Attachment 2

aci Acoustical Consultants Inc.
5031 – 210 Street
Edmonton, Alberta, Canada T6M 0A8
Phone: (780) 414-6373
www.aciacoustical.com

Environmental Noise Survey
For The

Stratotech Park Raceway
In
Sturgeon County, AB

Prepared for:
Stratotech Park

Prepared by:
P. Froment, B.Sc., B.Ed., P.L.(Eng.)
aci Acoustical Consultants Inc.
Edmonton, Alberta
APEGA Permit to Practice #P7735

PROFESSIONAL LICENSEE (ENGINEERING) ALBERTA
PATRICK FROMENT
Member ID :196923

06/22/2022

PERMIT TO PRACTICE
ACI ACOUSTICAL CONSULTANTS INC.
Signature
Date 6/22/2022
PERMIT NUMBER: P 7735
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

aci Project #: 22-039
June 22, 2022

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Executive Summary

aci Acoustical Consultants Inc., of Edmonton AB, was retained by Stratotech Park in Sturgeon County, AB to conduct an environmental noise study for their racetrack (the Track) at 55112 825 in Sturgeon County, AB. The purpose of the work was to perform on-site measurements of motorcycles and drifting vehicles while they were on the track. At the same time, measurements were conducted simultaneously in various directions away from the Track. In addition, a long-term noise monitoring was conducted within the study area that measured the noise climate of the area from May 28 – June 13, 2022. Site work was conducted for aci on May 28, June 2 & June 13 2022 by P. Froment, B.Sc., B.Ed., P.L.(Eng.).

Short-term sound level measurements were performed at the Track on Saturday May 28, 2022 during a motorcycle lapping event and again on June 2, 2022 specifically to measure the contributions of a drifting vehicle. For the May 28, 2022 event, the measured noise levels at the 3 locations outside of the track boundaries ranged from 55.4 to 60.1 L_{eq}[1] dBA. In reviewing the overall broadband L_{eq} & 1/3 octave band L_{eq} sound levels, it was found that there was no direct correlation between the measured noise levels at the 3 locations outside of the track and from those taken at the Track.

The results of the June 2, 2022 for the vehicle drifting indicated noise levels ranging from 33.5 to 60.1 L_{eq} dBA at the 3 locations outside of the track boundaries. Similarly to the car lapping event, the overall broadband L_{eq} & 1/3 octave band L_{eq} sound levels at the 3 locations outside of the track, were not found a direct correlation to the measured noise levels taken at the Track.

It was noted however that the noise contributions from the Track were subjectively audible at the various measurement locations and in the audio recordings, however, those contributions were not the dominant noise source.

The L_{eq}Day noise levels during the 16-day noise monitoring period ranged from 58.1 – 63.7 dBA. In comparing daytime periods with/without activities at the Track there was no clear indication that there was a significant change in the overall noise climate at the noise monitoring location from day-to-day, regardless of the events at the Track. In addition, in reviewing the 1/3 octave band L_{eq} sound levels, the traces from the monitoring are not congruent with the Track measurements (both from the motorcycle and vehicle drifting data). The 1/3 octave band L_{eq} sound levels from the shows the typical trend of traffic noise with mid frequencies (315 Hz – 800 Hz) from engines and exhaust and, mid-high frequency noise (near 1,000 Hz) resulting from tire noise.

As a result, based on the results of the noise monitoring and the short-term measurements during events at the track, the noise contributions from the track did not have a significant impact on the noise climate of the study area, particularly for the monitoring location southwest of the Track.

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[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 Stratotech Park in Sturgeon County, AB to conduct an environmental noise study for their racetrack (the Track) at 55112 825 in Sturgeon County, AB. The purpose of the work was to perform on-site measurements of motorcycles and drifting vehicles while they were on the track. At the same time, measurements were conducted simultaneously in various directions away from the Track. In addition, a long-term noise monitoring was conducted within the study area that measured the noise climate of the area from May 28 – June 13, 2022. Site work was conducted for aci on May 28, June 2 & June 13 2022 by P. Froment, B.Sc., B.Ed., P.L.(Eng.).

2.0 Project & Location Description

2.1. Track Description

As indicated in Figure 1, the Track is located approximately 2.3 km northwest of Fort Saskatchewan, AB. As shown in Figure 2, the full course is 1.7 km in length and has the longest straight-away along the western border of the property. The course was built in 2000 and remained open until 2013, during which time events for car lapping, motorcycle lapping and racing, drifting, and go-karting took place at the Track. In spring 2020, events at the Track resumed and it is anticipated that the Track will host approximately 60 events per year.

The Track only operates during the daytime hours and is available from 08:00 – 21:00 throughout the spring – fall months. The operating hours will be reduced at the start and end of the season, which is based on available sunlight. In addition, the actual operational hours are estimated to be approximately 300 hours per season.

As part of the project, the long-term monitor was in place to measure the noise levels during five (5) motorcycle lapping events and one (1) drifting event.

2.2. Current Noise Sources within Study Area

The Track is found within the Alberta Industrial Heartland Region, as shown in Figure 1, and as such, there are numerous industrial facilities within proximity to the Track. These facilities include but are not limited to Horton CBI, Univar, Bunge Canada, NSC Minerals, Clearstream, McAsphalt, etc. In addition to these smaller facilities, the Nutrien, Sherritt and Dow Chemical facilities on the east side of the North Saskatchewan River (NSR) are within 4 km of the eastern border of the Track.

Along with the numerous industrial facilities, there is also the CN Sturgeon Support Yard approximately 1.0 km southeast of the Track which services a CN Mainline. This mainline continues north before crossing the NSR towards the Plains facility. However, prior to it crossing the river, there are several branches from the mainline. One branch runs parallel to the western border of the Track and services the industrial facilities to the north.

Highway 825 which is immediately east of the Track, is considered heavily traveled[1] at all times of day and night. In addition, it is composed of high number of heavy vehicles (19.4%)[2]. Additionally, continuous traffic on Highways 15 & 37 also contribute to the overall noise climate of the area.

Based on the current industrial noise sources, the noise contributions from the various roadways in addition to the noise contributions from the rail line, the current noise climate of the area would be anticipated to be relatively elevated.

2.3. Residential Locations within Study Area

The most impacted residential receptors are found west of the Track with the nearest impacted residential location approximately 800 m west of the western border. There is partial line-of-sight for residents immediately west of the Track. Further to the south, there is no line-of-sight for residents due to a small band of trees, a storage yard in addition to variations in the topography.

Approximately 4 km northeast of the Track is the Riverside subdivision which consists of a series of rural-residential properties laid out in a generally east/west manner. There is no direct line-of-sight between the subdivision and the Track (due to the increased distance).

Residents to southwest of the Track include those within the hamlet of Lamoureux (1.9 km to nearest resident) and residents in the northwest corner of Fort Saskatchewan (2.2 km to nearest resident). Residents in Lamoureux do not have direct line-of-sight to the Track due to the significant drop in elevation. Residents in the northwest of Fort Saskatchewan are at a similar elevation to the Track however they do not have direct line-of-sight to the Track due to vegetation to the west and to the increased distance.

[1] The 2021 AADT for Highway 825 (obtained from the Alberta Transportation website) is 3540. Assuming 10% of this traffic occurs during the night-time equates to approximately 39 vehicles per hour during the nighttime. This meets the AER Directive 038 and AUC Rule 012 requirement of 10 vehicles per hour for the road to be considered Heavily Traveled.

[2] As per the Alberta Transportation website.

3.0 Measurement Methods

3.1. Short Term Sound Level Measurements

Short-term sound level measurements were performed at the Track on Saturday May 28, 2022 during a motorcycle lapping event and again on June 2, 2022 specifically to measure the contributions of a drifting vehicle. The purpose of the measurements was to obtain noise level data of the vehicles while they were under "typical" operations at the Track. This would allow for a comparison of the characteristics of the noise from the Track (frequency or "pitch") to those measured at variation locations away from the Track. In addition, the measurements allowed for the observation of specific procedures and operations associated with the Track.

For the motorcycle lapping event, noise measurements were conducted at 4 locations for approximately 1 – 1.5 hours. Figure 3 provides an example of a noise monitor in place for the short-term measurements. For the drifting measurements, the measurement locations were conducted at 4 locations[1] for approximately 40 minutes. All measurements locations are identified in Figure 1. The short-term sound level measurements were conducted using 15-second Leq samples. The information gathered consisted of broadband linear, A-weighted, C-weighted and 1/3 octave band sound levels.

The wind speeds were relatively high during the motorcycle lapping event[2] while the wind was calm during the drifting measurement.

Refer to Appendix I for a detailed description of all measurement equipment used in addition to calibration records, Appendix II for a description of the acoustical terminology, and Appendix III for a list of common noise sources. The noise measurement instrumentation was calibrated at the start of the monitoring and then checked afterwards to ensure that there had been no calibration drift over the duration of the monitoring.

It is important to note that any comparison of measurement data taken from phones or other measurement devices that have not been calibrated should not be considered.

[1] The locations differed slightly from the motorcycle lapping event.
[2] Due to the proximity of the sound level meter at M4 (discussed in subsequent sections) to the motorcycles, the effects of the wind were negligible.

3.2. Environmental Noise Monitoring

As part of the study, a long-term environmental noise monitoring was conducted within the southern portion of the study area. The noise monitoring location, as indicated in Figure 1, was selected to determine the noise contributions of the Track for residents with the greatest concern. The noise monitor was located approximately 15 m east of Range Road 225 and approximately 50 m west of Highway 825. This placed the noise monitor approximately 1.2 km southwest of the southern most portion of the track. The microphone was placed at a height of 2.5 m above ground, as shown in Figure 4. The noise monitor was started at 08:48 on Saturday May 28, 2022 and ran for approximately 16 days until 08:40 on Monday June 13, 2022. This is well beyond the requirement of 7 days as required by Sturgeon County officials.

The noise monitoring was conducted collecting broadband A-weighted and C-weighted as well as 1/3 octave band sound levels. In addition, the noise monitoring was accompanied by a digital audio recording for more detailed post process analysis.

A local weather monitoring station was used throughout the entire noise monitoring period to obtain the wind speed and wind direction.

4.0 Noise Descriptors

Environmental noise levels from industrial and commercial noise sources 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 daytime (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. As activities at the Track only occur during the daytime, the L_{eq}Day will be discussed, though the results of

As Sturgeon County does not have a specific policy related to this type of activity, there will be no comparison of the measured noise levels to any criteria.

5.0 Results and Discussion

5.1. Short-Term Sound Level Measurements

As previously mentioned, short-term sound level measurements were performed on May 28 & June 2, 2022, at the Track and within the study area. The results of each measurement will be discussed individually.

5.1.1. Motorcycle Lapping Event (May 28, 2022)

As previous mentioned, noise measurements were conducted at 4 locations within the study area during the measurement period (08:30 – 10:00) on May 28, 2022. For the purposes of the data analysis, 10:08 to 10:20 was investigated as this was the time period in which the noise levels were stable as it excluded the gap between session on the track. In addition, this time period had the highest measured noise levels from the track. Therefore the results provided in Table 1 and illustrated in Figure 5 (broadband A-weighted L_{eq} sound levels from the Track) & Figure 6 (1/3 octave band L_{eq} sound levels from all monitoring locations) provide conservative estimates of the noise climate within the study area when the motorcycles were the loudest on the track.

Table 1. Short-Term Sound Level Measurement Results

Measurement Location	Distance		L_{eq}(dBA)
M1 (Southwest Location & Noise Monitor)	1.2 km South of South Track		59.1
M2 (North Location)	1.4 km Northeast of North Track		60.1
M3 (Southeast Location)	1.0 km Southeast of East Track		55.4
M4 (Track Location)	12 m from centre of Track		88.7

As indicated in Table 1, the measured noise levels at the 3 locations outside of the track boundaries ranged from 55.4 to 60.1 L_{eq} dBA. In reviewing the 1/3 octave band L_{eq} sound levels in Figure 6, there is no direct correlation between the measured noise levels at M1 – M3 and those from taken from the Track (M4). The measurements from the Track show elevated noise levels in the mid frequencies (315 Hz – 800 Hz) where the 1/3 octave band L_{eq} sound levels (frequency content) from the M1 & M2 in particular, show the typical trend of low frequency noise (near 63 – 80 Hz) resulting from engines and exhaust associated with heavy truck and, mid-high frequency noise (near 1,000 Hz) resulting from tire noise.

It should be noted that the noise contributions from the Track were subjectively audible at all monitoring locations, however, they were not the dominant noise source which validates the measured data.

5.1.2. Vehicle Drifting (June 2, 2022)

Similarly to the measurements conducted for the car lapping event, noise measurements were conducted at 4 locations within the study area for the vehicle drifting on June 2, 2022. The Track measurement location (M6) was in a different location from the previous measurement location, in order to obtain better data from the drifting vehicle. In addition, the southeast measurement location was moved closer to the hamlet of Lamoureux[1](M5). The two other locations (M1 & M2) were at the same location as the May 28, 2022 measurement.

The entire measurement period was 10:45 – 11:15. For the purposes of the data analysis, 10:50 to 10:57 was investigated as this time period had two passes of the drifting vehicle. In addition, this time period had the highest measured noise levels on the track. Therefore the results provided in Table 2 and illustrated in Figure 7 (broadband A-weighted L_{eq} sound levels from the Track) & Figure 8 (1/3 octave band L_{eq} sound levels from all monitoring locations) provide conservative estimates of the noise climate within the study area when the motorcycles were the loudest on the track.

Table 2. Short-Term Sound Level Measurement Results

Measurement Location	Distance		L_{eq}(dBA)
M1 (Southwest Location & Noise Monitor)	1.2 km South of South Track		60.1
M2 (North Location)	1.4 km Northeast of North Track		33.5
M5 (Southeast Location)	1.8 km Southeast of East Track		39.9
M6 (Track Location)	24 m from centre of Track		71.2

As indicated in Table 2, the measured noise levels at the 3 locations outside of the track boundaries ranged from 33.5 to 60.1 L_{eq} dBA. In reviewing the 1/3 octave band L_{eq} sound levels in Figure 8, there is no direct correlation between the measured noise levels at M1, M2 & M5 and those from taken from the Track (M6). The measurements from the Track show elevated noise levels in the 40 Hz & 160 Hz, 1/3 octave bands (frequency content). The 1/3 octave band L_{eq} sound levels from the M1 shows the typical trend of traffic noise relating to engines and exhaust and, mid-high frequency noise (near 1,000 Hz) resulting from tire noise. The overall broadband values found in Table 2 and the 1/3 octave band L_{eq} sound levels illustrated in Figure 8, show relatively low noise levels for M2 & M3, with no correlation to the M6 measurement.

Similarly to the May 28, 2022 measurement, noise contributions from the Track were subjectively audible, however, they were not the dominant noise source which validates the measured data.

[1] There was too much activity near this location on May 28, 2022.

5.2. Environmental Monitoring

The broadband A-weighted L_{eq} sound levels obtained from the environmental noise monitoring are presented in Table 3 while the 1/3 octave band L_{eq} sound levels are illustrated in Figure 9. All L_{eq} results are considered "raw" in that no data has been removed. Therefore, the values within Table 3 are representative of the noise climate within proximity to the southwestern residents. This includes all contributions from the Track, as well as contributions from the roadways, trains, and industrial facilities. As activities at the Track only occur during the daytime, only the L_{eq}Day will be discussed, though as shown in Table 3, the results of the L_{eq}Night and L_{eq}24 have also been provided.

Table 3. Leq Results From Long-Term Monitoring

Date	Activities	L_{eq}24 (dBA)	L_{eq}Day (dBA)	L_{eq}Night (dBA)
28-May-22	Motorcycle Lapping Event (08:00 - 16:00)	N/A	59.8	N/A
29-May-22	Motorcycle Lapping Event (08:00 - 16:00)	58.3	59.3	55.8
30-May-22	Car Lapping Event (08:00 - 16:00)	57.7	58.1	56.8
31-May-22	No Events	59.0	59.1	59.0
01-Jun-22	No Events	59.8	60.3	58.8
02-Jun-22	No Events	60.7	61.1	59.7
03-Jun-22	No Events	60.5	61.7	57.5
04-Jun-22	No Events	59.3	60.6	55.8
05-Jun-22	Car Lapping Event (08:00 - 15:00) Car Lapping Event (17:00 - 21:00)	59.0	60.5	54.4
06-Jun-22	No Events	62.3	63.6	58.8
07-Jun-22	No Events	61.8	62.7	59.6
08-Jun-22	No Events	62.6	63.7	59.6
09-Jun-22	No Events	61.0	61.8	59.2
10-Jun-22	No Events	59.0	59.3	58.2
11-Jun-22	Drifting Event (09:00 - 16:00)	58.5	59.3	56.6
12-Jun-22	No Events	57.5	58.4	55.4
Maximum		**62.6**	**63.7**	**59.7**
Minimum		**57.5**	**58.1**	**54.4**
Average		**59.8**	**60.6**	**57.7**

As indicated in Table 3, the L_{eq}Day noise levels during the 16-day noise monitoring period ranged from 58.1 – 63.7 dBA. In comparing daytime periods with/without activities at the Track there does not appear to be a clear indication that there is a significant change in the overall noise climate from day-to-day, regardless of if there was an event or not. In addition, in reviewing the 1/3 octave band L_{eq} sound levels in Figure 9, the traces from the monitoring are not congruent with the Track measurements (both from the motorcycle and vehicle drifting data). The 1/3 octave band L_{eq} sound levels from the shows the typical trend of traffic noise with mid frequencies (315 Hz – 800 Hz) from engines and exhaust and, mid-high frequency noise (near 1,000 Hz) resulting from tire noise.

As a result, based on the results of the noise monitoring and the short-term measurements during events at the track, the noise contributions from the track do not have a significant impact on the noise climate of the study area, particularly for the monitoring location southwest of the Track.

5.3. Weather Conditions

Weather data (wind speed and direction) during the noise monitoring is provided in Figure 10 in the form of a rose chart. In general, the wind speeds were relatively high and primarily from the northwest and southeast.

6.0 Conclusion

Short-term sound level measurements were performed at the Track on Saturday May 28, 2022 during a motorcycle lapping event and again on June 2, 2022 specifically to measure the contributions of a drifting vehicle. For the May 28, 2022 event, the measured noise levels at the 3 locations outside of the track boundaries ranged from 55.4 to 60.1 L_{eq} dBA. In reviewing the overall broadband L_{eq} & 1/3 octave band L_{eq} sound levels, it was found that there was no direct correlation between the measured noise levels at the 3 locations outside of the track and from those taken at the Track.

The results of the June 2, 2022 for the vehicle drifting indicated noise levels ranging from 33.5 to 60.1 L_{eq} dBA at the 3 locations outside of the track boundaries. Similarly to the car lapping event, the overall broadband L_{eq} & 1/3 octave band L_{eq} sound levels at the 3 locations outside of the track, were not found a direct correlation to the measured noise levels taken at the Track.

It was noted however that the noise contributions from the Track were subjectively audible at the various measurement locations and in the audio recordings, however, those contributions were not the dominant noise source.

The L_{eq}Day noise levels during the 16-day noise monitoring period ranged from 58.1 – 63.7 dBA. In comparing daytime periods with/without activities at the Track there was no clear indication that there was a significant change in the overall noise climate at the noise monitoring location from day-to-day, regardless of the events at the Track. In addition, in reviewing the 1/3 octave band L_{eq} sound levels, the traces from the monitoring are not congruent with the Track measurements (both from the motorcycle and vehicle drifting data). The 1/3 octave band L_{eq} sound levels from the shows the typical trend of traffic noise with mid frequencies (315 Hz – 800 Hz) from engines and exhaust and, mid-high frequency noise (near 1,000 Hz) resulting from tire noise.

As a result, based on the results of the noise monitoring and the short-term measurements during events at the track, the noise contributions from the track did not have a significant impact on the noise climate of the study area, particularly for the monitoring location southwest of the Track.

7.0 References

- Alberta Energy Regulator (AER), *Directive 038 on Noise Control, 2007*, Calgary, Alberta
- Alberta Utility Commission (AUC), *Rule 012 on Noise Control*, 2017, Calgary, Alberta
- 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.

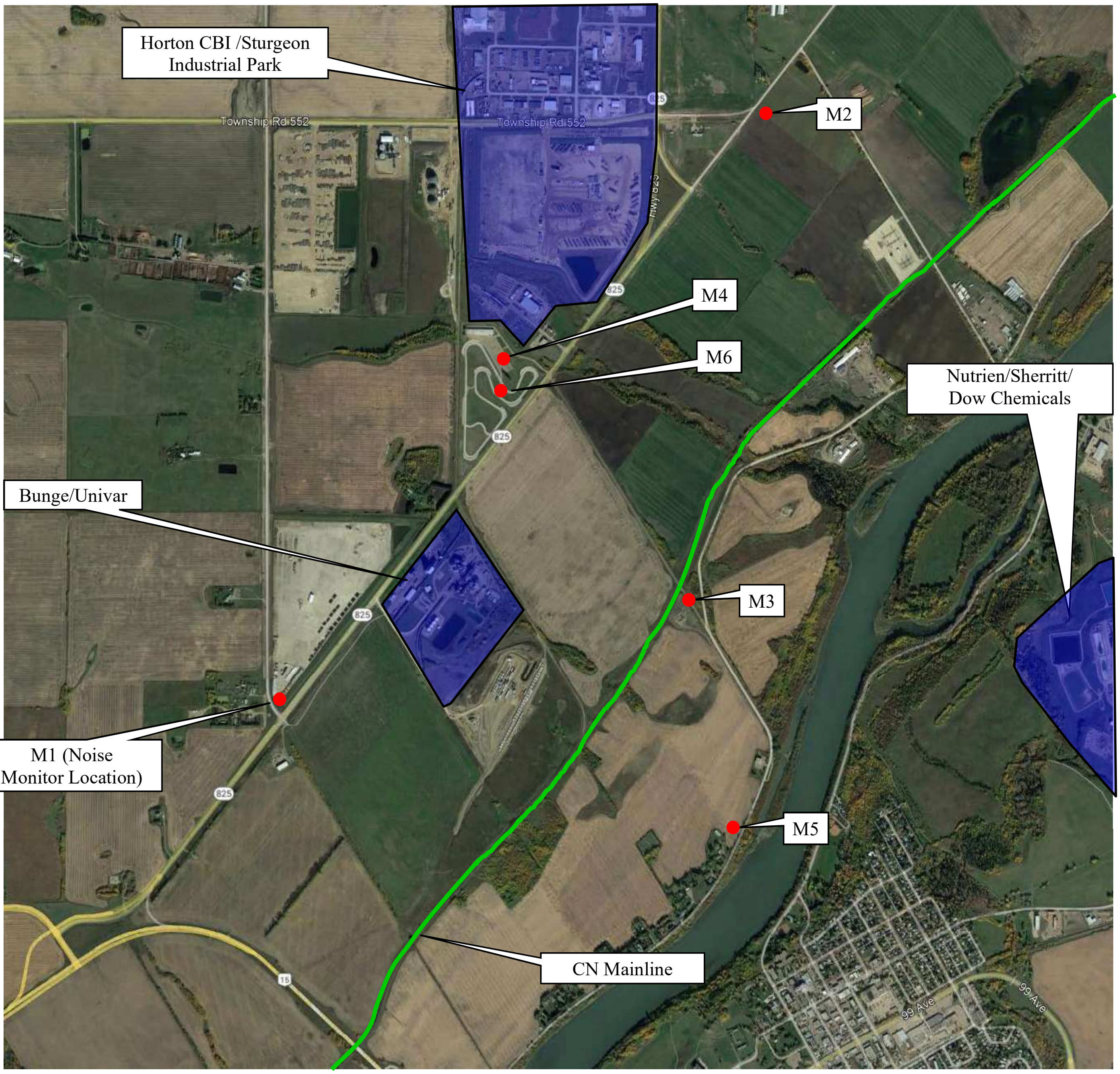

Figure 1. Study Area

Figure 2. Stratotech Park

Figure 3. Example of Noise Monitor Used for Short Term Measurement

Figure 4. Noise & Weather Monitors Used for Environmental Noise Study

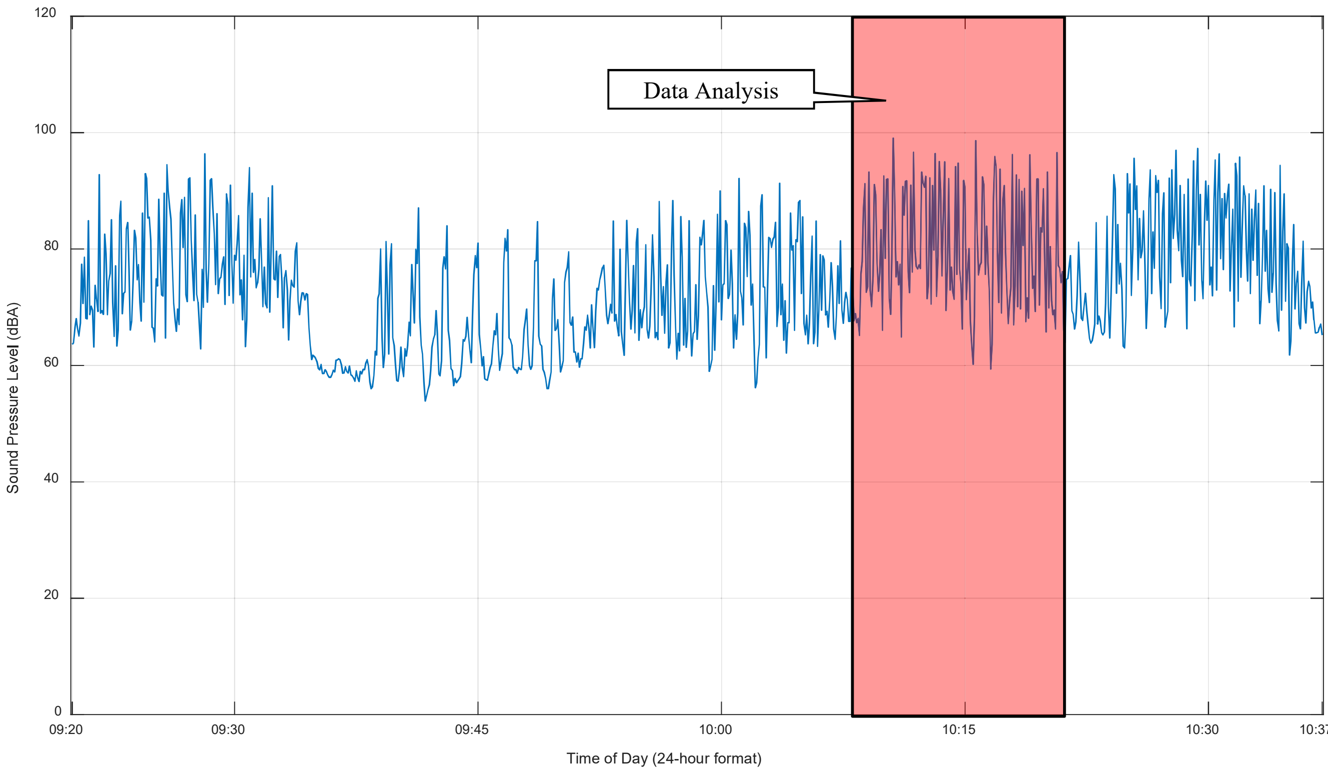

Figure 5. 5-Second L_{eq} Sound Levels from Car Lapping Event

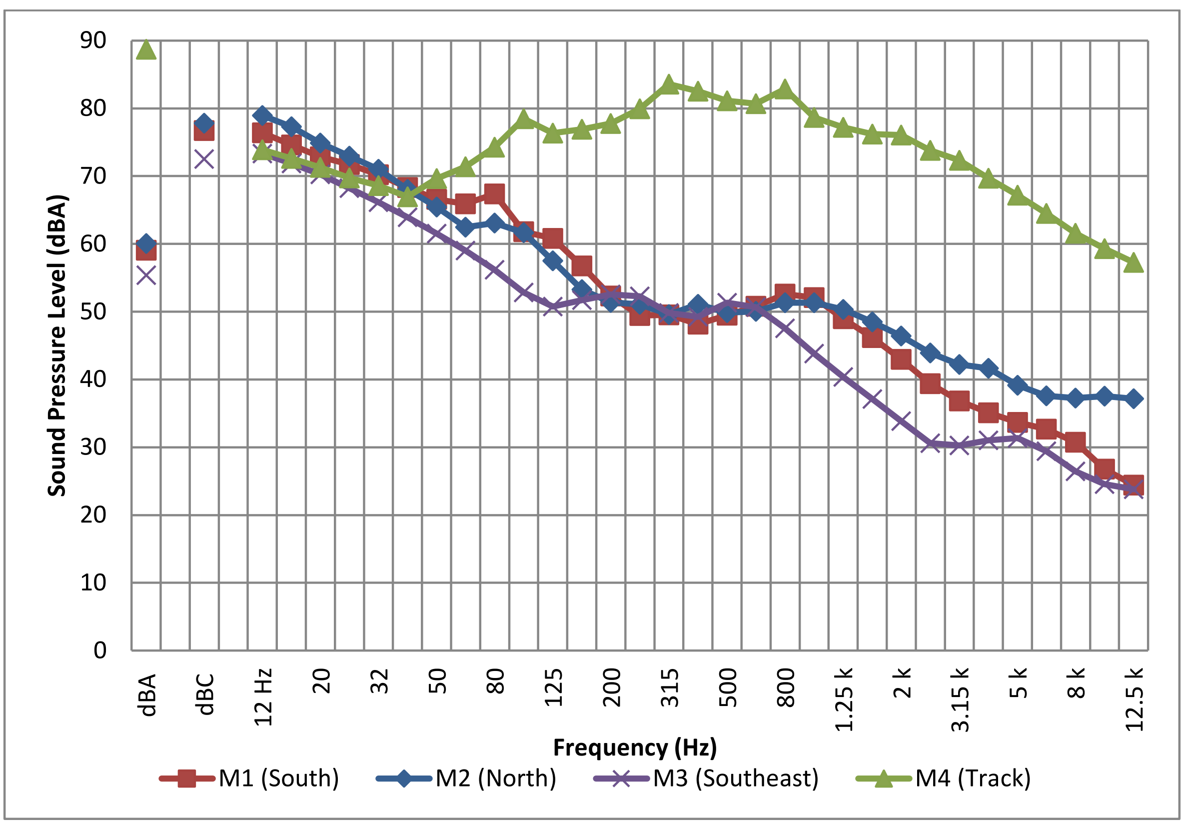

Figure 6. 1/3 Octave Band Sound Levels from Car Lapping Event

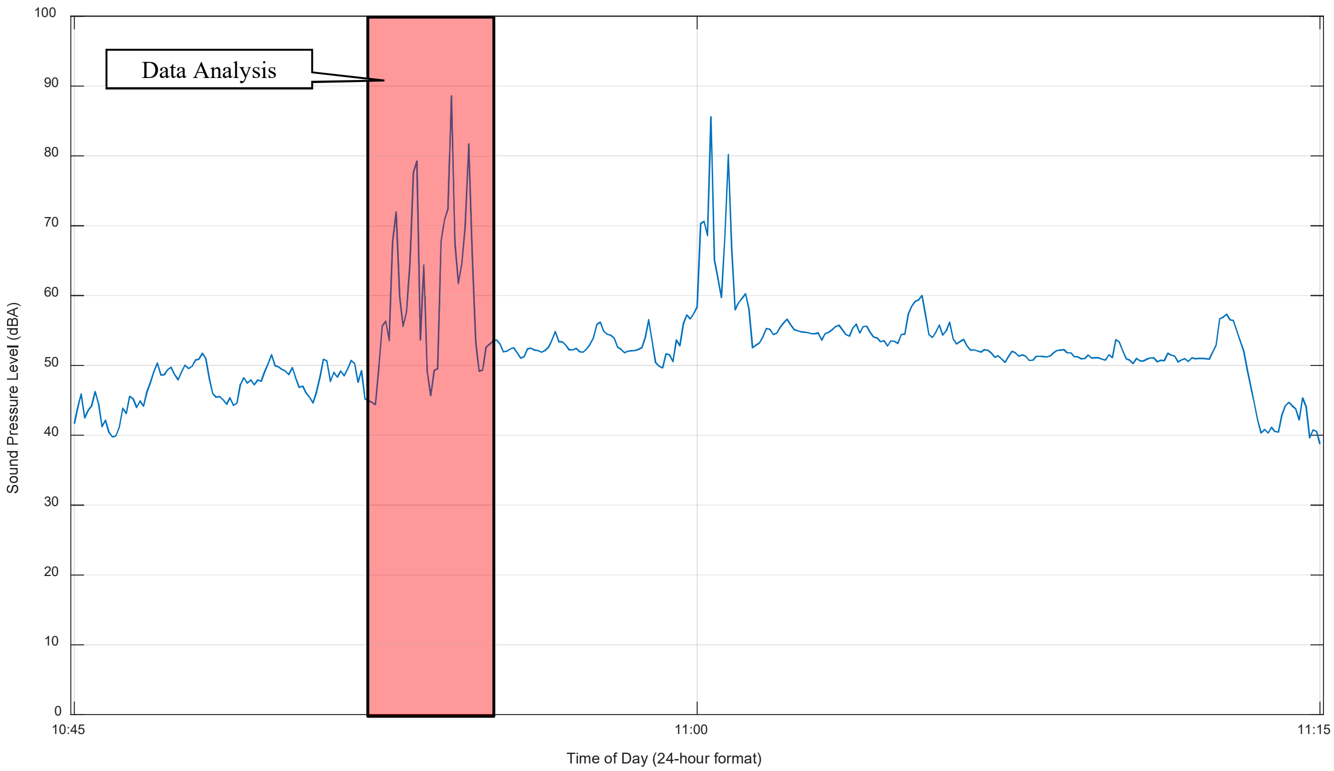

Figure 7. 5-Second L_{eq} Sound Levels from Vehicle Drifting

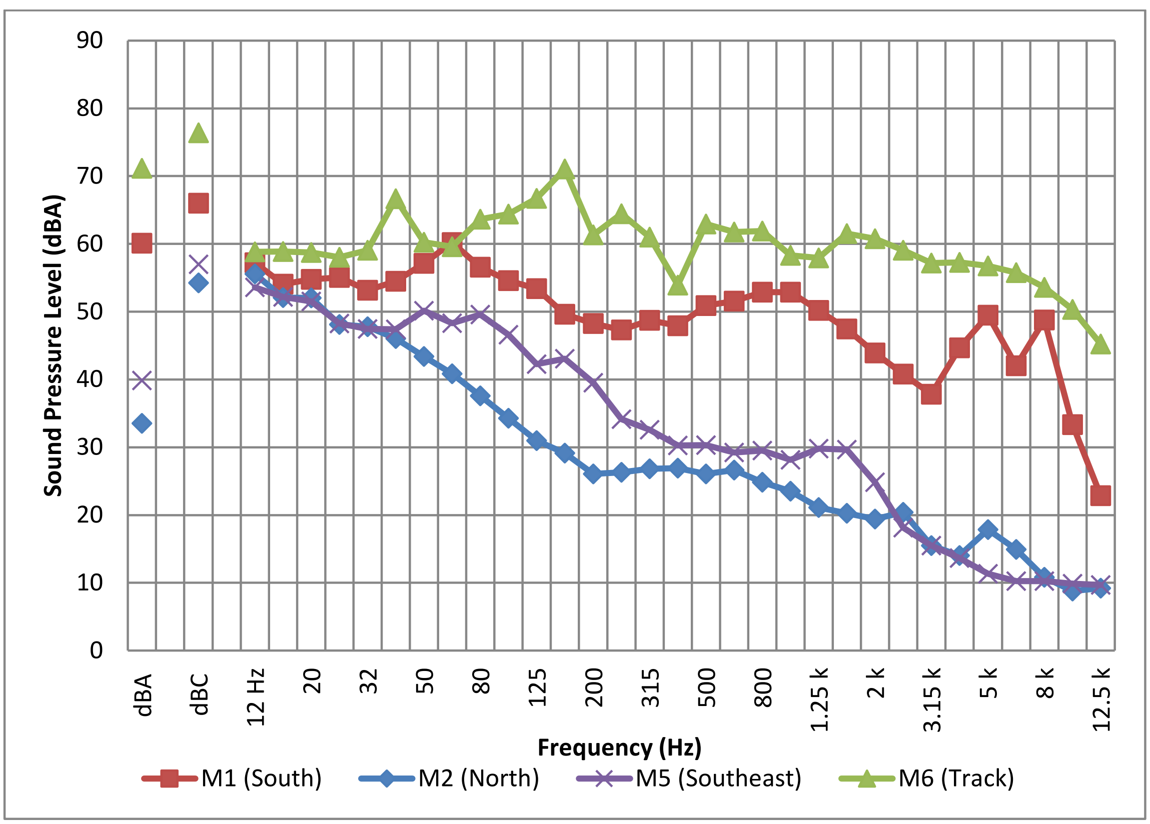

Figure 8. 1/3 Octave Band Sound Levels from Vehicle Drifting

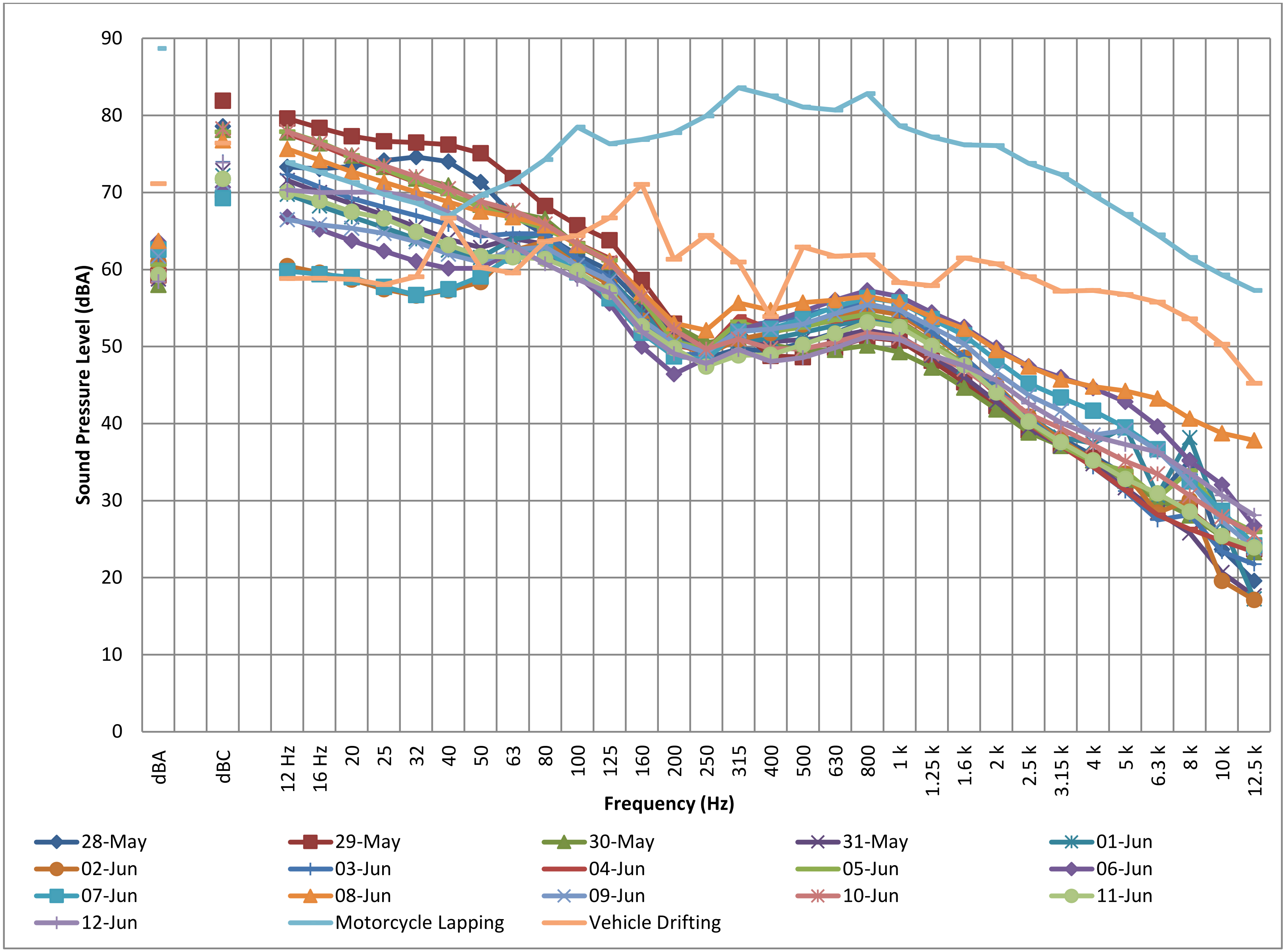

Figure 9. L_{eq}Day 1/3 Octave Band Sound Levels from Noise Monitoring (May 28 – June 12, 2022)

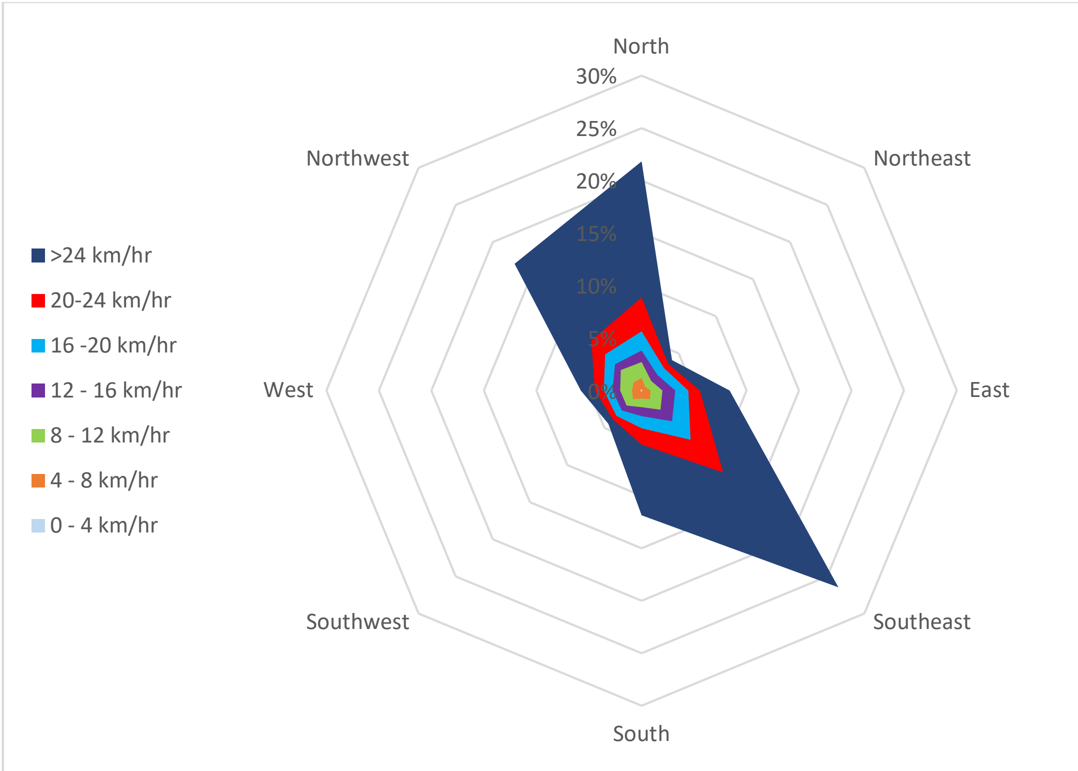

Figure 10. May 28 – June 13, 2022 - Wind Rose at Monitoring Location

Appendix I MEASUREMENT EQUIPMENT USED

Brüel and Kjær 2250/2270 (Unit 2/ Unit 3/ Unit 4 / Unit 5 / Unit 6)

The environmental noise monitoring equipment used for the project consisted of a Brüel and Kjær Type 2250/2270 Precision Integrating Sound Level Meter enclosed in an environmental case, a tripod, a weather protective microphone hood. The system acquired data in 15-second L_{eq} samples using 1/3 octave band frequency analysis and overall A-weighted and C-weighted sound levels. The sound level meter conforms to Type 1, ANSI S1.4, ANSI S1.43, IEC 61672-1, IEC 60651, IEC 60804 and DIN 45657. The 1/3 octave filters conform to S1.11 – Type 0-C, and IEC 61260 – Class 0. The calibrator conforms to IEC 942 and ANSI S1.40. The sound level meter, pre-amplifier and microphone were certified on April 07, 2021 / April 07, 2021 / March 04, 2021 / March 04, 2021 / March 04, 2021 and the calibrator (type B&K 4231) was certified on January 24, 2022 by a NIST NVLAP Accredited Calibration Laboratory for all requirements of ISO 17025: 1999 and relevant requirements of ISO 9002:1994, ISO 9001:2000 and ANSI/NCSL Z540: 1994 Part 1. All measurement methods and instrumentation conform to the requirements of Industry Standards. Simultaneous digital audio was recorded directly on the sound level meter using a 8 kHz sample rate for more detailed post-processing analysis. Refer to the next section in the Appendix for a detailed description of the various acoustical descriptive terms used.

Weather Monitor

The weather monitoring equipment used for the study consisted of an Orion Weather Station 9510-A-1 with a WXT520 Self-Aspirating Radiation Shield Sensor Unit, a Weather MicroServer 9590 Data-logger, and a Lightning Arrestor. The Data-logger and batteries were located in a grounded, weather protective case. The Sensor Unit was mounted on a sturdy survey tripod (with supporting guy-wires) at approximately 5.0 m above ground. The system was set up to record data in 1-minute samples obtaining the wind-speed, peak wind-speed, and wind-direction in a rolling 2-minute average as well as the 1-minute temperature, relative humidity, barometric pressure, rain rate and total rain accumulation.

Record of Calibration Results

Description	Date	Time	Pre / Post	Calibration Level	Calibrator Model	Serial Number
M1	28-May-22	8:45	Pre	93.9 dBA	B&K 4231	2575493
M1	13-Jun-22	10:40	Post	93.8 dBA	B&K 4231	2575493
M2	28-May-22	7:50	Pre	93.9 dBA	B&K 4231	2575493
M2	28-May-22	10:15	Post	93.9 dBA	B&K 4231	2575493
M2	02-Jun-22	9:50	Pre	93.9 dBA	B&K 4231	2575493
M2	02-Jun-22	11:50	Post	93.9 dBA	B&K 4231	2575493
M3	28-May-22	8:05	Pre	93.9 dBA	B&K 4231	2575493
M3	28-May-22	10:30	Post	93.8 dBA	B&K 4231	2575493
M4	28-May-22	9:15	Pre	93.9 dBA	B&K 4231	2642956
M4	28-May-22	10:40	Post	93.9 dBA	B&K 4231	2642956
M5	02-Jun-22	10:05	Pre	93.9 dBA	B&K 4231	2575493
M5	02-Jun-22	11:35	Post	93.9 dBA	B&K 4231	2575493
M6	02-Jun-22	10:40	Pre	93.9 dBA	B&K 4231	2575493
M6	02-Jun-22	11:25	Post	93.9 dBA	B&K 4231	2575493

B&K 2270 Unit #2 SLM Calibration Certificate

CALIBRATED BY TRANSCAT CERTIFICATE OF CALIBRATION

Customer: ACI ACCOUSTICAL CONSULTANTS IN
5031-210 STREET NW
EDMONTON, AB T6M 0A8

PO Number: BILAWCHUK

ANAB ACCREDITED ISO/IEC 17025 CALIBRATION LABORATORY
ANAB AC-2489.07

ilac-MRA

Certificate/SO Number: 17-Q1X3X-100-1 Revision 0

Manufacturer: Bruel & Kjaer
Model Number: 2270
Description: Sound Level Meter
Serial Number: 3002718/2850742
ID: UNIT 2

As-Found: In Tolerance
As-Left: In Tolerance

Issue Date: Apr 07, 2021
Calibration Date: Apr 07, 2021

Calibrated To: Manufacturer Specification
Calibration Procedure: 1-AC28548-3

Transcat Calibration Laboratories have been audited and found in compliance with ISO/IEC 17025:2017. Accredited calibrations performed within the Lab?s Scope of Accreditation are indicated by the presence of the Accrediting Body?s Logo and Certificate Number. Any measurements on an accredited calibration not covered by that Lab?s Scope of Accreditation are listed in the notes section of the certificate. SCC, NRC, CLAS or ANAB do not guarantee the accuracy of an individual calibration by accredited laboratories.

Transcat calibrations, as applicable, are performed in compliance with the requirements of the Transcat Quality Manual QAC-P01-000, the customer?s Purchase Order and/or Quality Agreement requirements, ISO 9001:2015, ANSI/NCSL Z540.1-1994 (R2002) or NQA-1, as applicable. Complete records of work performed are maintained by Transcat and are available for inspection. Laboratory standards used in the performance of this calibration are listed on this certificate.

Transcat documents the traceability of measurements to the SI units through the National Institute of Standards and Technology(NIST), or the National Research Council of Canada (NRC), or other national measurement institutes (NMI) that are signatories to the CIPM Mutual Recognition Arrangement, or accepted fundamental and/or natural physical constants, or by the use of specified methods, consensus standards or ratio type measurements. Documentation supporting traceability information is available for review upon written request at a Transcat facility. The measured quantity and the measurement uncertainty are required for further dissemination of traceability.

A binary decision rule, utilizing simple acceptance, and simple rejection criteria is used for the determination of compliance, unless otherwise superseded by the client?s Decision Rule. When Calibration Tolerance compliance statements are present, they are reported without factoring in the effects of uncertainty and comply with the guidelines established by ASME B89.7.3.1-2001 (R2019) as follows:
-The acceptance zone is defined as: less than or equal to the high calibration tolerance limit, and/or greater than or equal to the low calibration tolerance limit. The rejection zones are defined as greater than the high calibration tolerance limit and/or less than the low calibration tolerance limit.
-Single measurement results in the acceptance zone are be identified as in-tolerance. Single measurement results in the rejection zone are identified as out-of-tolerance (OOT).
-When all measurement results are in the acceptance zone for repeated measurements, for the same characteristic, the test is identified as in-tolerance. For repeated characteristic measurements, a single measurement result in the rejection zone, will cause the test to be identified as out-of-tolerance (OOT).

Uncertainties are reported with a coverage factor k=2, providing a level of confidence of approximately 95%. All calibrations have been performed using processes having a TUR of 4:1 or better (3:1 for mass calibrations), unless otherwise noted. The Test Uncertainty Ratio (TUR) is calculated in accordance with NCSL International RP-18. For mass calibrations: Conventional mass referenced to 8.0 g/cm³.

The results in this report relate only to the item calibrated or tested. Recorded calibration data is valid at the time of calibration within the stated uncertainties at the environmental conditions noted. The determination of compliance to the specification is specific to the model/serial no./ID no. referenced above based on the tolerances shown; these tolerances are either the original equipment manufacturers (OEM?s) warranted specifications or the client?s requested specifications. This certificate may not be reproduced except in full, without the written approval of Transcat. Additional information, if applicable may be included on separate report(s).

Date Received: March 19, 2021
Service Level : R9

Certificate - Page 1 of 7

Customer Number: 9-330269-000
OPS-F20-014R8 04/01/21 FP014R0 4/2/2021

B&K 4231 Unit #2 Calibrator Calibration Certificate

Scantek, Inc.
CALIBRATION LABORATORY

ISO 17025: 2017, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.47413

Instrument:	**Acoustical Calibrator**	*Date Calibrated:* **1/24/2022** *Cal Due:*		
Model:	**4231**	*Status:*	**Received**	**Sent**
Manufacturer:	**Brüel and Kjær**	*In tolerance:*	**X**	**X**
Serial number:	**2575493**	*Out of tolerance:*		
Class (IEC 60942):	**1**	*See comments:*		
Barometer type:		*Contains non-accredited tests:* __Yes _X_ No		
Barometer s/n:				
Customer:	**ACI Acoustical Consultants Inc.**	*Address:* **5031 - 210 Street, Edmonton, Alberta, CANADA T6M 0A8**		
Tel/Fax:	**780-414-6373 / 780-414-6376**			

Tested in accordance with the following procedures and standards:
Calibration of Acoustical Calibrators, Scantek Inc., Rev. 10/1/2010

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Nov 8, 2021	Scantek, Inc./ NVLAP	Nov 8, 2022
DS-360-SRS	Function Generator	88077	Dec 3, 2020	ACR Env./ A2LA	Dec 3, 2022
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Feb 4, 2021	ACR Env. / A2LA	Feb 4, 2022
PTU300-Vaisala	EnvironmentalMonitor	P5011262	Sept 10, 2021	ACR Env./ A2LA	Sept 10, 2022
140-Norsonic	Real Time Analyzer	1406423	Nov 8, 2021	Scantek / NVLAP	Nov 8, 2022
PC Program 1018 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
4134-Brüel&Kjær	Microphone	173368	Nov 8, 2021	Scantek, Inc. / NVLAP	Nov 8, 2022
1203-Norsonic	Preamplifier	14059	March 3, 2021	Scantek, Inc./ NVLAP	March 3, 2022

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK)

Calibrated by:	Bailey Partoza	**Authorized signatory:**	William Gallagher
Signature		Signature	
Date	1/24/22	Date	1/25/2022

Calibration Certificates or Test Reports shall not be reproduced, except in full, without written approval of the laboratory.
This Calibration Certificate or Test Reports shall not be used to claim product certification, approval or endorsement by NVLAP, NIST, or any agency of the federal government.
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B&K 2270 Unit #3 SLM Calibration Certificates

CALIBRATED BY TRANSCAT

CERTIFICATE OF CALIBRATION

Customer: ACI ACCOUSTICAL CONSULTANTS IN
5031-210 STREET NW
EDMONTON, AB T6M 0A8

PO Number: BILAWCHUK

ANAB ACCREDITED ISO/IEC 17025 CALIBRATION LABORATORY
ANAB AC-2489.07

ilac-MRA

Certificate/SO Number: 17-Q1X3X-80-1 Revision 0

Manufacturer: Bruel & Kjaer
Model Number: 2270
Description: Sound Level Meter
Serial Number: 3002730/2850741
ID: UNIT 3

As-Found: In Tolerance
As-Left: In Tolerance

Issue Date: Apr 07, 2021
Calibration Date: Apr 07, 2021

Calibrated To: Manufacturer Specification
Calibration Procedure: 1-AC28548-3

Transcat Calibration Laboratories have been audited and found in compliance with ISO/IEC 17025:2017. Accredited calibrations performed within the Lab?s Scope of Accreditation are indicated by the presence of the Accrediting Body?s Logo and Certificate Number. Any measurements on an accredited calibration not covered by that Lab?s Scope of Accreditation are listed in the notes section of the certificate. SCC, NRC, CLAS or ANAB do not guarantee the accuracy of an individual calibration by accredited laboratories.

Transcat calibrations, as applicable, are performed in compliance with the requirements of the Transcat Quality Manual QAC-P01-000, the customer?s Purchase Order and/or Quality Agreement requirements, ISO 9001:2015, ANSI/NCSL Z540.1-1994 (R2002) or NQA-1, as applicable. Complete records of work performed are maintained by Transcat and are available for inspection. Laboratory standards used in the performance of this calibration are listed on this certificate.

Transcat documents the traceability of measurements to the SI units through the National Institute of Standards and Technology(NIST), or the National Research Council of Canada (NRC), or other national measurement institutes (NMI) that are signatories to the CIPM Mutual Recognition Arrangement, or accepted fundamental and/or natural physical constants, or by the use of specified methods, consensus standards or ratio type measurements. Documentation supporting traceability information is available for review upon written request at a Transcat facility. The measured quantity and the measurement uncertainty are required for further dissemination of traceability.

A binary decision rule, utilizing simple acceptance, and simple rejection criteria is used for the determination of compliance, unless otherwise superseded by the client?s Decision Rule. When Calibration Tolerance compliance statements are present, they are reported without factoring in the effects of uncertainty and comply with the guidelines established by ASME B89.7.3.1-2001(R2019) as follows:
-The acceptance zone is defined as: less than or equal to the high calibration tolerance limit, and/or greater than or equal to the low calibration tolerance limit. The rejection zones are defined as greater than the high calibration tolerance limit and/or less than the low calibration tolerance limit.
-Single measurement results in the acceptance zone are be identified as in-tolerance. Single measurement results in the rejection zone are identified as out-of-tolerance (OOT).
-When all measurement results are in the acceptance zone for repeated measurements, for the same characteristic, the test is identified as in-tolerance. For repeated characteristic measurements, a single measurement result in the rejection zone, will cause the test to be identified as out-of-tolerance (OOT).

Uncertainties are reported with a coverage factor k=2, providing a level of confidence of approximately 95%. All calibrations have been performed using processes having a TUR of4:1 or better (3:1 for mass calibrations), unless otherwise noted. The Test Uncertainty Ratio (TUR) is calculated in accordance with NCSL International RP-18. For mass calibrations: Conventional mass referenced to 8.0 g/cm³.

The results in this report relate only to the item calibrated or tested. Recorded calibration data is valid at the time of calibration within the stated uncertainties at the environmental conditions noted. The determination of compliance to the specification is specific to the model/serial no./ID no. referenced above based on the tolerances shown; these tolerances are either the original equipment manufacturers(OEM?s) warranted specifications or the client?s requested specifications. This certificate may not be reproduced except in full, without the written approval of Transcat. Additional information, if applicable may be included on separate report(s).

Date Received: March 19, 2021
Service Level: R9

Certificate - Page 1 of 7

Customer Number: 9-330269-000
OPS-F20-014R8 04/01/21 FP014R0 4/2/2021

B&K 2270 Unit #4 SLM Calibration Certificate

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.46085

Instrument: **Sound Level Meter**
Model: **2270**
Manufacturer: **Brüel and Kjær**
Serial number: **2644639**
Tested with: **Microphone 4189 s/n 2595637**
Preamplifier ZC0032 s/n 5842
Type (class): **1**
Customer: **ACI Acoustical Consultants Inc.**
Tel/Fax: **780-414-6373 / 780-414-6376**

Date Calibrated: **3/5/2021** *Cal Due:*

Status:	Received	Sent
In tolerance:	X	X
Out of tolerance:		
See comments:		

Contains non-accredited tests: __Yes X No
Calibration service: __ Basic X Standard
Address: **5031 - 210 Street, Edmonton, Alberta, CANADA T6M 0A8**

Tested in accordance with the following procedures and standards:
Calibration of Sound Level Meters, Scantek Inc., Rev. 6/26/2015
SLM & Dosimeters – Acoustical Tests, Scantek Inc., Rev. 7/6/2011

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 31, 2020	Scantek, Inc./ NVLAP	Oct 31, 2021
DS-360-SRS	Function Generator	33584	Oct 23, 2019	ACR Env./ A2LA	Oct 23, 2021
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Feb 4, 2021	ACR Env. / A2LA	Feb 4, 2022
HM30-Thommen	Meteo Station	1040170/39633	Dec 7, 2020	ACR Env./ A2LA	Dec 7, 2021
PC Program 1019 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1251-Norsonic	Calibrator	30878	Oct 26, 2020	Scantek, Inc./ NVLAP	Oct 26, 2021

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK).

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
23.0	100.24	39.5

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	William D. Gallagher
Signature	Lydon Dawkins	Signature	William D. Gallagher
Date	3/5/2021	Date	3/5/2021

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B&K 2270 Unit #4 Microphone Calibration Certificate

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.46086

Instrument:	**Microphone**	*Date Calibrated:* **3/4/2021**	*Cal Due:*	
Model:	**4189**	*Status:*	**Received**	**Sent**
Manufacturer:	**Brüel & Kjær**	*In tolerance:*	**X**	**X**
Serial number:	**2595637**	*Out of tolerance:*		
Composed of:		*See comments:*		

Contains non-accredited tests: __Yes _X_ No

Customer: **ACI Acoustical Consultants Inc.**
Tel/Fax: **780-414-6373/780-414-6376**
Address: **5031 - 210 Street, Edmonton, Alberta, CANADA T6M 0A8**

Tested in accordance with the following procedures and standards:
Calibration of Measurement Microphones, Scantek, Inc., Rev. 2/25/2015

Instrumentation used for calibration: N-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 31, 2020	Scantek, Inc./ NVLAP	Oct 31, 2021
DS-360-SRS	Function Generator	33584	Oct 23, 2019	ACR Env./ A2LA	Oct 23, 2021
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Feb 4, 2021	ACR Env. / A2LA	Feb 4, 2022
HM30-Thommen	Meteo Station	1040170/39633	Dec 7, 2020	ACR Env./ A2LA	Dec 7, 2021
PC Program 1017 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1253-Norsonic	Calibrator	28326	Oct 26, 2020	Scantek, Inc./ NVLAP	Oct 26, 2021
1203-Norsonic	Preamplifier	14059	March 3, 2021	Scantek, Inc./ NVLAP	March 3, 2022
4180-Brüel&Kjær	Microphone	2246115	Oct 1, 2019	DPLA / DANAK	Oct 1, 2021

Instrumentation and test results are traceable to SI - BIPM through standards maintained by NPL (UK) and NIST (USA)

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	William D. Gallagher
Signature	Lydon Dawkins	Signature	William D. Gallagher
Date	3/4/2021	Date	3/5/2021

Calibration Certificates or Test Reports shall not be reproduced, except in full, without written approval of the laboratory.
This Calibration Certificate or Test Reports shall not be used to claim product certification, approval or endorsement by NVLAP, NIST, or any agency of the federal government.
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B&K 2250 Unit #5 SLM Calibration Certificate

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.46081

Instrument: **Sound Level Meter**
Model: **2250**
Manufacturer: **Brüel and Kjær**
Serial number: **2722894**
Tested with: **Microphone 4189 s/n 271977**
Preamplifier ZC0032 s/n 13895
Type (class): **1**
Customer: **ACI Acoustical Consultants Inc.**
Tel/Fax: **780-414-6373 / 780-414-6376**

Date Calibrated: **3/4/2021** *Cal Due:*

Status:	**Received**	**Sent**
In tolerance:	**X**	**X**
Out of tolerance:		
See comments:		

Contains non-accredited tests: __**Yes** **X** **No**
Calibration service: __ **Basic** **X** **Standard**
Address: **5031 - 210 Street, Edmonton, Alberta, CANADA T6M 0A8**

Tested in accordance with the following procedures and standards:
Calibration of Sound Level Meters, Scantek Inc., Rev. 6/26/2015
SLM & Dosimeters – Acoustical Tests, Scantek Inc., Rev. 7/6/2011

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 31, 2020	Scantek, Inc./ NVLAP	Oct 31, 2021
DS-360-SRS	Function Generator	33584	Oct 23, 2019	ACR Env./ A2LA	Oct 23, 2021
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Feb 4, 2021	ACR Env. / A2LA	Feb 4, 2022
HM30-Thommen	Meteo Station	1040170/39633	Dec 7, 2020	ACR Env./ A2LA	Dec 7, 2021
PC Program 1019 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1251-Norsonic	Calibrator	30878	Oct 26, 2020	Scantek, Inc./ NVLAP	Oct 26, 2021

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK).

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
22.8	99.52	44.9

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	William D. Gallagher
Signature	Lydon Dawkins	Signature	William D. Gallagher
Date	3/4/2021	Date	3/5/2021

Calibration Certificates or Test Reports shall not be reproduced, except in full, without written approval of the laboratory.
This Calibration Certificate or Test Reports shall not be used to claim product certification, approval or endorsement by NVLAP, NIST, or any agency of the federal government.
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B&K 2250 Unit #5 Microphone Calibration Certificate

Scantek, Inc.
CALIBRATION LABORATORY

ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.46082

Instrument:	**Microphone**	*Date Calibrated:* **3/4/2021**	*Cal Due:*
Model:	**4189**		
Manufacturer:	**Brüel & Kjær**		
Serial number:	**271977**		
Composed of:			

Status:	**Received**	**Sent**
In tolerance:	**X**	**X**
Out of tolerance:		
See comments:		

Contains non-accredited tests: __**Yes** _**X** **No**

Customer: **ACI Acoustical Consultants Inc.**
Tel/Fax: **780-414-6373/780-414-6376**
Address: **5031 - 210 Street, Edmonton, Alberta, CANADA T6M 0A8**

Tested in accordance with the following procedures and standards:
Calibration of Measurement Microphones, Scantek, Inc., Rev. 2/25/2015

Instrumentation used for calibration: N-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 31, 2020	Scantek, Inc./ NVLAP	Oct 31, 2021
DS-360-SRS	Function Generator	33584	Oct 23, 2019	ACR Env./ A2LA	Oct 23, 2021
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Feb 4, 2021	ACR Env. / A2LA	Feb 4, 2022
HM30-Thommen	Meteo Station	1040170/39633	Dec 7, 2020	ACR Env./ A2LA	Dec 7, 2021
PC Program 1017 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1253-Norsonic	Calibrator	28326	Oct 26, 2020	Scantek, Inc./ NVLAP	Oct 26, 2021
1203-Norsonic	Preamplifier	14059	March 3, 2021	Scantek, Inc./ NVLAP	March 3, 2022
4180-Brüel&Kjær	Microphone	2246115	Oct 1, 2019	DPLA / DANAK	Oct 1, 2021

Instrumentation and test results are traceable to SI - BIPM through standards maintained by NPL (UK) and NIST (USA)

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	William D. Gallagher
Signature	Lydon Dawkins	Signature	William D Gallagher
Date	3/4/2021	Date	3/5/2021

Calibration Certificates or Test Reports shall not be reproduced, except in full, without written approval of the laboratory.
This Calibration Certificate or Test Reports shall not be used to claim product certification, approval or endorsement by NVLAP, NIST, or any agency of the federal government.
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B&K 2250 Unit #6 SLM Calibration Certificate

Scantek, Inc.
CALIBRATION LABORATORY

ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP® CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.46083

Instrument:	**Sound Level Meter**
Model:	**2250**
Manufacturer:	**Brüel and Kjær**
Serial number:	**2661161**
Tested with:	**Microphone 4189 s/n 2650730** **Preamplifier ZC0032 s/n 9935**
Type (class):	**1**
Customer:	**ACI Acoustical Consultants Inc.**
Tel/Fax:	**780-414-6373 / 780-414-6376**

Date Calibrated: **3/4/2021** *Cal Due:*

Status:	**Received**	**Sent**
In tolerance:	**X**	**X**
Out of tolerance:		
See comments:		

Contains non-accredited tests: __**Yes** **X** **No**
Calibration service: __ **Basic** **X** **Standard**
Address: **5031 - 210 Street, Edmonton, Alberta, CANADA T6M 0A8**

Tested in accordance with the following procedures and standards:
Calibration of Sound Level Meters, Scantek Inc., Rev. 6/26/2015
SLM & Dosimeters – Acoustical Tests, Scantek Inc., Rev. 7/6/2011

Instrumentation used for calibration: Nor-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 31, 2020	Scantek, Inc./ NVLAP	Oct 31, 2021
DS-360-SRS	Function Generator	33584	Oct 23, 2019	ACR Env./ A2LA	Oct 23, 2021
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Feb 4, 2021	ACR Env. / A2LA	Feb 4, 2022
HM30-Thommen	Meteo Station	1040170/39633	Dec 7, 2020	ACR Env./ A2LA	Dec 7, 2021
PC Program 1019 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1251-Norsonic	Calibrator	30878	Oct 26, 2020	Scantek, Inc./ NVLAP	Oct 26, 2021

Instrumentation and test results are traceable to SI (International System of Units) through standards maintained by NIST (USA) and NPL (UK).

Environmental conditions:

Temperature (°C)	Barometric pressure (kPa)	Relative Humidity (%)
22.9	99.66	42.5

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	William D. Gallagher
Signature	Lydon Dawkins	Signature	William D. Gallagher
Date	3/4/2021	Date	3/5/2021

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B&K 2250 Unit #6 Microphone Calibration Certificate

Scantek, Inc.
CALIBRATION LABORATORY
ISO 17025: 2005, ANSI/NCSL Z540:1994 Part 1
ACCREDITED by NVLAP (an ILAC MRA signatory)

NVLAP®
CALIBRATION
NVLAP Lab Code: 200625-0

Calibration Certificate No.46084

Instrument: **Microphone**
Model: **4189**
Manufacturer: **Brüel & Kjær**
Serial number: **2650730**
Composed of:

Date Calibrated: **3/4/2021** *Cal Due:*

Status:	**Received**	**Sent**
In tolerance:	**X**	**X**
Out of tolerance:		
See comments:		

Contains non-accredited tests: __**Yes** _**X** **No**

Customer: **ACI Acoustical Consultants Inc.**
Tel/Fax: **780-414-6373/780-414-6376**
Address: **5031 - 210 Street, Edmonton, Alberta, CANADA T6M 0A8**

Tested in accordance with the following procedures and standards:
Calibration of Measurement Microphones, Scantek, Inc., Rev. 2/25/2015

Instrumentation used for calibration: N-1504 Norsonic Test System:

Instrument - Manufacturer	Description	S/N	Cal. Date	Traceability evidence Cal. Lab / Accreditation	Cal. Due
483B-Norsonic	SME Cal Unit	31052	Oct 31, 2020	Scantek, Inc./ NVLAP	Oct 31, 2021
DS-360-SRS	Function Generator	33584	Oct 23, 2019	ACR Env./ A2LA	Oct 23, 2021
34401A-Agilent Technologies	Digital Voltmeter	MY47011118	Feb 4, 2021	ACR Env. / A2LA	Feb 4, 2022
HM30-Thommen	Meteo Station	1040170/39633	Dec 7, 2020	ACR Env./ A2LA	Dec 7, 2021
PC Program 1017 Norsonic	Calibration software	v.6.1T	Validated Nov 2014	Scantek, Inc.	-
1253-Norsonic	Calibrator	28326	Oct 26, 2020	Scantek, Inc./ NVLAP	Oct 26, 2021
1203-Norsonic	Preamplifier	14059	March 3, 2021	Scantek, Inc./ NVLAP	March 3, 2022
4180-Brüel&Kjær	Microphone	2246115	Oct 1, 2019	DPLA / DANAK	Oct 1, 2021

Instrumentation and test results are traceable to SI - BIPM through standards maintained by NPL (UK) and NIST (USA)

Calibrated by:	Lydon Dawkins	**Authorized signatory:**	William D. Gallagher
Signature	Lydon Dawkins	Signature	William D Gallagher
Date	3/4/2021	Date	3/5/2021

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Appendix II THE ASSESSMENT OF ENVIRONMENTAL NOISE (GENERAL)

Sound Pressure Level

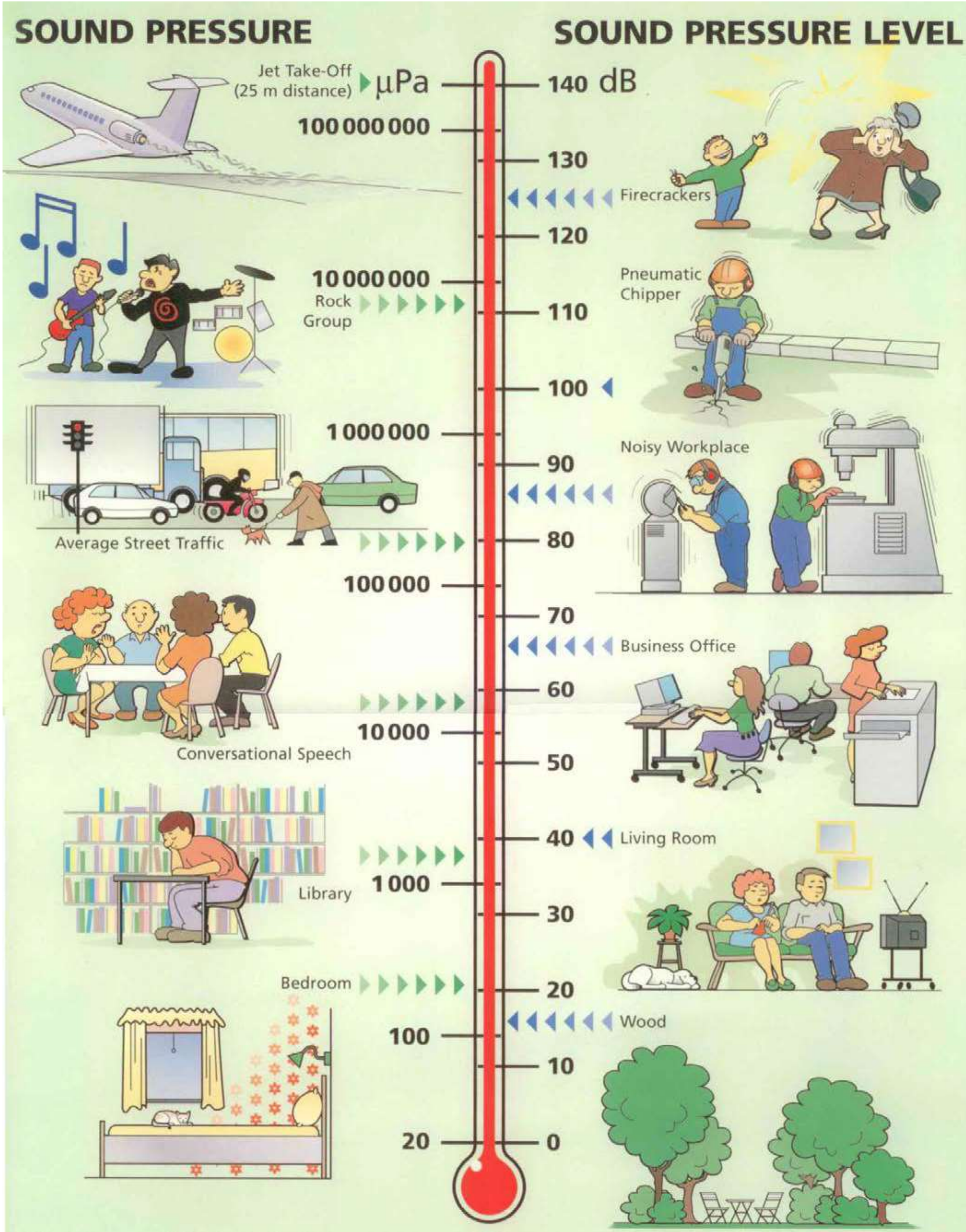
Sound pressure is initially measured in Pascal's (Pa). Humans can hear several orders of magnitude in sound pressure levels, so a more convenient scale is used. This scale is known as the decibel (dB) scale, named after Alexander Graham Bell (telephone guy). It is a base 10 logarithmic scale. When we 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 ($P_{ref} = 2 \times 10^{-5}$ 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
SOUND PRESSURE LEVEL
Jet Take-Off (25 m distance)
µPa
140 dB
100 000 000
130
Firecrackers
120
10 000 000
Rock Group
110
Pneumatic Chipper
100
1 000 000
Noisy Workplace
90
Average Street Traffic
80
100 000
70
Business Office
60
10 000
Conversational Speech
50
40
Living Room
Library
1000
30
Bedroom
20
Wood
100
10
20
0

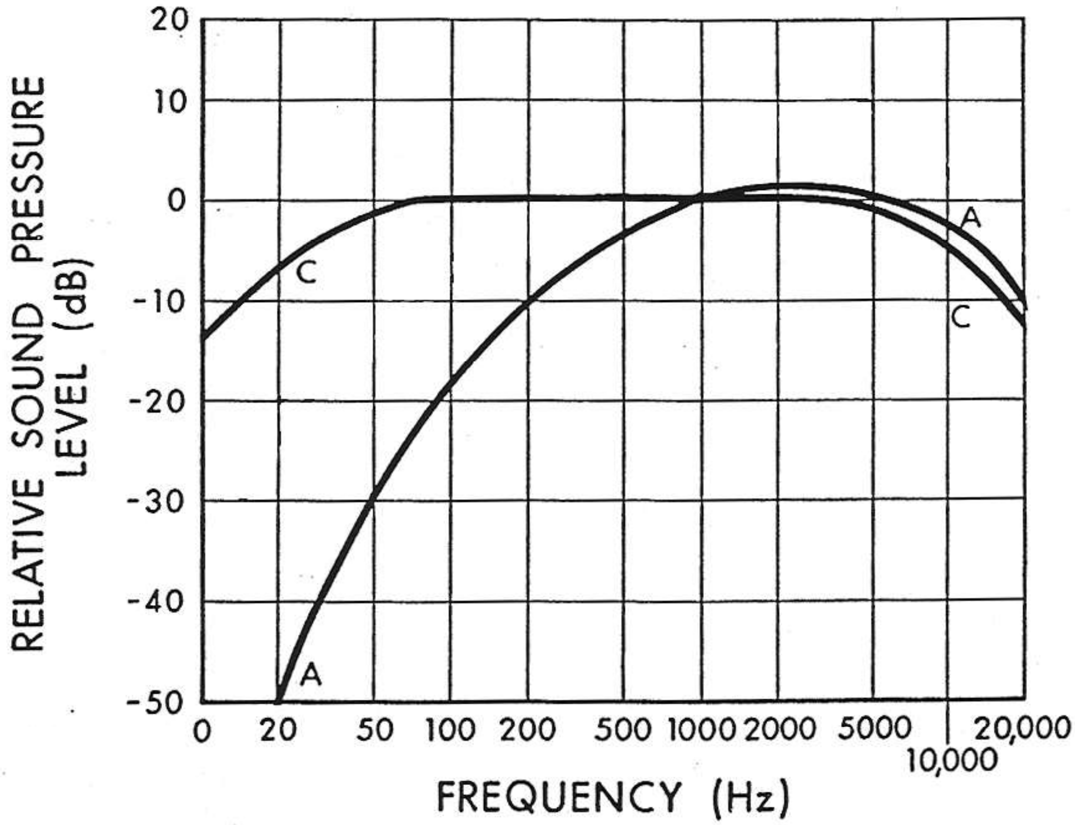
Frequency

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

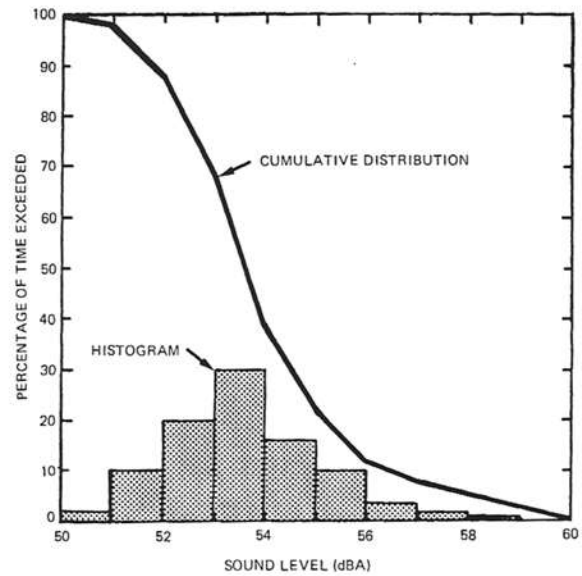


Figure 16.6 Statistically processed community noise showing histogram and cumulative distribution of A weighted sound levels.

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

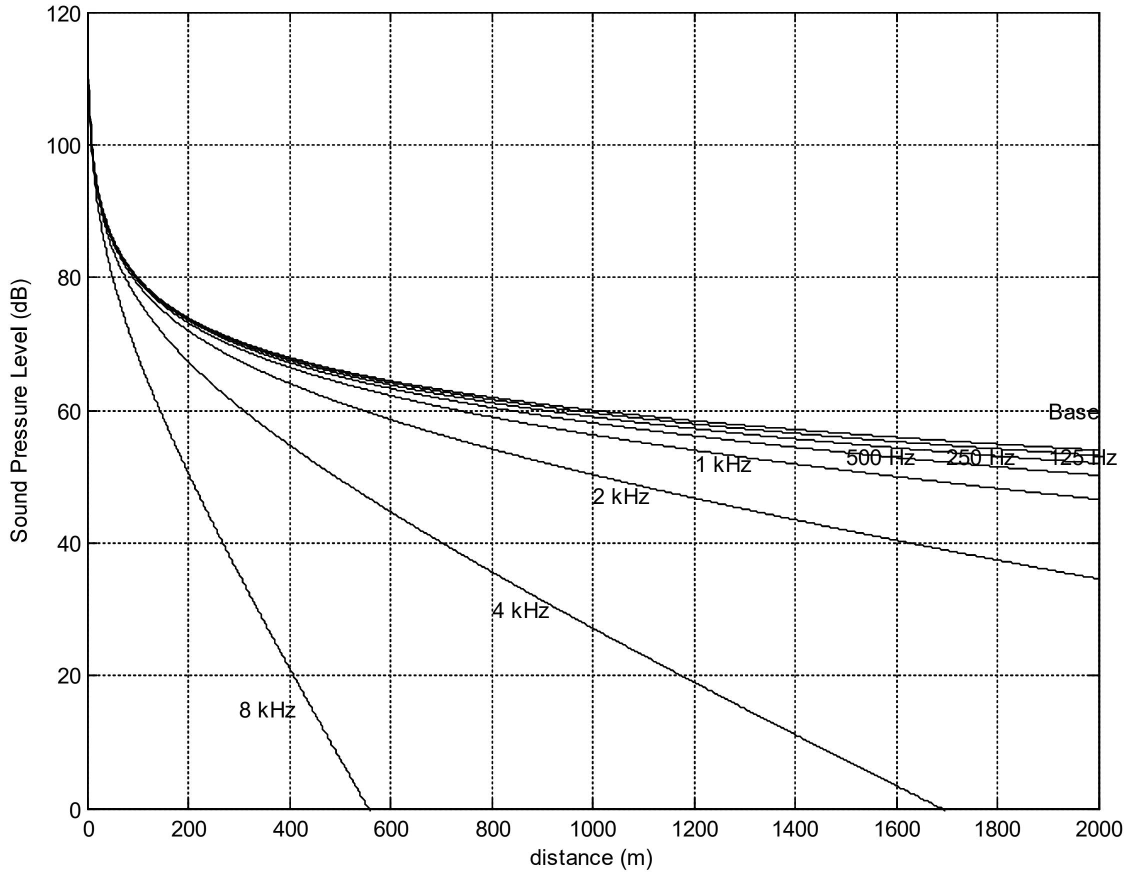
As sound transmits through a medium, there is an attenuation (or dissipation of acoustic energy) which can be attributed to three mechanisms:

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 °C	Relative Humidity (%)	Frequency (Hz) 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 10ºC 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

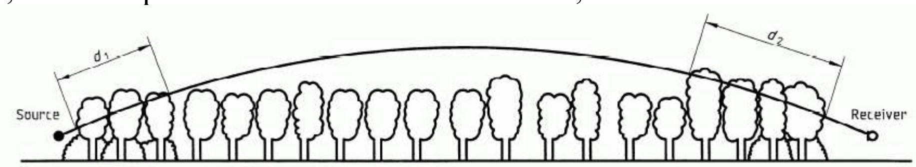
- Can be an effective absorber due to large area covered
- Only effective at low height above ground. Does not affect sound transmitted direct from source to receiver if there is line of sight.
- Typically less absorption than atmospheric absorption when there is line of sight.
- Approximate rule of 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 m	**Nominal midband frequency** Hz 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 approximately 1/2 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 the Alberta Energy Regulator Directive 038 (February, 2007)

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 the Alberta Energy Regulator Directive 038 (February, 2007)

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).