
R106	62.8	0.9		60.7	-1.2		R140	56.0	0.4		55.3	-0.3
R107	60.8	0.9		58.7	-1.2		R141	56.6	0.2		56.2	-0.2
R108	59.3	0.8		57.4	-1.1		R142	56.0	0.1		55.7	-0.2
R109	58.2	0.8		56.4	-1.0		R143	56.5	0.2		56.1	-0.2
R110	57.3	0.8		55.6	-0.9		R144	57.1	0.1		56.8	-0.2
R111	56.2	0.7		54.6	-0.9		R145	59.6	0.1		59.4	-0.1

Table 5C. Effects of Changing Stoney Trail Traffic Volumes for Region 3

Receptor	L_{eq}24 with +25% Vehicles Per Day (dBA)	Increase Compared to Future Vehicles Per Day (dBA)		L_{eq}24 with -25% Vehicles Per Day (dBA)	Decrease Compared to Future Vehicles Per Day (dBA)		Receptor	L_{eq}24 with +25% Vehicles Per Day (dBA)	Increase Compared to Future Vehicles Per Day (dBA)		L_{eq}24 with -25% Vehicles Per Day (dBA)	Decrease Compared to Future Vehicles Per Day (dBA)
R146	59.2	0.1		59.0	-0.1		R182	62.1	1.0		59.9	-1.2
R147	55.6	0.3		55.1	-0.2		R183	61.9	1.0		59.7	-1.2
R148	54.9	0.3		54.2	-0.4		R184	61.6	0.9		59.4	-1.3
R149	55.6	0.3		54.9	-0.4		R185	62.0	0.9		59.8	-1.3
R150	58.8	0.3		58.1	-0.4		R186	62.1	1.0		59.9	-1.2
R151	58.6	0.4		57.6	-0.6		R187	62.5	0.9		60.3	-1.3
R152	59.0	0.6		57.7	-0.7		R188	62.4	1.0		60.2	-1.2
R153	59.5	0.7		58.0	-0.8		R189	62.3	0.9		60.1	-1.3
R154	58.4	0.7		56.7	-1.0		R190	61.4	1.0		59.2	-1.2
R155	58.6	0.8		56.7	-1.1		R191	60.4	1.0		58.2	-1.2
R156	59.7	0.9		57.7	-1.1		R192	61.8	1.0		59.6	-1.2
R157	60.7	0.9		58.6	-1.2		R193	62.0	1.0		59.8	-1.2
R158	60.7	0.9		58.6	-1.2		R194	62.1	1.0		59.9	-1.2
R159	60.9	1.0		58.7	-1.2		R195	61.5	1.0		59.3	-1.2
R160	61.0	0.9		58.9	-1.2		R196	61.8	0.9		59.6	-1.3
R161	61.1	0.9		58.9	-1.3		R197	61.8	1.0		59.6	-1.2
R162	61.1	0.9		59.0	-1.2		R198	62.3	0.9		60.1	-1.3
R163	61.8	1.0		59.6	-1.2		R199	62.4	1.0		60.2	-1.2
R164	62.1	0.9		59.9	-1.3		R200	62.0	0.9		59.8	-1.3
R165	61.1	1.0		58.9	-1.2		R201	61.6	0.9		59.4	-1.3
R166	60.8	1.0		58.6	-1.2		R202	61.3	1.0		59.1	-1.2
R167	59.1	0.9		57.0	-1.2		R203	62.1	1.0		59.9	-1.2
R168	57.7	0.9		55.6	-1.2		R204	61.9	1.0		59.7	-1.2
R169	56.7	0.9		54.7	-1.1		R205	58.8	0.7		57.2	-0.9
R170	55.4	0.8		53.5	-1.1		R206	58.6	0.7		57.0	-0.9
R171	54.5	0.7		52.9	-0.9		R207	57.9	0.8		56.3	-0.8
R172	55.5	0.6		54.1	-0.8		R208	57.7	0.7		56.2	-0.8
R173	55.5	0.7		54.0	-0.8		R209	59.8	0.6		58.6	-0.6
R174	55.4	0.8		53.5	-1.1		R210	59.6	0.5		58.6	-0.5
R175	55.6	0.9		53.6	-1.1		R211	58.7	0.5		57.8	-0.4
R176	54.9	0.9		52.9	-1.1		R212	59.2	0.3		58.5	-0.4
R177	56.5	0.9		54.5	-1.1		R213	63.8	0.1		63.6	-0.1
R178	58.8	1.0		56.6	-1.2		R214	61.0	0.1		60.7	-0.2
R179	59.5	1.0		57.3	-1.2		R215	61.4	0.1		61.2	-0.1
R180	60.3	0.9		58.2	-1.2		R216	62.0	0.0		61.9	-0.1
R181	62.0	1.0		59.8	-1.2							

6.3.2. Traffic Speed Analysis

In order to determine the effect of different traffic speeds, two scenarios were modeled. The baseline future conditions case included a speed of 100 km/hr on Stoney Trail throughout the entire study area. This speed was increased to 110 km/hr and then decreased to 90 km/hr to determine the relative change compared to 100 km/hr. It is unlikely that the posted traffic speeds will fall outside of this range. Tables 6A – 6C show the $L_{eq}24$ results for both the 110 km/hr and 90 km/hr conditions as well as the change in noise levels (relative to 100 km/hr) at all modeled receptor locations. **When increasing the speed to 110 km/hr, the noise levels increased by 0.0 – 0.6 dBA. When reducing the speed to 90 km/hr, the noise levels decreased by 0.0 – 0.6 dBA.** As with the traffic volumes assessment, the largest changes were at locations where the noise climate was completely dominated by the noise from Stoney Trail. The locations with the lowest changes were those where the noise climate was dominated by City of Calgary Roads. The relative increase in noise levels with a speed increase to 110 km/hr would result in a small number of additional locations along northeast Stoney Trail to have noise levels at or above 65 dBA $L_{eq}24$. Given that a minimum 2.0 – 3.0 dBA change is required before most people start to notice a change, changing the traffic speeds will not significantly impact the perceived noise climate.

Table 6A. Effects of Changing Stoney Trail Traffic Speed for Region 1

Receptor	L_{eq}24 with 110 km/hr on Stoney Trail (dBA)	Increase Compared to 100 km/hr (dBA)		L_{eq}24 with 90 km/hr on Stoney Trail (dBA)	Decrease Compared to 100 km/hr (dBA)		Receptor	L_{eq}24 with 110 km/hr on Stoney Trail (dBA)	Increase Compared to 100 km/hr (dBA)		L_{eq}24 with 90 km/hr on Stoney Trail (dBA)	Decrease Compared to 100 km/hr (dBA)
R1	60.7	0.1		60.5	-0.1		R40	62.6	0.4		61.8	-0.4
R2	61.4	0.1		61.2	-0.1		R41	62.5	0.4		61.7	-0.4
R3	61.7	0.1		61.5	-0.1		R42	62.7	0.5		61.9	-0.3
R4	63.4	0.1		63.1	-0.2		R43	63.1	0.4		62.3	-0.4
R5	64.7	0.2		64.3	-0.2		R44	63.3	0.4		62.6	-0.3
R6	65.6	0.2		65.2	-0.2		R45	63.5	0.4		62.8	-0.3
R7	66.4	0.3		65.9	-0.2		R46	63.9	0.4		63.2	-0.3
R8	66.1	0.4		65.4	-0.3		R47	63.2	0.4		62.5	-0.3
R9	66.7	0.4		65.9	-0.4		R48	62.7	0.3		62.1	-0.3
R10	66.9	0.4		66.1	-0.4		R49	63.0	0.3		62.4	-0.3
R11	66.3	0.4		65.5	-0.4		R50	62.0	0.2		61.5	-0.3
R12	64.9	0.4		64.1	-0.4		R51	61.1	0.2		60.7	-0.2
R13	65.6	0.5		64.8	-0.3		R52	59.7	0.2		59.3	-0.2
R14	65.7	0.4		64.9	-0.4		R53	59.0	0.2		58.7	-0.1
R15	66.2	0.5		65.3	-0.4		R54	60.0	0.1		59.8	-0.1
R16	66.7	0.5		65.9	-0.3		R55	59.8	0.1		59.7	0.0
R17	65.7	0.5		64.8	-0.4		R56	61.2	0.1		61.0	-0.1
R18	65.6	0.5		64.7	-0.4		R57	59.6	0.1		59.4	-0.1
R19	65.1	0.5		64.2	-0.4		R58	59.4	0.1		59.3	0.0
R20	65.0	0.5		64.1	-0.4		R59	58.6	0.1		58.4	-0.1
R21	64.9	0.5		64.0	-0.4		R60	58.6	0.1		58.4	-0.1
R22	65.4	0.5		64.5	-0.4		R61	58.7	0.1		58.6	0.0
R23	64.3	0.5		63.4	-0.4		R62	62.1	0.1		62.0	0.0
R24	63.8	0.4		62.9	-0.5		R63	62.8	0.3		62.1	-0.4
R25	63.8	0.5		62.8	-0.5		R64	61.9	0.4		61.2	-0.3
R26	63.7	0.5		62.8	-0.4		R65	62.4	0.4		61.7	-0.3
R27	62.9	0.5		62.0	-0.4		R66	62.2	0.3		61.6	-0.3
R28	62.4	0.5		61.4	-0.5		R67	62.3	0.3		61.7	-0.3
R29	60.7	0.5		59.7	-0.5		R68	62.2	0.3		61.6	-0.3
R30	58.4	0.5		57.5	-0.4		R69	61.8	0.3		61.2	-0.3
R31	57.4	0.5		56.5	-0.4		R70	61.6	0.3		61.1	-0.2
R32	57.9	0.5		57.0	-0.4		R71	61.4	0.2		60.9	-0.3
R33	58.6	0.5		57.7	-0.4		R72	61.0	0.3		60.5	-0.2
R34	59.2	0.4		58.3	-0.5		R73	61.5	0.2		61.1	-0.2
R35	60.2	0.5		59.3	-0.4		R74	62.6	0.2		62.3	-0.1
R36	61.6	0.5		60.7	-0.4		R75	62.6	0.1		62.4	-0.1
R37	62.8	0.5		61.9	-0.4		R76	62.6	0.1		62.4	-0.1
R38	62.7	0.5		61.8	-0.4		R77	62.4	0.1		62.2	-0.1
R39	62.6	0.4		61.8	-0.4							

Table 6B. Effects of Changing Stoney Trail Traffic Speed for Region 2

Receptor	L_{eq}24 with 110 km/hr on Stoney Trail (dBA)	Increase Compared to 100 km/hr (dBA)		L_{eq}24 with 90 km/hr on Stoney Trail (dBA)	Decrease Compared to 100 km/hr (dBA)		Receptor	L_{eq}24 with 110 km/hr on Stoney Trail (dBA)	Increase Compared to 100 km/hr (dBA)		L_{eq}24 with 90 km/hr on Stoney Trail (dBA)	Decrease Compared to 100 km/hr (dBA)
R78	62.5	0.0		62.5	0.0		R112	56.7	0.3		56.2	-0.2
R79	62.6	0.0		62.6	0.0		R113	56.2	0.4		55.5	-0.3
R80	62.9	0.0		62.8	-0.1		R114	55.3	0.3		54.7	-0.3
R81	62.3	0.1		62.1	-0.1		R115	57.6	0.5		56.7	-0.4
R82	60.9	0.1		60.7	-0.1		R116	57.4	0.5		56.5	-0.4
R83	60.9	0.1		60.7	-0.1		R117	57.2	0.4		56.3	-0.5
R84	61.7	0.2		61.4	-0.1		R118	55.8	0.5		54.9	-0.4
R85	61.7	0.2		61.3	-0.2		R119	57.2	0.5		56.3	-0.4
R86	61.9	0.3		61.4	-0.2		R120	60.0	0.4		59.1	-0.5
R87	62.4	0.3		61.9	-0.2		R121	59.7	0.5		58.8	-0.4
R88	63.2	0.4		62.6	-0.2		R122	59.6	0.4		58.7	-0.5
R89	63.3	0.4		62.6	-0.3		R123	60.0	0.5		59.1	-0.4
R90	62.3	0.3		61.6	-0.4		R124	59.8	0.4		58.9	-0.5
R91	61.6	0.4		60.9	-0.3		R125	60.0	0.5		59.1	-0.4
R92	60.4	0.4		59.7	-0.3		R126	59.8	0.5		58.9	-0.4
R93	59.6	0.4		58.9	-0.3		R127	59.6	0.4		58.7	-0.5
R94	59.7	0.5		58.9	-0.3		R128	59.5	0.4		58.7	-0.4
R95	60.4	0.4		59.6	-0.4		R129	59.1	0.5		58.2	-0.4
R96	63.8	0.5		62.9	-0.4		R130	59.0	0.4		58.2	-0.4
R97	64.4	0.5		63.5	-0.4		R131	58.4	0.5		57.5	-0.4
R98	64.5	0.4		63.6	-0.5		R132	58.6	0.4		57.8	-0.4
R99	64.6	0.5		63.7	-0.4		R133	58.7	0.4		57.9	-0.4
R100	63.6	0.4		62.8	-0.4		R134	57.9	0.4		57.2	-0.3
R101	63.7	0.5		62.8	-0.4		R135	57.6	0.3		57.1	-0.2
R102	63.6	0.5		62.7	-0.4		R136	56.3	0.3		55.8	-0.2
R103	63.7	0.5		62.8	-0.4		R137	56.5	0.3		56.0	-0.2
R104	63.6	0.5		62.7	-0.4		R138	56.4	0.1		56.1	-0.2
R105	63.8	0.5		62.9	-0.4		R139	55.6	0.2		55.2	-0.2
R106	62.4	0.5		61.4	-0.5		R140	55.8	0.2		55.5	-0.1
R107	60.3	0.4		59.4	-0.5		R141	56.5	0.1		56.3	-0.1
R108	58.9	0.4		58.1	-0.4		R142	56.0	0.1		55.8	-0.1
R109	57.8	0.4		57.0	-0.4		R143	56.4	0.1		56.2	-0.1
R110	56.9	0.4		56.2	-0.3		R144	57.0	0.0		56.9	-0.1
R111	55.8	0.3		55.2	-0.3		R145	59.5	0.0		59.5	0.0

Table 6C. Effects of Changing Stoney Trail Traffic Speed for Region 3

Receptor	L_{eq}24 with 110 km/hr on Stoney Trail (dBA)	Increase Compared to 100 km/hr (dBA)		L_{eq}24 with 90 km/hr on Stoney Trail (dBA)	Decrease Compared to 100 km/hr (dBA)		Receptor	L_{eq}24 with 110 km/hr on Stoney Trail (dBA)	Increase Compared to 100 km/hr (dBA)		L_{eq}24 with 90 km/hr on Stoney Trail (dBA)	Decrease Compared to 100 km/hr (dBA)
R146	59.1	0.0		59.1	0.0		R182	61.6	0.5		60.7	-0.4
R147	55.5	0.2		55.3	0.0		R183	61.4	0.5		60.5	-0.4
R148	54.8	0.2		54.5	-0.1		R184	61.2	0.5		60.2	-0.5
R149	55.5	0.2		55.1	-0.2		R185	61.6	0.5		60.6	-0.5
R150	58.6	0.1		58.3	-0.2		R186	61.6	0.5		60.7	-0.4
R151	58.4	0.2		58.0	-0.2		R187	62.1	0.5		61.1	-0.5
R152	58.7	0.3		58.2	-0.2		R188	61.9	0.5		61.0	-0.4
R153	59.1	0.3		58.5	-0.3		R189	61.9	0.5		60.9	-0.5
R154	58.1	0.4		57.3	-0.4		R190	60.9	0.5		60.0	-0.4
R155	58.2	0.4		57.4	-0.4		R191	59.9	0.5		59.0	-0.4
R156	59.2	0.4		58.4	-0.4		R192	61.3	0.5		60.4	-0.4
R157	60.2	0.4		59.3	-0.5		R193	61.5	0.5		60.6	-0.4
R158	60.3	0.5		59.4	-0.4		R194	61.6	0.5		60.6	-0.5
R159	60.4	0.5		59.5	-0.4		R195	61.0	0.5		60.1	-0.4
R160	60.6	0.5		59.6	-0.5		R196	61.4	0.5		60.4	-0.5
R161	60.6	0.4		59.7	-0.5		R197	61.3	0.5		60.4	-0.4
R162	60.7	0.5		59.8	-0.4		R198	61.9	0.5		60.9	-0.5
R163	61.3	0.5		60.4	-0.4		R199	61.9	0.5		61.0	-0.4
R164	61.7	0.5		60.7	-0.5		R200	61.6	0.5		60.6	-0.5
R165	60.6	0.5		59.7	-0.4		R201	61.2	0.5		60.2	-0.5
R166	60.3	0.5		59.4	-0.4		R202	60.8	0.5		59.9	-0.4
R167	58.7	0.5		57.7	-0.5		R203	61.6	0.5		60.7	-0.4
R168	57.3	0.5		56.3	-0.5		R204	61.4	0.5		60.4	-0.5
R169	56.3	0.5		55.4	-0.4		R205	58.5	0.4		57.7	-0.4
R170	55.0	0.4		54.2	-0.4		R206	58.2	0.3		57.5	-0.4
R171	54.1	0.3		53.4	-0.4		R207	57.5	0.4		56.8	-0.3
R172	55.2	0.3		54.6	-0.3		R208	57.4	0.4		56.7	-0.3
R173	55.2	0.4		54.5	-0.3		R209	59.5	0.3		59.0	-0.2
R174	55.0	0.4		54.2	-0.4		R210	59.3	0.2		58.9	-0.2
R175	55.1	0.4		54.3	-0.4		R211	58.5	0.3		58.1	-0.1
R176	54.5	0.5		53.6	-0.4		R212	59.1	0.2		58.8	-0.1
R177	56.0	0.4		55.2	-0.4		R213	63.7	0.0		63.6	-0.1
R178	58.3	0.5		57.4	-0.4		R214	60.9	0.0		60.8	-0.1
R179	59.0	0.5		58.0	-0.5		R215	61.3	0.0		61.2	-0.1
R180	59.9	0.5		58.9	-0.5		R216	62.0	0.0		61.9	-0.1
R181	61.5	0.5		60.6	-0.4							

6.3.3. % Heavy Trucks Analysis

In order to determine the effect of varying % heavy trucks, two scenarios were modeled. The future conditions were increased by 5% and then decreased by 5% to determine a relative range of values. It is unlikely that the % heavy trucks will fall outside of this range. The results are shown in Tables 7A – 7C. It can be seen that **the relative sound level increase with a relative increase of 5% heavy trucks is approximately 0.0 – 0.9 dBA. The relative sound level decrease with a relative decrease of 5% heavy trucks is approximately 0.0 – 1.1 dBA.** As with the traffic volumes and traffic speeds assessments, the largest changes were at locations where the noise climate was completely dominated by the noise from Stoney Trail. The locations with the lowest changes were those where the noise climate was dominated by City of Calgary Roads. The relative increase in noise levels with a relative increase of 5% heavy trucks would result in a small number of additional locations along northeast Stoney Trail to have noise levels at or above 65 dBA $L_{eq}24$. Again, given that a minimum 2.0 – 3.0 dBA change is required before most people start to notice a change, it will take a significant change to the % heavy trucks before most people will notice the difference.

In general, the effect of changing the % heavy trucks is logarithmic. The difference between 0% and 1% is significant (approximately 0.7 dBA) while the difference between 10% and 11% is much less (approximately 0.2 dBA). Since the % heavy trucks is at least 6% during the day-time along the entire Stoney Trail, small % changes will not have a significant impact.

Table 7A. Effects of Changing Stoney Trail % Heavy Trucks for Region 1

Receptor	L_{eq}24 with 5% Greater Heavy Trucks on Stoney Trail (dBA)	Increase Compared to Future Conditions (dBA)		L_{eq}24 with 5% Fewer Heavy Trucks on Stoney Trail (dBA)	Decrease Compared to Future Conditions (dBA)		Receptor	L_{eq}24 with 5% Greater Heavy Trucks on Stoney Trail (dBA)	Increase Compared to Future Conditions (dBA)		L_{eq}24 with 5% Fewer Heavy Trucks on Stoney Trail (dBA)	Decrease Compared to Future Conditions (dBA)
R1	60.8	0.2		60.4	-0.2		R40	62.8	0.6		61.3	-0.9
R2	61.5	0.2		61.1	-0.2		R41	62.7	0.6		61.3	-0.8
R3	61.8	0.2		61.3	-0.3		R42	62.9	0.7		61.5	-0.7
R4	63.5	0.2		63.0	-0.3		R43	63.3	0.6		61.9	-0.8
R5	64.8	0.3		64.2	-0.3		R44	63.6	0.7		62.2	-0.7
R6	65.8	0.4		65.0	-0.4		R45	63.7	0.6		62.4	-0.7
R7	66.6	0.5		65.6	-0.5		R46	64.1	0.6		62.9	-0.6
R8	66.3	0.6		65.1	-0.6		R47	63.4	0.6		62.2	-0.6
R9	66.9	0.6		65.5	-0.8		R48	63.0	0.6		61.7	-0.7
R10	67.1	0.6		65.7	-0.8		R49	63.2	0.5		62.1	-0.6
R11	66.5	0.6		65.1	-0.8		R50	62.2	0.4		61.3	-0.5
R12	65.2	0.7		63.7	-0.8		R51	61.2	0.3		60.5	-0.4
R13	65.8	0.7		64.3	-0.8		R52	59.8	0.3		59.2	-0.3
R14	66.0	0.7		64.5	-0.8		R53	59.1	0.3		58.5	-0.3
R15	66.4	0.7		64.9	-0.8		R54	60.1	0.2		59.7	-0.2
R16	66.9	0.7		65.4	-0.8		R55	59.9	0.2		59.6	-0.1
R17	65.9	0.7		64.4	-0.8		R56	61.2	0.1		61.0	-0.1
R18	65.9	0.8		64.2	-0.9		R57	59.6	0.1		59.4	-0.1
R19	65.4	0.8		63.7	-0.9		R58	59.5	0.2		59.2	-0.1
R20	65.2	0.7		63.6	-0.9		R59	58.6	0.1		58.3	-0.2
R21	65.2	0.8		63.5	-0.9		R60	58.6	0.1		58.4	-0.1
R22	65.7	0.8		64.0	-0.9		R61	58.7	0.1		58.5	-0.1
R23	64.6	0.8		62.9	-0.9		R62	62.1	0.1		62.0	0.0
R24	64.1	0.7		62.5	-0.9		R63	63.0	0.5		61.8	-0.7
R25	64.1	0.8		62.3	-1.0		R64	62.1	0.6		60.9	-0.6
R26	64.0	0.8		62.3	-0.9		R65	62.6	0.6		61.4	-0.6
R27	63.2	0.8		61.5	-0.9		R66	62.4	0.5		61.2	-0.7
R28	62.6	0.7		60.9	-1.0		R67	62.5	0.5		61.3	-0.7
R29	60.9	0.7		59.3	-0.9		R68	62.4	0.5		61.3	-0.6
R30	58.6	0.7		57.0	-0.9		R69	62.0	0.5		61.0	-0.5
R31	57.6	0.7		56.1	-0.8		R70	61.8	0.5		60.8	-0.5
R32	58.1	0.7		56.6	-0.8		R71	61.6	0.4		60.7	-0.5
R33	58.8	0.7		57.3	-0.8		R72	61.1	0.4		60.3	-0.4
R34	59.5	0.7		57.9	-0.9		R73	61.6	0.3		60.9	-0.4
R35	60.4	0.7		58.8	-0.9		R74	62.7	0.3		62.2	-0.2
R36	61.9	0.8		60.2	-0.9		R75	62.7	0.2		62.3	-0.2
R37	63.0	0.7		61.4	-0.9		R76	62.7	0.2		62.4	-0.1
R38	62.9	0.7		61.3	-0.9		R77	62.4	0.1		62.2	-0.1
R39	62.9	0.7		61.3	-0.9							

Table 7B. Effects of Changing Stoney Trail % Heavy Trucks for Region 2

Receptor	L_{eq}24 with 5% Greater Heavy Trucks on Stoney Trail (dBA)	Increase Compared to Future Conditions (dBA)		L_{eq}24 with 5% Fewer Heavy Trucks on Stoney Trail (dBA)	Decrease Compared to Future Conditions (dBA)		Receptor	L_{eq}24 with 5% Greater Heavy Trucks on Stoney Trail (dBA)	Increase Compared to Future Conditions (dBA)		L_{eq}24 with 5% Fewer Heavy Trucks on Stoney Trail (dBA)	Decrease Compared to Future Conditions (dBA)
R78	62.5	0.0		62.4	-0.1		R112	56.9	0.5		56.0	-0.4
R79	62.7	0.1		62.5	-0.1		R113	56.3	0.5		55.2	-0.6
R80	63.0	0.1		62.8	-0.1		R114	55.5	0.5		54.3	-0.7
R81	62.3	0.1		62.1	-0.1		R115	57.8	0.7		56.3	-0.8
R82	61.0	0.2		60.6	-0.2		R116	57.6	0.7		56.0	-0.9
R83	61.0	0.2		60.5	-0.3		R117	57.5	0.7		55.9	-0.9
R84	61.8	0.3		61.3	-0.2		R118	56.1	0.8		54.5	-0.8
R85	61.8	0.3		61.2	-0.3		R119	57.5	0.8		55.8	-0.9
R86	62.0	0.4		61.2	-0.4		R120	60.3	0.7		58.7	-0.9
R87	62.6	0.5		61.6	-0.5		R121	60.0	0.8		58.3	-0.9
R88	63.3	0.5		62.3	-0.5		R122	59.9	0.7		58.2	-1.0
R89	63.5	0.6		62.3	-0.6		R123	60.3	0.8		58.6	-0.9
R90	62.5	0.5		61.3	-0.7		R124	60.1	0.7		58.5	-0.9
R91	61.8	0.6		60.5	-0.7		R125	60.3	0.8		58.6	-0.9
R92	60.6	0.6		59.3	-0.7		R126	60.1	0.8		58.5	-0.8
R93	59.9	0.7		58.5	-0.7		R127	59.9	0.7		58.3	-0.9
R94	59.9	0.7		58.5	-0.7		R128	59.8	0.7		58.2	-0.9
R95	60.6	0.6		59.1	-0.9		R129	59.3	0.7		57.8	-0.8
R96	64.0	0.7		62.5	-0.8		R130	59.2	0.6		57.7	-0.9
R97	64.6	0.7		63.0	-0.9		R131	58.6	0.7		57.1	-0.8
R98	64.8	0.7		63.2	-0.9		R132	58.8	0.6		57.4	-0.8
R99	64.8	0.7		63.2	-0.9		R133	59.0	0.7		57.5	-0.8
R100	63.9	0.7		62.3	-0.9		R134	58.1	0.6		56.9	-0.6
R101	63.9	0.7		62.3	-0.9		R135	57.8	0.5		56.8	-0.5
R102	63.9	0.8		62.2	-0.9		R136	56.5	0.5		55.5	-0.5
R103	63.9	0.7		62.3	-0.9		R137	56.7	0.5		55.7	-0.5
R104	63.9	0.8		62.2	-0.9		R138	56.5	0.2		55.9	-0.4
R105	64.0	0.7		62.4	-0.9		R139	55.7	0.3		55.1	-0.3
R106	62.6	0.7		61.0	-0.9		R140	55.9	0.3		55.4	-0.2
R107	60.6	0.7		59.0	-0.9		R141	56.5	0.1		56.2	-0.2
R108	59.2	0.7		57.6	-0.9		R142	56.0	0.1		55.7	-0.2
R109	58.0	0.6		56.6	-0.8		R143	56.4	0.1		56.1	-0.2
R110	57.1	0.6		55.8	-0.7		R144	57.1	0.1		56.9	-0.1
R111	56.1	0.6		54.8	-0.7		R145	59.6	0.1		59.4	-0.1

Table 7C. Effects of Changing Stoney Trail % Heavy Trucks for Region 3

Receptor	L_{eq}24 with 5% Greater Heavy Trucks on Stoney Trail (dBA)	Increase Compared to Future Conditions (dBA)		L_{eq}24 with 5% Fewer Heavy Trucks on Stoney Trail (dBA)	Decrease Compared to Future Conditions (dBA)		Receptor	L_{eq}24 with 5% Greater Heavy Trucks on Stoney Trail (dBA)	Increase Compared to Future Conditions (dBA)		L_{eq}24 with 5% Fewer Heavy Trucks on Stoney Trail (dBA)	Decrease Compared to Future Conditions (dBA)
R146	59.2	0.1		59.0	-0.1		R182	61.9	0.8		60.2	-0.9
R147	55.5	0.2		55.2	-0.1		R183	61.7	0.8		60.0	-0.9
R148	54.9	0.3		54.3	-0.3		R184	61.4	0.7		59.7	-1.0
R149	55.6	0.3		55.0	-0.3		R185	61.8	0.7		60.1	-1.0
R150	58.7	0.2		58.2	-0.3		R186	61.9	0.8		60.2	-0.9
R151	58.5	0.3		57.8	-0.4		R187	62.3	0.7		60.6	-1.0
R152	58.9	0.5		57.9	-0.5		R188	62.2	0.8		60.5	-0.9
R153	59.3	0.5		58.2	-0.6		R189	62.1	0.7		60.4	-1.0
R154	58.3	0.6		56.9	-0.8		R190	61.2	0.8		59.5	-0.9
R155	58.4	0.6		57.0	-0.8		R191	60.2	0.8		58.5	-0.9
R156	59.5	0.7		57.9	-0.9		R192	61.6	0.8		59.9	-0.9
R157	60.5	0.7		58.9	-0.9		R193	61.8	0.8		60.1	-0.9
R158	60.5	0.7		58.9	-0.9		R194	61.9	0.8		60.2	-0.9
R159	60.7	0.8		59.0	-0.9		R195	61.3	0.8		59.6	-0.9
R160	60.8	0.7		59.2	-0.9		R196	61.6	0.7		59.9	-1.0
R161	60.9	0.7		59.2	-1.0		R197	61.6	0.8		59.9	-0.9
R162	61.0	0.8		59.3	-0.9		R198	62.2	0.8		60.4	-1.0
R163	61.6	0.8		59.9	-0.9		R199	62.2	0.8		60.5	-0.9
R164	62.0	0.8		60.2	-1.0		R200	61.8	0.7		60.1	-1.0
R165	60.9	0.8		59.2	-0.9		R201	61.4	0.7		59.7	-1.0
R166	60.6	0.8		58.9	-0.9		R202	61.1	0.8		59.4	-0.9
R167	59.0	0.8		57.3	-0.9		R203	61.9	0.8		60.2	-0.9
R168	57.5	0.7		55.9	-0.9		R204	61.7	0.8		60.0	-0.9
R169	56.5	0.7		55.0	-0.8		R205	58.7	0.6		57.4	-0.7
R170	55.2	0.6		53.8	-0.8		R206	58.4	0.5		57.2	-0.7
R171	54.4	0.6		53.1	-0.7		R207	57.7	0.6		56.5	-0.6
R172	55.4	0.5		54.2	-0.7		R208	57.6	0.6		56.4	-0.6
R173	55.4	0.6		54.2	-0.6		R209	59.7	0.5		58.8	-0.4
R174	55.3	0.7		53.8	-0.8		R210	59.5	0.4		58.7	-0.4
R175	55.4	0.7		53.9	-0.8		R211	58.6	0.4		57.9	-0.3
R176	54.8	0.8		53.2	-0.8		R212	59.2	0.3		58.6	-0.3
R177	56.3	0.7		54.8	-0.8		R213	63.8	0.1		63.6	-0.1
R178	58.6	0.8		56.9	-0.9		R214	61.0	0.1		60.8	-0.1
R179	59.3	0.8		57.6	-0.9		R215	61.4	0.1		61.2	-0.1
R180	60.2	0.8		58.5	-0.9		R216	62.0	0.0		61.9	-0.1
R181	61.8	0.8		60.1	-0.9							

6.3.4. Cumulative Sensitivity Analysis

With the information provided by the sensitivity analysis for each of the three main traffic parameters, it is possible to determine a cumulative effect if all three are taken into account simultaneously. The results are presented in Tables 8A – 8C. Relative increases for locations which are most directly impacted by Stoney Trail are as high as 2.1 dBA. At locations in which the noise climate is most directly impacted by City of Calgary roadways, the increases are as low as 0.1 dBA. The relative increase in noise levels associated with a relative increase of 25% traffic volumes, 5% heavy trucks and a speed of 110 km/hr would result in a small number of additional locations along northeast Stoney Trail to have noise levels at or above 65 dBA $L_{eq}24$.

Table 8A. Effects of Cumulative Effects on Noise Levels For Region 1

Receptor	L_{eq}24 with 25% Additional Vehicles, Speed of 110 km/hr, 5% Greater Heavy Trucks on Stoney Trail (dBA)	Increase Compared to Future Conditions (dBA)		Receptor	L_{eq}24 with 25% Additional Vehicles, Speed of 110 km/hr, 5% Greater Heavy Trucks on Stoney Trail (dBA)	Increase Compared to Future Conditions (dBA)
R1	61.1	0.5		R40	64.1	1.9
R2	61.9	0.6		R41	63.9	1.8
R3	62.3	0.7		R42	64.1	1.9
R4	64.0	0.7		R43	64.4	1.7
R5	65.4	0.9		R44	64.7	1.8
R6	66.5	1.1		R45	64.9	1.8
R7	67.5	1.4		R46	65.2	1.7
R8	67.3	1.6		R47	64.5	1.7
R9	68.0	1.7		R48	64.0	1.6
R10	68.3	1.8		R49	64.1	1.4
R11	67.7	1.8		R50	63.1	1.3
R12	66.4	1.9		R51	61.9	1.0
R13	67.0	1.9		R52	60.4	0.9
R14	67.2	1.9		R53	59.6	0.8
R15	67.6	1.9		R54	60.5	0.6
R16	68.2	2.0		R55	60.2	0.5
R17	67.2	2.0		R56	61.4	0.3
R18	67.2	2.1		R57	59.9	0.4
R19	66.7	2.1		R58	59.7	0.4
R20	66.5	2.0		R59	58.9	0.4
R21	66.5	2.1		R60	58.9	0.4
R22	67.0	2.1		R61	58.9	0.3
R23	65.9	2.1		R62	62.2	0.2
R24	65.4	2.0		R63	64.1	1.6
R25	65.4	2.1		R64	63.2	1.7
R26	65.3	2.1		R65	63.6	1.6
R27	64.5	2.1		R66	63.5	1.6
R28	64.0	2.1		R67	63.5	1.5
R29	62.3	2.1		R68	63.4	1.5
R30	59.9	2.0		R69	62.9	1.4
R31	58.9	2.0		R70	62.6	1.3
R32	59.4	2.0		R71	62.4	1.2
R33	60.1	2.0		R72	61.9	1.2
R34	60.8	2.0		R73	62.3	1.0
R35	61.7	2.0		R74	63.2	0.8
R36	63.2	2.1		R75	63.2	0.7
R37	64.4	2.1		R76	63.0	0.5
R38	64.2	2.0		R77	62.7	0.4
R39	64.2	2.0				

Table 8B. Effects of Cumulative Effects on Noise Levels For Region 2

Receptor	$L_{eq}24$ with 25% Additional Vehicles, Speed of 110 km/hr, 5% Greater Heavy Trucks on Stoney Trail (dBA)	Increase Compared to Future Conditions (dBA)		Receptor	$L_{eq}24$ with 25% Additional Vehicles, Speed of 110 km/hr, 5% Greater Heavy Trucks on Stoney Trail (dBA)	Increase Compared to Future Conditions (dBA)
R78	62.6	0.1		R112	57.7	1.3
R79	62.8	0.2		R113	57.3	1.5
R80	63.1	0.2		R114	56.5	1.5
R81	62.5	0.3		R115	59.1	2.0
R82	61.3	0.5		R116	58.9	2.0
R83	61.4	0.6		R117	58.8	2.0
R84	62.3	0.8		R118	57.4	2.1
R85	62.5	1.0		R119	58.8	2.1
R86	62.8	1.2		R120	61.6	2.0
R87	63.4	1.3		R121	61.3	2.1
R88	64.3	1.5		R122	61.2	2.0
R89	64.6	1.7		R123	61.6	2.1
R90	63.6	1.6		R124	61.4	2.0
R91	62.9	1.7		R125	61.6	2.1
R92	61.7	1.7		R126	61.4	2.1
R93	61.0	1.8		R127	61.1	1.9
R94	61.1	1.9		R128	61.0	1.9
R95	61.9	1.9		R129	60.6	2.0
R96	65.3	2.0		R130	60.5	1.9
R97	65.9	2.0		R131	59.8	1.9
R98	66.1	2.0		R132	60.0	1.8
R99	66.1	2.0		R133	60.2	1.9
R100	65.2	2.0		R134	59.2	1.7
R101	65.2	2.0		R135	58.6	1.3
R102	65.2	2.1		R136	57.4	1.4
R103	65.2	2.0		R137	57.6	1.4
R104	65.2	2.1		R138	57.1	0.8
R105	65.3	2.0		R139	56.2	0.8
R106	63.9	2.0		R140	56.4	0.8
R107	61.9	2.0		R141	56.9	0.5
R108	60.4	1.9		R142	56.3	0.4
R109	59.2	1.8		R143	56.8	0.5
R110	58.3	1.8		R144	57.3	0.3
R111	57.1	1.6		R145	59.7	0.2

Table 8C. Effects of Cumulative Effects on Noise Levels For Region 3

Receptor	L_{eq}24 with 25% Additional Vehicles, Speed of 110 km/hr, 5% Greater Heavy Trucks on Stoney Trail (dBA)	Increase Compared to Future Conditions (dBA)		Receptor	L_{eq}24 with 25% Additional Vehicles, Speed of 110 km/hr, 5% Greater Heavy Trucks on Stoney Trail (dBA)	Increase Compared to Future Conditions (dBA)
R146	59.3	0.2		R182	63.2	2.1
R147	55.9	0.6		R183	63.1	2.2
R148	55.4	0.8		R184	62.8	2.1
R149	56.1	0.8		R185	63.2	2.1
R150	59.3	0.8		R186	63.3	2.2
R151	59.3	1.1		R187	63.7	2.1
R152	59.8	1.4		R188	63.6	2.2
R153	60.4	1.6		R189	63.5	2.1
R154	59.4	1.7		R190	62.5	2.1
R155	59.6	1.8		R191	61.5	2.1
R156	60.8	2.0		R192	63.0	2.2
R157	61.8	2.0		R193	63.2	2.2
R158	61.9	2.1		R194	63.2	2.1
R159	62.0	2.1		R195	62.7	2.2
R160	62.2	2.1		R196	63.0	2.1
R161	62.3	2.1		R197	62.9	2.1
R162	62.3	2.1		R198	63.5	2.1
R163	63.0	2.2		R199	63.6	2.2
R164	63.3	2.1		R200	63.2	2.1
R165	62.3	2.2		R201	62.8	2.1
R166	62.0	2.2		R202	62.5	2.2
R167	60.3	2.1		R203	63.2	2.1
R168	58.9	2.1		R204	63.0	2.1
R169	57.8	2.0		R205	59.8	1.7
R170	56.4	1.8		R206	59.5	1.6
R171	55.5	1.7		R207	58.8	1.7
R172	56.4	1.5		R208	58.6	1.6
R173	56.4	1.6		R209	60.5	1.3
R174	56.5	1.9		R210	60.2	1.1
R175	56.6	1.9		R211	59.3	1.1
R176	56.0	2.0		R212	59.7	0.8
R177	57.5	1.9		R213	64.0	0.3
R178	59.9	2.1		R214	61.2	0.3
R179	60.6	2.1		R215	61.6	0.3
R180	61.5	2.1		R216	62.2	0.2
R181	63.2	2.2				

7.0 Conclusion

The results of the Current Conditions noise monitoring indicated noise levels which were below 65 dBA $L_{eq}24$. It is important to note, however, that all of the noise monitoring locations were within the TUC and not on residential property and, as such, the results cannot be directly compared to the applicable criteria of 65 dBA $L_{eq}24$ since the noise monitoring results would be higher than at residential property locations. In most locations, Stoney Trail was the dominant noise source. However there were locations at which other intersecting City streets either contributed a significant amount or were dominant.

The noise modeling results for Current Conditions matched well with the measurement results. The modeled noise levels did not exceeded the limit of 65 dBA $L_{eq}24$ at any of the residential outdoor receptor locations.

The noise modeling results for the Future Conditions (with projected traffic volumes for the 1.6 million population) indicated noise levels which were still below the limit of 65 dBA $L_{eq}24$ at most locations. The exceptions to this were locations northwest of the future interchange at Stoney Trail and 17 Avenue SE. The model indicated that some of the residential receptors at this location will have noise levels at or above 65 dBA $L_{eq}24$. It is important to note that most of the residential lots in this region have either no fence or rather, an acoustically ineffective fence (i.e. large gaps between the fence-boards). As such, fences were not included in the model at these locations.

A sensitivity analysis of the traffic volumes, traffic speeds, and % heavy trucks indicated that significant individual increases to each parameter or significant increases to all three combined, would result in additional locations with noise levels at or above 65 dBA $L_{eq}24$. Again, these were all locations at which fences were not included in the noise model because of the relative ineffectiveness of the existing fences to act as noise barriers.

8.0 References

- *"Noise Attenuation Guidelines for Provincial Highways Under Provincial Jurisdiction Within Cities and Urban Areas"*, by Alberta Transportation. October, 2002
- *"Environmental Noise Monitoring for Northeast Stoney Trail in Calgary, AB"*. Prepared for Alberta Transportation by aci Acoustical Consultants Inc. April, 2011.
- *"Environmental Noise Monitoring for Northwest Stoney Trail in Calgary, AB"*. Prepared for Alberta Transportation by aci Acoustical Consultants Inc. April, 2011.
- City of Edmonton Urban Traffic Noise Policy (C506), 2004
- International Organization for Standardization (ISO), *Standard 1996-1, Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basic quantities and assessment procedures, 2003,* Geneva Switzerland.
- International Organization for Standardization (ISO), *Standard 9613-1, Acoustics – Attenuation of sound during propagation outdoors – Part 1: Calculation of absorption of sound by the atmosphere, 1993,* Geneva Switzerland.
- International Organization for Standardization (ISO), *Standard 9613-2, Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation, 1996,* Geneva Switzerland.

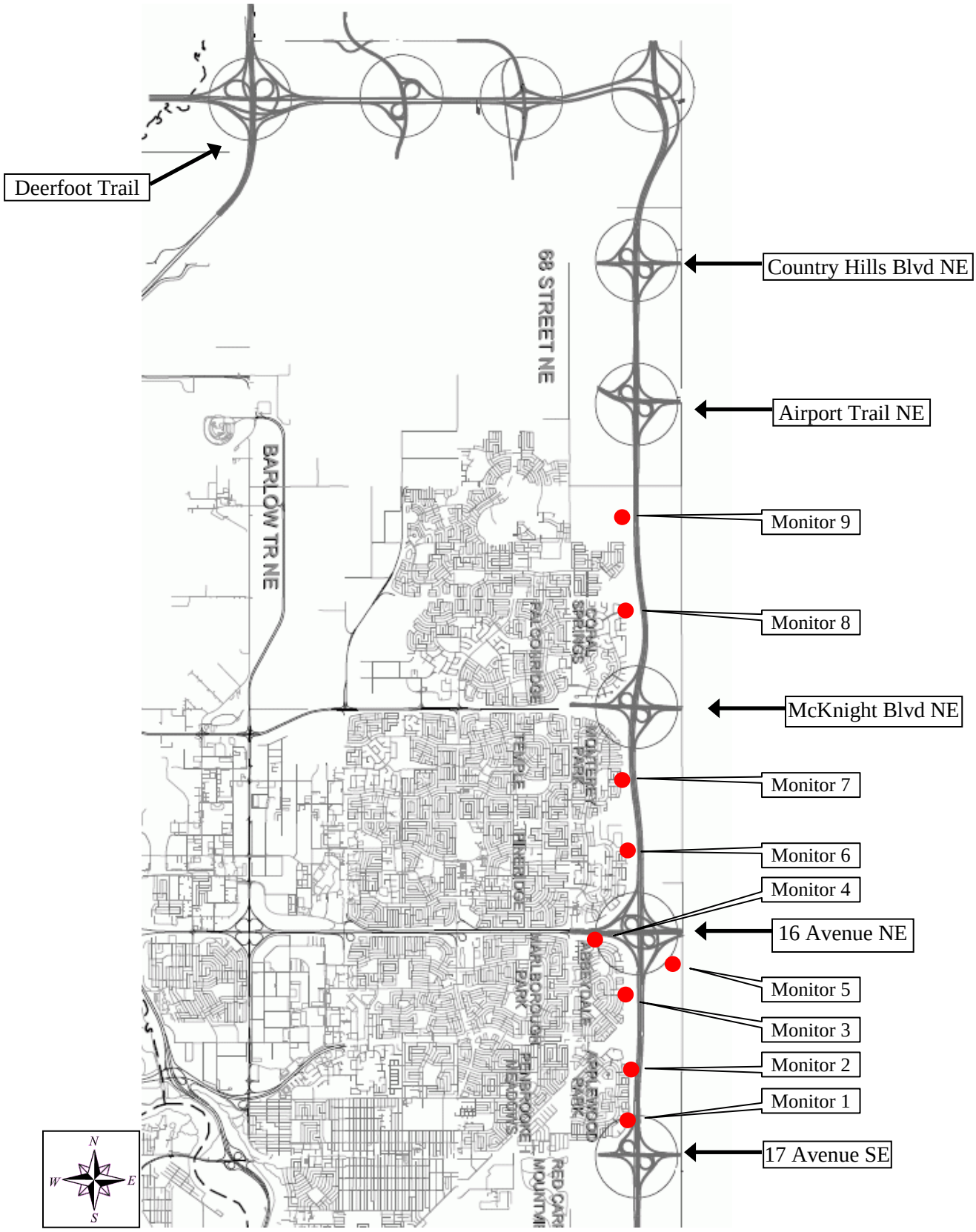


Figure 1A. Stoney Trail Northeast

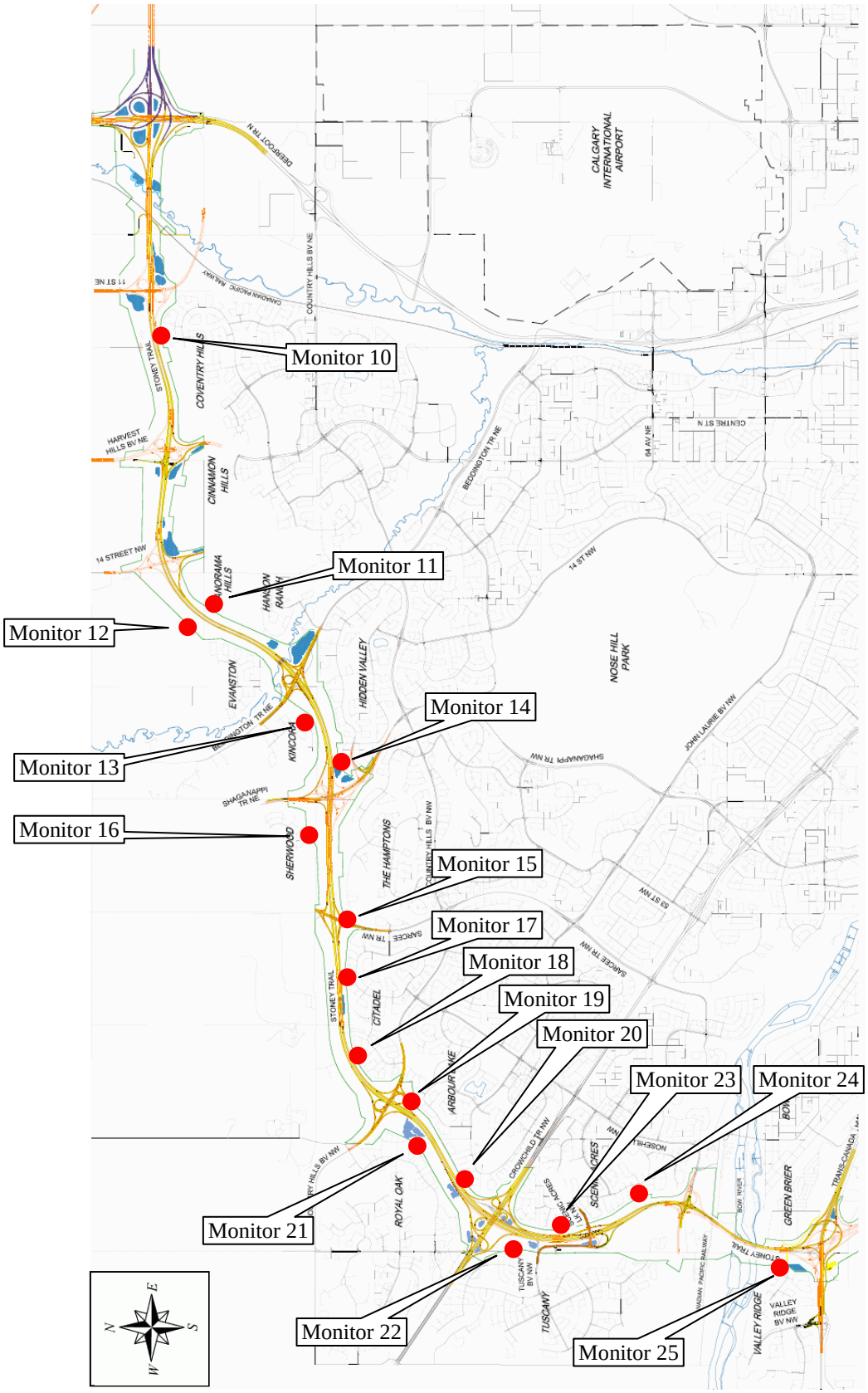


Figure 1B. Stoney Trail Northwest

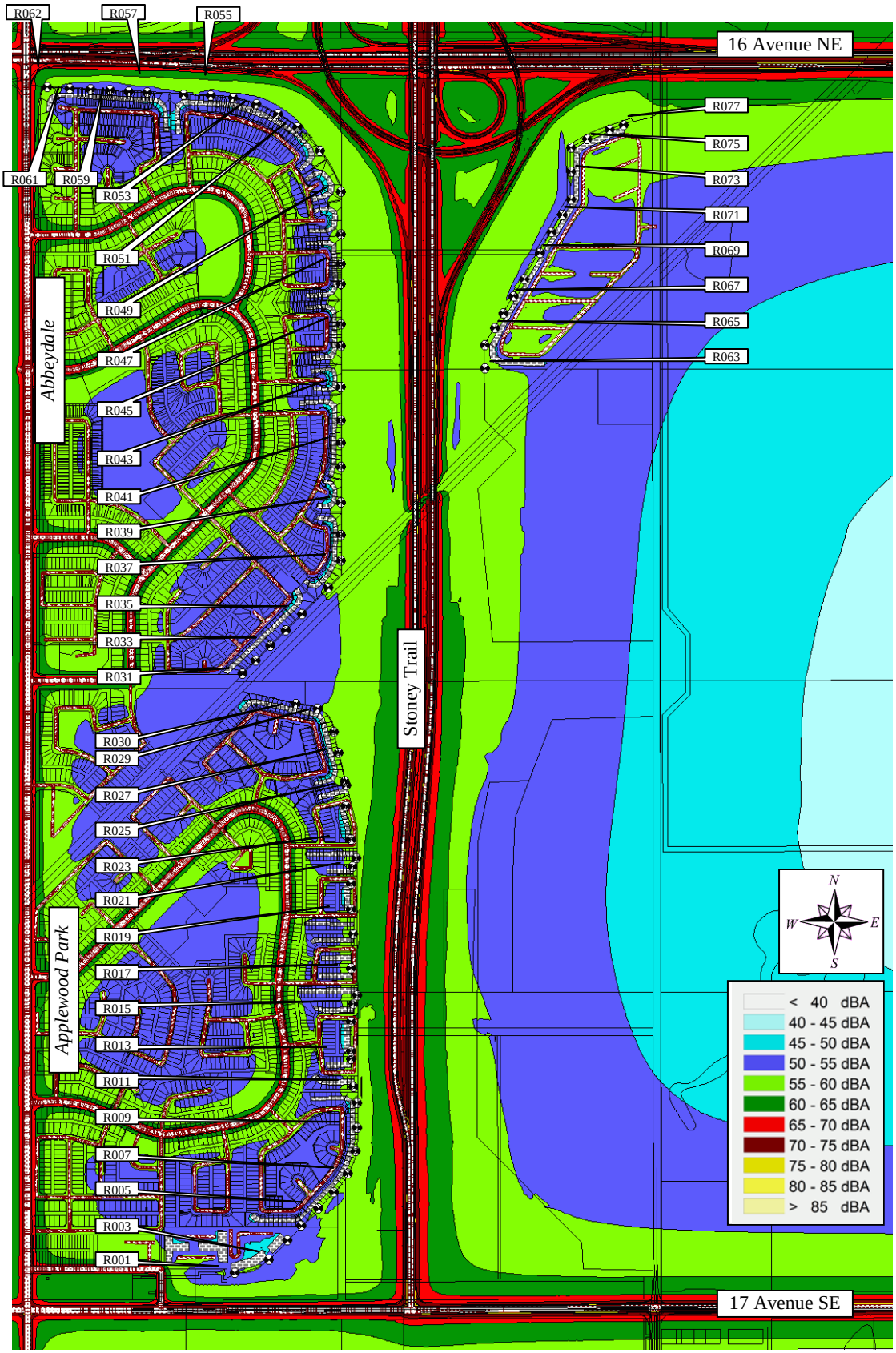


Figure 2A. Current Conditions L_{eq}24 Sound Levels for Region 1

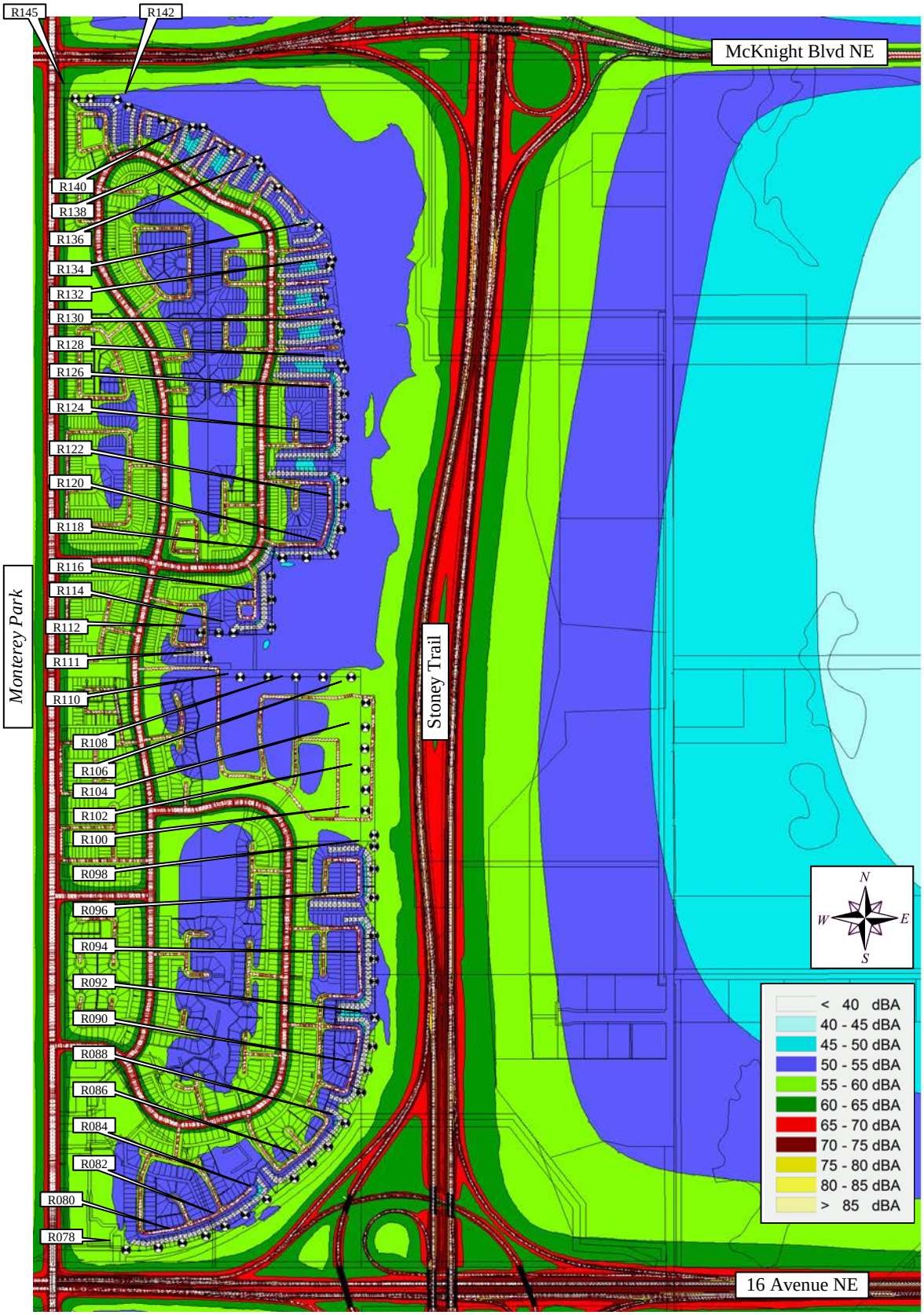


Figure 2B. Current Conditions $L_{eq}24$ Sound Levels for Region 2

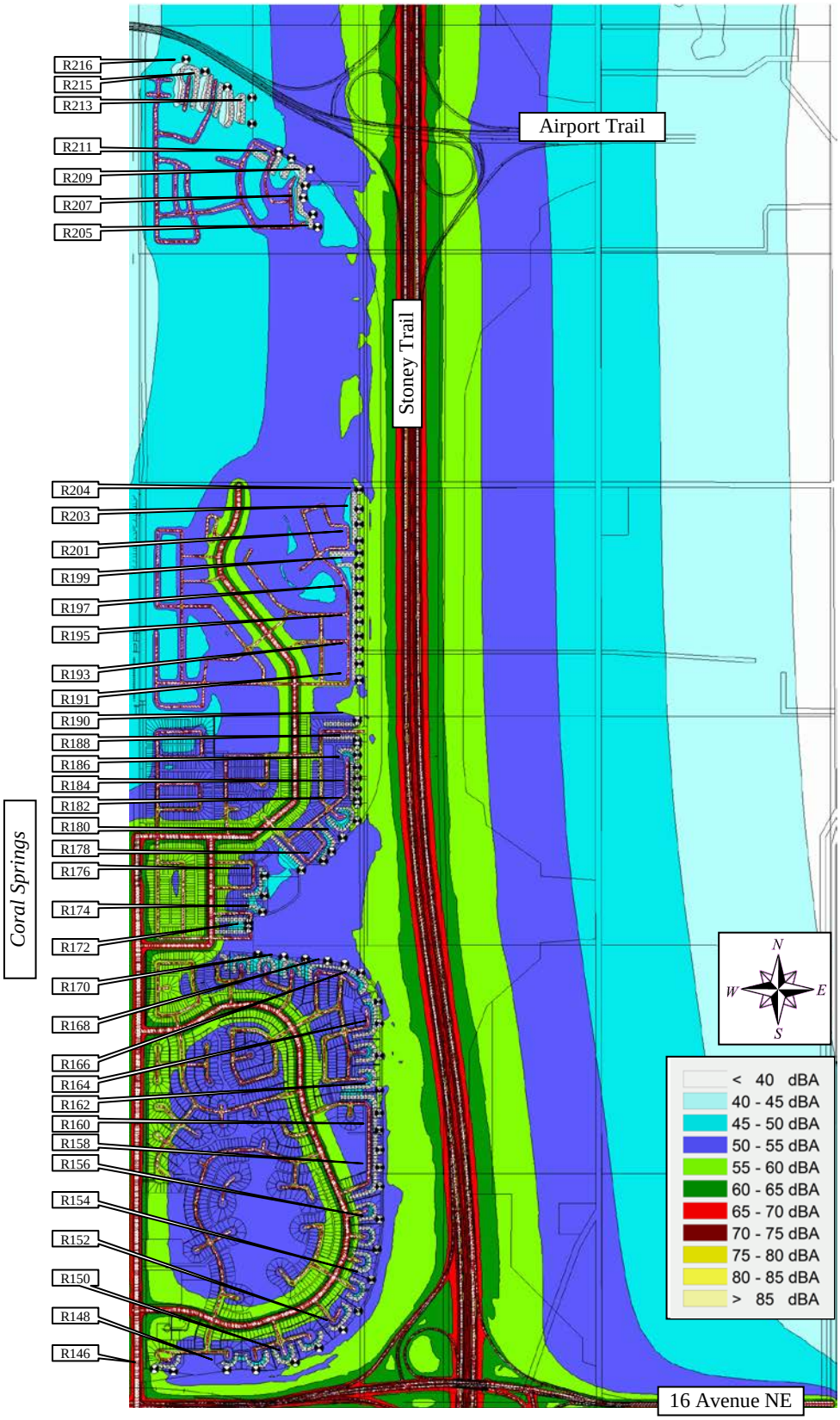


Figure 2C. Current Conditions $L_{eq}24$ Sound Levels for Region 3

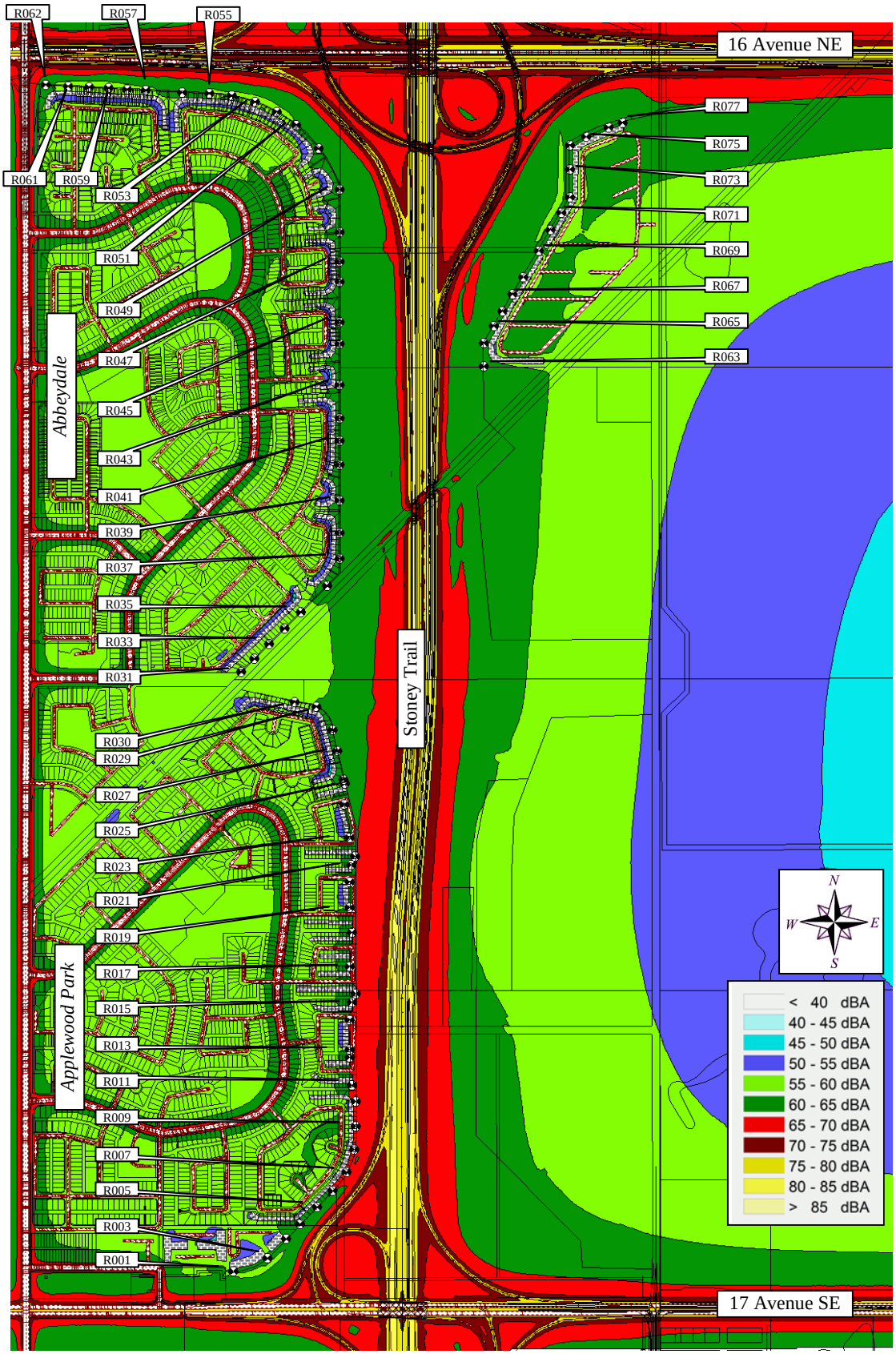


Figure 3A. Future Conditions L_{eq}24 Sound Levels for Region 1

Figure 3B. Future Conditions L_{eq}24 Sound Levels for Region 2

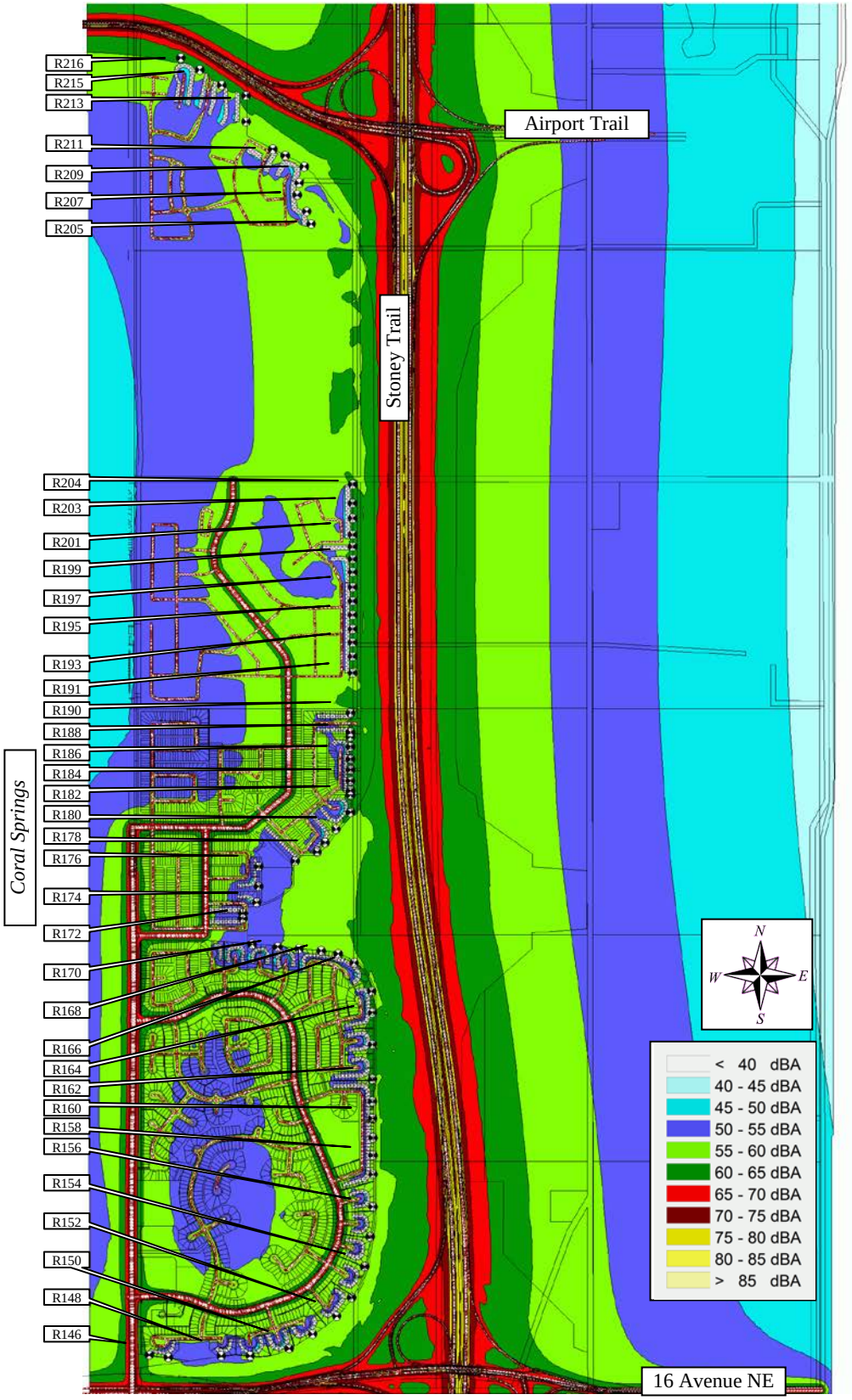


Figure 3C. Future Conditions L_{eq}24 Sound Levels for Region 3

Appendix I

NOISE MODELLING PARAMETERS

Current Conditions

Road	Day (Vehicles Per Hour)	Day % Heavy Vehicles	Night (Vehicles Per Hour)	Night % Heavy Vehicles	Speed (km/hr)	Total Volume (vehicles per day)
Stoney Trail (Hwy. 1 West End - Nose Hill Drive) NB	1275	6	250	6	85	21375
Stoney Trail (Hwy. 1 West End - Nose Hill Drive) SB	1100	8	350	6	85	19650
Stoney Trail (Nose Hill Drive - Scenic Acres Link) NB	1215	6	350	6	70	21375
Stoney Trail (Nose Hill Drive - Scenic Acres Link) SB	1100	8	350	6	70	19650
Stoney Trail (Scenic Acres Link - Crowchild Trail) NB	1270	6	250	6	70	21300
Stoney Trail (Scenic Acres Link - Crowchild Trail) SB	1100	7	350	6	70	19650
Stoney Trail (Crowchild Trail - Country Hills Blvd) NB	1200	10	450	3	70	22050
Stoney Trail (Crowchild Trail - Country Hills Blvd) SB	1170	8	450	10	70	21600
Stoney Trail (Country Hills Blvd - Sarcee Trail) NB	1290	10	400	5	100	22950
Stoney Trail (Country Hills Blvd - Sarcee Trail) SB	1360	9	240	9	100	22560
Stoney Trail (Sarcee Trail - Shaganappi Trail) EB	1250	10	400	3	100	22350
Stoney Trail (Sarcee Trail - Shaganappi Trail) WB	1350	9	250	9	100	22500
Stoney Trail (Shaganappi Trail - Beddington Trail) EB	1272	10	363	3	100	22347
Stoney Trail (Shaganappi Trail - Beddington Trail) WB	1322	8	211	10	100	21729
Stoney Trail (Beddington Trail - 114 Street NW) EB	855	10	300	3	100	15525
Stoney Trail (Beddington Trail - 114 Street NW) WB	920	9	200	9	100	15600
Stoney Trail (114 Street NW - Harvest Hills Blvd) EB	890	10	280	3	100	15870
Stoney Trail (114 Street NW - Harvest Hills Blvd) WB	940	9	170	9	100	15630
Stoney Trail (Harvest Hills Blvd - 11 Street NE) EB	915	10	280	3	100	16245
Stoney Trail (Harvest Hills Blvd - 11 Street NE) WB	945	8	160	10	100	15615
Stoney Trail (11 Street NE - Deerfoot Trail) EB	915	10	280	3	100	16245
Stoney Trail (11 Street NE - Deerfoot Trail) WB	940	8	170	10	100	15630
Stoney Trail (Deerfoot Trail - Metis Trail) EB	710	11	123	14	100	11757
Stoney Trail (Deerfoot Trail - Metis Trail) WB	591	16	169	8	100	10386
Stoney Trail (Metis Trail - Country Hills Blvd NE) EB	710	11	123	14	100	11757
Stoney Trail (Metis Trail - Country Hills Blvd NE) WB	591	16	169	8	100	10386
Stoney Trail (Country Hills Blvd NE - 96 Avenue NE) NB	710	11	123	14	100	11757
Stoney Trail (Country Hills Blvd NE - 96 Avenue NE) SB	591	16	169	8	100	10386
Stoney Trail (96 Avenue NE - McKnight Blvd NE) NB	695	11	150	14	100	11775
Stoney Trail (96 Avenue NE - McKnight Blvd NE) SB	580	16	190	8	100	10410
Stoney Trail (McKnight Blvd NE - 16 Avenue NE) NB	695	11	150	14	100	11775
Stoney Trail (McKnight Blvd NE - 16 Avenue NE) SB	585	16	180	8	100	10395
Stoney Trail (16 Avenue NE - 17 Avenue SE) NB	585	12	95	15	100	9630
Stoney Trail (16 Avenue NE - 17 Avenue SE) NB	538	15	157	6	100	9483
West Valley Road, WB Stoney Trail to NB West Valley Road Ramp	311	3	58	3	50	5177
West Valley Road, EB Stoney Trail to NB West Valley Road Ramp	37	3	7	3	50	618
West Valley Road, SB West Valley Road to EB Stoney Trail Ramp	300	3	56	3	50	5003
West Valley Road, SB West Valley Road to WB Stoney Trail Ramp	9	3	2	3	50	156
Hwy. 1 (West End, West of Stoney Trail) EB	1026	6	190	6	100	17100
Hwy. 1 (West End, West of Stoney Trail) WB	1026	6	190	6	100	17100
Hwy. 1 (West End, East of Stoney Trail) EB	1411	5	261	5	80	23520
Hwy. 1 (West End, East of Stoney Trail) WB	1411	5	261	5	80	23520
Hwy. 1 (West End) EB to Stoney Trail NB Ramp	343	6	63	5	80	5710
Hwy. 1 (West End) WB to Stoney Trail NB Ramp	743	6	138	5	80	12380
Hwy. 1 (West End) SB Stoney Trail to EB Hwy. 1 Ramp	716	8	133	5	80	11940
Hwy. 1 (West End) SB Stoney Trail to WB Hwy. 1 Ramp	346	8	64	5	80	5770
Nose Hill Drive (West of Stoney Trail) EB	413	4	77	4	60	6890
Nose Hill Drive (West of Stoney Trail) WB	413	4	77	4	60	6890
Nose Hill Drive (East of Stoney Trail) EB	490	8	91	8	60	8165
Nose Hill Drive (East of Stoney Trail) WB	490	8	91	8	60	8165
Nose Hill Drive, NB Stoney Trail to EB Nose Hill Drive Ramp	202	8	37	8	80	3370
Nose Hill Drive, WB Nose Hill Drive to NB Stoney Trail Ramp	176	8	33	8	80	2940
Nose Hill Drive, SB Stoney Trail to WB Nose Hill Drive Ramp	119	4	22	4	80	1990
Nose Hill Drive, EB Nose Hill Drive to SB Stoney Trail Ramp	213	4	39	4	80	3550

Current Conditions (Cont.)

Road	Day (Vehicles Per Hour)	Day % Heavy Vehicles	Night (Vehicles Per Hour)	Night % Heavy Vehicles	Speed (km/hr)	Total Volume (vehicles per day)
Scenic Acres Link	660	8	122	8	60	11000
Scenic Acres Link, NB Stoney Trail to EB Scenic Acres Link Ramp	140	8	26	8	80	2340
Scenic Acres Link, NB Stoney Trail to WB Scenic Acres Link Ramp	131	4	24	4	80	2190
Scenic Acres Link, WB Scenic Acres Link to NB Stoney Trail Ramp	162	8	30	8	80	2700
Scenic Acres Link, WB Scenic Acres Link to NB Tuscany Blvd Ramp	73	8	14	8	80	1220
Scenic Acres Link, WB Scenic Acres Link to SB Stoney Trail Ramp	89	8	17	8	80	1490
Scenic Acres Link, SB Stoney Trail to NB Tuscany Blvd Ramp	272	4	50	4	80	4530
Scenic Acres Link, SB Stoney Trail to EB Scenic Acres Link Ramp	144	8	27	8	80	2400
Scenic Acres Link, SB Tuscany Blvd to SB Stoney Trail Ramp	148	4	27	4	80	2460
Scenic Acres Link, SB Tuscany Blvd to NB Stoney Trail Ramp	241	4	45	4	80	4020
Scenic Acres Link, SB Tuscany Blvd to EB Scenic Acres Link Ramp	51	8	9	8	80	850
Crowchild Trail (West of Stoney Trail) EB	908	5	168	5	60	15140
Crowchild Trail (West of Stoney Trail) WB	908	5	168	5	60	15140
Crowchild Trail (East of Stoney Trail) EB	1042	4	193	4	60	17365
Crowchild Trail (East of Stoney Trail) WB	1042	4	193	4	60	17365
Country Hills Blvd NW (West of Stoney Trail) EB	922	7	171	7	60	15360
Country Hills Blvd NW (West of Stoney Trail) WB	922	7	171	7	60	15360
Country Hills Blvd NW (East of Stoney Trail) EB	664	3	123	3	60	11070
Country Hills Blvd NW (East of Stoney Trail) WB	664	3	123	3	60	11070
Country Hills Blvd NW, NB Stoney Trail to EB Country Hills Blvd Ramp	230	10	43	3	80	3840
Country Hills Blvd NW, NB Stoney Trail to WB Country Hills Blvd Ramp	395	10	73	3	80	6590
Country Hills Blvd NW, WB Country Hills Blvd to NB Stoney Trail Ramp	114	10	21	3	80	1900
Country Hills Blvd NW, WB Country Hills Blvd to SB Stoney Trail Ramp	182	8	34	10	80	3040
Country Hills Blvd NW, SB Stoney Trail to WB Country Hills Blvd Ramp	253	9	47	9	80	4210
Country Hills Blvd NW, SB Stoney Trail to EB Country Hills Blvd Ramp	136	9	25	9	80	2270
Country Hills Blvd NW, EB Country Hills Blvd to SB Stoney Trail Ramp	307	8	57	10	80	5120
Country Hills Blvd NW, EB Country Hills Blvd to NB Stoney Trail Ramp	223	10	41	3	80	3710
Sarcee Trail (North of Stoney Trail) NB	353	9	65	9	60	5875
Sarcee Trail (North of Stoney Trail) SB	353	9	65	9	60	5875
Sarcee Trail (South of Stoney Trail) NB	442	12	82	12	60	7370
Sarcee Trail (South of Stoney Trail) SB	442	12	82	12	60	7370
Sarcee Trail, NB Sarcee Trail to EB Stoney Trail Ramp	200	9	60	3	80	3540
Sarcee Trail, NB Sarcee Trail to WB Stoney Trail Ramp	109	9	20	9	80	1810
Sarcee Trail, WB Stoney Trail to NB Sarcee Trail Ramp	142	9	26	9	80	2365
Sarcee Trail, WB Stoney Trail to SB Sarcee Trail Ramp	219	9	41	9	80	3655
Sarcee Trail, SB Sarcee Trail to WB Stoney Trail Ramp	100	9	19	9	80	1670
Sarcee Trail, SB Sarcee Trail to EB Stoney Trail Ramp	111	9	20	3	80	1845
Sarcee Trail, EB Stoney Trail to SB Sarcee Trail Ramp	94	9	17	3	80	1570
Sarcee Trail, EB Stoney Trail to NB Sarcee Trail Ramp	105	9	19	3	80	1750
Shaganappi Trail (North of Stoney Trail) NB	106	9	20	9	60	1760
Shaganappi Trail (North of Stoney Trail) SB	106	9	20	9	60	1760
Shaganappi Trail (South of Stoney Trail) NB	53	3	10	3	60	880
Shaganappi Trail (South of Stoney Trail) SB	53	3	10	3	60	880
Shaganappi Trail, WB Stoney Trail to NB Shaganappi Trail Ramp	57	10	11	3	80	950
Shaganappi Trail, SB Shaganappi Trail to WB Stoney Trail Ramp	49	9	9	9	80	810
Beddington Trail (West of Stoney Trail) EB	823	10	152	10	60	13710
Beddington Trail (West of Stoney Trail) WB	823	10	152	10	60	13710
Beddington Trail (East of Stoney Trail) EB	896	10	166	10	60	14930
Beddington Trail (East of Stoney Trail) WB	896	10	166	10	60	14930
Beddington Trail, EB Stoney Trail to EB Beddington Trail Ramp	306	10	57	3	80	5105
Beddington Trail, EB Stoney Trail to WB Beddington Trail Ramp	155	10	29	3	80	2575
Beddington Trail, WB Beddington Trail to EB Stoney Trail Ramp	109	10	20	3	80	1810
Beddington Trail, WB Beddington Trail to WB Stoney Trail Ramp	334	8	62	10	80	5565
Beddington Trail, WB Stoney Trail to WB Beddington Trail Ramp	156	9	29	9	80	2600
Beddington Trail, WB Stoney Trail to EB Beddington Trail Ramp	68	9	13	9	80	1130
Beddington Trail, EB Beddington Trail to WB Stoney Trail Ramp	218	8	40	10	80	3635
Beddington Trail, EB Beddington Trail to EB Stoney Trail Ramp	142	10	26	3	80	2360

Current Conditions (Cont.)

Road	Day (Vehicles Per Hour)	Day % Heavy Vehicles	Night (Vehicles Per Hour)	Night % Heavy Vehicles	Speed (km/hr)	Total Volume (vehicles per day)
114 Street NW, NB 114 Street NW to EB Stoney Trail Ramp	56	10	10	3	80	940
114 Street NW, EB Stoney Trail to SB 114 Street NW Ramp	83	10	15	3	80	1380
Harvest Hills Blvd (North of Stoney Trail) NB	174	14	32	14	60	2905
Harvest Hills Blvd (North of Stoney Trail) SB	174	14	32	14	60	2905
Harvest Hills Blvd (South of Stoney Trail) NB	323	6	60	6	60	5385
Harvest Hills Blvd (South of Stoney Trail) SB	323	6	60	6	60	5385
Deerfoot Trail (North of Stoney Trail) NB	2085	10	386	10	110	34750
Deerfoot Trail (North of Stoney Trail) SB	2085	10	386	10	110	34750
Deerfoot Trail (South of Stoney Trail) NB	1939	10	359	10	110	32320
Deerfoot Trail (South of Stoney Trail) SB	1939	10	359	10	110	32320
Deerfoot Trail, NB Deerfoot Trail to EB Stoney Trail Ramp	50	11	9	14	100	830
Deerfoot Trail, NB Deerfoot Trail to WB Stoney Trail Ramp	284	8	53	10	100	4740
Deerfoot Trail, WB Stoney Trail to NB Deerfoot Trail Ramp	187	16	35	8	100	3110
Deerfoot Trail, WB Stoney Trail to SB Deerfoot Trail Ramp	66	16	12	8	100	1100
Deerfoot Trail, SB Deerfoot Trail to WB Stoney Trail Ramp	246	8	46	10	100	4100
Deerfoot Trail, SB Deerfoot Trail to EB Stoney Trail Ramp	193	11	36	14	100	3210
Deerfoot Trail, EB Stoney Trail to SB Deerfoot Trail Ramp	237	10	44	3	100	3950
Deerfoot Trail, EB Stoney Trail to NB Deerfoot Trail Ramp	304	10	56	3	100	5060
Metis Trail (North of Stoney Trail) NB	131	10	24	10	60	2190
Metis Trail (North of Stoney Trail) SB	131	10	24	10	60	2190
Metis Trail (South of Stoney Trail) NB	119	10	22	10	60	1980
Metis Trail (South of Stoney Trail) SB	119	10	22	10	60	1980
Metis Trail, NB Metis Trail to EB Stoney Trail Ramp	31	11	6	14	80	520
Metis Trail, NB Metis Trail to WB Stoney Trail Ramp	59	16	11	8	80	980
Metis Trail, WB Stoney Trail to NB Metis Trail Ramp	43	16	8	8	80	710
Metis Trail, WB Stoney Trail to SB Metis Trail Ramp	19	16	3	8	80	310
Metis Trail, SB Metis Trail to WB Stoney Trail Ramp	58	16	11	8	80	970
Metis Trail, SB Metis Trail to EB Stoney Trail Ramp	49	11	9	14	80	820
Metis Trail, EB Stoney Trail to SB Metis Trail Ramp	63	11	12	14	80	1050
Metis Trail, EB Stoney Trail to NB Metis Trail Ramp	47	11	9	14	80	780
Country Hills Blvd NE (West of Stoney Trail) EB	161	7	30	7	60	2690
Country Hills Blvd NE (West of Stoney Trail) WB	161	7	30	7	60	2690
Country Hills Blvd NE (East of Stoney Trail) EB	65	7	12	7	60	1085
Country Hills Blvd NE (East of Stoney Trail) WB	65	7	12	7	60	1085
Country Hills Blvd NE, NB Stoney Trail to EB Country Hills Blvd Ramp	20	16	4	8	80	340
Country Hills Blvd NE, NB Stoney Trail to WB Country Hills Blvd Ramp	60	16	11	8	80	1000
Country Hills Blvd NE, WB Country Hills Blvd to NB Stoney Trail Ramp	15	16	3	8	80	250
Country Hills Blvd NE, WB Country Hills Blvd to SB Stoney Trail Ramp	26	11	5	14	80	440
Country Hills Blvd NE, SB Stoney Trail to WB Country Hills Blvd Ramp	68	11	13	14	80	1140
Country Hills Blvd NE, SB Stoney Trail to EB Country Hills Blvd Ramp	11	11	2	14	80	190
Country Hills Blvd NE, EB Country Hills Blvd to SB Stoney Trail Ramp	89	11	16	14	80	1480
Country Hills Blvd NE, EB Country Hills Blvd to NB Stoney Trail Ramp	49	16	9	8	80	810
McKnight Blvd (West of Stoney Trail) EB	381	9	71	9	60	6355
McKnight Blvd (West of Stoney Trail) WB	381	9	71	9	60	6355
McKnight Blvd (East of Stoney Trail) EB	87	10	16	10	60	1455
McKnight Blvd (East of Stoney Trail) WB	87	10	16	10	60	1455
McKnight Blvd, NB Stoney Trail to EB McKnight Blvd Ramp	18	16	3	8	80	300
McKnight Blvd, NB Stoney Trail to WB McKnight Blvd Ramp	237	16	44	8	80	3950
McKnight Blvd, WB McKnight Blvd to NB Stoney Trail Ramp	10	16	2	8	80	160
McKnight Blvd, WB McKnight Blvd to SB Stoney Trail Ramp	23	11	4	14	80	390
McKnight Blvd, SB Stoney Trail to WB McKnight Blvd Ramp	103	11	19	14	80	1720
McKnight Blvd, SB Stoney Trail to EB McKnight Blvd Ramp	12	11	2	14	80	200
McKnight Blvd, EB McKnight Blvd to SB Stoney Trail Ramp	227	11	42	14	80	3790
McKnight Blvd, EB McKnight Blvd to NB Stoney Trail Ramp	83	16	15	8	80	1390
16 Avenue NE (West of Stoney Trail) EB	671	5	124	5	60	11180
16 Avenue NE (West of Stoney Trail) WB	671	5	124	3	60	11180
16 Avenue NE (East of Stoney Trail) EB	671	9	124	9	100	11185

Current Conditions (Cont.)

Road	Day (Vehicles Per Hour)	Day % Heavy Vehicles	Night (Vehicles Per Hour)	Night % Heavy Vehicles	Speed (km/hr)	Total Volume (vehicles per day)
16 Avenue NE (East of Stoney Trail) WB	671	9	124	9	100	11185
16 Avenue NE, NB Stoney Trail to EB 16 Avenue NE Ramp	26	12	5	15	80	430
16 Avenue NE, NB Stoney Trail to WB 16 Avenue NE Ramp	89	12	17	15	80	1490
16 Avenue NE, WB 16 Avenue NE to NB Stoney Trail Ramp	189	11	35	14	80	3150
16 Avenue NE, WB 16 Avenue NE to SB Stoney Trail Ramp	37	15	7	6	80	610
16 Avenue NE, SB Stoney Trail to WB 16 Avenue NE Ramp	134	16	25	8	80	2240
16 Avenue NE, SB Stoney Trail to EB 16 Avenue NE Ramp	183	16	34	8	80	3050
16 Avenue NE, EB 16 Avenue NE to SB Stoney Trail Ramp	76	15	14	6	80	1270
16 Avenue NE, EB 16 Avenue NE to NB Stoney Trail Ramp	134	11	25	14	80	2230
17 Avenue SE, West of Stoney Trail	1070	9	198	9	60	17830
17 Avenue SE, East of Stoney Trail	1377	9	255	9	80	22950
Arterial Roads	1200	5	222	5	60	20000
Collector Roads	480	3	89	3	60	8000
Residential Streets	12	3	2	3	50	200

Future Conditions (1.6 Million Population)

Road	Day (Vehicles Per Hour)	Day % Heavy Vehicles	Night (Vehicles Per Hour)	Night % Heavy Vehicles	Speed (km/hr)	Total Volume (vehicles per day)
Stoney Trail (Hwy. 1 West End - Nose Hill Drive) NB	1819	6	357	6	100	30500
Stoney Trail (Hwy. 1 West End - Nose Hill Drive) SB	1707	8	543	6	100	30500
Stoney Trail (Nose Hill Drive - Scenic Acres Link) NB	1393	6	401	6	100	24500
Stoney Trail (Nose Hill Drive - Scenic Acres Link) SB	1372	8	436	6	100	24500
Stoney Trail (Scenic Acres Link - Crowchild Trail) NB	1491	6	293	6	100	25000
Stoney Trail (Scenic Acres Link - Crowchild Trail) SB	1399	7	445	6	100	25000
Stoney Trail (Crowchild Trail - Country Hills Blvd) NB	1361	10	510	3	100	25000
Stoney Trail (Crowchild Trail - Country Hills Blvd) SB	1354	8	521	10	100	25000
Stoney Trail (Country Hills Blvd - Sarcee Trail) NB	1265	10	392	5	100	22500
Stoney Trail (Country Hills Blvd - Sarcee Trail) SB	1356	9	239	9	100	22500
Stoney Trail (Sarcee Trail - Shaganappi Trail) EB	1454	10	465	3	100	26000
Stoney Trail (Sarcee Trail - Shaganappi Trail) WB	1560	9	289	9	100	26000
Stoney Trail (Shaganappi Trail - Beddington Trail) EB	1736	10	495	3	100	30500
Stoney Trail (Shaganappi Trail - Beddington Trail) WB	1856	8	296	10	100	30500
Stoney Trail (Beddington Trail - 114 Street NW) EB	1542	10	541	3	100	28000
Stoney Trail (Beddington Trail - 114 Street NW) WB	1651	9	359	9	100	28000
Stoney Trail (114 Street NW - Harvest Hills Blvd) EB	1570	10	494	3	100	28000
Stoney Trail (114 Street NW - Harvest Hills Blvd) WB	1684	9	305	9	100	28000
Stoney Trail (Harvest Hills Blvd - 11 Street NE) EB	1436	10	440	3	100	25500
Stoney Trail (Harvest Hills Blvd - 11 Street NE) WB	1543	8	261	10	100	25500
Stoney Trail (11 Street NE - Deerfoot Trail) EB	1436	10	440	3	100	25500
Stoney Trail (11 Street NE - Deerfoot Trail) WB	1534	8	277	10	100	25500
Stoney Trail (Deerfoot Trail - Metis Trail) EB	1298	11	225	14	100	21500
Stoney Trail (Deerfoot Trail - Metis Trail) WB	1223	16	350	8	100	21500
Stoney Trail (Metis Trail - Country Hills Blvd NE) EB	1902	11	330	14	100	31500
Stoney Trail (Metis Trail - Country Hills Blvd NE) WB	1792	16	513	8	100	31500
Stoney Trail (Country Hills Blvd NE - 96 Avenue NE) NB	2053	11	356	14	100	34000
Stoney Trail (Country Hills Blvd NE - 96 Avenue NE) SB	1935	16	553	8	100	34000
Stoney Trail (96 Avenue NE - McKnight Blvd NE) NB	2125	11	459	14	100	36000
Stoney Trail (96 Avenue NE - McKnight Blvd NE) SB	2006	16	657	8	100	36000
Stoney Trail (McKnight Blvd NE - 16 Avenue NE) NB	2390	11	516	14	100	40500
Stoney Trail (McKnight Blvd NE - 16 Avenue NE) SB	2279	16	701	8	100	40500
Stoney Trail (16 Avenue NE - 17 Avenue SE) NB	2460	12	400	15	100	40500
Stoney Trail (16 Avenue NE - 17 Avenue SE) NB	2298	15	671	6	100	40500
Stoney Trail South of 17 Avenue SE NB	2430	12	450	15	100	40500
Stoney Trail South of 17 Avenue SE SB	2430	15	450	6	100	40500
West Valley Road, WB Stoney Trail to NB West Valley Road Ramp	311	3	57	3	50	5177
West Valley Road, EB Stoney Trail to NB West Valley Road Ramp	37	3	7	3	50	618
West Valley Road, SB West Valley Road to EB Stoney Trail Ramp	300	3	56	3	50	5003
West Valley Road, SB West Valley Road to WB Stoney Trail Ramp	9	3	2	3	50	156
Hwy. 1 (West End, West of Stoney Trail) EB	2526	6	467	6	100	42092
Hwy. 1 (West End, West of Stoney Trail) WB	2569	6	475	6	100	42806
Hwy. 1 (West End, East of Stoney Trail) EB	1894	5	350	5	100	31569
Hwy. 1 (West End, East of Stoney Trail) WB	1820	5	337	5	100	30333
Hwy. 1 (West End) EB to Stoney Trail NB Ramp	675	6	125	5	100	11243
Hwy. 1 (West End) WB to Stoney Trail NB Ramp	327	6	60	5	100	5447
Hwy. 1 (West End) SB Stoney Trail to EB Hwy. 1 Ramp	470	8	87	5	100	7835
Hwy. 1 (West End) SB Stoney Trail to WB Hwy. 1 Ramp	720	8	133	5	100	11993
Nose Hill Drive (West of Stoney Trail) EB	457	4	85	4	60	7619
Nose Hill Drive (West of Stoney Trail) WB	457	4	85	4	60	7619
Nose Hill Drive (East of Stoney Trail) EB	662	8	123	8	60	11039
Nose Hill Drive (East of Stoney Trail) WB	418	8	77	8	60	6959
Nose Hill Drive, NB Stoney Trail to EB Nose Hill Drive Ramp	439	8	81	8	80	7319
Nose Hill Drive, NB Stoney Trail to WB Nose Hill Drive Ramp	425	4	79	4	80	7079

Future Conditions (1.6 Million Population) (Cont.)

Road	Day (Vehicles Per Hour)	Day % Heavy Vehicles	Night (Vehicles Per Hour)	Night % Heavy Vehicles	Speed (km/hr)	Total Volume (vehicles per day)
Nose Hill Drive, WB Nose Hill Drive to NB Stoney Trail Ramp	155	8	29	8	80	2580
Nose Hill Drive, WB Nose Hill Drive to SB Stoney Trail Ramp	205	8	38	8	80	3420
Nose Hill Drive, SB Stoney Trail to WB Nose Hill Drive Ramp	7	4	1	4	80	120
Nose Hill Drive, SB Stoney Trail to EB Nose Hill Drive Ramp	194	8	36	8	80	3240
Nose Hill Drive, EB Nose Hill Drive to SB Stoney Trail Ramp	418	4	77	4	80	6959
Nose Hill Drive, EB Nose Hill Drive to NB Stoney Trail Ramp	11	4	2	4	80	180
Scenic Acres Link	644	8	119	8	60	10739
Scenic Acres Link, NB Stoney Trail to EB Scenic Acres Link Ramp	112	8	21	8	80	1860
Scenic Acres Link, NB Stoney Trail to WB Scenic Acres Link Ramp	97	4	18	4	80	1620
Scenic Acres Link, WB Scenic Acres Link to NB Stoney Trail Ramp	122	8	23	8	80	2040
Scenic Acres Link, WB Scenic Acres Link to NB Tuscany Blvd Ramp	83	8	15	8	80	1380
Scenic Acres Link, WB Scenic Acres Link to SB Stoney Trail Ramp	119	8	22	8	80	1980
Scenic Acres Link, SB Stoney Trail to NB Tuscany Blvd Ramp	277	4	51	4	80	4620
Scenic Acres Link, SB Stoney Trail to EB Scenic Acres Link Ramp	126	8	23	8	80	2100
Scenic Acres Link, SB Tuscany Blvd to SB Stoney Trail Ramp	108	4	20	4	80	1800
Scenic Acres Link, SB Tuscany Blvd to NB Stoney Trail Ramp	266	4	49	4	80	4440
Scenic Acres Link, SB Tuscany Blvd to EB Scenic Acres Link Ramp	72	8	13	8	80	1200
Crowchild Trail (West of Stoney Trail) EB	1454	5	269	5	60	24238
Crowchild Trail (West of Stoney Trail) WB	1400	5	259	5	60	23338
Crowchild Trail (East of Stoney Trail) EB	1087	4	201	4	60	18118
Crowchild Trail (East of Stoney Trail) WB	1116	4	206	4	60	18598
Crowchild Trail, NB Stoney Trail to EB Crowchild Trail Ramp	97	6	18	4	80	1620
Crowchild Trail, NB Stoney Trail to WB Crowchild Trail Ramp	446	6	83	4	80	7439
Crowchild Trail, WB Crowchild Trail to NB Stoney Trail Ramp	378	10	70	3	80	6299
Crowchild Trail, WB Crowchild Trail to SB Stoney Trail Ramp	133	7	25	4	80	2220
Crowchild Trail, SB Stoney Trail to WB Crowchild Trail Ramp	349	8	65	10	80	5819
Crowchild Trail, SB Stoney Trail to EB Crowchild Trail Ramp	342	8	63	10	80	5699
Crowchild Trail, EB Crowchild Trail to SB Stoney Trail Ramp	482	7	89	4	80	8039
Crowchild Trail, EB Crowchild Trail to NB Stoney Trail Ramp	302	10	56	3	80	5039
Country Hills Blvd NW (West of Stoney Trail) EB	1249	7	231	7	60	20818
Country Hills Blvd NW (West of Stoney Trail) WB	1202	7	222	7	60	20038
Country Hills Blvd NW (East of Stoney Trail) EB	630	3	117	3	60	10499
Country Hills Blvd NW (East of Stoney Trail) WB	626	3	116	3	60	10439
Country Hills Blvd NW, NB Stoney Trail to EB Country Hills Blvd Ramp	198	10	37	3	80	3300
Country Hills Blvd NW, NB Stoney Trail to WB Country Hills Blvd Ramp	684	10	127	3	80	11399
Country Hills Blvd NW, WB Country Hills Blvd to NB Stoney Trail Ramp	194	10	36	3	80	3240
Country Hills Blvd NW, WB Country Hills Blvd to SB Stoney Trail Ramp	198	8	37	10	80	3300
Country Hills Blvd NW, SB Stoney Trail to WB Country Hills Blvd Ramp	284	9	53	9	80	4740
Country Hills Blvd NW, SB Stoney Trail to EB Country Hills Blvd Ramp	212	9	39	9	80	3540
Country Hills Blvd NW, EB Country Hills Blvd to SB Stoney Trail Ramp	691	8	128	10	80	11519
Country Hills Blvd NW, EB Country Hills Blvd to NB Stoney Trail Ramp	338	10	63	3	80	5639
Sarcee Trail (North of Stoney Trail) NB	1325	9	245	9	60	22078
Sarcee Trail (North of Stoney Trail) SB	1253	9	232	9	60	20878
Sarcee Trail (South of Stoney Trail) NB	796	12	147	12	60	13259
Sarcee Trail (South of Stoney Trail) SB	698	12	129	12	60	11639
Sarcee Trail, NB Sarcee Trail to EB Stoney Trail Ramp	353	9	106	3	80	6240
Sarcee Trail, NB Sarcee Trail to WB Stoney Trail Ramp	72	9	13	9	80	1200
Sarcee Trail, WB Stoney Trail to NB Sarcee Trail Ramp	356	9	66	9	80	5939
Sarcee Trail, WB Stoney Trail to SB Sarcee Trail Ramp	310	9	57	9	80	5159
Sarcee Trail, SB Sarcee Trail to WB Stoney Trail Ramp	443	9	82	9	80	7379
Sarcee Trail, SB Sarcee Trail to EB Stoney Trail Ramp	270	9	50	3	80	4500
Sarcee Trail, EB Stoney Trail to SB Sarcee Trail Ramp	47	9	9	3	80	780
Sarcee Trail, EB Stoney Trail to NB Sarcee Trail Ramp	479	9	89	3	80	7979
Shaganappi Trail (North of Stoney Trail) NB	1325	9	245	9	60	22078
Shaganappi Trail (North of Stoney Trail) SB	1253	9	232	9	60	20878
Shaganappi Trail (South of Stoney Trail) NB	1778	3	329	3	60	29637

Future Conditions (1.6 Million Population) (Cont.)

Road	Day (Vehicles Per Hour)	Day % Heavy Vehicles	Night (Vehicles Per Hour)	Night % Heavy Vehicles	Speed (km/hr)	Total Volume (vehicles per day)
Shaganappi Trail (South of Stoney Trail) SB	1757	3	325	3	60	29277
Shaganappi Trail, NB Shaganappi Trail to EB Stoney Trail Ramp	760	10	141	3	80	12659
Shaganappi Trail, NB Shaganappi Trail to WB Stoney Trail Ramp	223	9	41	9	80	3720
Shaganappi Trail, WB Stoney Trail to NB Shaganappi Trail Ramp	245	10	45	3	80	4080
Shaganappi Trail, WB Stoney Trail to SB Shaganappi Trail Ramp	814	10	151	3	80	13559
Shaganappi Trail, SB Shaganappi Trail to WB Stoney Trail Ramp	371	9	69	9	80	6179
Shaganappi Trail, SB Shaganappi Trail to EB Stoney Trail Ramp	299	10	55	3	80	4980
Shaganappi Trail, EB Stoney Trail to SB Shaganappi Trail Ramp	360	9	67	9	80	5999
Shaganappi Trail, EB Stoney Trail to NB Shaganappi Trail Ramp	284	9	53	9	80	4740
Beddington Trail (West of Stoney Trail) EB	1206	10	223	10	60	20098
Beddington Trail (West of Stoney Trail) WB	1246	10	230	10	60	20758
Beddington Trail (East of Stoney Trail) EB	1591	10	294	10	60	26517
Beddington Trail (East of Stoney Trail) WB	1652	10	306	10	60	27537
Beddington Trail, EB Stoney Trail to EB Beddington Trail Ramp	508	10	94	3	80	8459
Beddington Trail, EB Stoney Trail to WB Beddington Trail Ramp	209	10	39	3	80	3480
Beddington Trail, WB Beddington Trail to EB Stoney Trail Ramp	421	10	78	3	80	7019
Beddington Trail, WB Beddington Trail to WB Stoney Trail Ramp	547	8	101	10	80	9119
Beddington Trail, WB Stoney Trail to WB Beddington Trail Ramp	374	9	69	9	80	6239
Beddington Trail, WB Stoney Trail to EB Beddington Trail Ramp	565	9	105	9	80	9419
Beddington Trail, EB Beddington Trail to WB Stoney Trail Ramp	281	8	52	10	80	4680
Beddington Trail, EB Beddington Trail to EB Stoney Trail Ramp	385	10	71	3	80	6419
114 Street NW (North of Stoney Trail) NB	1447	8	268	8	60	24118
114 Street NW (North of Stoney Trail) SB	1530	8	283	8	60	25497
114 Street NW (South of Stoney Trail) NB	432	8	80	8	60	7199
114 Street NW (South of Stoney Trail) SB	407	8	75	8	60	6779
114 Street NW, NB 114 Street NW to EB Stoney Trail Ramp	83	10	15	3	80	1380
114 Street NW, NB 114 Street NW to WB Stoney Trail Ramp	234	9	43	9	80	3900
114 Street NW, WB Stoney Trail to NB 114 Street NW Ramp	702	9	130	9	80	11699
114 Street NW, WB Stoney Trail to SB 114 Street NW Ramp	72	9	13	9	80	1200
114 Street NW, SB 114 Street NW to WB Stoney Trail Ramp	738	9	137	9	80	12299
114 Street NW, SB 114 Street NW to EB Stoney Trail Ramp	684	10	127	3	80	11399
114 Street NW, EB Stoney Trail to SB 114 Street NW Ramp	227	10	42	3	80	3780
114 Street NW, EB Stoney Trail to NB 114 Street NW Ramp	630	10	117	3	80	10499
Harvest Hills Blvd (North of Stoney Trail) NB	1462	14	270	14	60	24358
Harvest Hills Blvd (North of Stoney Trail) SB	1591	14	294	14	60	26517
Harvest Hills Blvd (South of Stoney Trail) NB	929	6	172	6	60	15478
Harvest Hills Blvd (South of Stoney Trail) SB	922	6	170	6	60	15358
Harvest Hills Blvd, NB Harvest Hills Blvd to EB Stoney Trail Ramp	259	10	48	3	80	4320
Harvest Hills Blvd, NB Harvest Hills Blvd to WB Stoney Trail Ramp	270	9	50	9	80	4500
Harvest Hills Blvd, WB Stoney Trail to NB Harvest Hills Blvd Ramp	576	8	107	10	80	9599
Harvest Hills Blvd, WB Stoney Trail to SB Harvest Hills Blvd Ramp	209	8	39	10	80	3480
Harvest Hills Blvd, SB Harvest Hills Blvd to WB Stoney Trail Ramp	547	9	101	9	80	9119
Harvest Hills Blvd, SB Harvest Hills Blvd to EB Stoney Trail Ramp	630	10	117	3	80	10499
Harvest Hills Blvd, EB Stoney Trail to SB Harvest Hills Blvd Ramp	299	10	55	3	80	4980
Harvest Hills Blvd, EB Stoney Trail to NB Harvest Hills Blvd Ramp	486	10	90	3	80	8099
11 Street NE (North of Stoney Trail) NB	1300	8	240	8	60	21658
11 Street NE (North of Stoney Trail) SB	1361	8	252	8	60	22678
11 Street NE (South of Stoney Trail) NB	1188	8	220	8	60	19798
11 Street NE (South of Stoney Trail) SB	1091	8	202	8	60	18178
11 Street NE, NB 11 Street NE to EB Stoney Trail Ramp	202	10	37	3	80	3360
11 Street NE, NB 11 Street NE to WB Stoney Trail Ramp	734	9	136	9	80	12239
11 Street NE, WB Stoney Trail to NB 11 Street NE Ramp	655	9	121	9	80	10919
11 Street NE, WB Stoney Trail to SB 11 Street NE Ramp	166	9	31	9	80	2760
11 Street NE, SB 11 Street NE to WB Stoney Trail Ramp	385	9	71	9	80	6419
11 Street NE, SB 11 Street NE to EB Stoney Trail Ramp	731	10	135	3	80	12179
11 Street NE, EB Stoney Trail to SB 11 Street NE Ramp	680	10	126	3	80	11339
11 Street NE, EB Stoney Trail to NB 11 Street NE Ramp	392	10	73	3	80	6539

Future Conditions (1.6 Million Population) (Cont.)

Road	Day (Vehicles Per Hour)	Day % Heavy Vehicles	Night (Vehicles Per Hour)	Night % Heavy Vehicles	Speed (km/hr)	Total Volume (vehicles per day)
Deerfoot Trail (North of Stoney Trail) NB	3643	10	674	10	110	60714
Deerfoot Trail (North of Stoney Trail) SB	3222	10	596	10	110	53695
Deerfoot Trail (South of Stoney Trail) NB	3125	10	578	10	110	52075
Deerfoot Trail (South of Stoney Trail) SB	3053	10	565	10	110	50875
Deerfoot Trail, NB Deerfoot Trail to EB Stoney Trail Ramp	396	11	73	14	100	6599
Deerfoot Trail, NB Deerfoot Trail to WB Stoney Trail Ramp	796	8	147	10	100	13259
Deerfoot Trail, WB Stoney Trail to NB Deerfoot Trail Ramp	720	16	133	8	100	11999
Deerfoot Trail, WB Stoney Trail to SB Deerfoot Trail Ramp	313	16	58	8	100	5219
Deerfoot Trail, SB Deerfoot Trail to WB Stoney Trail Ramp	774	8	143	10	100	12899
Deerfoot Trail, SB Deerfoot Trail to EB Stoney Trail Ramp	695	11	129	14	100	11579
Deerfoot Trail, EB Stoney Trail to SB Deerfoot Trail Ramp	857	10	159	3	100	14279
Deerfoot Trail, EB Stoney Trail to NB Deerfoot Trail Ramp	864	10	160	3	100	14399
Metis Trail (North of Stoney Trail) NB	1156	10	214	10	60	19258
Metis Trail (North of Stoney Trail) SB	745	10	138	10	60	12419
Metis Trail (South of Stoney Trail) NB	749	10	139	10	60	12479
Metis Trail (South of Stoney Trail) SB	662	10	123	10	60	11039
Metis Trail, NB Metis Trail to EB Stoney Trail Ramp	22	11	4	14	80	360
Metis Trail, NB Metis Trail to WB Stoney Trail Ramp	364	16	67	8	80	6059
Metis Trail, WB Stoney Trail to NB Metis Trail Ramp	205	16	38	8	80	3420
Metis Trail, WB Stoney Trail to SB Metis Trail Ramp	43	16	8	8	80	720
Metis Trail, SB Metis Trail to WB Stoney Trail Ramp	378	16	70	8	80	6299
Metis Trail, SB Metis Trail to EB Stoney Trail Ramp	151	11	28	14	80	2520
Metis Trail, EB Stoney Trail to SB Metis Trail Ramp	403	11	75	14	80	6719
Metis Trail, EB Stoney Trail to NB Metis Trail Ramp	587	11	109	14	80	9779
Country Hills Blvd NE (West of Stoney Trail) EB	630	7	117	7	60	10499
Country Hills Blvd NE (West of Stoney Trail) WB	410	7	76	7	60	6839
Country Hills Blvd NE (East of Stoney Trail) EB	234	7	43	7	60	3900
Country Hills Blvd NE (East of Stoney Trail) WB	169	7	31	7	60	2820
Country Hills Blvd NE, NB Stoney Trail to EB Country Hills Blvd Ramp	72	16	13	8	80	1200
Country Hills Blvd NE, NB Stoney Trail to WB Country Hills Blvd Ramp	263	16	49	8	80	4380
Country Hills Blvd NE, WB Country Hills Blvd to NB Stoney Trail Ramp	43	16	8	8	80	720
Country Hills Blvd NE, WB Country Hills Blvd to SB Stoney Trail Ramp	54	11	10	14	80	900
Country Hills Blvd NE, SB Stoney Trail to WB Country Hills Blvd Ramp	76	11	14	14	80	1260
Country Hills Blvd NE, SB Stoney Trail to EB Country Hills Blvd Ramp	90	11	17	14	80	1500
Country Hills Blvd NE, EB Country Hills Blvd to SB Stoney Trail Ramp	504	11	93	14	80	8399
Country Hills Blvd NE, EB Country Hills Blvd to NB Stoney Trail Ramp	54	16	10	8	80	900
96 Avenue NE, NB Stoney Trail to WB 96 Avenue NE Ramp	245	16	45	8	80	4080
96 Avenue NE, SB Stoney Trail to WB 96 Avenue NE Ramp	245	11	45	14	80	4080
96 Avenue NE, EB 96 Avenue NE to SB Stoney Trail Ramp	452	11	84	14	80	7529
96 Avenue NE, EB 96 Avenue NE to NB Stoney Trail Ramp	452	16	84	8	80	7529
McKnight Blvd (West of Stoney Trail) EB	684	9	127	9	60	11399
McKnight Blvd (West of Stoney Trail) WB	695	9	129	9	60	11579
McKnight Blvd (East of Stoney Trail) EB	198	10	37	10	60	3300
McKnight Blvd (East of Stoney Trail) WB	90	10	17	10	60	1500
McKnight Blvd, NB Stoney Trail to EB McKnight Blvd Ramp	83	16	15	8	80	1380
McKnight Blvd, NB Stoney Trail to WB McKnight Blvd Ramp	425	16	79	8	80	7079
McKnight Blvd, WB McKnight Blvd to NB Stoney Trail Ramp	22	16	4	8	80	360
McKnight Blvd, WB McKnight Blvd to SB Stoney Trail Ramp	7	11	1	14	80	120
McKnight Blvd, SB Stoney Trail to WB McKnight Blvd Ramp	209	11	39	14	80	3480
McKnight Blvd, SB Stoney Trail to EB McKnight Blvd Ramp	22	11	4	14	80	360
McKnight Blvd, EB McKnight Blvd to SB Stoney Trail Ramp	518	11	96	14	80	8639
McKnight Blvd, EB McKnight Blvd to NB Stoney Trail Ramp	72	16	13	8	80	1200
16 Avenue NE (West of Stoney Trail) EB	2549	5	472	5	60	42476
16 Avenue NE (West of Stoney Trail) WB	2232	5	413	3	60	37196
16 Avenue NE (East of Stoney Trail) EB	1879	9	348	9	100	31317
16 Avenue NE (East of Stoney Trail) WB	2189	9	405	9	100	36476
16 Avenue NE, NB Stoney Trail to EB 16 Avenue NE Ramp	104	12	19	15	80	1740

Future Conditions (1.6 Million Population) (Cont.)

Road	Day (Vehicles Per Hour)	Day % Heavy Vehicles	Night (Vehicles Per Hour)	Night % Heavy Vehicles	Speed (km/hr)	Total Volume (vehicles per day)
16 Avenue NE, NB Stoney Trail to WB 16 Avenue NE Ramp	796	12	147	15	80	13259
16 Avenue NE, WB 16 Avenue NE to NB Stoney Trail Ramp	673	11	125	14	80	11219
16 Avenue NE, WB 16 Avenue NE to SB Stoney Trail Ramp	313	15	58	6	80	5219
16 Avenue NE, SB Stoney Trail to WB 16 Avenue NE Ramp	234	16	43	8	80	3900
16 Avenue NE, SB Stoney Trail to EB 16 Avenue NE Ramp	331	16	61	8	80	5519
16 Avenue NE, EB 16 Avenue NE to SB Stoney Trail Ramp	810	15	150	6	80	13499
16 Avenue NE, EB 16 Avenue NE to NB Stoney Trail Ramp	302	11	56	14	80	5039
17 Avenue SE (West of Stoney Trail) EB	1033	9	191	9	60	17218
17 Avenue SE (West of Stoney Trail) WB	1300	9	240	9	60	21658
17 Avenue SE (East of Stoney Trail) EB	1397	9	258	9	80	23278
17 Avenue SE (East of Stoney Trail) WB	1469	9	272	9	80	24478
17 Avenue SE, NB Stoney Trail to EB 17 Avenue SE Ramp	490	12	91	15	80	8159
17 Avenue SE, NB Stoney Trail to WB 17 Avenue SE Ramp	522	12	97	15	80	8699
17 Avenue SE, WB 17 Avenue SE to NB Stoney Trail Ramp	486	12	90	15	80	8099
17 Avenue SE, WB 17 Avenue SE to SB Stoney Trail Ramp	479	15	89	6	80	7979
17 Avenue SE, SB Stoney Trail to WB 17 Avenue SE Ramp	274	15	51	6	80	4560
17 Avenue SE, SB Stoney Trail to EB 17 Avenue SE Ramp	371	15	69	6	80	6179
17 Avenue SE, EB 17 Avenue SE to SB Stoney Trail Ramp	313	15	58	6	80	5219
17 Avenue SE, EB 17 Avenue NE to NB Stoney Trail Ramp	184	12	34	15	80	3060
Arterial Roads	1200	5	222	5	60	20000
Collector Roads	480	3	89	3	60	8000
Residential Streets	12	3	2	3	50	200

Appendix II

THE ASSESSMENT OF ENVIRONMENTAL NOISE (GENERAL)

Sound Pressure Level

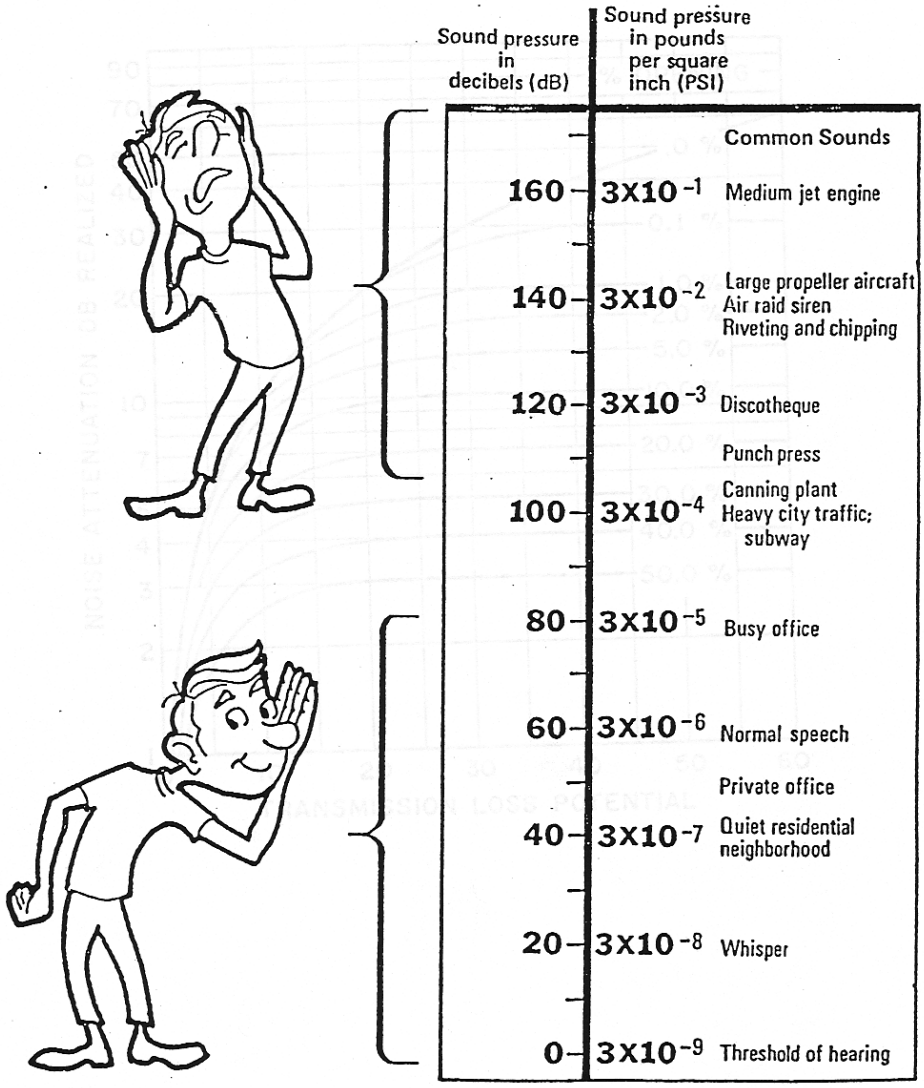
Sound pressure is initially measured in Pascal's (Pa). Humans can hear several orders of magnitude in sound pressure levels, so a more convenient scale is used. This scale is known as the decibel (dB) scale, named after Alexander Graham Bell (telephone guy). It is a base 10 logarithmic scale. When we measure pressure we typically measure the RMS sound pressure.

$$SPL = 10\log_{10}\left[\frac{P_{RMS}^{2}}{P_{ref}^{2}}\right] = 20\log_{10}\left[\frac{P_{RMS}}{P_{ref}}\right]$$

Where: SPL = Sound Pressure Level in dB
P_{RMS} = Root Mean Square measured pressure (Pa)
P_{ref} = Reference sound pressure level ($P_{ref} = 2\text{x}10^{-5}$ Pa = 20 μPa)

This reference sound pressure level is an internationally agreed upon value. It represents the threshold of human hearing for "typical" people based on numerous testing. It is possible to have a threshold which is lower than 20 μPa which will result in negative dB levels. As such, zero dB does not mean there is no sound!

In general, a difference of 1 – 2 dB is the threshold for humans to notice that there has been a change in sound level. A difference of 3 dB (factor of 2 in acoustical energy) is perceptible and a change of 5 dB is strongly perceptible. A change of 10 dB is typically considered a factor of 2. This is quite remarkable when considering that 10 dB is 10-times the acoustical energy!


Sound pressure in decibels (dB)
Sound pressure in pounds per square inch (PSI)
Common Sounds
160
3X10 -1
Medium jet engine
140
3X10 -2
Large propeller aircraft
Air raid siren
Riveting and chipping
120
3X10 -3
Discotheque
Punch press
100
3X10 -4
Canning plant
Heavy city traffic; subway
80
3X10 -5
Busy office
60
3X10 -6
Normal speech
Private office
40
3X10 -7
Quiet residential neighborhood
20
3X10 -8
Whisper
0
3X10 -9
Threshold of hearing

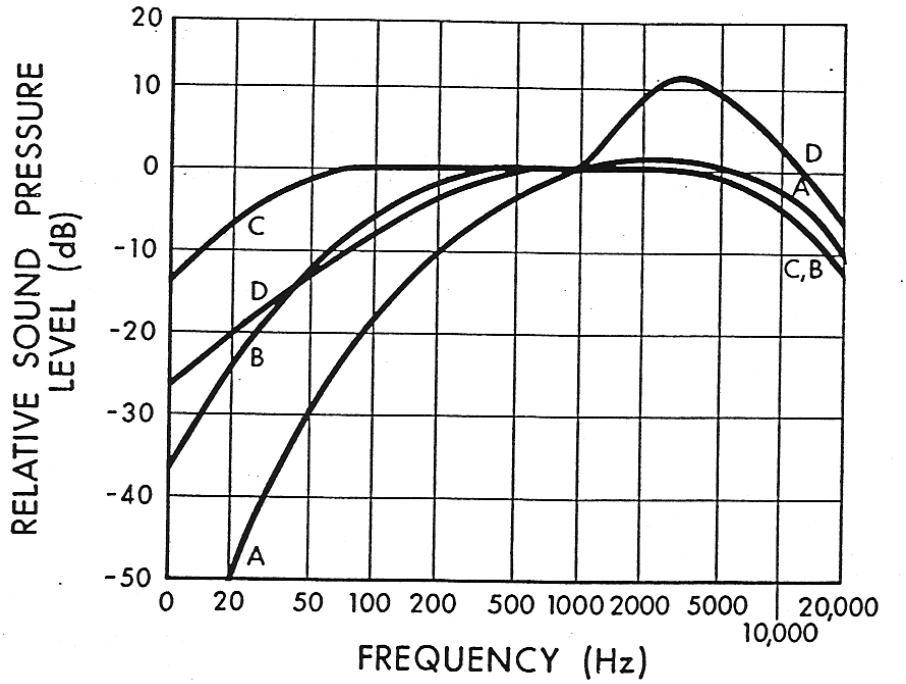
Frequency

The range of frequencies audible to the human ear ranges from approximately 20 Hz to 20 kHz. Within this range, the human ear does not hear equally at all frequencies. It is not very sensitive to low frequency sounds, is very sensitive to mid frequency sounds and is slightly less sensitive to high frequency sounds. Due to the large frequency range of human hearing, the entire spectrum is often divided into 31 bands, each known as a 1/3 octave band.

The internationally agreed upon center frequencies and upper and lower band limits for the 1/1 (whole octave) and 1/3 octave bands are as follows:

Whole Octave			1/3 Octave		
Lower Band Limit	Center Frequency	Upper Band Limit	Lower Band Limit	Center Frequency	Upper Band Limit
11	**16**	22	14.1	**16**	17.8
			17.8	**20**	22.4
22	**31.5**	44	22.4	**25**	28.2
			28.2	**31.5**	35.5
			35.5	**40**	44.7
44	**63**	88	44.7	**50**	56.2
			56.2	**63**	70.8
			70.8	**80**	89.1
88	**125**	177	89.1	**100**	112
			112	**125**	141
			141	**160**	178
177	**250**	355	178	**200**	224
			224	**250**	282
			282	**315**	355
355	**500**	710	355	**400**	447
			447	**500**	562
			562	**630**	708
710	**1000**	1420	708	**800**	891
			891	**1000**	1122
			1122	**1250**	1413
1420	**2000**	2840	1413	**1600**	1778
			1778	**2000**	2239
			2239	**2500**	2818
2840	**4000**	5680	2818	**3150**	3548
			3548	**4000**	4467
			4467	**5000**	5623
5680	**8000**	11360	5623	**6300**	7079
			7079	**8000**	8913
			8913	**10000**	11220
11360	**16000**	22720	11220	**12500**	14130
			14130	**16000**	17780
			17780	**20000**	22390

Human hearing is most sensitive at approximately 3500 Hz which corresponds to the ¼ wavelength of the ear canal (approximately 2.5 cm). Because of this range of sensitivity to various frequencies, we typically apply various weighting networks to the broadband measured sound to more appropriately account for the way humans hear. By default, the most common weighting network used is the so-called "A-weighting". It can be seen in the figure that the low frequency sounds are reduced significantly with the A-weighting.



Combination of Sounds

When combining multiple sound sources the general equation is:

$$\Sigma SPL_n = 10\log_{10}\left[\sum_{i=1}^{n} 10^{\frac{SPL_i}{10}}\right]$$

Examples:

- Two sources of 50 dB each add together to result in 53 dB.
- Three sources of 50 dB each add together to result in 55 dB.
- Ten sources of 50 dB each add together to result in 60 dB.
- One source of 50 dB added to another source of 40 dB results in 50.4 dB

It can be seen that, if multiple similar sources exist, removing or reducing only one source will have little effect.

Sound Level Measurements

Over the years a number of methods for measuring and describing environmental noise have been developed. The most widely used and accepted is the concept of the Energy Equivalent Sound Level (L_{eq}) which was developed in the US (1970's) to characterize noise levels near US Air-force bases. This is the level of a steady state sound which, for a given period of time, would contain the same energy as the time varying sound. The concept is that the same amount of annoyance occurs from a sound having a high level for a short period of time as from a sound at a lower level for a longer period of time.
The L_{eq} is defined as:

$$L_{eq} = 10\log_{10}\left[\frac{1}{T}\int_0^T 10^{\frac{dB}{10}}\,dT\right] = 10\log_{10}\left[\frac{1}{T}\int_0^T \frac{P^2}{P_{ref}^2}\,dT\right]$$

We must specify the time period over which to measure the sound. i.e. 1-second, 10-seconds, 15-seconds, 1-minute, 1-day, etc. **An L_{eq} is meaningless if there is no time period associated**.

In general there a few very common L_{eq} sample durations which are used in describing environmental noise measurements. These include:

- $L_{eq}24$ - Measured over a 24-hour period
- L_{eq}Night - Measured over the night-time (typically 22:00 – 07:00)
- L_{eq}Day - Measured over the day-time (typically 07:00 – 22:00)
- L_{DN} - Same as $L_{eq}24$ with a 10 dB penalty added to the night-time

Statistical Descriptor

Another method of conveying long term noise levels utilizes statistical descriptors. These are calculated from a cumulative distribution of the sound levels over the entire measurement duration and then determining the sound level at xx % of the time.

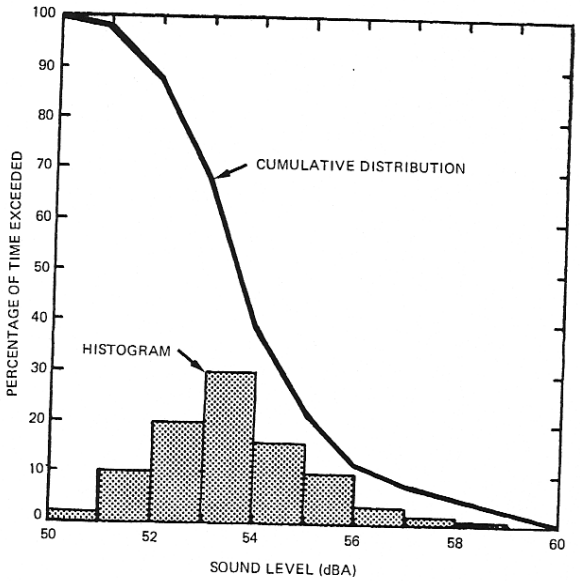


Figure 16.6 Statistically processed community noise showing histogram and cumulative distribution of A weighted sound levels.

Industrial Noise Control, Lewis Bell, Marcel Dekker, Inc. 1994

The most common statistical descriptors are:

L_{min} - minimum sound level measured
L_{01} - sound level that was exceeded only 1% of the time
L_{10} - sound level that was exceeded only 10% of the time.
- Good measure of intermittent or intrusive noise
- Good measure of Traffic Noise

L_{50} - sound level that was exceeded 50% of the time (arithmetic average)
- Good to compare to L_{eq} to determine steadiness of noise

L_{90} - sound level that was exceeded 90% of the time
- Good indicator of typical "ambient" noise levels

L_{99} - sound level that was exceeded 99% of the time
L_{max} - maximum sound level measured

These descriptors can be used to provide a more detailed analysis of the varying noise climate:

- If there is a large difference between the L_{eq} and the L_{50} (L_{eq} can never be any lower than the L_{50}) then it can be surmised that one or more short duration, high level sound(s) occurred during the time period.
- If the gap between the L_{10} and L_{90} is relatively small (less than 15 – 20 dBA) then it can be surmised that the noise climate was relatively steady.

Sound Propagation

In order to understand sound propagation, the nature of the source must first be discussed. In general, there are three types of sources. These are known as 'point', 'line', and 'area'. This discussion will concentrate on point and line sources since area sources are much more complex and can usually be approximated by point sources at large distances.

Point Source

As sound radiates from a point source, it dissipates through geometric spreading. The basic relationship between the sound levels at two distances from a point source is:

$$\therefore SPL_1 - SPL_2 = 20\log_{10}\left(\frac{r_2}{r_1}\right)$$

Where: SPL_1 = sound pressure level at location 1, SPL_2 = sound pressure level at location 2
r_1 = distance from source to location 1, r_2 = distance from source to location 2

Thus, the reduction in sound pressure level for a point source radiating in a free field is **6 dB per doubling of distance**. This relationship is independent of reflectivity factors provided they are always present. Note that this only considers geometric spreading and does not take into account atmospheric effects. Point sources still have some physical dimension associated with them, and typically do not radiate sound equally in all directions in all frequencies. The directionality of a source is also highly dependent on frequency. As frequency increases, directionality increases.

Examples (note no atmospheric absorption):

- A point source measuring 50 dB at 100m will be 44 dB at 200m.
- A point source measuring 50 dB at 100m will be 40.5 dB at 300m.
- A point source measuring 50 dB at 100m will be 38 dB at 400m.
- A point source measuring 50 dB at 100m will be 30 dB at 1000m.

Line Source

A line source is similar to a point source in that it dissipates through geometric spreading. The difference is that a line source is equivalent to a long line of many point sources. The basic relationship between the sound levels at two distances from a line source is:

$$SPL_1 - SPL_2 = 10\log_{10}\left(\frac{r_2}{r_1}\right)$$

The difference from the point source is that the '20' term in front of the 'log' is now only 10. Thus, the reduction in sound pressure level for a line source radiating in a free field is **3 dB per doubling of distance**.

Examples (note no atmospheric absorption):

- A line source measuring 50 dB at 100m will be 47 dB at 200m.
- A line source measuring 50 dB at 100m will be 45 dB at 300m.
- A line source measuring 50 dB at 100m will be 44 dB at 400m.
- A line source measuring 50 dB at 100m will be 40 dB at 1000m.

Atmospheric Absorption

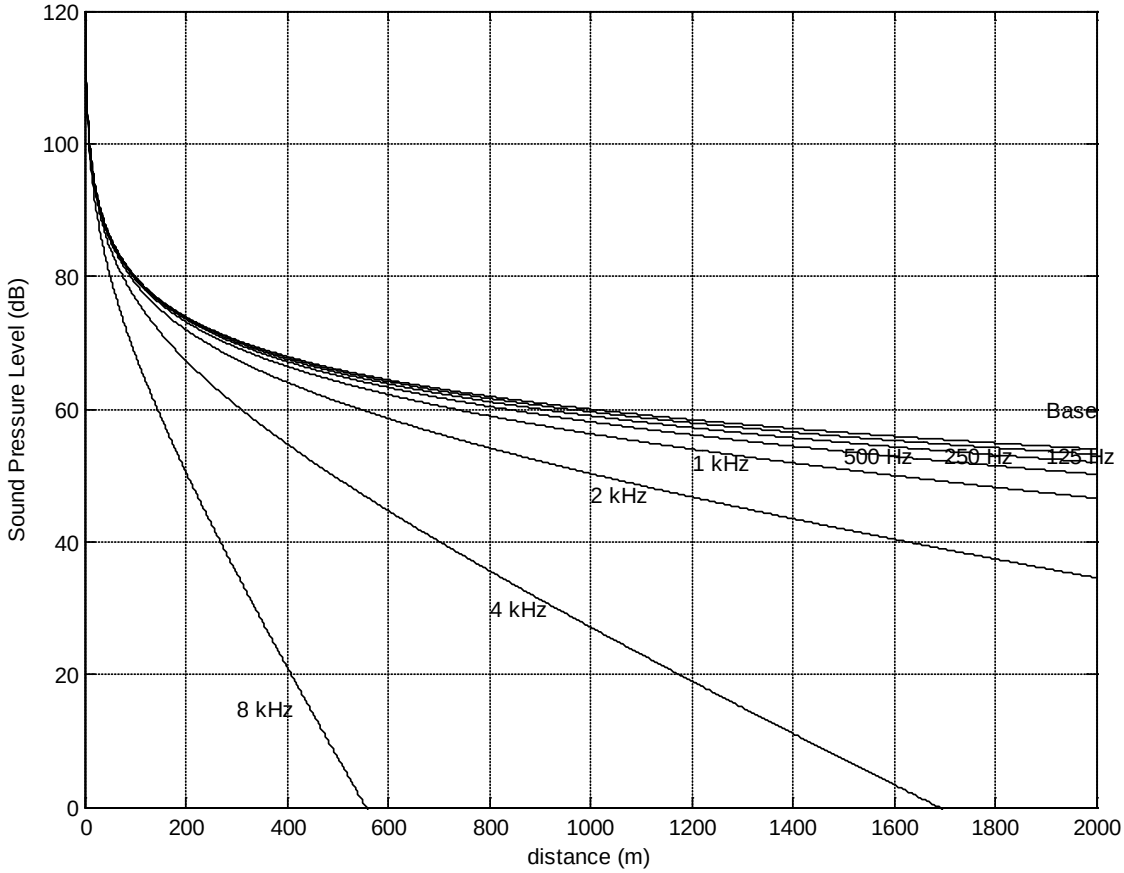
As sound transmits through a medium, there is an attenuation (or dissipation of acoustic energy) which can be attributed to three mechanisms:

1) **Viscous Effects** - Dissipation of acoustic energy due to fluid friction which results in thermodynamically irreversible propagation of sound.
2) **Heat Conduction Effects** - Heat transfer between high and low temperature regions in the wave which result in non-adiabatic propagation of the sound.
3) **Inter Molecular Energy Interchanges** - Molecular energy relaxation effects which result in a time lag between changes in translational kinetic energy and the energy associated with rotation and vibration of the molecules.

The following table illustrates the attenuation coefficient of sound at standard pressure (101.325 kPa) in units of dB/100m.

Temperature	Relative Humidity	Frequency (Hz)					
^{o}C	(%)	125	250	500	1000	2000	4000
30	20	0.06	0.18	0.37	0.64	1.40	4.40
	50	0.03	0.10	0.33	0.75	1.30	2.50
	90	0.02	0.06	0.24	0.70	1.50	2.60
20	20	0.07	0.15	0.27	0.62	1.90	6.70
	50	0.04	0.12	0.28	0.50	1.00	2.80
	90	0.02	0.08	0.26	0.56	0.99	2.10
10	20	0.06	0.11	0.29	0.94	3.20	9.00
	50	0.04	0.11	0.20	0.41	1.20	4.20
	90	0.03	0.10	0.21	0.38	0.81	2.50
0	20	0.05	0.15	0.50	1.60	3.70	5.70
	50	0.04	0.08	0.19	0.60	2.10	6.70
	90	0.03	0.08	0.15	0.36	1.10	4.10

- As frequency increases, absorption tends to increase
- As Relative Humidity increases, absorption tends to decrease
- There is no direct relationship between absorption and temperature
- **The net result of atmospheric absorption is to modify the sound propagation of a point source from 6 dB/doubling-of-distance to approximately 7 – 8 dB/doubling-of-distance (based on anecdotal experience)**



Atmospheric Absorption at 10°C and 70% RH

Meteorological Effects

There are many meteorological factors which can affect how sound propagates over large distances. These various phenomena must be considered when trying to determine the relative impact of a noise source either after installation or during the design stage.

Wind

- Can greatly alter the noise climate away from a source depending on direction
- Sound levels downwind from a source can be increased due to refraction of sound back down towards the surface. This is due to the generally higher velocities as altitude increases.
- Sound levels upwind from a source can be decreased due to a "bending" of the sound away from the earth's surface.
- Sound level differences of ±10dB are possible depending on severity of wind and distance from source.
- Sound levels crosswind are generally not disturbed by an appreciable amount
- Wind tends to generate its own noise, however, and can provide a high degree of masking relative to a noise source of particular interest.

Temperature

- Temperature effects can be similar to wind effects
- Typically, the temperature is warmer at ground level than it is at higher elevations.
- If there is a very large difference between the ground temperature (very warm) and the air aloft (only a few hundred meters) then the transmitted sound refracts upward due to the changing speed of sound.
- If the air aloft is warmer than the ground temperature (known as an *inversion*) the resulting higher speed of sound aloft tends to refract the transmitted sound back down towards the ground. This essentially works on Snell's law of reflection and refraction.
- Temperature inversions typically happen early in the morning and are most common over large bodies of water or across river valleys.
- Sound level differences of ±10dB are possible depending on gradient of temperature and distance from source.

Rain

- Rain does not affect sound propagation by an appreciable amount unless it is very heavy
- The larger concern is the noise generated by the rain itself. A heavy rain striking the ground can cause a significant amount of highly broadband noise. The amount of noise generated is difficult to predict.
- Rain can also affect the output of various noise sources such as vehicle traffic.

Summary

- In general, these wind and temperature effects are difficult to predict
- Empirical models (based on measured data) have been generated to attempt to account for these effects.
- Environmental noise measurements must be conducted with these effects in mind. Sometimes it is desired to have completely calm conditions, other times a "worst case" of downwind noise levels are desired.

Topographical Effects

Similar to the various atmospheric effects outlined in the previous section, the effect of various geographical and vegetative factors must also be considered when examining the propagation of noise over large distances.

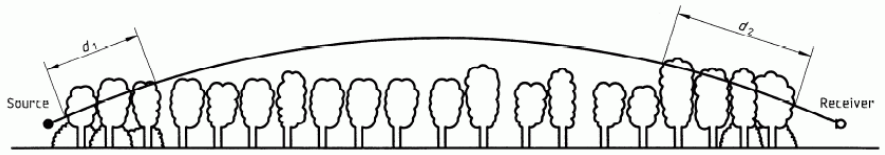
Topography
- One of the most important factors in sound propagation.
- Can provide a natural barrier between source and receiver (i.e. if berm or hill in between).
- Can provide a natural amplifier between source and receiver (i.e. large valley in between or hard reflective surface in between).
- Must look at location of topographical features relative to source and receiver to determine importance (i.e. small berm 1km away from source and 1km away from receiver will make negligible impact).

Grass
- Can be an effective absorber due to large area covered
- Only effective at low height above ground. Does not affect sound transmitted direct from source to receiver if there is line of sight.
- Typically less absorption than atmospheric absorption when there is line of sight.
- Approximate rule of thumb based on empirical data is:

$$A_g = 18\log_{10}(f) - 31 \qquad (dB/100m)$$

Where: A_g is the absorption amount

Trees
- Provide absorption due to foliage
- Deciduous trees are essentially ineffective in the winter
- Absorption depends heavily on density and height of trees
- No data found on absorption of various kinds of trees
- Large spans of trees are required to obtain even minor amounts of sound reduction
- In many cases, trees can provide an effective visual barrier, even if the noise attenuation is negligible.



NOTE — $d_f = d_1 + d_2$

For calculating d_1 and d_2, the curved path radius may be assumed to be 5 km.

Figure A.1 — Attenuation due to propagation through foliage increases linearly with propagation distance d_f through the foliage

Table A.1 — Attenuation of an octave band of noise due to propagation a distance d_f through dense foliage

Propagation distance d_f	Nominal midband frequency Hz							
m	63	125	250	500	1 000	2 000	4 000	8 000
	Attenuation, dB:							
$10 \leq d_f \leq 20$	0	0	1	1	1	1	2	3
	Attenuation, dB/m:							
$20 \leq d_f \leq 200$	0,02	0,03	0,04	0,05	0,06	0,08	0,09	0,12

Tree/Foliage attenuation from ISO 9613-2:1996

Bodies of Water

- Large bodies of water can provide the opposite effect to grass and trees.
- Reflections caused by small incidence angles (grazing) can result in larger sound levels at great distances (increased reflectivity, Q).
- Typically air temperatures are warmer high aloft since air temperatures near water surface tend to be more constant. Result is a high probability of temperature inversion.
- Sound levels can “carry” much further.

Snow

- Covers the ground for much of the year in northern climates.
- Can act as an absorber or reflector (and varying degrees in between).
- Freshly fallen snow can be quite absorptive.
- Snow which has been sitting for a while and hard packed due to wind can be quite reflective.
- Falling snow can be more absorptive than rain, but does not tend to produce its own noise.
- Snow can cover grass which might have provided some means of absorption.
- Typically sound propagates with less impedance in winter due to hard snow on ground and no foliage on trees/shrubs.

Appendix III

SOUND LEVELS OF FAMILIAR NOISE SOURCES

Used with Permission Obtained from EUB Guide 38: Noise Control Directive User Guide (November 1999)

Source[1]	Sound Level (dBA)
Bedroom of a country home	30
Soft whisper at 1.5 m	30
Quiet office or living room	40
Moderate rainfall	50
Inside average urban home	50
Quiet street	50
Normal conversation at 1 m	60
Noisy office	60
Noisy restaurant	70
Highway traffic at 15 m	75
Loud singing at 1 m	75
Tractor at 15 m	78-95
Busy traffic intersection	80
Electric typewriter	80
Bus or heavy truck at 15 m	88-94
Jackhammer	88-98
Loud shout	90
Freight train at 15 m	95
Modified motorcycle	95
Jet taking off at 600 m	100
Amplified rock music	110
Jet taking off at 60 m	120
Air-raid siren	130

[1] Cottrell, Tom, 1980, *Noise in Alberta*, Table 1, p.8, ECA80 - 16/1B4 (Edmonton: Environment Council of Alberta).

SOUND LEVELS GENERATED BY COMMON APPLIANCES

Used with Permission Obtained from EUB Guide 38: Noise Control Directive User Guide (November 1999)

Source[1]	Sound level at 3 feet (dBA)
Freezer	38-45
Refrigerator	34-53
Electric heater	47
Hair clipper	50
Electric toothbrush	48-57
Humidifier	41-54
Clothes dryer	51-65
Air conditioner	50-67
Electric shaver	47-68
Water faucet	62
Hair dryer	58-64
Clothes washer	48-73
Dishwasher	59-71
Electric can opener	60-70
Food mixer	59-75
Electric knife	65-75
Electric knife sharpener	72
Sewing machine	70-74
Vacuum cleaner	65-80
Food blender	65-85
Coffee mill	75-79
Food waste disposer	69-90
Edger and trimmer	81
Home shop tools	64-95
Hedge clippers	85
Electric lawn mower	80-90

[1] Reif, Z. F., and Vermeulen, P. J., 1979, "Noise from domestic appliances, construction, and industry," Table 1, p.166, in Jones, H. W., ed., *Noise in the Human Environment*, vol. 2, ECA79-SP/1 (Edmonton: Environment Council of Alberta).