Acoustic Assessment

Scott Property Project

SLR Project No: 203.50179.00000

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global **environmental** and **advisory** solutions

Acoustic Assessment

Lehigh Hanson Materials Limited
Scott Property Project
Rocky View County, Alberta
SLR Project No: 203.501179.00000

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This document has been prepared by SLR Canada. The material and data in this report were prepared under the supervision and direction of the undersigned.

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EXECUTIVE SUMMARY

SLR Consulting (Canada) Ltd. (SLR) was retained by Lehigh Hanson Materials Limited (Lehigh) to complete an Acoustic Assessment for the proposed Scott Property Project (the Project).

Lehigh is proposing to construct and operate the Project, which will be located in Rocky View County (RVC), in the rural community of Bearspaw, Alberta. The Project will occupy the majority of 05-26-02-W5M, with the exception of 33.9 acres in the southwest corner of the parcel. The Project is bound by 144 Avenue NW (also known as Burma Road) to the south, Range Road 24 to the East, and Range Road 25 (also known as Twelve Mile Coulee Road) to the west.

The property totals an area of approximately 600 acres (243 hectares [ha]), of which 395 acres (160 ha) are proposed for development as a sand and gravel pit, with a maximum open pit area of 60 acres (24 ha) at any given time. The Project will be operated in six phases with an anticipated operational lifespan of 25 to 30 years, with each phase approximately five years in duration.

The Project location was selected for development, as the lands are comprised of a significant quantity of high quality and close to market aggregate resources. The Project lands are currently pastureland, predominantly used for agricultural purposes (i.e., hay, tame pasture, and cattle grazing), and surrounding lands include residential areas and industrial activities (e.g., transmission lines and neighbouring aggregate operations). Following operation, the Project lands will be reclaimed to an equivalent end land use.

An acoustic assessment has been undertaken to assess the potential sound egress from the Project operations in relation to the nearest noise sensitive receptors. This report details the methodology, results and conclusions of the sound monitoring, propagation modelling and associated assessment.

Sound monitoring was undertaken at four locations to provide a good representation of the existing acoustic environment for the variety of surrounding receptors. The ambient sound level monitoring survey was conducted between October 31, 2019 to November 04, 2019. The predominant sound sources at each monitoring location were road traffic sounds from nearby roads and occasional aircraft flyovers. Nearby gravel pits in the area including Burnco Pit, STAR Pit, Lafarge Pit and Lehigh's Spyhill Pit, were confirmed to be in operation during normal operating hours. However, sound emissions from their operations were not audible at any of the monitoring locations during the survey period.

Sound propagation modelling was undertaken to predict the sound levels from the Project operations using international standards and worst-case assumptions for meteorological and topographic conditions.

The assessment of predicted sound levels concluded that the Project operations should not exceed the sound level criterion at any noise sensitive receptors, with the inclusion of the proposed acoustic mitigation measures detailed in this report.

Alternative Project operation scenarios were also assessed, and results are presented for reference purposes in the Appendices of this report.

1. ACOUSTICAL TERMINOLOGY

The primary acoustical metrics used to describe environmental sound in this study are as follows:

L_{eq}	Often referred to as the "Equivalent Continuous Sound Level". The L_{eq} value is the sound energy average over the entire measurement time. It is defined as a calculated sound level over the measured time that has the same acoustic energy as the actual fluctuating sound levels that occurred during the same period. L_{eq} is the single number descriptor commonly used for environmental sound measurements. This parameter is often applied over 24 hours, or over distinct daytime and nighttime periods. For example, the daytime L_{eq} represents the cumulative effects of all sound occurring in the 15-hour daytime period from 07:00 hours to 22:00 hours. The nighttime L_{eq} represents the cumulative effects of all sound events occurring in the nighttime period from 22:00 hours to 07:00 hours;
L_{max}	The "Maximum Sound Level". The L_{max} is the maximum sound level observed. This metric is useful for quantifying the highest sound level expected during short duration events such as a vehicle pass by or dog barking;
L_{min}	The "Minimum Sound Level". The L_{min} is the minimum sound level observed;
L_{90}	The "Statistical Sound Level" equaled or exceeded 90% of the time. This level represents a good indicator of the baseline sound of the overall acoustic environment. A statistical measure of sound over a period and is defined as the sound level exceeded for a certain percentage of the time; and
L_w	sound power level. It is a measure of the total sound energy radiated by a source of sound and is used to calculate sound pressure levels at a distant location. The LWA is the A-weighted sound power level.
Acoustic Environment	the sound with contribution from all sources, as modified by the current environment and associated conditions;
Ambient Sound Level	the sound level that is a composite of different airborne sounds from many sources far away from and near the point of measurement. The ambient sound level does not include sound from wind and must be determined without it and without sound from any source that is being assessed;
Atmospheric Attenuation	the effect of sound absorption by moisture in the air;

A weighting	the ear can recognize a sound depending on the pitch or frequencies found at the source. Microphones cannot differentiate sound in the same way as the ear and to counter this, the sound measuring instrument applies a correction to correspond more closely to the frequency response of the human ear by reducing the low and high frequencies. The correction factor is called 'A Weighting' and the resulting measurements are written as dBA, for broadband sound level. The dBA is internationally accepted and has been found to correspond well with subjective reaction to sound;
Comprehensive Sound Level (CSL)	defined in multiple Alberta Regulations as "The sound level that is a composite of different airborne sounds from many sources far away from near the point of measurement. The CSL does include industrial components and should be measured with them, but abnormal noise events are excluded. The CSL is used to determine whether a facility is consistent with this guideline".
C weighting	a frequency correction factor that is tailored towards higher sound levels and has less attenuation in the low frequency region. The C weighting is typically used to assess high sound levels in relation to human exposure and an indication of the low frequency content when compared to the A weighted sound level for the same situation. It is typically quoted as a broadband sound level;
dB Average Sound Level	refers to the logarithmic average (acoustically referred to as the decibel average) of recorded data values for a sound level parameter over the entire monitoring survey;
Free Field Sound Field	a sound field in which the effects of obstacles or boundaries on propagating sound are negligible;
Frequency	the number of wave oscillations per second (hertz) of an acoustic pressure wave propagating through the air. This is linked to the subjective phenomenon pitch;
Sound Pressure Level (L_p)	the physical measurement of sound, which utilizes a logarithmic scale and quantifies the amplitude or volume of acoustic pressure waves propagating through the air;
Mean Sound Level	refers to the arithmetic average (mean) of recorded data values for a sound level parameter over the entire monitoring survey;
Mode Sound Level	refers to the most repeated value (mode) of recorded data values for a sound level parameter over the entire monitoring survey;
One-third Octave Bands	used to represent the frequency or content of a sound. Bass and Treble on a Hi-Fi system is a very basic representation of the frequency content of sound. One-third octave bands are derived by splitting the audio signal into discrete entities. A single octave band comprises 3 one-third octave bands. One-third octave and octave bands are usually presented without a weighting/filter such as A weighting, however such weightings can be applied to frequency spectra to then derive a weighted overall single result;
Permissible Sound Level (PSL)	the maximum sound level that a facility must not exceed at any established location;

Sound Level Contribution	the contribution of sound from one or more sources to the overall sound level from all sources affecting a location;
Spectrum	the quantification of the components of a sound as a function of frequency.
Third-Octave	the interval in frequency between two sounds having a ratio of 2 to the one-third power, or approximately 1.26;
Third-Octave Band Sound Pressure Level	the total sound pressure level of sound components in a specific one-third octave band;
Tonality	tonal sound contains a prominent frequency and is characterized by a definite pitch. A broadband sound such as white noise or television static has no tonality, whereas a guitar string when plucked is a tonal sound; and
Z Weighting	indicates that the sound level has no frequency weighting applied, representing the unweighted levels from the microphone. This is typically used for frequency sound levels such as one-third-octave/octave bands.

Table 1 Typical Sound Sources and Acoustic Environments

Sound Pressure Level, dBA	Example
0	Threshold of hearing for normal young people
20	Recording studio, ambient level
40	Quiet residential neighborhood, ambient level
60	Department store, restaurant, speech levels
80	Next to busy highway, shouting
100	Textile mill; press room with presses running, punch press and wood planers, at operator's position
120	Ship's engine room, rock concert; in front and close to speakers
140	Moon launch at 100mm, artillery fire; gunner's position and threshold of pain

Table 2 Sound Pressure Level Addition Rule

Difference, dB	Add to Higher Level, dB	Example
0 to 1	3	50 dB + 50 dB = 53 dB
2 to 4	2	50 dB + 52 dB = 54 dB
5 to 9	1	50 dB + 57 dB = 58 dB
10 or more	0	50 dB + 60 dB = 60 dB

2. BACKGROUND AND SCOPE OF REPORT

SLR Consulting (Canada) Limited (SLR) was retained by Lehigh Hanson Materials Limited (Lehigh) to complete an acoustic assessment for the proposed Scott Property Project (the Project).

Lehigh is proposing to construct and operate the Project, which will be located in Rocky View County (RVC), in the rural community of Bearspaw, Alberta. The Project will occupy the majority of 05-26-02-W5M, with the exception of 33.9 acres in the southwest corner of the parcel. The Project is bound by 144 Avenue NW (also known as Burma Road) to the south, Range Road 24 to the East, and Range Road 25 (also known as Twelve Mile Coulee Road) to the west.

The property totals an area of approximately 600 acres (243 hectares [ha]), of which 395 acres (160 ha) are proposed for development as a sand and gravel pit, with a maximum open pit area of 60 acres (24 ha) at any given time. The Project will be operated in six phases with an anticipated operational lifespan of 25 to 30 years, with each phase approximately five years in duration.

RVC is the applicable regulatory authority for environmental noise from the Project.

A context plan is shown in **Figure 1** indicating the Scott Property boundary (in red). Gravel pits in the area currently in operation include:

- Burnco Pit, located to the east
- STAR Pit, located to the south-east
- Lafarge Pit, located approximately 2,800 m to the south-east
- Lehigh Spyhill Pit, located approximately 4,000 m to the south-east (boundary shown in blue)

Project phases are indicated in **Figure 2.**

An acoustic assessment has been undertaken to assess the potential sound egress from the Project operations in relation to the nearest noise sensitive receptors. This report details the methodology, results and conclusions of the sound monitoring, propagation modelling and associated assessment.

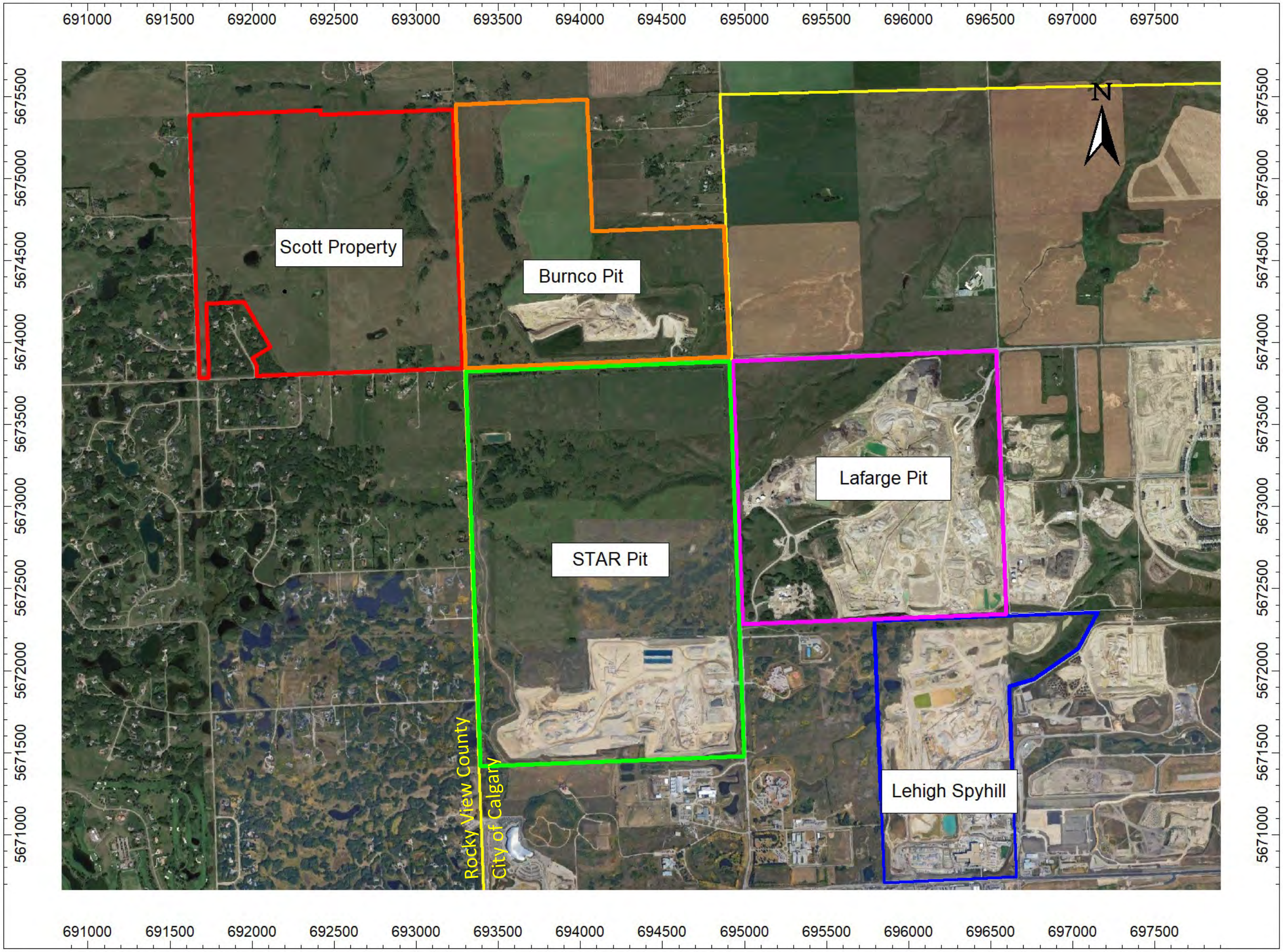


Figure 1: Site Context

Figure 2: Project Phases

3. MINING PLAN

The Project will include the following key components (refer to the Master Site Development Plan (MSDP) for additional details):

- Crusher with in-pit conveyor;
- Access roads;
- Off-site conveyor system;
- Operation & Maintenance Building;
- Perimeter berms; and
- Site ponds for water management.

Project activities and anticipated schedule are described in detail in the MSDP and are summarized in **Table 3** below.

Table 3 Project Activities

Activity	Details	Schedule
Site Preparation	• Initial topsoil, subsoil and overburden stripping and stockpiling for future reclamation. • Berm construction. • Establishing operating footprint (access roads, crusher, conveyors, stormwater ponds).	Commencing in 2022 for an estimated period of 2 years.
Operation	• Material excavation. • Crushing and screening with use of in-pit conveyors to move material. • Dust control. • Conveying material to Inland's Spy Hill Property using off-site conveyor. • Topsoil, subsoil and overburden stripping and stockpiling for future reclamation. • Progressive reclamation.	Commencing in 2024 for an estimated period of 25 – 30 years.
Final Reclamation	• Replacing and recontouring reclamation materials. • De-compaction. • Removing infrastructure. • Seeding and weed control.	Commencing following operational activities for an estimated period of 3 years.

The analysis has been focused on the mining operations for Phase 2 of the Project, which will take place in the south-west area of the property as shown in **Figure 2**. The Phase 2 scenario analyzed corresponds to the worst-case location from the sound emissions perspective, as the process areas will be nearest to the noise sensitive receptors during this 5-year period. The Project is proposed to operate Monday to Friday between 07:00 hrs and 18:00 hrs, except for conveying material to Spyhill, which will also operate on Saturdays (without any crushing activities). No activities of any type will be performed during nighttime hours; therefore, all analysis has focused on daytime hours only.

4. OPERATION AND EQUIPMENT DETAILS

Considering the Project operations specified in **Table 3** , the key activities to be assessed with respect to sound egress were as follows:

- Material excavation and reclamation: to be performed during January and February each year; and;
- Crushing and conveying: to be performed during April to November each year.

The raw material will be extracted from the aggregate pit area using excavators and will be crushed with a mobile jaw crusher (crusher) in the same area. The crusher will break any larger rocks in the raw feed material, which is then transported in an open conveyor to the south-east corner of the Site, and then conveyed off the Site to the Lehigh Spyhill Pit, located approximately 4 km to the south-east. The conveyor outside the Lehigh property will be covered over the belt and at transfer points and will be situated behind a berm. Therefore, its sound emissions are expected to be negligible at any residential receptor location in the area.

A 4 m high perimeter berm located along the east, south and west property boundary will be constructed prior to the start of aggregate extraction activities as a visual and sound barrier.

The equipment to be utilized for each operational activity is identified in **Table 4.**

Table 4 Equipment Sound Sources

Activity	Equipment & Model	Qty.	Power Rating	Working Area	L_W, dBA
Material excavation and reclamation	CAT 631K Scraper	4	570 HP	Route between Aggregate Pit and Reclamation Area	112
	CAT D9 Dozer	1	410 HP	Reclamation Area	112
Crushing and conveying	Metso Nordberg NW130 Crusher	1	200 HP	Aggregate Pit	124
	CAT 374 Excavator*	1	472 HP	Aggregate Pit	121
	CAT D10 Dozer	1	600 HP	Aggregate Pit	115
	CAT 990 Loader	1	699 HP	Aggregate Pit	115
	48'' Conveyor	1	-	In-pit conveyor route	110

*Including rock breaking attachment

Octave band sound power levels for each equipment item are detailed in **Appendix A.** The octave band sound power levels for each source were obtained or calculated from manufacturer's data, acoustical reference literature or previous studies.

Figure 3 below specifies the analyzed operations for Phase 2 of the Project. As mentioned, this particular operation scenario within the Phase 2 period was selected for the assessment, as the process areas will be nearest to the noise sensitive receptors. It is important to clarify that this particular scenario represents a specific operating year corresponding approximate to 1/5th of the Phase 2.

Figure 3: Phase 2 Operation Details

4.1 ALTERNATIVE OPERATING SCENARIOS

Two alternative operating scenarios for the Project were also considered by Lehigh and analyzed by SLR:

- Haul truck scenario: in this scenario the use of in-pit haul trucks was considered as an alternative to the in-pit conveyor for transporting the material within the Scott Property; and
- Blasting scenario: in this scenario the use of drill/blast equipment was considered as an alternative to the use of rock-breaking equipment during crushing activities.

Operating details and modelling results for each scenario are presented for informational purposes in **Appendix C** and **Appendix D**, respectively**.**

5. NOISE SENSITIVE RECEPTORS

The noise sensitive receptors included in the acoustic assessment are those within the vicinity of the Project site, as per **Table 5** and displayed in **Figure 4. .** It is acknowledged that there are additional residences in the area that could be considered sensitive receptors. However, the residences selected as sensitive receptors for the purpose of this assessment represent the points where the Project had the potential for causing the highest sound levels, and the remaining residences farther away will experience lower sound levels than the nearest identified sensitive receptor.

Table 5 Noise Sensitive Receptors

Receptor ID	Distance from Property Line, m	Direction from Site	Easting, m	Northing, m
R1	83	S	5673755.05	693209.70
R2	100	S	5673720.45	692718.75
R3	86	S	5673743.80	692412.92
R4	102	S	5673697.02	692130.82
R5	38	SW	5674035.17	692028.51
R6	35	SW	5674142.52	691970.26
R7	25	SW	5674217.58	691897.69
R8	66	W	5675216.44	691558.10
R9	59	N	5675470.69	693073.10

Figure 4: Noise Sensitive Receptors

6. SOUND MONITORING SURVEY

SLR conducted ambient sound level monitoring to assess the ambient sound levels at four locations inside the current Project boundary. These locations were chosen for their security and being representative of the acoustic environment at the nearest noise sensitive receptors to the Project. Quantifying the acoustic environment before the Project becomes active makes it possible to assess the sound contribution from it in relation to the pre-operational levels to add context to potential changes in sound levels at the noise sensitive receptors and inform the mitigation design.

The ambient sound level monitoring survey was conducted between October 31, 2019 to November 04, 2019.

6.1 MONITORING LOCATIONS

A sound level meter (SLM) was deployed to monitor the ambient sound levels at each location. A weather sensor collected meteorological conditions concurrently to the SLM, including wind speed and precipitation at each monitoring site. Sound monitoring locations (labelled as A1 to A4) and associated details are described in **Table 6**. **Figure 5** shows the plan view of the monitoring locations used in the sound monitoring survey.

Table 6 Summary of Ambient Sound Monitoring Locations

Monitoring Location ID	Easting, m	Northing, m
A1	693129.40	5673885.60
A2	692020.30	5674130.90
A3	691658.70	5675352.50
A4	693164.17	5675394.87

Figure 5: Sound Monitoring Locations

6.2 INSTRUMENTATION

The instrumentation used to conduct the monitoring was as follows:

- Larson Davis 831C integrating sound level meter (4);
- Larson Davis PRM2103 preamplifier (4);
- PCB 377B02 microphone (4);
- Larson Davis CAL200 acoustic calibrator; and
- Vaisala WXT536 weather station (4).

The sound monitoring instrumentation was calibrated at the beginning of the ambient sound level monitoring survey and then checked again after the survey using an acoustic calibrator, with no drift in calibration observed. The acoustic calibrator was laboratory calibrated during the 12 months preceding the ambient sound level monitoring survey (Refer to **Appendix E**). The Larson Davis 831C system is rated as Type 1 measurement system in reference to ANSI S1.4-2014 Standards. These measurement systems were laboratory calibrated during the 24 months preceding the ambient sound level monitoring survey, in line with industry standards. Microphones and weather sensors were raised to 1.5 meters above ground and measured continuously from the time of deployment to collection. Windscreens were installed on all microphones.

6.3 MEASUREMENTS CONDUCTED

Gustavo Elgueta, B. Sc., and Jasen Stein, E.I.T., of SLR conducted the ambient sound level monitoring surveys at all four locations. Monitoring locations were selected with careful attention to ensure there was no significant acoustic contamination at the monitoring locations and that they were as representative of the acoustic environment at the associated noise sensitive receptor as possible.

The equipment was stationed on site for the duration of the program, with in-person observations undertaken every day during varying times. Audio recordings were made continuously throughout the ambient sound level monitoring survey and used to verify the monitored sound levels.

Sound sources that contributed to the monitored ambient sound levels consisted primarily of vehicle traffic on nearby roadways. Aircraft flyovers were frequent and audible during the site visits from the Springbank Airport.

Upon inspection on November 01, 2019, SLR personnel performed observations near the Burnco Pit site and were able to hear intermittent industrial activity, confirming the site was active for some duration of the ambient sound survey. However, sound corresponding to these operations was inaudible at all the ambient sound level monitoring locations. The other nearby pits were also inaudible at all monitoring locations.

Although sound related to the operation of nearby pits in the area were not audible at the monitoring locations during the survey period, they may become audible at different times depending on specific operating and/or meteorological conditions.

Monitored sound levels and meteorological parameters were assessed in 10-minute averaging periods, with each 10-minute interval resulting in one sound sample and one simultaneously recorded meteorological sample. Values of L_{90} and L_{eq} were collected including overall A weighted sound levels, C-weighted sound levels, and spectral frequency data at each of the one third octave band centre frequencies (i.e. 31.5 Hz, 63 Hz, 125 Hz, etc.), for each averaging period. The data were then used to calculate periodic values for each daytime (07:00 hrs – 22:00 hrs).

The ambient sound level monitoring survey was conducted in the late autumn which represents a period during which the Project will be in operation. The monitored wind direction varied across many different directions during the survey. The types of vegetation, ground cover conditions, and differing terrain conditions (i.e., tall grass, snow cover, wet ground, ploughed earth, or rocky ground) can affect the amount of sound absorption that occurs as sound waves pass over the ground. For example, moist soil or soft fresh snow are highly sound absorptive, as opposed to hard packed ground or crusty snow, which are highly sound reflective. Approximately half the monitoring duration occurred during snowfall or snow accumulation which if included would have affected the ambient sound levels. Sound levels recorded during this period were excluded from the analysis.

6.4 AMBIENT SOUND LEVEL SURVEY RESULTS

Table 7 summarizes the measured L_{A90} and L_{Aeq} levels for daytime (07:00 hrs – 22:00 hrs) each monitoring location.

Table 7 Summary of Ambient Sound Level Monitoring Results

Monitoring Location ID	Daytime L_{A90}, dB	Daytime L_{Aeq}, dB
A1	39	56
A2	36	43
A3	34	42
A4	36	49

The selected threshold for rejecting sound levels during periods of wind is above a ground level wind speed of 5 m/s. Therefore, data registered over that ground level wind speed was not included in the assessment.

The levels presented in **Table 7** include approximately 30 hours of daytime data, which is acceptable to characterize the ambient sound for that period in the area. Periods of snow and/or snow accumulation, starting on November 02 at 22:00 hrs, were not considered in the assessment.

Figures showing registered sound level data (L_{A90}, L_{Aeq}, L_{ASmax}), recorded wind speeds and directions, and data not considered at each monitoring location during the survey period are specified in **Appendix F.**

7. RELEVANT GUIDANCE AND METHODOLOGY

RVC regulates noise through the Noise Control Bylaw No. C-5772-2003. The bylaw states that no person shall “make, continue, cause, or allow to be made or continued any excessive, unnecessary, or unusual noise of any type.” The bylaw also states that, if an activity “necessarily involves the creation of noise,” the noise must be “minimized as much as practicable.” This bylaw does not prescribe quantitative limits for noise emissions.

Efforts to develop and implement a resource policy for the aggregates industry within RVC were made in 2017-2019 by the County. A draft Aggregate Resources Plan (ARP) was put forward detailing the proposed policy and standards for various environmental considerations including noise. However, on April 30, 2019, a Council vote confirmed that no specific policy would come into place and each individual aggregate extraction application would be evaluated on its own merit.

Follow up discussions and technical consultations were undertaken with RVC Administration regarding potential approaches to policies, technical assessment methodology and criteria prior to assessment, with consideration given to the specification of the original draft ARP.

7.1 NOISE GUIDELINES

The following sections summarize relevant noise guidelines that were taken as a reference for the Project.

The above-mentioned RVC Draft ARP, quantitative noise guidelines applicable to other industries and jurisdictions in Alberta, other regulations applicable to mining projects in Ontario, and a summary of recommended noise guidelines from Health Canada and the World Health Organization (WHO) have been analyzed. These noise guidelines may be used as references to determine acceptable goals for the Project. Since Lehigh produces continuous noise when equipment is operating, this review focuses on guidelines for continuous (L_{eq}) noise levels.

7.1.1 RVC DRAFT AGGREGATE RESOURCES PLAN

The original RVC Draft Aggregate Resources Plan specifies the following:

"daytime operations should not exceed the following for aggregate extraction and/or processing development:

- *Daytime (07:00 hrs to 22:00 hrs on weekdays, 09:00 hrs to 22:00 hrs on weekends):*
    - *55 dB L_{Aeq} (1-hour, free field) or 10 dB above recorded ambient sound levels (measured as L_{A90}), whichever is the lesser, at the nearest or most impacted dwellings.*
    - *Where the recorded ambient sound levels are above 50 dB, sound levels at the most impacted dwelling(s) or institutional building(s) shall not exceed 5 dB above ambient sound level.*

The lowest Permissible Sound Level (PSL) after the respective adjustments, shall be 45 dB L_{Aeq} for the daytime period".

7.1.2 AUC RULE 012 AND AER DIRECTIVE 038

Rule 012 sets out requirements for noise control for facilities under the jurisdiction of the Alberta Utilities Commission (AUC). Directive 038: Noise Control states the requirements for noise control as they apply to all operations and facilities under the jurisdiction of the Alberta Energy Regulator (AER). The purpose of these regulations is to ensure that the sound from a facility, measured cumulatively with sound from other energy-related facilities, does not exceed the established permissible sound levels. In residential areas nearby the Project, the daytime L_{Aeq} PSL for a newly proposed facility would be 58 dB using the methodology found in these guidelines, with reference to the residential dwelling density in the area. Daytime is defined as 07:00 to 22:00 in both guidelines.

7.1.3 TOWN OF COCHRANE NOISE CONTROL BYLAW 16/2011

This bylaw establishes PSLs for continuous sound in residential areas. For the daytime period (07:00 hrs – 22:00 hrs), no person shall cause or permit to be caused, continuous sound that exceeds 65 dB L_{Aeq} measured over a period of one (1) hour at any point of reception within a residential development.

7.1.4 CITY OF CALGARY NOISE BYLAW 5M2004

This bylaw establishes PSLs for continuous sound in different residential locations. For the daytime period (07:00 hrs – 22:00 hrs), no person shall cause or permit to be caused, continuous sound that exceeds 65 dB L_{Aeq} measured over a period of one (1) hour at any point of reception within a residential development.

7.1.5 ONTARIO MOECC NPC-300

In the province of Ontario, mining projects must meet the Publication NPC-300 noise guidelines for stationary noise sources. Limits are receptor based and are based on "predictable worst-case" 1-hour L_{eq}, with different limits during the day, evening and night. The limits also vary depending on the nature of the location as follows:

- "Class 1" urban – 50 dBA daytime/evening, 45 dBA night
- "Class 2" semi-rural – 50 dBA daytime/evening, 47 dBA evening for Outdoor Living Areas, 45 dBA night
- "Class 3" rural – 45 dBA daytime/evening, 40 dBA night

7.1.6 HEALTH CANADA GUIDELINES

Health Canada's 2017 Guidance for Evaluating Human Health Impacts in Environmental Assessment: Noise is applicable to new projects. This guideline details approaches to assess the health impacts of noise. It addresses issues such as sleep disturbance, low frequency noise, interference with speech comprehension and indicators of potential health effects such as complaints and annoyance. For each of these issues, the Health Canada guideline provides a review of relevant literature to inform the assessment of noise impacts for new proposals.

Health Canada notes that background outdoor continuous noise levels should be kept below L_{Aeq} 55 dB to sustain good outdoor speech comprehension.

The literature referenced by Health Canada indicates that the community reaction to intruding noise can be related to the normalized outdoor day-night noise level (normalized L_{DN}) as follows:

- Normalized L_{DN} 55 dBA - no reaction although noise is generally noticeable
- Normalized L_{DN} 62 dBA - widespread complaints
- Normalized L_{DN} 75 dBA - vigorous community reaction

Note that although the L_{DN}, L_{Aeq} and $L_{night,outside}$ parameters all use units of A-weighted decibels, they are derived differently and cannot be directly compared. Health Canada recommends that a +5 dB adjustment be added to noise that is audibly tonal at the receptor. The adjustment is only added for the duration of the tonal noise event.

An L_{DN} of 55 dBA is equivalent to a night-time continuous L_{Aeq} noise level of 45 dB, in conjunction with a daytime continuous L_{Aeq} noise level of 55 dB.

While noise-related complaints can be an indicator of human health effects, individual responses to sound can vary greatly and reliance on complaints alone may only provide a partial indication of a noise problem.

Low-frequency noise is commonly not well perceived by the human ear but may induce vibrations in buildings that may be perceptible or cause building elements to "rattle". Health Canada notes that annoyance related to noise is greater when low-frequency noise is present.

Environmental noise is usually characterized using A-weighted noise levels that reflect audibility to the human ear. Since low-frequency noise is not always audible by ear, the impacts of low-frequency noise need to be assessed separately, using unweighted noise levels and frequency analysis. Health Canada references the American National Standard ANSI S12.9-2005 Part 4 for advice on the levels at which essentially continuous low frequency airborne noise causes annoyance. ANSI S12.9 2005 provides the following information in relation to low frequency noise:

- Annoyance is minimal when sound pressure levels are less than 65 dB at octave band center frequencies of 16, 31.5 and 63 Hz;
- Increased annoyance begins when rattles occur, which begins at low frequency sound pressure levels of 70-75 dB (unweighted); and
- To prevent the likelihood of noise induced rattles, the logarithmic sum of noise in the 16, 31.5 and 63 Hz octave bands should be less than 70 dB.

Referencing the ANSI guidance, Health Canada recommends that mitigation measures for low frequency noise be implemented if the 70 dB "rattle criterion" is exceeded.

7.1.7 WORLD HEALTH ORGANIZATION (WHO)

According to the WHO Guidelines for Community noise, the capacity of a noise to induce annoyance depends upon its physical characteristics, including the sound pressure level, spectral characteristics and variations of these properties with time. During daytime, few people are highly annoyed at L_{Aeq} levels below 55 dB(A), and few are moderately annoyed at L_{Aeq} levels below 50 dB(A). Sound levels during the evening and night should be 5–10 dB lower than during the day. Noise with low-frequency components require lower guideline values. For intermittent noise, it is emphasized that it is necessary to take into account both the maximum sound pressure level and the number of noise events. Guidelines or noise abatement measures should also take into account residential outdoor activities.

7.1.8 SUMMARY OF NOISE GUIDELINES

The following table summarizes the PSLs applicable to the Project considering the guidelines presented in the previous sections.

Table 8 Summary of Guideline PSLs

Guideline	Parameter	Project Applicable Daytime PSL, dB
RVC Draft Guideline	$L_{Aeq\ (day)}$	45 to 55
AUC Rule 012	$L_{Aeq\ (15\text{-hr day})}$	58
AER Directive 038	$L_{Aeq\ (15\text{-hr day})}$	58
Town of Cochrane Noise Control Bylaw 16/2011	$L_{Aeq\ (day)}$	65
City of Calgary Noise Bylaw	$L_{Aeq\ (day)}$	65
Ontario MOECC NPC-300	$L_{Aeq\ (1\text{-hr day})}$	50
Health Canada	$L_{Aeq\ (day)}$	55
World Health Organization	$L_{Aeq\ (day)}$	50 to 55

7.2 ASSESSMENT CRITERIA

Considering ambient sound survey results, guidelines presented in the previous sections and further discussions with RVC, it was concluded that sound emission levels from the project must be as low as reasonably practicable using feasible and appropriate acoustic mitigation along with best practices. It has been agreed that sound levels should not exceed 55 dB L_{Aeq} at the nearest residences at any time. Off-site traffic on public roads, has been excluded from the assessment.

It is important to note that the established PSL for the Project is 10 dB more stringent than the City of Calgary limit which applies to the nearby pits that are within the City of Calgary boundary.

8. SOUND PROPAGATION MODELLING

This section presents the sound propagation modelling results of the proposed Project.

CadnaA, version 2019 MR 1 was used to undertake the sound propagation modelling. CadnaA is an outdoor sound level prediction software program developed by DataKustik GmbH, Germany. The calculation algorithms used by the program are from international standards (ISO 9613, part 1 (Acoustics – Calculation of the absorption of sound by the atmosphere) and part 2 (Acoustics – Attenuation of sound during propagation outdoors). DataKustik has confirmed that CadnaA is certified under ISO/TR 17534-3. The following outdoor sound propagation effects were included in the computer model calculations:

- Distance dissipation;
- Ground attenuation;
- Atmospheric absorption;
- Barrier attenuation; and
- Moderate downwind conditions.

Meteorological parameters and ground attenuation values typical of spring/summer/fall seasonal conditions were used in the noise model calculations. Predicted sound levels were calculated for a temperature of 10˚C, a relative humidity of 70%, and moderate downwind conditions.

Ground cover in the study area is mostly cultivated or grass fields as shown in Figure 1. An overall ground absorption factor of 0.7 was used in the model, which corresponds to grasslands or cultivated fields, and is appropriate for the ground cover in the study area.

The computer noise model results do not include the effects of background sound in the area, such as road traffic, community or natural sounds, or sound from transportation sources.

The sound propagation model only considered the conveyor portion operating within the Project boundary. As mentioned in Section 2, sound emissions from the off-site covered conveyor are expected to be negligible at the residential receptors.

The sound propagation modelling also considers the existing topography of the surrounding study area and future mining operations. Modelling was undertaken considering the most unfavorable topography condition for noise propagation, in order to assess a worst-case scenario. The worst-case topographic conditions considered are the following for each activity:

- Material excavation and reclamation once Phase 1 is completed; and
- Crushing and conveying once Phase 1 is completed and Stripping for Phase 2 is ongoing.

8.1 ACOUSTIC MITIGATION MEASURES

The site operations will implement acoustic mitigation measures in the form of a 4-m high berm at the east, south and west site perimeter (as shown in **Figure 2**) to remove line of sight to the nearest noise sensitive receptors. Furthermore, the operation and phased development approach below the surface level will increase the sound attenuation between the sound sources and receptor locations.

Additionally, acoustic shrouds will be installed on the crusher unit to reduce the sound level during operation.

White noise/broadband reverse alarms are recommended to be installed on all mobile equipment to minimize the tonal sound characteristics from operations.

9. ASSESSMENT

9.1 SOUND LEVEL CRITERIA

The sound emissions from the Project operations were assessed using the criteria outlined in **Section 6.2**, which was based on consultation with RVC and the review of relevant noise guidelines.

9.2 SOUND LEVEL ASSESSMENT AT RECEPTOR LOCATIONS

Table 9 specifies the predicted sound levels and the assessment at each receptor considering material excavation and reclamation activities.

Table 9 Assessment of Operational Sound Levels - Material Excavation and Reclamation

Receptor	Predicted L_{Aeq}, dB	Daytime PSL L_{Aeq}, dB	Compliance Margin, dB
R1	38.4	55	16.6
R2	42.6	55	12.4
R3	44.4	55	10.6
R4	43.5	55	11.5
R5	48.2	55	6.8
R6	48.2	55	6.8
R7	42.9	55	12.1
R8	34.4	55	20.6
R9	33.2	55	21.8

Table 10 specifies the predicted sound levels and assessment at each receptor considering crushing and conveying activities.

Table 10 Assessment of Operational Sound Levels – Crushing and Conveying

Receptor	Predicted L_{Aeq}, dB	Daytime PSL L_{Aeq}, dB	Compliance Margin, dB
R1	47.1	55	7.9
R2	47.7	55	7.3
R3	47.7	55	7.3
R4	48.3	55	6.7
R5	47.8	55	7.2
R6	47.8	55	7.2
R7	45.0	55	10
R8	34.2	55	20.8
R9	31.2	55	23.8

It is seen that the levels are below the established PSLs in both cases by a margin of more than 5 dB.

Sound contour maps showing the predicted L_{Aeq} levels (not including ambient sound levels) are included in **Appendix B** for each activity.

As mentioned in **Section 3.1**, two alternative operation scenarios for the Project were also considered by Lehigh. The *Haul truck* and *Blasting* scenarios are also in compliance with the established PSLs for all activities. Refer to **Appendix C** and **Appendix D,** respectively for results and conclusions.

9.3 CUMULATIVE ASSESSMENT

There are no proposed gravel pits with a development permit that have the potential to add to the sound contributions from the Project operations at the assessed noise sensitive receptors.

Regarding the existing gravel pits in the area, sound contributions from the Burnco, STAR and Lafarge pits may be audible at the receptors located south of the Project property line, on Burma Road (R1 to R4).

The STAR and Lafarge pits are located within the City of Calgary boundary, therefore, their applicable daytime PSLs would be 65 dB L_{Aeq}. The Burnco Pit is located within the Rocky View County boundary, so similarly to the Project, a daytime PSL of 55 dB L_{Aeq} is applicable to its operation.

Assuming a worst-case scenario where the sound emissions from all the nearby pits are generating noise equal to their respective PSLs, the added sound contribution from the Project at the receptors would result in “no net increase”[1] to the total sound levels, as the contribution from the Project will be at least 10 dB below the maximum PSL established for the nearby pits.

10. CONCLUSIONS

An acoustic assessment of the environmental sound due to operations of the proposed Scott Property Project was undertaken. The assessment included a sound monitoring survey to assess the current acoustic environment to develop assessment criteria in line with the technical consultations with RVC.

Sound propagation modelling predicts that the operational sound at the nearest noise sensitive receptors would be below the criteria for all phases with inclusion of appropriate acoustic mitigation and best practice by a margin of more than 5 dB. As required by the Rocky View County Noise Control Bylaw No. C-5772-2003, through the noise impact control measures identified, noise emissions would be minimized as much as practicable.

11. STATEMENT OF LIMITATIONS

This report has been prepared and the work referred to in this report has been undertaken by SLR for Lehigh hereafter referred to as the “Client”. The report has been prepared in accordance with the Scope of Work and agreement between SLR and the Client. It is intended for the sole and exclusive use of the Client. Other than by the Client and as set out herein, copying or distribution of this report or use of or reliance on the information contained herein, in whole or in part, is not permitted without the express written permission of SLR.

This report has been prepared for specific application to this site and site conditions existing at the time work for the report was completed. Any conclusions or recommendations made in this report reflect SLR’s professional opinion.

Information contained within this report may have been provided to SLR from third party sources. This information may not have been verified by a third party and/or updated since the date of issuance of the external report and cannot be warranted by SLR. SLR is entitled to rely on the accuracy and completeness of the information provided from third party sources and no obligation to update such information.

Nothing in this report is intended to constitute or provide a legal opinion. SLR makes no representation as to the requirements of compliance with environmental laws, rules, regulations, or policies established by federal, provincial, or local government bodies. Revisions to the regulatory standards referred to in this report may be expected over time. As a result, modifications to the findings, conclusions, and recommendations in this report may be necessary.

The Client may submit this report to the RVC or related Alberta environmental regulatory authorities or persons for review and comment purposes.

[1] No net increase is defined as the logarithmic addition of sound pressure levels when predicting noise, where the sum does not exceed the levels by 0.4 dBA, i.e. 30 dB + 40 dB = 40.4 dB

FIGURES

Acoustic Assessment
Scott Property Project
SLR Project No.:203.50179.00000

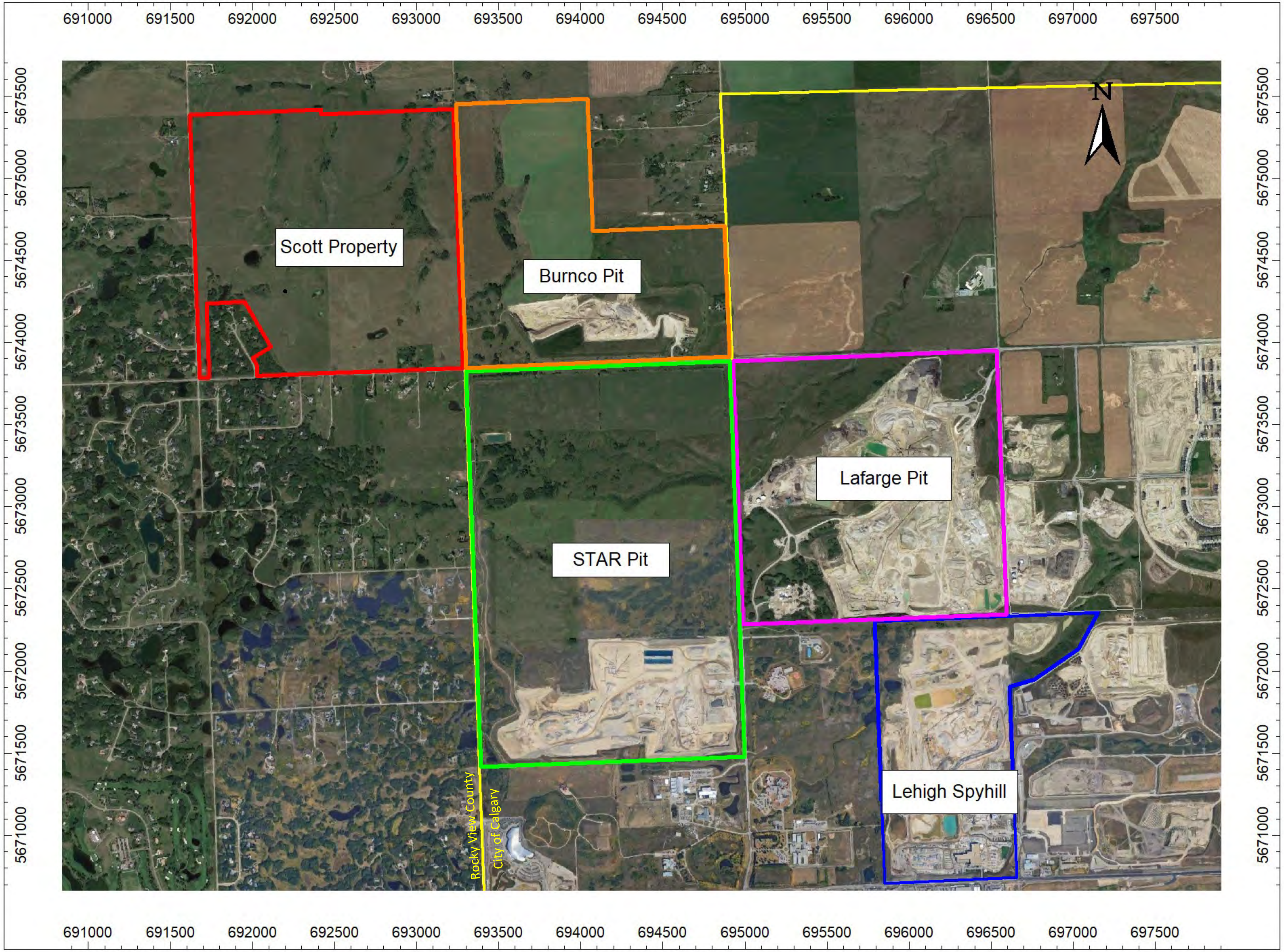


Figure 1: Site Context

Figure 2: Project Phases

Figure 3: Phase 2 Operation Details

Figure 4: Noise Sensitive Receptors

Figure 5: Sound Monitoring Locations

APPENDIX A
Equipment Sound Power Levels

Acoustic Assessment
Scott Property Project
SLR Project No.: 203.50179.00000

Appendix A – Equipment Sound Data

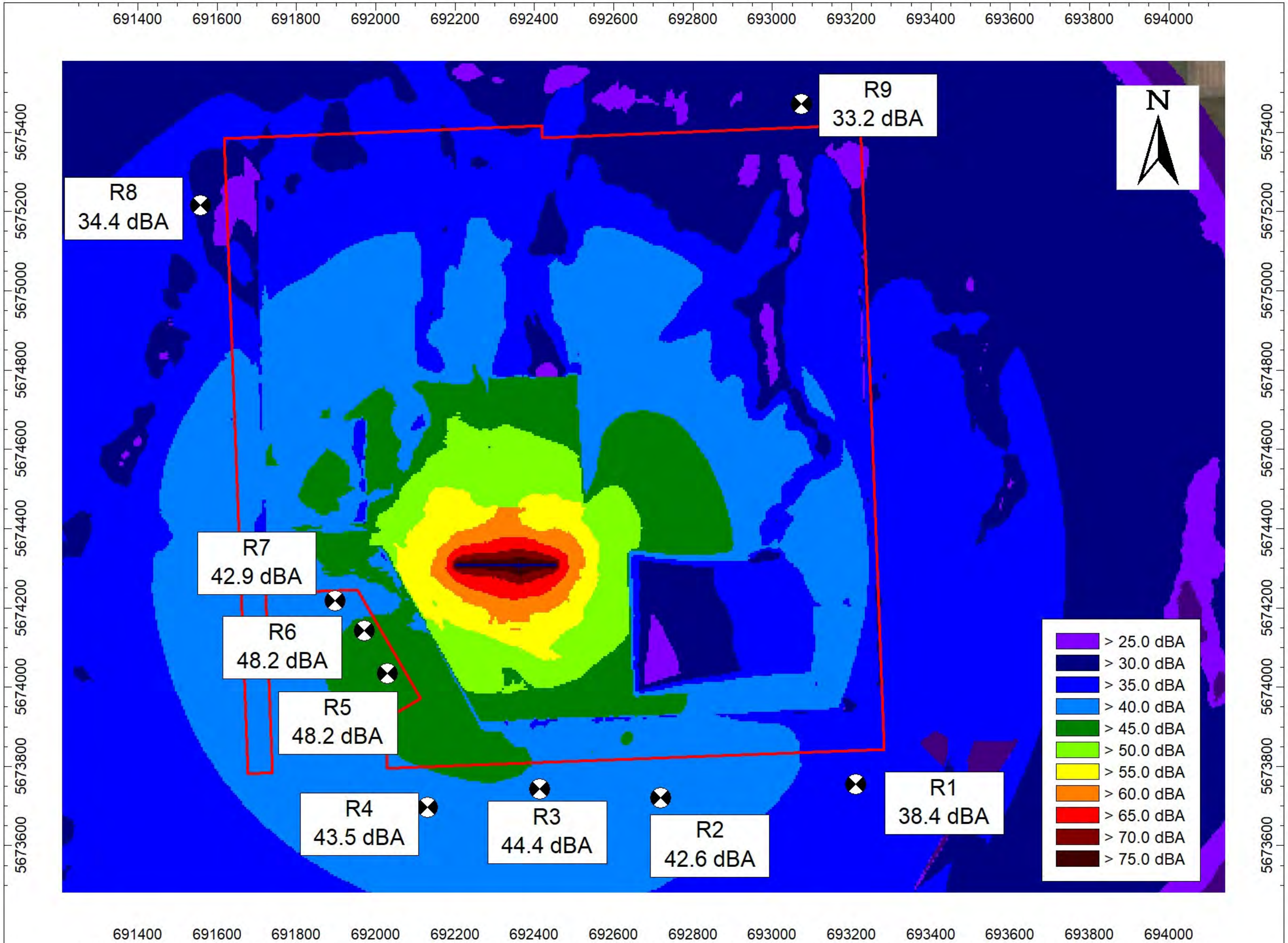
Table A-1: Sound Source Sound Power Data

Noise Source	Octave Band Sound Power Level (dB)									Overall (dBA)
	31.5	63	125	250	500	1000	2000	4000	8000	
CAT 631K Scrapper	119	119	114	109	110	105	102	96	89	111
CAT D9 Dozer	121	121	122	113	105	106	102	100	96	112
Metso Nordberg NW130 Crusher*	126	126	126	125	122	119	116	110	104	124
CAT 374 Excavator**	119	119	117	113	117	115	115	112	108	121
CAT D10 Dozer	124	124	125	116	108	109	105	103	99	115
CAT 990 Loader	113	113	113	112	110	111	108	102	95	115
48'' Conveyor	104	104	102	101	104	108	100	96	90	110
TRIO CT 4252 Crusher***	96	100	107	112	112	111	109	105	98	116
CAT 773 Haul Truck	111	111	114	113	113	111	108	102	95	115
D65 Atlas Copco Blasting Drill	114	114	120	113	116	112	111	106	105	118

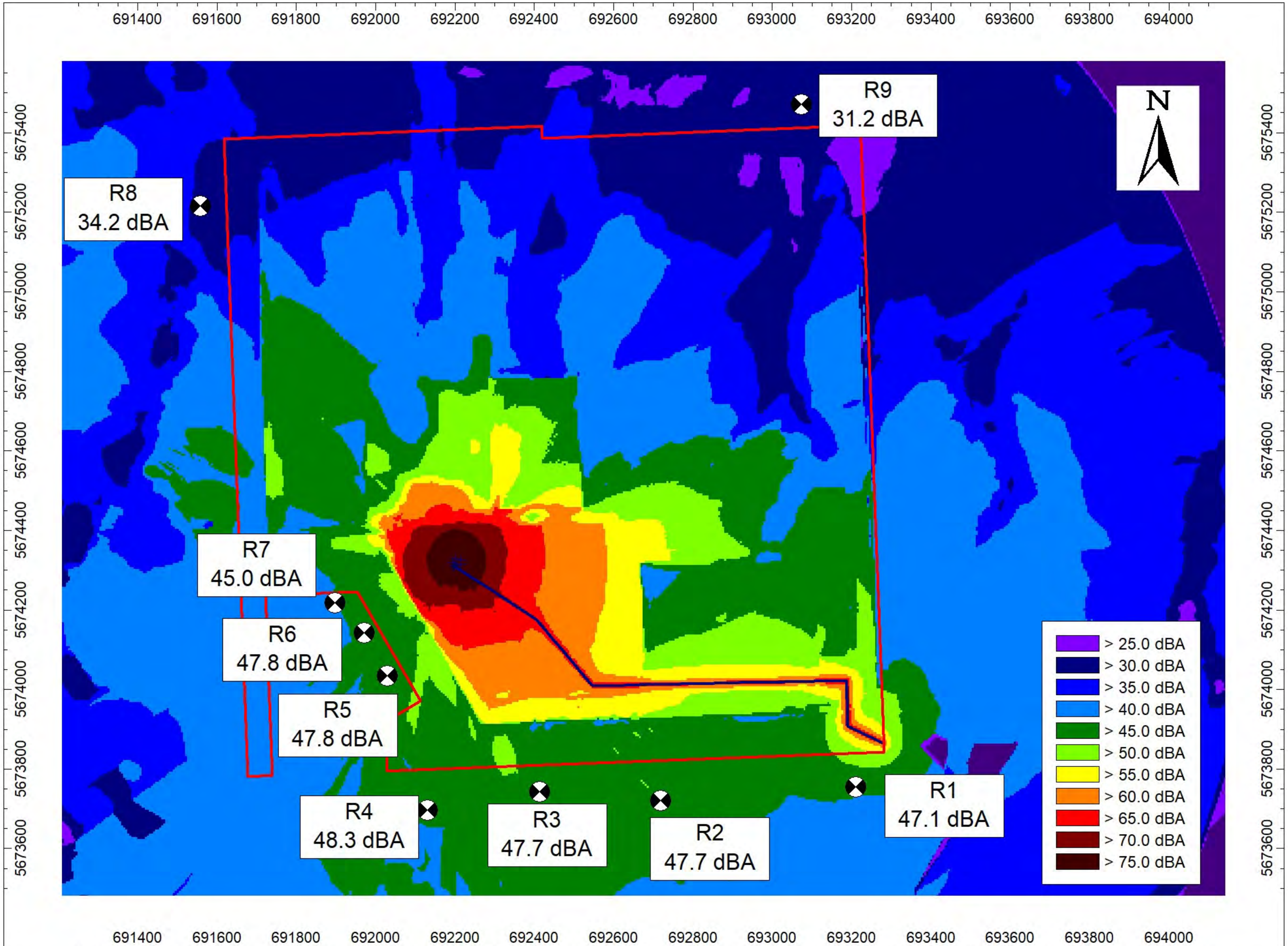
*Not including acoustic shroud
**Including rock breaking attachment
***Considering semi-enclosure attenuation of 5 dB

APPENDIX B
Sound Contour Maps

Acoustic Assessment
Scott Property Project
SLR Project No.: 203.50179.00000



Sound Contour Map – Material Excavation and Reclamation



Sound Contour Map – Crushing and Conveying

APPENDIX C
Haul Truck Scenario Details and Results

Acoustic Assessment
Scott Property Project
SLR Project No.: 203.50179.00000

The present appendix shows the modelling results of the Project operations considering the Haul truck scenario for crushing and conveying activities. In this scenario, the use of in-pit haul trucks was considered as an alternative of the in-pit conveyor to transport the material. The overland conveyor would still be used to transport crushed material from the Project to the Spyhill pit processing facilities.

1.0 SOUND PROPAGATION MODELLING

Sound propagation modelling setup was consistent with the description presented in the section 7 of the report. **Table C-1** below specifies the equipment considered in the calculations. In this scenario, haul trucks deliver aggregate from the aggregate pit to the crusher position, in the south-east corner of the property, at an approximate depth of 25 m. The crushed material is then loaded into an open conveyor from its bottom that ramps up and out to the surface, and then off the site to the Lehigh Spyhill Pit.

The 4 m perimeter berm was considered in the calculations. The crusher in this scenario will be partially enclosed. No other mitigation measures were included in the calculations.

Table C-1 Equipment Sound Sources – Haul Truck Scenario

Activity	Equipment & Model	Qty.	Power Rating	Working Area	L_W, dBA
Crushing and conveying	TRIO CT 4252 Crusher	1	200 HP	SE Corner of property	116
	D65 Atlas Copco Blasting Drill	1	540 HP	Aggregate Pit	118
	CAT D10 Dozer	1	600 HP	Aggregate Pit	115
	CAT 990 Loader	1	699 HP	Aggregate Pit	115
	CAT 773 Haul Truck	4	775 HP	In-pit haul truck route	115
	CAT 773 Water Truck	1	775 HP	In-pit haul truck route	108

Octave Band sound power levels associated to the Crusher and Haul Trucks are presented in **Appendix B.**

The following table summarizes the modelling results for the Project phase 2 using haul trucks.

Table C-2 Assessment of Operational Sound Levels – Crushing and Conveying – Haul Truck Scenario

Receptor	Predicted L_{Aeq}, dB	Daytime PSL L_{Aeq}, dB	Compliance Margin, dB
R1	46.1	55	8.9
R2	46.6	55	8.4

Receptor	Predicted L_{Aeq}, dB	Daytime PSL L_{Aeq}, dB	Compliance Margin, dB
R3	47.0	55	8.0
R4	48.4	55	6.6
R5	47.4	55	7.6
R6	45.8	55	9.2
R7	43.2	55	11.8
R8	34.4	55	20.6
R9	35.9	55	19.1

It is seen that the levels are below the established PSLs in both cases by a margin of more than 5 dB.

APPENDIX D
Blasting Scenario Details and Results

Acoustic Assessment
Scott Property Project
SLR Project No.: 203.50179.00000

The present appendix shows the modelling results of the of the Project operations considering blasting drilling equipment instead of rock breaking equipment for mining activities. Additionally, blasting air pressure levels have been calculated and presented. Vibration effects due to blasting have not been assessed.

1.0 SOUND PROPAGATION MODELLING

Sound propagation modelling setup was consistent with the description presented in the section 7 of the report. **Table D-1** below specifies the equipment considered in the calculations.

Mitigation measures described in the section 7.1 of the report were included in the calculations.

Table D-1 Equipment Sound Sources – Blasting Drill Scenario

Activity	Equipment & Model	Qty.	Power Rating	Working Area	L_W, dBA
Crushing and conveying	Metso Nordberg NW130 Crusher	1	200 HP	Aggregate Pit	124
	D65 Atlas Copco Blasting Drill	1	540 HP	Aggregate Pit	118
	CAT D10 Dozer	1	600 HP	Aggregate Pit	115
	CAT 990 Loader	1	699 HP	Aggregate Pit	115
	48'' Conveyor	1	-	In-pit conveyor route	110

Octave Band sound power levels associated to the Blasting Drill are presented in **Appendix B.**

The following table summarizes the modelling results for the Project Phase 2 using blasting drilling equipment.

Table D-2 Assessment of Operational Sound Levels – Crushing and conveying – Blasting Drill Scenario

Receptor	Predicted L_{Aeq}, dB	Daytime PSL L_{Aeq}, dB	Compliance Margin, dB
R1	46.9	55	7.9
R2	47.2	55	7.3
R3	47.2	55	7.3
R4	48.1	55	6.7
R5	47.6	55	7.2
R6	47.6	55	7.2
R7	44.9	55	10

Receptor	Predicted L_{Aeq}, dB	Daytime PSL L_{Aeq}, dB	Compliance Margin, dB
R8	34.0	55	20.8
R9	31.1	55	23.8

It is seen that the levels are below the established PSLs in both cases by a margin of more than 5 dB.

2.0 BLASTING OVERPRESSURE

When an explosive charge is detonated, energy is released which may be used for many applications. A portion of the energy is dissipated in two forms: as air blast in the form of pressure waves travelling through the air and often heard as an audible explosion, and as vibration in the form of seismic waves travelling within the ground which travel outward from the blast site. The air blast and ground vibration levels will naturally decay with distance from the blast site. Various factors may affect the actual rate of decay for a particular blast.

Sound pressure levels measured using a sound level meter can have various units such as "dB", "dBA", or "dBC". The unit "dB" represents linear decibels, with no frequency weighting. The unit "dBA" represents decibels weighted according to the A-weighting scale. The A-weighting scale approximates the way humans hear different frequencies (our ears are less sensitive to low frequencies than to mid and high frequencies). The unit "dBA" is typically used to gauge human reaction. The unit "dBC" represents decibels weighted according to the C-weighting scale. The C-weighting scale does not remove as much low frequency energy and therefore provides a value that is more sensitive to sounds containing significant low frequency energy. To determine blast effects upon a structure (either the sound pressure level or the vibration level), it is not useful to weight the results on the dBA scale since we are not concerned with human response to the levels, therefore, the linear dB scale is the most appropriate.

Air blast is a transient time-varying overpressure (i.e. the pressure over and above the ambient air pressure); therefore, the peak value of the overpressure will represent the greatest potential to cause structural damage.

2.1 PREDICTING AIR BLASTING OVERPRESSURE

To facilitate comparing or estimating the effects from blasts of varying charge weights and varying distances, some scaling method is required. The conventional scaling method in use is referred to as Scaled Distance (Ds), a number that provides a means of scaling a ratio of distance and charge weight.

Cube Root Scaled Distance is derived by dividing the true ground path distance (in m) between the detonating charge and the object of interest by the cube root of the charge weight (in kg). This is used for scaling blasts involving linear charges (the length is more than four times the diameter) and would apply to most conventional blasts.

$$Ds = \frac{Distance}{Weight^{1/3}}$$

The calculation method is based on prediction curves developed on data gathered from blasts in many varied locations and from research done by various individuals and organizations. The prediction curves use a basic formula for estimating air overpressures:

$$P = K(Ds)^{-1.2}$$

where P represents the peak pressure in Pa. K represents the factor that defines the intensity of the air overpressure and can depend on various site characteristics such as: depth of the charge burial, terrain features, blast orientation, atmospheric conditions, etc. The typical lower and upper K factor bounds for confined charges ranges from 1773 to 5683 for normal blasting. As many site-specific factors are currently unknown for the Scott project, it is recommended that for initial blasting, the results using the upper bound factor are used, until site measurements can confirm an appropriate site-specific K factor range. The attenuation slope of -1.2 used in the equation is typical for static conditions and represents a reduction of approximately 7.2 dB for each doubling of distance.

The formula for converting pressure to decibels is:

$$Lp = 20 \log \left(\frac{P}{20\ x\ 10^{-6}} \right) = 20 \log P + 94$$

2.2 BLAST ASSESSMENT CRITERIA

There are no guidance documents or regulations published within Alberta regarding methodology for predicting and assessing overpressure due to blasting activities. Therefore, blasting pressure levels will be assessed against limits specified by the Ontario Ministry of the Environment and Climate Change (MOECC) in the NPC-119 Regulation.

According to NPC-119, If the person in charge of a blasting operation carries out routine monitoring of the peak pressure level, the peak pressure level limit for concussion resulting from blasting operations in a mine or quarry is 128 dB.

2.3 AIR BLASTING OVERPRESSURE RESULTS

Table D-3 summarizes the distance from the detonation point to each receptor. Detailed blast patterns and locations were not available, so for the purpose of the assessment, a single detonation point was assumed to be located in the middle of the aggregate pit. The maximum weight of explosive is 15 kg per hole and the maximum number of charges within any 8 ms period is 3, therefore, the maximum weight of explosive per delay assumed for this assessment is 45 kg.

Table D-3: Blasting Overpressure Calculation Inputs

Receptor	Distance, m	Maximum charge weight, kg
R1	1180.35	45
R2	804.12	45
R3	628.20	45
R4	641.01	45
R5	348.42	45
R6	305.62	45
R7	331.05	45
R8	1103.16	45

Receptor	Distance, m	Maximum charge weight, kg
R9	1441.17	45

Table D-4 summarize the blasting overpressure results at each receptor following the method described in the previous section.

Table D-4: Blasting Overpressure Results and Assessment.

Receptor	Predicted L_{peak}, dB	NPC-119 Limit L_{peak}, dB	Compliance Determination (Y/N)
R1	108.6	128	Y
R2	112.6	128	Y
R3	115.2	128	Y
R4	115.0	128	Y
R5	121.3	128	Y
R6	122.7	128	Y
R7	121.8	128	Y
R8	109.3	128	Y
R9	106.5	128	Y

It is seen that the levels are in compliance with the NPC-119 limit at all the receptors. Even though the levels are below the mentioned limit, sound due to blasting activities may still be noticeable by nearest residents and annoyance could be experienced by them. For this reason, it is recommended to notify the residents in advance before performing any blasting activities.

APPENDIX E
Monitoring Instrumentation Calibration Records

Acoustic Assessment
Scott Property Project
SLR Project No.: 203.50179.00000

Monitoring Location	Description	Serial Number	Calibration Certificate Date (dd/mm/yyyy)
A1	Larson Davis 831C sound level meter	10764	15/04/2019
A1	PCB Piezotronics 377B02 microphone	311789	15/04/2019
A1	Larson Davis WS001 primary wind screen	N/A	N/A
A1	Brüel & Kjær EH-2152 secondary wind screen	N/A	N/A
A1	Vaisala WXT536 weather station	N/A	N/A
A2	Larson Davis 831C sound level meter	10763	15/04/2019
A2	PCB Piezotronics 377B02 microphone	311878	15/04/2019
A2	Larson Davis WS001 primary wind screen	N/A	N/A
A2	Brüel & Kjær EH-2152 secondary wind screen	N/A	N/A
A2	Vaisala WXT536 weather station	N/A	N/A
A3	Larson Davis 831C sound level meter	10761	15/04/2019
A3	PCB Piezotronics 377B02 microphone	311879	15/04/2019
A3	Larson Davis WS001 primary wind screen	N/A	N/A
A3	Brüel & Kjær EH-2152 secondary wind screen	N/A	N/A
A3	Vaisala WXT536 weather station	N/A	N/A
A4	Larson Davis 831C sound level meter	10762	15/04/2019
A4	PCB Piezotronics 377B02 microphone	311704	15/04/2019
A4	Larson Davis WS001 primary wind screen	N/A	N/A
A4	Brüel & Kjær EH-2152 secondary wind screen	N/A	N/A
A4	Vaisala WXT536 weather station	N/A	N/A

Calibration Certificate

Certificate Number 2019004569

Customer:

SLR Consulting Canada
1185-10201 Southport Road SW
Calgary, AB T2W 4X9, Canada

Model Number	831C	***Procedure Number***	D0001.8384		
Serial Number	10764	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	15 Apr 2019		
Initial Condition	As Manufactured	***Calibration Due***			
		Temperature	23.72	°C	± 0.25 °C
Description	Larson Davis Model 831C Class 1 Sound Level Meter Firmware Revision: 03.3.0R3	***Humidity***	50.5	%RH	± 2.0 %RH
		Static Pressure	85.67	kPa	± 0.13 kPa

Evaluation Method ***Tested with:*** ***Data reported in dB re 20 μPa.***

Larson Davis PRM2103. S/N 001510
PCB 377B02. S/N 311789
Larson Davis CAL200. S/N 9079
Larson Davis CAL291. S/N 0108

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61260:2014 Class 1	ANSI S1.11-2014 Class 1
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.

Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Correction data from Larson Davis SoundAdvisor Model 831C Reference Manual, I831C.01 Rev B, 2017-03-31

For 1/4" microphones, the Larson Davis ADP024 1/4" to 1/2" adaptor is used with the calibrators and the Larson Davis ADP043 1/4" to

1/2" adaptor is used with the preamplifier.

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 μPa; Reference Range: 0 dB gain

Periodic tests were performed in accordance with precedures from IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part3.

No Pattern approval for IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 available.

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 because (a) evidence was not publicly available, from an independent testing organization responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 or correction data for acoustical test of frequency weighting were not provided in the Instruction Manual and (b) because the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3 cover only a limited subset of the specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Larson Davis CAL291 Residual Intensity Calibrator	2018-09-19	2019-09-19	001250
SRS DS360 Ultra Low Distortion Generator	2018-06-21	2019-06-21	006311
Hart Scientific 2626-H Temperature Probe	2018-08-19	2019-08-19	006798
Larson Davis CAL200 Acoustic Calibrator	2018-07-24	2019-07-24	007027
Larson Davis Model 831	2019-02-22	2020-02-22	007182
PCB 377A13 1/2 inch Prepolarized Pressure Microphone	2019-03-06	2020-03-06	007185

Acoustic Calibration

Measured according to IEC 61672-3:2013 10 and ANSI S1.4-2014 Part 3: 10

Measurement	Test Result [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
1000 Hz	114.01	113.80	114.20	0.14	Pass

Acoustic Signal Tests, C-weighting

Measured according to IEC 61672-3:2013 12 and ANSI S1.4-2014 Part 3: 12 using a comparison coupler with Unit Under Test (UUT) and reference SLM using slow time-weighted sound level for compliance to IEC 61672-1:2013 5.5; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Expected [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
125	-0.15	-0.20	-1.20	0.80	0.23	Pass
1000	0.16	0.00	-0.70	0.70	0.23	Pass
8000	-3.52	-3.00	-5.50	-1.50	0.32	Pass

-- End of measurement results--

Self-generated Noise

Measured according to IEC 61672-3:2013 11.1 and ANSI S1.4-2014 Part 3: 11.1

Measurement	Test Result [dB]
A-weighted, 20 dB gain	40.07

-- End of measurement results--

-- End of Report--

Signatory: Ron Harris

LARSON DAVIS - A PCB PIEZOTRONICS DIV.
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

~ Certificate of Calibration and Compliance ~

Microphone Model: 377B02 Serial Number: 311789 Manufacturer: PCB

Calibration Environmental Conditions

Environmental test conditions as printed on microphone calibration chart.

Reference Equipment

Manufacturer	Model #	Serial #	PCB Control #	Cal Date	Due Date
National Instruments	PCIe-6351	1896F08	CA1918	10/19/18	10/18/19
Larson Davis	PRM915	132	CA1552	11/29/18	11/29/19
Larson Davis	PRM902	4407	CA1248	5/23/18	5/23/19
Larson Davis	PRM916	125	TA469	6/26/18	6/26/19
Larson Davis	CAL250	5026	CA1278	9/19/18	9/19/19
Larson Davis	2201	115	TA472	4/12/18	4/12/19
Bruel & Kjaer	4192	2764626	CA1636	8/15/18	8/15/19
Larson Davis	GPRM902	4163	CA1089	6/12/18	6/12/19
Newport	iTHX-SD/N	1080002	CA1511	2/8/19	2/7/20
Larson Davis	PRA951-4	234	CA1154	10/24/18	10/24/19
Larson Davis	PRM915	147	CA2179	6/8/18	6/7/19
PCB	68510-02	N/A	CA2672	12/21/18	12/20/19
0	0	0	0	not required	not required
0	0	0	0	not required	not required
0	0	0	0	not required	not required

Frequency sweep performed with B&K UA0033 electrostatic actuator.

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration of reference equipment is traceable to one or more of the following National Labs; NIST, PTB or DFM.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI/NCSL Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Open Circuit Sensitivity is measured using the insertion voltage method following procedure AT603-5.
6. Measurement uncertainty (95% confidence level with coverage factor of 2) for sensitivity is +/-0.20 dB.
7. Unit calibrated per ACS-20.

Technician: Leonard Lukasik *LL*   Date: February 25, 2019

CALIBRATION CERT #1862.01

PCB PIEZOTRONICS VIBRATION DIVISION
3425 Walden Avenue, Depew, New York, 14043
TEL: 888-684-0013 FAX: 716-685-3886 www.pcb.com

ID.CAL112-3633938708.074+0

~ Calibration Report ~

Microphone Model: 377B02 Serial Number: 311789 Description: 1/2" Free-Field Microphone

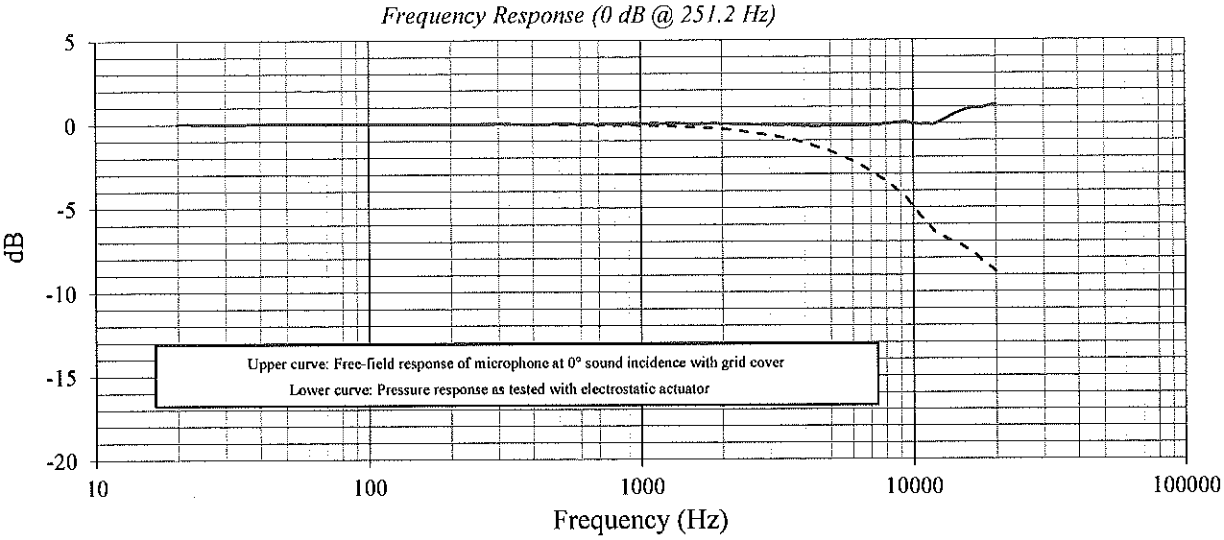
Calibration Data

Open Circuit Sensitivity @ 251.2 Hz: 49.49 mV/Pa
-26.11 dB re 1V/Pa

Polarization Voltage, External: 0 V
Capacitance: 13.8 pF

Temperature: 70 °F (21°C) Ambient Pressure: 981 mbar Relative Humidity: 26 %

Frequency Response (0 dB @ 251.2 Hz)



Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)
20.0	0.05	0.05	1679	-0.23	0.00	7499	-3.16	-0.09	-	-	-
25.1	0.02	0.02	1778	-0.25	0.00	7943	-3.40	-0.01	-	-	-
31.6	0.01	0.01	1884	-0.27	0.01	8414	-3.73	0.01	-	-	-
39.8	0.03	0.03	1995	-0.32	-0.01	8913	-4.06	0.05	-	-	-
50.1	0.03	0.03	2114	-0.34	0.00	9441	-4.44	0.08	-	-	-
63.1	0.03	0.03	2239	-0.40	-0.03	10000	-4.97	-0.02	-	-	-
79.4	0.02	0.02	2371	-0.44	-0.03	10593	-5.47	-0.07	-	-	-
100.0	0.02	0.02	2512	-0.51	-0.05	11220	-5.90	-0.04	-	-	-
125.9	0.01	0.01	2661	-0.57	-0.06	11885	-6.39	-0.07	-	-	-
158.5	0.01	0.01	2818	-0.62	-0.06	12589	-6.64	0.13	-	-	-
199.5	0.00	0.00	2985	-0.67	-0.05	13335	-6.87	0.32	-	-	-
251.2	0.00	0.00	3162	-0.76	-0.08	14125	-7.05	0.54	-	-	-
316.2	-0.01	0.00	3350	-0.83	-0.09	14962	-7.25	0.72	-	-	-
398.1	-0.02	-0.02	3548	-0.90	-0.08	15849	-7.50	0.85	-	-	-
501.2	-0.04	0.01	3758	-1.01	-0.11	16788	-7.79	0.93	-	-	-
631.0	-0.05	-0.01	3981	-1.14	-0.14	17783	-8.18	0.93	-	-	-
794.3	-0.07	0.02	4217	-1.26	-0.15	18837	-8.47	1.04	-	-	-
1000.0	-0.10	0.02	4467	-1.40	-0.17	19953	-8.81	1.12	-	-	-
1059.3	-0.11	0.02	4732	-1.51	-0.14	-	-	-	-	-	-
1122.0	-0.11	0.03	5012	-1.66	-0.13	-	-	-	-	-	-
1188.5	-0.14	0.01	5309	-1.83	-0.13	-	-	-	-	-	-
1258.9	-0.14	0.02	5623	-2.02	-0.14	-	-	-	-	-	-
1333.5	-0.15	0.03	5957	-2.20	-0.13	-	-	-	-	-	-
1412.5	-0.17	0.02	6310	-2.42	-0.13	-	-	-	-	-	-
1496.2	-0.20	0.00	6683	-2.64	-0.12	-	-	-	-	-	-
1584.9	-0.23	-0.02	7080	-2.89	-0.11	-	-	-	-	-	-

Technician: Leonard Lukasik *LL* Date: February 25, 2019

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ID:CAL112-3633936708.074+0

Calibration Certificate

Certificate Number 2019004565

Customer:

SLR Consulting Canada
1185-10201 Southport Road SW
Calgary, AB T2W 4X9, Canada

Model Number	831C	***Procedure Number***	D0001.8384		
Serial Number	10763	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	15 Apr 2019		
Initial Condition	As Manufactured	***Calibration Due***			
		Temperature	23.82	°C	± 0.25 °C
Description	Larson Davis Model 831C Class 1 Sound Level Meter Firmware Revision: 03.3.0R3	***Humidity***	50	%RH	± 2.0 %RH
		Static Pressure	85.67	kPa	± 0.13 kPa

Evaluation Method ***Tested with:*** ***Data reported in dB re 20 μPa.***

Larson Davis PRM2103. S/N 001509
PCB 377B02. S/N 311878
Larson Davis CAL200. S/N 9079
Larson Davis CAL291. S/N 0108

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61260:2014 Class 1	ANSI S1.11-2014 Class 1
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.

Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

Correction data from Larson Davis SoundAdvisor Model 831C Reference Manual, I831C.01 Rev B, 2017-03-31

For 1/4" microphones, the Larson Davis ADP024 1/4" to 1/2" adaptor is used with the calibrators and the Larson Davis ADP043 1/4" to

1/2" adaptor is used with the preamplifier.

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 µPa; Reference Range: 0 dB gain

Periodic tests were performed in accordance with precedures from IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part3.

No Pattern approval for IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 available.

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 because (a) evidence was not publicly available, from an independent testing organization responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 or correction data for acoustical test of frequency weighting were not provided in the Instruction Manual and (b) because the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3 cover only a limited subset of the specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Larson Davis CAL291 Residual Intensity Calibrator	2018-09-19	2019-09-19	001250
SRS DS360 Ultra Low Distortion Generator	2018-06-21	2019-06-21	006311
Hart Scientific 2626-H Temperature Probe	2018-08-19	2019-08-19	006798
Larson Davis CAL200 Acoustic Calibrator	2018-07-24	2019-07-24	007027
Larson Davis Model 831	2019-02-22	2020-02-22	007182
PCB 377A13 1/2 inch Prepolarized Pressure Microphone	2019-03-06	2020-03-06	007185

Acoustic Calibration

Measured according to IEC 61672-3:2013 10 and ANSI S1.4-2014 Part 3: 10

Measurement	Test Result [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
1000 Hz	114.01	113.80	114.20	0.14	Pass

Acoustic Signal Tests, C-weighting

Measured according to IEC 61672-3:2013 12 and ANSI S1.4-2014 Part 3: 12 using a comparison coupler with Unit Under Test (UUT) and reference SLM using slow time-weighted sound level for compliance to IEC 61672-1:2013 5.5; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Expected [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
125	-0.16	-0.20	-1.20	0.80	0.23	Pass
1000	0.16	0.00	-0.70	0.70	0.23	Pass
8000	-3.69	-3.00	-5.50	-1.50	0.32	Pass

-- End of measurement results--

Self-generated Noise

Measured according to IEC 61672-3:2013 11.1 and ANSI S1.4-2014 Part 3: 11.1

Measurement	Test Result [dB]
A-weighted, 20 dB gain	40.08

-- End of measurement results--

-- End of Report--

Signatory: Ron Harris

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1681 West 820 North
Provo, UT 84601, United States
716-684-0001

~ Certificate of Calibration and Compliance ~

Microphone Model: 377B02 Serial Number: 311878 Manufacturer: PCB

Calibration Environmental Conditions

Environmental test conditions as printed on microphone calibration chart.

Reference Equipment

Manufacturer	Model #	Serial #	PCB Control #	Cal Date	Due Date
National Instruments	PCIe-6351	1896F08	CA1918	10/19/18	10/18/19
Larson Davis	PRM915	132	CA1552	11/29/18	11/29/19
Larson Davis	PRM902	4407	CA1248	5/23/18	5/23/19
Larson Davis	PRM916	125	TA469	6/26/18	6/26/19
Larson Davis	CAL250	5026	CA1278	9/19/18	9/19/19
Larson Davis	2201	115	TA472	4/12/18	4/12/19
Bruel & Kjaer	4192	2764626	CA1636	8/15/18	8/15/19
Larson Davis	GPRM902	4163	CA1089	6/12/18	6/12/19
Newport	iTHX-SD/N	1080002	CA1511	2/8/19	2/7/20
Larson Davis	PRA951-4	234	CA1154	10/24/18	10/24/19
Larson Davis	PRM915	147	CA2179	6/8/18	6/7/19
PCB	68510-02	N/A	CA2672	12/21/18	12/20/19
0	0	0	0	not required	not required
0	0	0	0	not required	not required
0	0	0	0	not required	not required

Frequency sweep performed with B&K UA0033 electrostatic actuator.

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration of reference equipment is traceable to one or more of the following National Labs; NIST, PTB or DFM.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI/NCSL Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Open Circuit Sensitivity is measured using the insertion voltage method following procedure AT603-5.
6. Measurement uncertainty (95% confidence level with coverage factor of 2) for sensitivity is +/-0.20 dB.
7. Unit calibrated per ACS-20.

Technician: Leonard Lukasik LL Date: February 25, 2019

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ID:CAL112-3633938317.382+0

~ Calibration Report ~

Microphone Model: 377B02 Serial Number: 311878 Description: 1/2" Free-Field Microphone

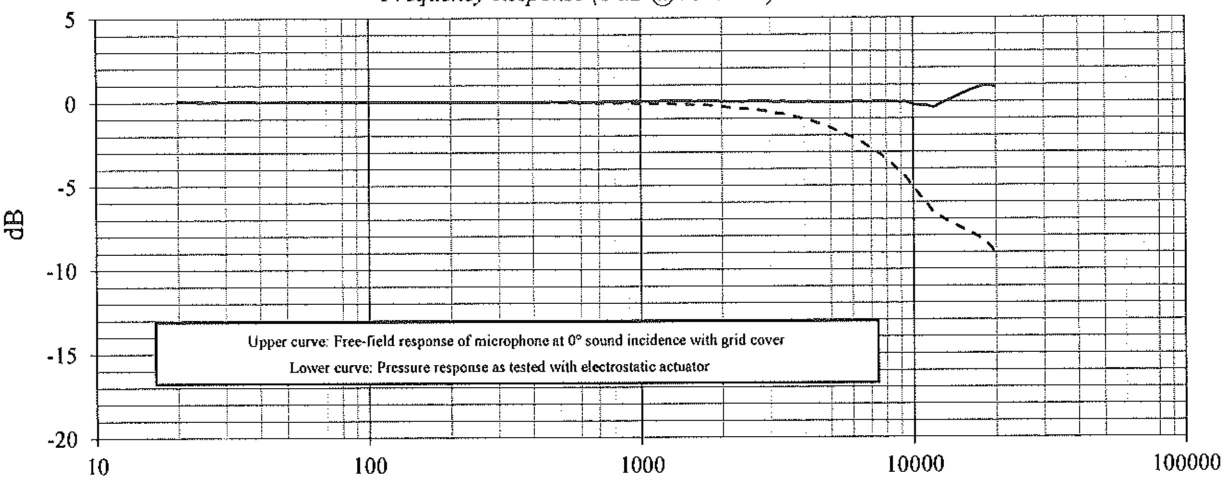
Calibration Data

Open Circuit Sensitivity @ 251.2 Hz: 47.70 mV/Pa
-26.43 dB re 1V/Pa

Polarization Voltage, External: 0 V
Capacitance: 13 pF

Temperature: 70 °F (21°C) Ambient Pressure: 981 mbar Relative Humidity: 26 %

Frequency Response (0 dB @ 251.2 Hz)



Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)
20.0	0.06	0.06	1679	-0.19	0.04	7499	-3.08	-0.01	-	-	-
25.1	0.04	0.04	1778	-0.20	0.05	7943	-3.40	-0.01	-	-	-
31.6	0.05	0.05	1884	-0.24	0.04	8414	-3.76	-0.03	-	-	-
39.8	0.04	0.04	1995	-0.28	0.03	8913	-4.15	-0.04	-	-	-
50.1	0.04	0.04	2114	-0.33	0.01	9441	-4.55	-0.03	-	-	-
63.1	0.03	0.03	2239	-0.36	0.01	10000	-5.12	-0.17	-	-	-
79.4	0.02	0.02	2371	-0.41	0.00	10593	-5.63	-0.23	-	-	-
100.0	0.02	0.02	2512	-0.44	0.02	11220	-6.11	-0.25	-	-	-
125.9	0.02	0.02	2661	-0.48	0.04	11885	-6.66	-0.34	-	-	-
158.5	0.01	0.01	2818	-0.53	0.03	12589	-6.91	-0.14	-	-	-
199.5	0.00	0.00	2985	-0.61	0.01	13335	-7.15	0.04	-	-	-
251.2	0.00	0.00	3162	-0.69	-0.01	14125	-7.37	0.23	-	-	-
316.2	0.00	0.01	3350	-0.73	0.01	14962	-7.56	0.41	-	-	-
398.1	-0.02	-0.02	3548	-0.84	-0.02	15849	-7.75	0.60	-	-	-
501.2	-0.02	0.02	3758	-0.92	-0.02	16788	-7.97	0.75	-	-	-
631.0	-0.05	-0.01	3981	-1.02	-0.02	17783	-8.22	0.89	-	-	-
794.3	-0.05	0.04	4217	-1.12	-0.01	18837	-8.59	0.92	-	-	-
1000.0	-0.08	0.04	4467	-1.27	-0.04	19953	-9.06	0.87	-	-	-
1059.3	-0.10	0.03	4732	-1.39	-0.02	-	-	-	-	-	-
1122.0	-0.12	0.02	5012	-1.57	-0.04	-	-	-	-	-	-
1188.5	-0.11	0.05	5309	-1.74	-0.04	-	-	-	-	-	-
1258.9	-0.11	0.05	5623	-1.92	-0.04	-	-	-	-	-	-
1333.5	-0.14	0.04	5957	-2.09	-0.02	-	-	-	-	-	-
1412.5	-0.14	0.05	6310	-2.29	0.00	-	-	-	-	-	-
1496.2	-0.15	0.05	6683	-2.55	-0.03	-	-	-	-	-	-
1584.9	-0.19	0.02	7080	-2.80	-0.02	-	-	-	-	-	-

Technician: Leonard Lukasik *LL* Date: February 25, 2019

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ID:CAL112-3633938317.382+0

Calibration Certificate

Certificate Number 2019004558
Customer:
SLR Consulting Canada
1185-10201 Southport Road SW
Calgary, AB T2W 4X9, Canada

Model Number	831C	***Procedure Number***	D0001.8384		
Serial Number	10761	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	15 Apr 2019		
Initial Condition	As Manufactured	***Calibration Due***			
Description	Larson Davis Model 831C Class 1 Sound Level Meter Firmware Revision: 03.3.0R3	***Temperature***	23.85	°C	± 0.25 °C
		Humidity	48.5	%RH	± 2.0 %RH
		Static Pressure	85.65	kPa	± 0.13 kPa

Evaluation Method ***Tested with:*** ***Data reported in dB re 20 μPa.***

Larson Davis PRM2103. S/N 001499
PCB 377B02. S/N 311769
Larson Davis CAL200. S/N 9079
Larson Davis CAL291. S/N 0108

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61260:2014 Class 1	ANSI S1.11-2014 Class 1
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.
Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

This report may not be reproduced, except in full, unless permission for the publication of an approved abstract is obtained in writing from the organization issuing this report.

Correction data from Larson Davis SoundAdvisor Model 831C Reference Manual, I831C.01 Rev B, 2017-03-31

For 1/4" microphones, the Larson Davis ADP024 1/4" to 1/2" adaptor is used with the calibrators and the Larson Davis ADP043 1/4" to

1/2" adaptor is used with the preamplifier.

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 µPa; Reference Range: 0 dB gain

Periodic tests were performed in accordance with precedures from IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part3.

No Pattern approval for IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 available.

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 because (a) evidence was not publicly available, from an independent testing organization responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 or correction data for acoustical test of frequency weighting were not provided in the Instruction Manual and (b) because the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3 cover only a limited subset of the specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Larson Davis CAL291 Residual Intensity Calibrator	2018-09-19	2019-09-19	001250
SRS DS360 Ultra Low Distortion Generator	2018-06-21	2019-06-21	006311
Hart Scientific 2626-H Temperature Probe	2018-08-19	2019-08-19	006798
Larson Davis CAL200 Acoustic Calibrator	2018-07-24	2019-07-24	007027
Larson Davis Model 831	2019-02-22	2020-02-22	007182
PCB 377A13 1/2 inch Prepolarized Pressure Microphone	2019-03-06	2020-03-06	007185

Acoustic Calibration

Measured according to IEC 61672-3:2013 10 and ANSI S1.4-2014 Part 3: 10

Measurement	Test Result [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
1000 Hz	114.00	113.80	114.20	0.14	Pass

Acoustic Signal Tests, C-weighting

Measured according to IEC 61672-3:2013 12 and ANSI S1.4-2014 Part 3: 12 using a comparison coupler with Unit Under Test (UUT) and reference SLM using slow time-weighted sound level for compliance to IEC 61672-1:2013 5.5; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Expected [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
125	-0.15	-0.20	-1.20	0.80	0.23	Pass
1000	0.14	0.00	-0.70	0.70	0.23	Pass
8000	-3.57	-3.00	-5.50	-1.50	0.32	Pass

-- End of measurement results--

Self-generated Noise

Measured according to IEC 61672-3:2013 11.1 and ANSI S1.4-2014 Part 3: 11.1

Measurement	Test Result [dB]
A-weighted, 20 dB gain	40.14

-- End of measurement results--

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1681 West 820 North
Provo, UT 84601, United States
716-684-0001

-- End of Report--

Signatory: Ron Harris

LARSON DAVIS - A PCB PIEZOTRONICS DIV.
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

Cert. #3622.01

~ *Certificate of Calibration and Compliance* ~

Microphone Model: 377B02 Serial Number: 311704 Manufacturer: PCB

Calibration Environmental Conditions

Environmental test conditions as printed on microphone calibration chart.

Reference Equipment

Manufacturer	Model #	Serial #	PCB Control #	Cal Date	Due Date
National Instruments	PCIe-6351	1896F08	CA1918	10/19/18	10/18/19
Larson Davis	PRM915	132	CA1552	11/29/18	11/29/19
Larson Davis	PRM902	4407	CA1248	5/23/18	5/23/19
Larson Davis	PRM916	125	TA469	6/26/18	6/26/19
Larson Davis	CAL250	5026	CA1278	9/19/18	9/19/19
Larson Davis	2201	115	TA472	4/12/18	4/12/19
Bruel & Kjaer	4192	2764626	CA1636	8/15/18	8/15/19
Larson Davis	GPRM902	4163	CA1089	6/12/18	6/12/19
Newport	iTHX-SD/N	1080002	CA1511	2/8/19	2/7/20
Larson Davis	PRA951-4	234	CA1154	10/24/18	10/24/19
Larson Davis	PRM915	147	CA2179	6/8/18	6/7/19
PCB	68510-02	N/A	CA2672	12/21/18	12/20/19
0	0	0	0	not required	not required
0	0	0	0	not required	not required
0	0	0	0	not required	not required

Frequency sweep performed with B&K UA0033 electrostatic actuator.

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration of reference equipment is traceable to one or more of the following National Labs; NIST, PTB or DFM.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI/NCSL Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Open Circuit Sensitivity is measured using the insertion voltage method following procedure AT603-5.
6. Measurement uncertainty (95% confidence level with coverage factor of 2) for sensitivity is +/-0.20 dB.
7. Unit calibrated per ACS-20.

Technician: Leonard Lukasik

Date: February 25, 2019

CALIBRATION CERT #1862.01

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VIBRATION DIVISION
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ID:CAL112-3633941447.528+0

~ Calibration Report ~

Microphone Model: 377B02 Serial Number: 311704 Description: 1/2" Free-Field Microphone

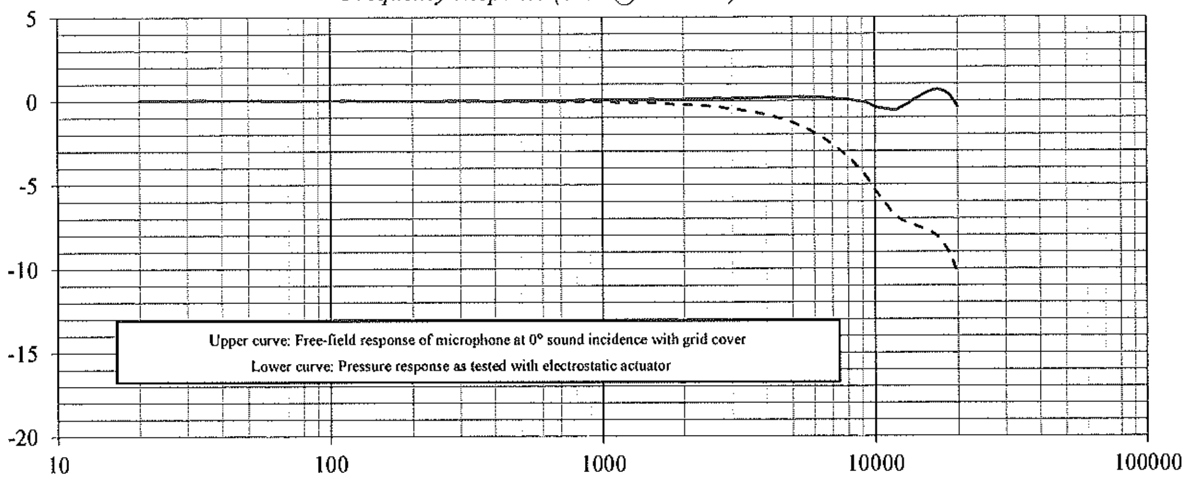
Calibration Data

Open Circuit Sensitivity @ 251.2 Hz: 51.54 mV/Pa
-25.76 dB re 1V/Pa

Polarization Voltage, External: 0 V
Capacitance: 12.4 pF

Temperature: 70 °F (21°C) Ambient Pressure: 982 mbar Relative Humidity: 26 %

Frequency Response (0 dB @ 251.2 Hz)



Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)
20.0	0.05	0.05	1679	-0.17	0.06	7499	-2.98	0.09	-	-	-
25.1	0.06	0.06	1778	-0.20	0.05	7943	-3.30	0.09	-	-	-
31.6	0.06	0.06	1884	-0.22	0.06	8414	-3.74	-0.01	-	-	-
39.8	0.05	0.05	1995	-0.23	0.08	8913	-4.17	-0.06	-	-	-
50.1	0.05	0.05	2114	-0.24	0.10	9441	-4.68	-0.16	-	-	-
63.1	0.04	0.04	2239	-0.28	0.09	10000	-5.31	-0.36	-	-	-
79.4	0.03	0.03	2371	-0.29	0.12	10593	-5.86	-0.46	-	-	-
100.0	0.03	0.03	2512	-0.34	0.12	11220	-6.39	-0.53	-	-	-
125.9	0.02	0.02	2661	-0.35	0.16	11885	-6.89	-0.57	-	-	-
158.5	0.01	0.01	2818	-0.43	0.13	12589	-7.14	-0.37	-	-	-
199.5	0.01	0.01	2985	-0.49	0.13	13335	-7.33	-0.14	-	-	-
251.2	0.00	0.00	3162	-0.53	0.15	14125	-7.47	0.13	-	-	-
316.2	0.00	0.01	3350	-0.60	0.14	14962	-7.62	0.35	-	-	-
398.1	-0.02	-0.02	3548	-0.67	0.15	15849	-7.80	0.55	-	-	-
501.2	-0.02	0.02	3758	-0.74	0.16	16788	-8.07	0.65	-	-	-
631.0	-0.04	0.00	3981	-0.82	0.18	17783	-8.55	0.56	-	-	-
794.3	-0.05	0.04	4217	-0.94	0.17	18837	-9.26	0.25	-	-	-
1000.0	-0.06	0.06	4467	-1.04	0.19	19953	-10.29	-0.36	-	-	-
1059.3	-0.07	0.06	4732	-1.17	0.20	-	-	-	-	-	-
1122.0	-0.09	0.05	5012	-1.30	0.23	-	-	-	-	-	-
1188.5	-0.09	0.06	5309	-1.49	0.21	-	-	-	-	-	-
1258.9	-0.11	0.05	5623	-1.67	0.21	-	-	-	-	-	-
1333.5	-0.13	0.05	5957	-1.87	0.20	-	-	-	-	-	-
1412.5	-0.12	0.07	6310	-2.09	0.20	-	-	-	-	-	-
1496.2	-0.12	0.08	6683	-2.37	0.15	-	-	-	-	-	-
1584.9	-0.14	0.07	7080	-2.66	0.12	-	-	-	-	-	-

Technician: Leonard Lukasik Date: February 25, 2019

CALIBRATION CERT #1862.01

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ID:CAL112-3633941447.528+0

Calibration Certificate

Certificate Number 2019004562

Customer:

SLR Consulting Canada
1185-10201 Southport Road SW
Calgary, AB T2W 4X9, Canada

Model Number	831C	***Procedure Number***	D0001.8384		
Serial Number	10762	***Technician***	Ron Harris		
Test Results	**Pass**	***Calibration Date***	15 Apr 2019		
Initial Condition	As Manufactured	***Calibration Due***			
Description	Larson Davis Model 831C Class 1 Sound Level Meter Firmware Revision: 03.3.0R3	***Temperature***	23.74	°C	± 0.25 °C
		Humidity	48.3	%RH	± 2.0 %RH
		Static Pressure	85.66	kPa	± 0.13 kPa

Evaluation Method ***Tested with:*** ***Data reported in dB re 20 μPa.***

Larson Davis PRM2103. S/N 001500
PCB 377B02. S/N 311704
Larson Davis CAL200. S/N 9079
Larson Davis CAL291. S/N 0108

Compliance Standards Compliant to Manufacturer Specifications and the following standards when combined with Calibration Certificate from procedure D0001.8378:

IEC 60651:2001 Type 1	ANSI S1.4-2014 Class 1
IEC 60804:2000 Type 1	ANSI S1.4 (R2006) Type 1
IEC 61260:2014 Class 1	ANSI S1.11-2014 Class 1
IEC 61672:2013 Class 1	ANSI S1.43 (R2007) Type 1

Issuing lab certifies that the instrument described above meets or exceeds all specifications as stated in the referenced procedure (unless otherwise noted). It has been calibrated using measurement standards traceable to the International System of Units (SI) through the National Institute of Standards and Technology (NIST), or other national measurement institutes, and meets the requirements of ISO/IEC 17025:2005.

Test points marked with a ‡ in the uncertainties column do not fall within this laboratory's scope of accreditation.

The quality system is registered to ISO 9001:2015.

This calibration is a direct comparison of the unit under test to the listed reference standards and did not involve any sampling plans to complete. No allowance has been made for the instability of the test device due to use, time, etc. Such allowances would be made by the customer as needed.

The uncertainties were computed in accordance with the ISO Guide to the Expression of Uncertainty in Measurement (GUM). A coverage factor of approximately 2 sigma (k=2) has been applied to the standard uncertainty to express the expanded uncertainty at approximately 95% confidence level.

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Correction data from Larson Davis SoundAdvisor Model 831C Reference Manual, I831C.01 Rev B, 2017-03-31

For 1/4" microphones, the Larson Davis ADP024 1/4" to 1/2" adaptor is used with the calibrators and the Larson Davis ADP043 1/4" to

1/2" adaptor is used with the preamplifier.

Calibration Check Frequency: 1000 Hz; Reference Sound Pressure Level: 114 dB re 20 µPa; Reference Range: 0 dB gain

Periodic tests were performed in accordance with precedures from IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part3.

No Pattern approval for IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 available.

The sound level meter submitted for testing successfully completed the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3, for the environmental conditions under which the tests were performed. However, no general statement or conclusion can be made about conformance of the sound level meter to the full specifications of IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 because (a) evidence was not publicly available, from an independent testing organization responsible for pattern approvals, to demonstrate that the model of sound level meter fully conformed to the class 1 specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1 or correction data for acoustical test of frequency weighting were not provided in the Instruction Manual and (b) because the periodic tests of IEC 61672-3:2013 / ANSI/ASA S1.4-2014/Part 3 cover only a limited subset of the specifications in IEC 61672-1:2013 / ANSI/ASA S1.4-2014/Part 1.

Standards Used

Description	Cal Date	Cal Due	Cal Standard
Larson Davis CAL291 Residual Intensity Calibrator	2018-09-19	2019-09-19	001250
SRS DS360 Ultra Low Distortion Generator	2018-06-21	2019-06-21	006311
Hart Scientific 2626-H Temperature Probe	2018-08-19	2019-08-19	006798
Larson Davis CAL200 Acoustic Calibrator	2018-07-24	2019-07-24	007027
Larson Davis Model 831	2019-02-22	2020-02-22	007182
PCB 377A13 1/2 inch Prepolarized Pressure Microphone	2019-03-06	2020-03-06	007185

Acoustic Calibration

Measured according to IEC 61672-3:2013 10 and ANSI S1.4-2014 Part 3: 10

Measurement	Test Result [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
1000 Hz	114.01	113.80	114.20	0.14	Pass

Acoustic Signal Tests, C-weighting

Measured according to IEC 61672-3:2013 12 and ANSI S1.4-2014 Part 3: 12 using a comparison coupler with Unit Under Test (UUT) and reference SLM using slow time-weighted sound level for compliance to IEC 61672-1:2013 5.5; ANSI S1.4-2014 Part 1: 5.5

Frequency [Hz]	Test Result [dB]	Expected [dB]	Lower Limit [dB]	Upper Limit [dB]	Expanded Uncertainty [dB]	Result
125	-0.17	-0.20	-1.20	0.80	0.23	Pass
1000	0.19	0.00	-0.70	0.70	0.23	Pass
8000	-3.17	-3.00	-5.50	-1.50	0.32	Pass

-- End of measurement results--

Self-generated Noise

Measured according to IEC 61672-3:2013 11.1 and ANSI S1.4-2014 Part 3: 11.1

Measurement	Test Result [dB]
A-weighted, 20 dB gain	40.21

-- End of measurement results--

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1681 West 820 North
Provo, UT 84601, United States
716-684-0001

-- End of Report--

Signatory: Ron Harris

LARSON DAVIS - A PCB PIEZOTRONICS DIV.
1681 West 820 North
Provo, UT 84601, United States
716-684-0001

~ Certificate of Calibration and Compliance ~

Microphone Model: 377B02 Serial Number: 311769 Manufacturer: PCB

Calibration Environmental Conditions

Environmental test conditions as printed on microphone calibration chart.

Reference Equipment

Manufacturer	Model #	Serial #	PCB Control #	Cal Date	Due Date
National Instruments	PCIe-6351	1896F08	CA1918	10/19/18	10/18/19
Larson Davis	PRM915	132	CA1552	11/29/18	11/29/19
Larson Davis	PRM902	4407	CA1248	5/23/18	5/23/19
Larson Davis	PRM916	125	TA469	6/26/18	6/26/19
Larson Davis	CAL250	5026	CA1278	9/19/18	9/19/19
Larson Davis	2201	115	TA472	4/12/18	4/12/19
Bruel & Kjaer	4192	2764626	CA1636	8/15/18	8/15/19
Larson Davis	GPRM902	4163	CA1089	6/12/18	6/12/19
Newport	iTHX-SD/N	1080002	CA1511	2/8/19	2/7/20
Larson Davis	PRA951-4	234	CA1154	10/24/18	10/24/19
Larson Davis	PRM915	147	CA2179	6/8/18	6/7/19
PCB	68510-02	N/A	CA2672	12/21/18	12/20/19
0	0	0	0	not required	not required
0	0	0	0	not required	not required
0	0	0	0	not required	not required

Frequency sweep performed with B&K UA0033 electrostatic actuator.

Condition of Unit

As Found: n/a

As Left: New Unit, In Tolerance

Notes

1. Calibration of reference equipment is traceable to one or more of the following National Labs; NIST, PTB or DFM.
2. This certificate shall not be reproduced, except in full, without written approval from PCB Piezotronics, Inc.
3. Calibration is performed in compliance with ISO 10012-1, ANSI/NCSL Z540.3 and ISO 17025.
4. See Manufacturer's Specification Sheet for a detailed listing of performance specifications.
5. Open Circuit Sensitivity is measured using the insertion voltage method following procedure AT603-5.
6. Measurement uncertainty (95% confidence level with coverage factor of 2) for sensitivity is +/-0.20 dB.
7. Unit calibrated per ACS-20.

Technician: Leonard Lukasik Date: February 25, 2019

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ID:CAL112-3633938519.147+0

~ Calibration Report ~

Microphone Model: 377B02 Serial Number: 311769 Description: 1/2" Free-Field Microphone

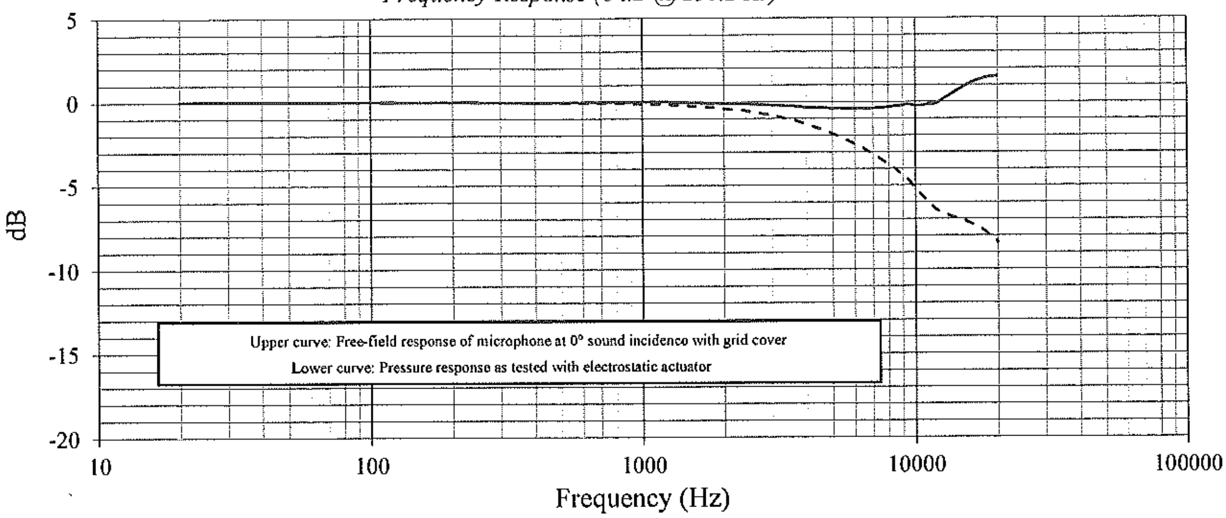
Calibration Data

Open Circuit Sensitivity @ 251.2 Hz: 51.15 mV/Pa
-25.82 dB re 1V/Pa

Polarization Voltage, External: 0 V
Capacitance: 14.3 pF

Temperature: 70 °F (21°C) Ambient Pressure: 981 mbar Relative Humidity: 26 %

Frequency Response (0 dB @ 251.2 Hz)



Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)	Freq (Hz)	Lower (dB)	Upper (dB)
20.0	0.04	0.04	1679	-0.29	-0.06	7499	-3.44	-0.37	-	-	-
25.1	0.04	0.04	1778	-0.33	-0.08	7943	-3.71	-0.32	-	-	-
31.6	0.04	0.04	1884	-0.34	-0.06	8414	-4.00	-0.27	-	-	-
39.8	0.05	0.05	1995	-0.40	-0.09	8913	-4.34	-0.23	-	-	-
50.1	0.04	0.04	2114	-0.45	-0.11	9441	-4.68	-0.16	-	-	-
63.1	0.04	0.04	2239	-0.47	-0.10	10000	-5.18	-0.23	-	-	-
79.4	0.04	0.04	2371	-0.50	-0.09	10593	-5.63	-0.23	-	-	-
100.0	0.02	0.02	2512	-0.59	-0.13	11220	-6.01	-0.15	-	-	-
125.9	0.02	0.02	2661	-0.66	-0.15	11885	-6.45	-0.13	-	-	-
158.5	0.01	0.01	2818	-0.73	-0.17	12589	-6.64	0.13	-	-	-
199.5	0.01	0.01	2985	-0.81	-0.19	13335	-6.82	0.37	-	-	-
251.2	0.00	0.00	3162	-0.88	-0.20	14125	-6.96	0.63	-	-	-
316.2	-0.01	0.00	3350	-0.99	-0.25	14962	-7.10	0.87	-	-	-
398.1	-0.02	-0.02	3548	-1.07	-0.25	15849	-7.26	1.09	-	-	-
501.2	-0.04	0.00	3758	-1.18	-0.28	16788	-7.46	1.26	-	-	-
631.0	-0.06	-0.02	3981	-1.34	-0.34	17783	-7.72	1.40	-	-	-
794.3	-0.07	0.02	4217	-1.47	-0.36	18837	-8.03	1.48	-	-	-
1000.0	-0.11	0.01	4467	-1.60	-0.37	19953	-8.40	1.53	-	-	-
1059.3	-0.12	0.01	4732	-1.74	-0.37	-	-	-	-	-	-
1122.0	-0.13	0.01	5012	-1.92	-0.39	-	-	-	-	-	-
1188.5	-0.14	0.01	5309	-2.09	-0.39	-	-	-	-	-	-
1258.9	-0.16	0.00	5623	-2.29	-0.41	-	-	-	-	-	-
1333.5	-0.20	-0.02	5957	-2.48	-0.41	-	-	-	-	-	-
1412.5	-0.21	-0.02	6310	-2.68	-0.39	-	-	-	-	-	-
1496.2	-0.25	-0.05	6683	-2.93	-0.41	-	-	-	-	-	-
1584.9	-0.26	-0.05	7080	-3.16	-0.38	-	-	-	-	-	-

Technician: Leonard Lukasik Date: February 25, 2019

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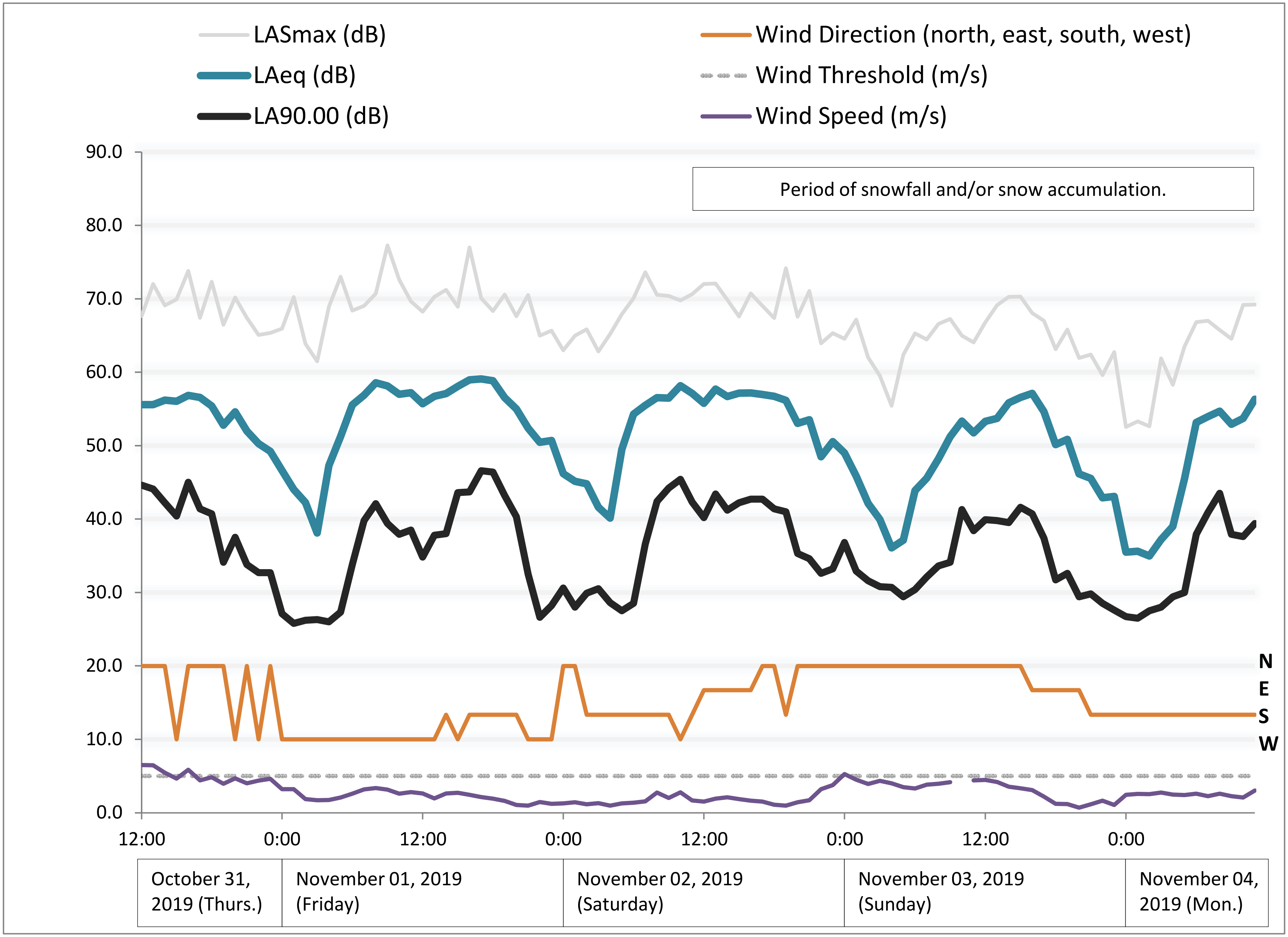
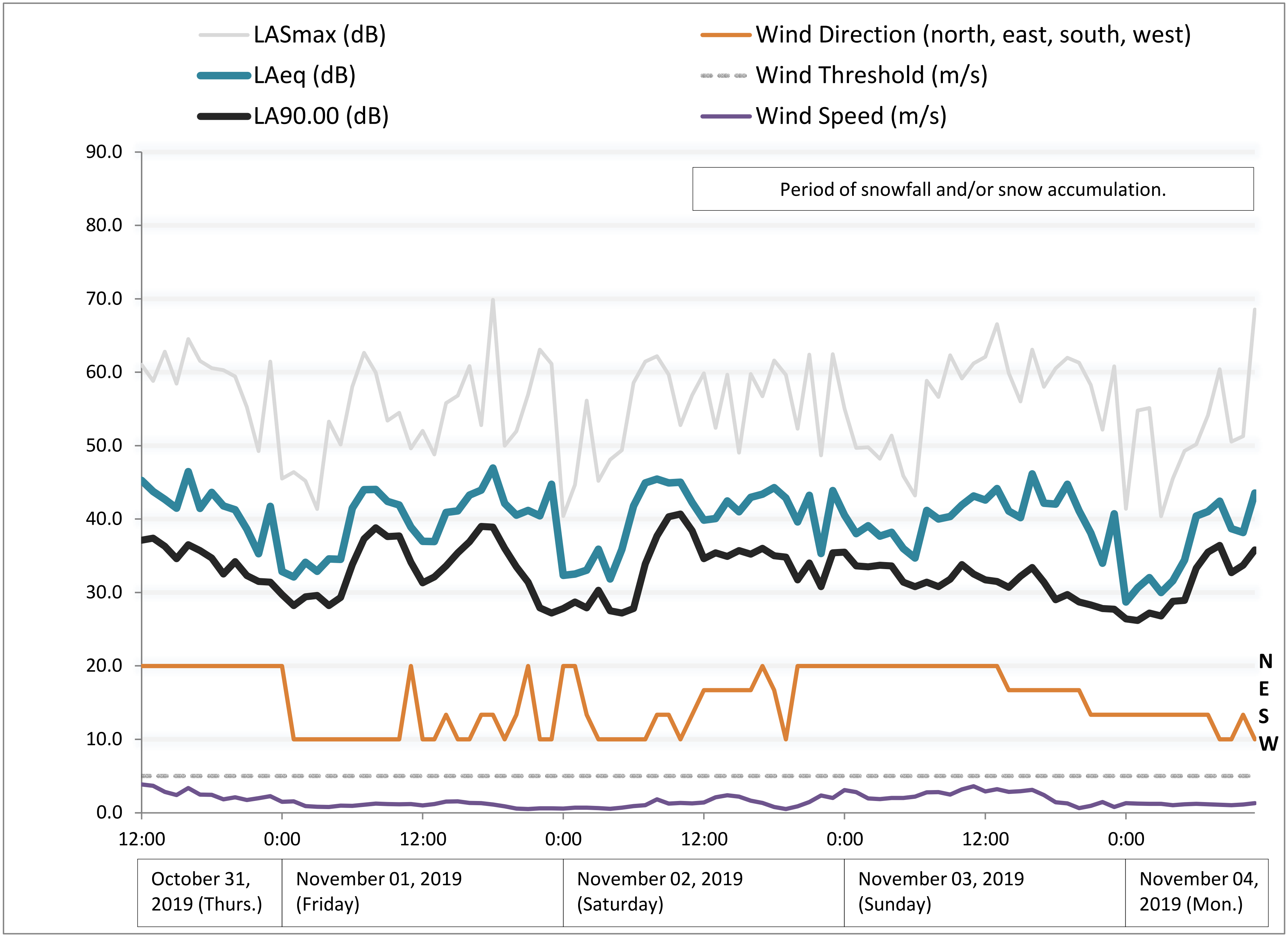
APPENDIX F
Measured Levels and Wind Data

Acoustic Assessment
Scott Property Project
SLR Project No.: 203.50179.00000

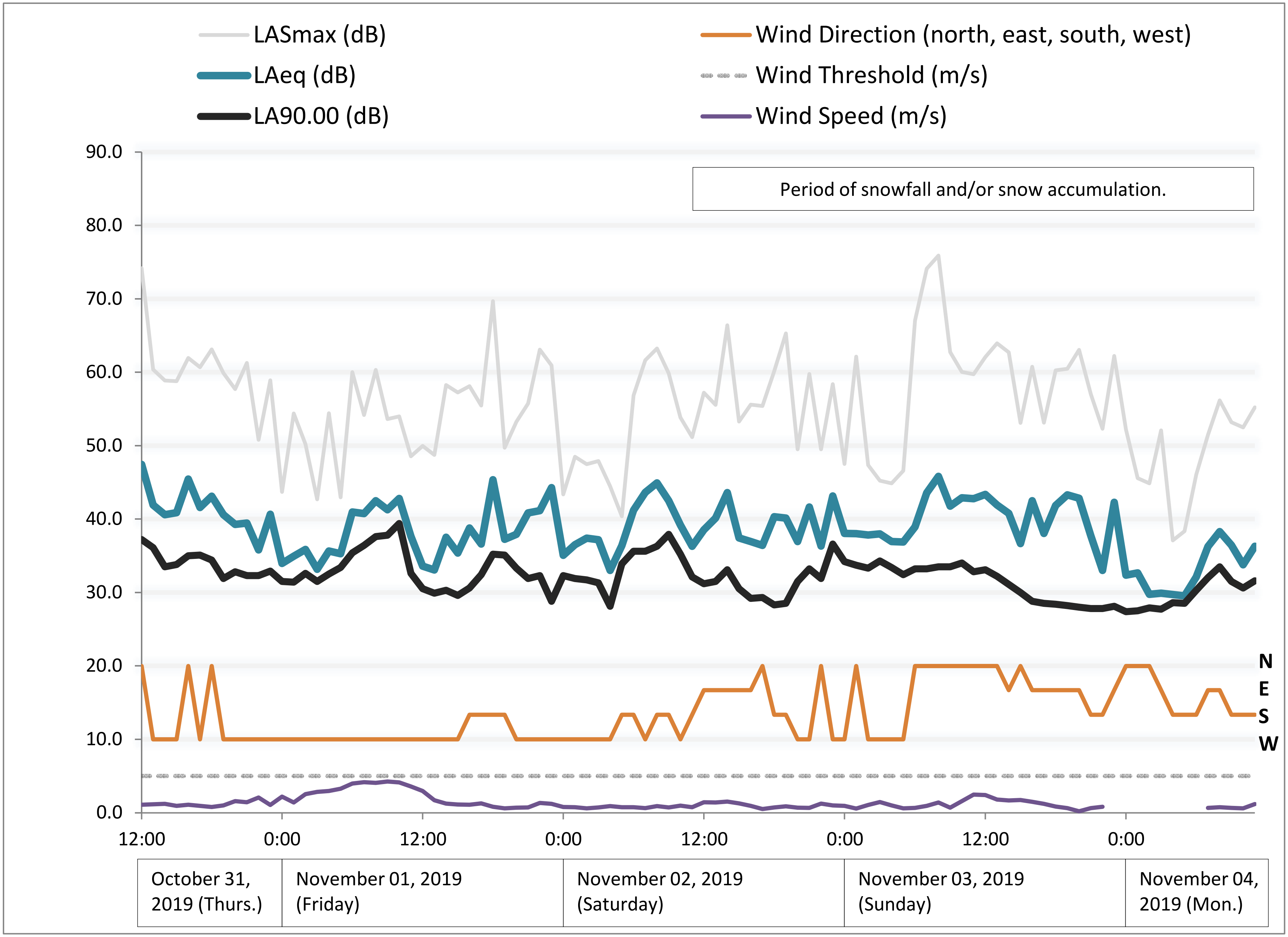
A1 - Measured Levels and Wind Data



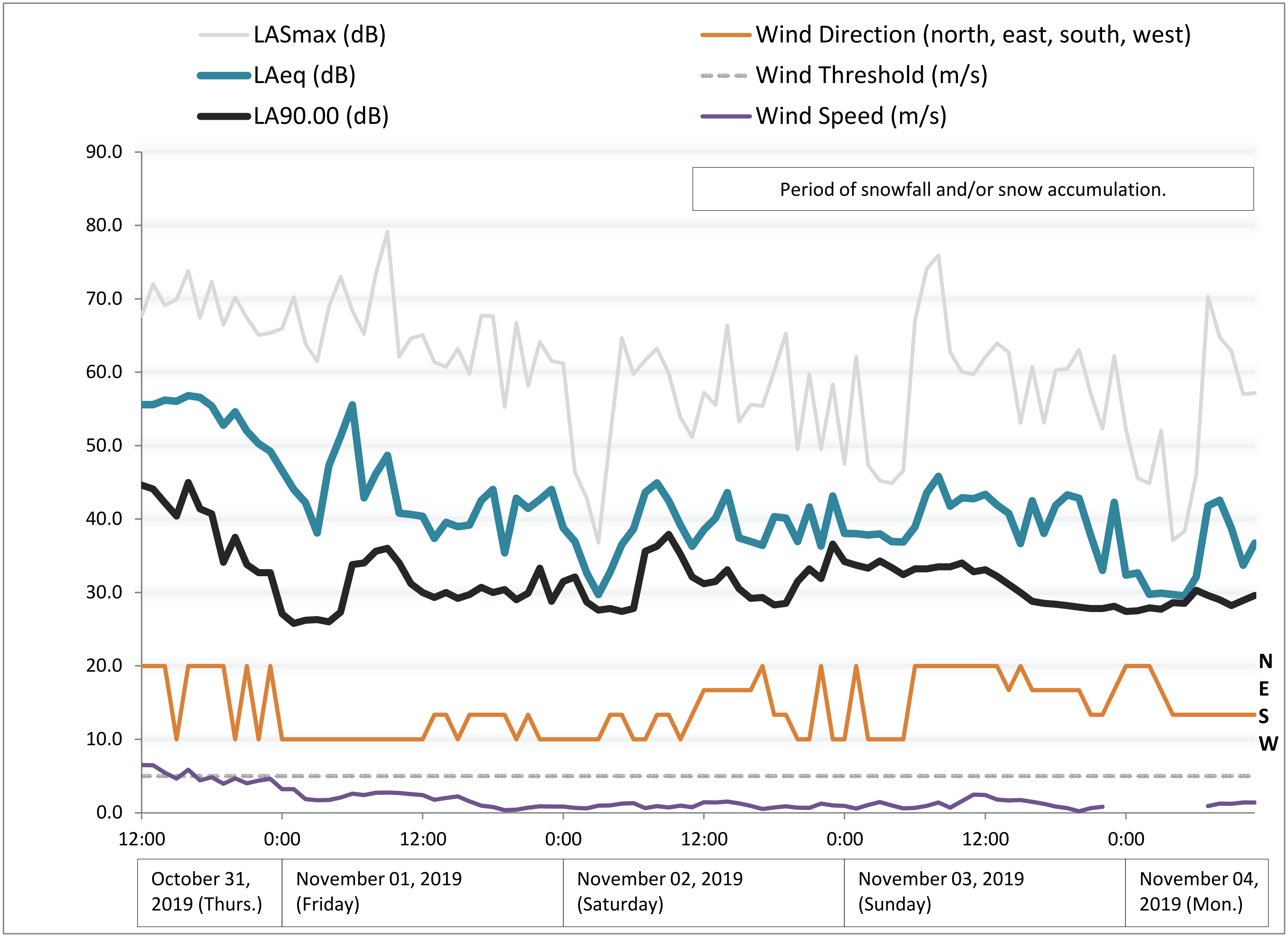
A2 - Measured Levels and Wind Data



A3 - Measured Levels and Wind Data



A4 - Measured Levels and Wind Data



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