ACOUSTIC ENVIRONMENT TECHNICAL REPORT FOR THE PROPOSED FORTISBC ENERGY INC. EAGLE MOUNTAIN – WOODFIBRE GAS PIPELINE PROJECT

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[redacted]

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EXECUTIVE SUMMARY

The Eagle Mountain – Woodfibre Gas Pipeline Project (the proposed Project) is a proposed natural gas pipeline from the area north of the Coquitlam Watershed, in Metro Vancouver, to Woodfibre, southwest of Squamish, British Columbia (BC). The proposed Project also includes the installation of additional compression capacity at existing stations located on Eagle Mountain (V1) in Coquitlam and Port Mellon north of Gibsons (V3), as well as a new proposed compressor station located in Squamish, BC (V2).

The Acoustic Environment Technical Report presents the potential interactions of the proposed Project with the Acoustic Environment. SNC-Lavalin Inc. (SNC-Lavalin) was contracted by TERA, a CH2M Hill Company, on behalf of FortisBC Energy (Vancouver Island) Inc. to evaluate the Acoustic Environment to support the Application for an Environmental Assessment Certificate for the proposed Project.

This study considered operational noise from compressor stations as the primary noise source from the proposed Project. The existing Acoustic Environment is characterized with field studies that measured existing sound levels (*i.e.*, background noise) at the proposed Squamish (V2), and existing Eagle Mountain (V1) and Port Mellon (V3) compressor station locations. Background measurements at Eagle Mountain and Port Mellon included sound levels with and without the existing compressors in operation. Noise models were developed for the new equipment at the Eagle Mountain compressor station as well as the Squamish compressor station. The Port Mellon compressor station (V3) was evaluated but not modelled because the new compressor being installed is expected to be quieter than the existing compressor and both compressors are not expected to operate simultaneously. Construction noise levels were also evaluated but not modelled because they are reversible and of relatively short duration.

The key findings of the Acoustic Environment Technical Report were as follows:

- the existing Acoustic Environment in the Acoustic Environment local study area (LSA) consists of vehicle traffic, industrial activities, creeks, rail lines, wildlife and the existing compressor stations;
- no reasonably foreseeable developments/activities were identified within the Acoustic Environment LSA or regional study area (RSA) that would act in combination with the proposed Project and cause adverse effects on the Acoustic Environment Valued Component (VC);
- the existing compressor station at Eagle Mountain (V1) does not substantially contribute to the ambient sound level (ASL) in the Acoustic Environment LSA;
- the existing compressor station at Port Mellon (V3) does not substantially contribute to the ASL in the Acoustic Environment LSA;
- construction-related noise is not expected to be substantial and should be managed using controls consistent with best practices;
- the permissible sound level at all dwellings within the Acoustic Environment LSA of the existing Eagle Mountain (V1) compressor station is 48 dBA at night;
- the permissible sound level at all dwellings within the Acoustic Environment LSA of the proposed Squamish (V2) compressor station is 48 dBA at night;
- the permissible sound level at all dwellings within the Acoustic Environment LSA of the existing Port Mellon (V3) compressor station is 40 dBA at night;
- the components proposed to be installed at the Eagle Mountain (V1B) compressor station with expected engineering measures are predicted to produce sound levels below the permissible sound level recommended by the BC Oil and Gas Commission (OGC) and the change in the calculated percentage of highly annoyed persons (%HA) at the receptors does not exceed Health Canada (HC) guidelines;

- the components proposed to be installed at the Squamish (V2) compressor station with expected engineering measures are predicted to produce sound levels below the permissible sound level recommended by the BC OGC and the change in the calculated %HA at the receptors does not exceed Health Canada guidelines; and

- the components proposed to be installed at the Port Mellon (V3) compressor station are expected to produce lower sound levels than the existing compressor unit.

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DEFINITIONS AND ACRONYM LIST

Definition/ Acronym	Full Name
%	Percentage
Application	Environmental Assessment Certificate Application
ASL	Ambient sound level
BC	British Columbia
BC OGC	BC Oil and Gas Commission
BSL	Basic sound level
CSA	Canadian Standards Association
dB	Decibels
dBA	dB A-weighted or decibels measured using the A sound filter that measures mid frequencies most effectively
dBC	dB C-weighted or decibels measured using the C sound filter that measures more high frequency sounds
EAC	Environmental Assessment Certificate – A legally binding certificate issued by ministers to a proponent that sets out project details, conditions, commitments and may include periodic reporting requirements. A certificate is typically valid for 5 years from the date it is issued by the ministers
EC	Environment Canada
FEI	FortisBC Energy Inc.
Guideline	BC OGC Noise Control Best Practices Guideline
HA	Highly annoyed persons
ISO	International Standards Organization
KI	Key indicator
LAeq	Equivalent sound pressure level over a time period using the A sound filter
LAF90	Sound pressure level using the A sound filter that is equalled or exceeded 90% of the measurement period
Ld	Equivalent sound pressure level measured between 0700 and 2200
LD	Larson and Davis
Ldn	Adjusted equivalent sound pressure level for day-night period
Leq	Equivalent sound pressure level averaged over time
Lex	Equivalent sound pressure level average over an eight hour work day
Lmax	Maximum sound pressure level over a time period
Ln	Equivalent sound pressure level measured between 2200 and 0700
LNG	Liquefied natural gas
Lp	Sound pressure level
LSA	Local study area
Lw	Sound power level
MMBTU	Million British thermal units
NIA	Noise impact assessment
NPS	Nominal pipe size
OGC	Oil and Gas Commission
OHSR-WCA	Occupational Health and Safety Regulations of the Workers Compensation Act
Proposed Project	Eagle Mountain – Woodfibre Gas Pipeline Project
PSL	Permissible sound level
RSA	Regional study area
SCADA	Supervisory control and data acquisition
SNC-Lavalin	SNC-Lavalin Inc.
SLM	Sound level meter
TK	Traditional Knowledge
TLU	Traditional Land Use

TL	Transmission loss
UTM	Universal Transverse Mercator
V1	Eagle Mountain compressor station
V1B	Proposed new compressor capacity at Eagle Mountain compressor station
V2	Proposed Squamish compressor station
V3	Port Mellon compressor station
VC	Valued component

1.0 INTRODUCTION

This Acoustic Environment Technical Report supports the application for an Environmental Assessment Certificate (EAC) (the Application) for the Atmospheric Environment Effects Assessment in terms of the Acoustic Environment Valued Component (VC). Specifically, this information supports Volume 1, Part B, Section 5.0 of the Application for the Eagle Mountain – Woodfibre Gas Pipeline Project (the proposed Project) which summarizes the information contained here, and relies on it to determine the level of potential adverse effects, residual adverse effects and cumulative adverse effects of the proposed Project on the Acoustic Environment.

1.1 Project Description

The proposed Project is a proposed natural gas pipeline from the area north of the Coquitlam Watershed, in Metro Vancouver, to Woodfibre, southwest of Squamish, British Columbia (BC). The proposed Project also includes the installation of additional compression capacity at existing compressor stations located at Eagle Mountain in Coquitlam and Port Mellon north of Gibsons, as well as construction of a new compressor station located in Squamish, BC.

The proposed Project will transport natural gas to a proposed liquefied natural gas (LNG) facility to be constructed and operated by Woodfibre LNG Limited southwest of Squamish, BC. It will generally parallel the existing FortisBC Energy Inc. (FEI) pipeline, which is part of the natural gas transmission system that services Squamish, Whistler, the Sunshine Coast and Vancouver Island. The proposed Project will increase the capacity of the transmission system in order to meet the requirements of the proposed LNG facility.

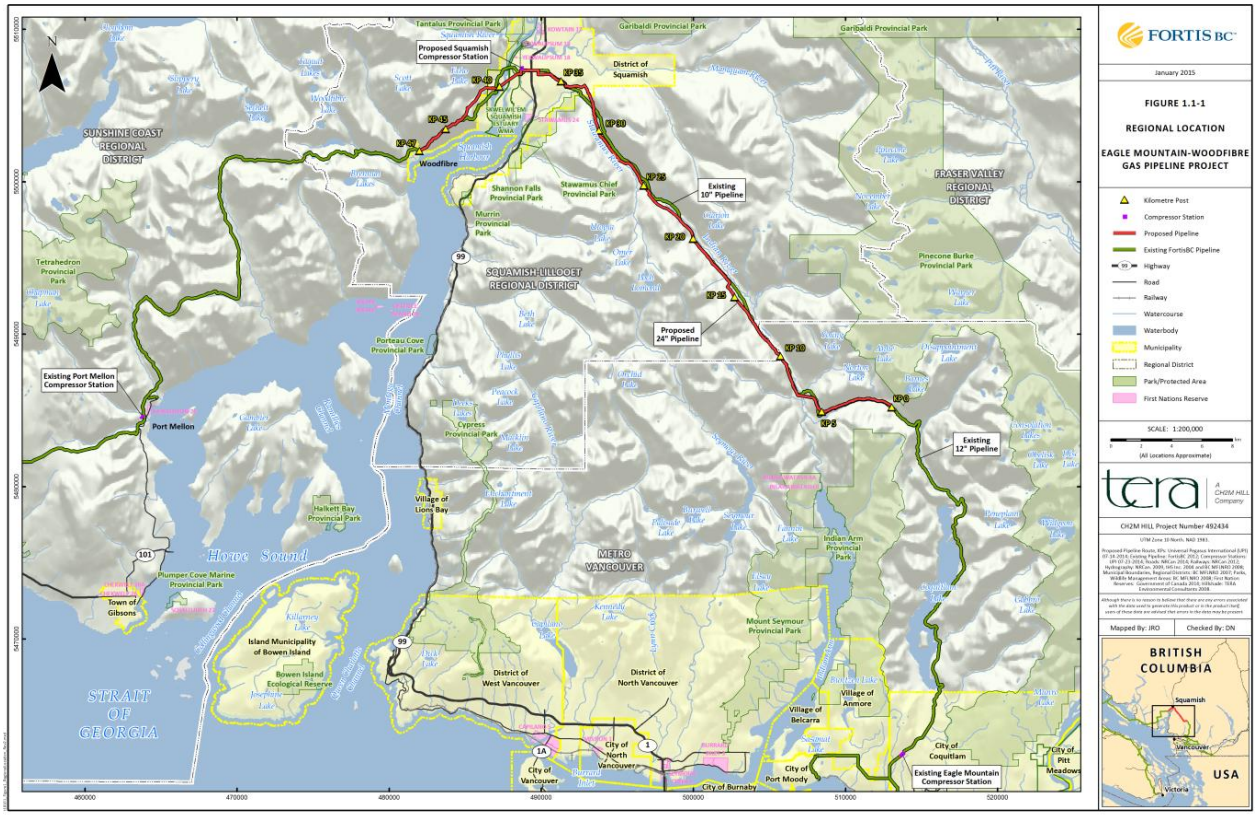
The proposed pipeline will be approximately 47 km long and 24 inches in diameter (NPS 24) and will be buried for most of the length, except where aerial crossings may be used. Temporary workspaces will be required for access road, stockpile sites and contractor yards. Barge landings are required at the existing Woodfibre and Indian Arm sites, as well as two new access points on the Squamish River. A custody transfer station will be required adjacent to the proposed LNG export facility delivery point at Woodfibre, BC. Other proposed Project components include: an electrical substation and electrical transmission lines at the existing Eagle Mountain and proposed Squamish compressor stations; mainline block valves, located at compressor stations and at other locations along the route; a Supervisory Control and Data Acquisition system; in-line inspection facilities; and cathodic protection. No worker construction camps are anticipated.

FortisBC is applying for an EAC under the BC *Environmental Assessment Act* for the proposed Project. FortisBC will also be seeking permits from the BC Oil and Gas Commission (BC OGC) to construct and operate the proposed Project pursuant to the BC *Oil and Gas Activities Act*.

The proposed facility (compressor) upgrades and developments will include the following:

- Eagle Mountain (V1) – two new electric motor drive compressor units of 20,500 hp capacity to be denoted as V1B to distinguish the new compressor units from existing compressor units;
- Squamish (V2) – two new electric motor drive compressor units of 16,600 hp capacity (one primary and one backup); and
- Port Mellon (V3) – one new gas turbine drive compressor unit of 6,130 hp capacity (to be used during low load periods for increased efficiency).

Figure 1.1-1 Regional location of the proposed Project.



1.2 Objectives

The objectives of this study are to:

- summarize existing regulatory standards and objectives related to noise that apply to the proposed Project;
- characterize the existing Acoustic Environment within the Acoustic Environment local study area (LSA) and Acoustic Environment regional study area (RSA);
- describe the noise related to the proposed Project construction, operation and decommissioning or abandonment;
- model the distribution and levels of noise emanating from the proposed Project's operations; and
- compare the proposed Project's sound level contributions with existing sources, background sound levels and regulatory standards and objectives.

The results of this study do not identify residual environmental or socio-economic effects nor provide conclusions regarding significance. Volume 1, Part B, Section 5.0 provides potential effects, mitigation and significance conclusions.

1.3 Regulatory Standards and Objectives

This section provides information on the regulatory standards and objectives at the federal, provincial and local level as they relate to the Acoustic Environment.

1.3.1 Federal Standards

1.3.1.1 Health Canada's Useful Information for Environmental Assessments

Although not a regulation, Health Canada's *2010 Useful Information for Environmental Assessments* provides guidance for conducting environmental assessments. Health Canada does not have any enforceable noise guidelines or thresholds, so it draws on various internationally recognised acoustic standards in reference to noise assessments and makes the following recommendations:

- sensitive noise receptors (i.e., residences, schools, etc.) and areas with a "reasonable expectation of peace and quiet" should be identified and mapped in reference to the proposed facility;
- existing or baseline sound levels at receptors should be determined for both daytime and night-time and included on the map of receptors;
- all potential noise sources during construction, operation, and decommissioning or abandonment, as well as any tonal, low frequency, impulsive or highly impulsive noise sources should be identified and their associated sound levels estimated;
- the noise levels anticipated at receptor locations during operation should be predicted and compared with baseline levels during daytime and night-time, and if warranted, also predicted following the application of mitigation measures;
- the severity of any predicted changes in noise levels should be evaluated and where health effects are predicted, mitigation measures should be employed, as well as community consultation programs;
- plans for noise management and complaint resolution should be prepared as required; and
- the expected duration and frequency of noise due to construction and any other non-continuous activities should be determined for guidance on whether activities can be considered short-term with regards to complaint levels.

For event durations of greater than one year, such as operational noise, where predicted noise levels are in the range of 45 dB to 75 dB, Health Canada advises the evaluation of health impact endpoints based on the percentage of those likely to become highly annoyed. Health Canada also proposes mitigation when that percentage changes by more than 6.5% or when the combination of baseline and predicted noise levels exceed 75 dB.

1.3.2 Provincial Standards in British Columbia

1.3.2.1 British Columbia Oil and Gas Commission Noise Control Best Practices Guideline

The BC OGC sets Permissible Sound Levels (PSLs) for activities under its jurisdiction. The 2009 BC OGC Noise Control Best Practices Guideline (Guideline) sets PSLs during operation, but does not set limits for temporary or construction noise. BC OGC (2009) provides the following recommendations the for temporary or construction noise: restricting these activities to daytime hours (0700 - 2200); ensuring all equipment is fitted with appropriate muffler systems; taking advantage of existing physical barriers and screening; advising residents of noise events; and, using scheduling to limit disruption.

BC OGC (2009) requires Noise Impact Assessments (NIAs) to demonstrate that facilities meet the requirements. In addition to calculating the PSL, operators are required to identify all facility noise sources and their sound pressure levels; and, to estimate the noise levels received at the nearest or most likely affected dwelling using a noise model. Noise levels at dwellings are compared with the calculated PSL to determine compliance with the Guideline. All assumptions and methodology used in the modelling of noise and PSL estimates must also be presented in the NIA.

The default PSL is 40 dBA at night at the nearest dwelling to the facility. If the ambient sound level (ASL) around the facility is above 40 dBA at night, an adjusted PSL can be calculated. The adjusted PSL is defined as a sum of:

- the Basic Sound Level (BSL), determined by both the density of dwellings and distance to transportation sources (*i.e.,* roadways, airports or rail lines);
- the daytime adjustment, accounts for sound levels commonly being higher in the daytime;
- a Class A adjustment, a seasonal or background level adjustment if summertime BSLs are not appropriate due to seasonal or other background noise (non-industry) conditions; and,
- a Class B) adjustment for temporary noise sources.

The PSLs are derived for the closest dwellings within 1.5 km of a facility's fence line. A base value is determined which includes adjustments intended to more accurately reflect specific aspects of the proposed Project and the environment. The PSL at a dwelling is determined by:

PSL	=	BSL	+	Daytime Adjustment	+	Class A Adjustments	+	Class B Adjustments

The minimum BSL in the Guideline is 40 dBA Leq; dBA is decibels measured using the A sound filter that measures mid-frequencies most effectively similar to the human ear at levels typical of rural background, and Leq is the equivalent steady sound level of noise averaged over time. The BSL is adjusted for proximity to transportation noise sources and for higher population density. The BSLs for night-time are presented in Table 1.3-1.The BC OGC Guideline defines dwelling density per quarter section of land, which corresponds to one-fourth of a square mile, or approximately 0.65 km^2. The daytime adjustment is 10 dBA above the night-time level. The Class A adjustments account for seasonal conditions and the actual (measured) ASL in the area. The Class B adjustments are for temporary noise generating activities. This adjustment is 0 dBA if the duration of the activity is more than 60 days.

TABLE 1.3-1
BASIC SOUND LEVELS FOR NIGHT-TIME

	Dwelling unit density per quarter section of land		
Proximity to transportation	**1 - 8 dwellings; 22:00 - 07:00 (nighttime) (dBA Leq)**	**9 - 160 dwellings; 22:00 - 07:00 (nighttime) (dBA Leq)**	**>160 dwellings; 22:00 - 07:00 (nighttime) (dBA Leq)**
Category 1	40	43	46
Category 2	45	48	51
Category 3	50	53	56

*Notes:
- The average rural ambient noise level is 5 dBA less than the BSL.
- Category 1—dwelling units more than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers.
- Category 2—dwelling units more than 30 m but less than 500 m from heavily travelled roads and/or rail lines and not subject to frequent aircraft flyovers.
- Category 3—dwelling units less than 30 m from heavily travelled roads and/or rail lines and/or subject to frequent aircraft flyovers.
- Density per quarter section—refers to a quarter section with the affected dwelling at the centre (a 451 m radius). For quarter sections with various land uses or with mixed densities, the density chosen is then averaged for the area under consideration.
- See Appendix 1 for more definitions.

* Source: BC OGC Guideline (March 2009).

1.3.2.2 Worker's Compensation Act, Occupational Health and Safety Regulations (BC Reg 296/97 as Amended) [B.C. Reg. 382/2004, s.1]

Section 7.2 of the Occupational Health and Safety Regulations of the *Workers Compensation Act* (OHSR-WCA) sets the maximum daily noise exposure level of workers at 85 dBC Lex and the maximum peak sound level is set to 140 dBC. Lex represents the noise exposure level averaged over an eight hour work day, and dBC is decibels measured using a C filter weighting that is more sensitive to sounds at low frequencies. T. According to Section 7.3 of the OHSR-WCA, if a worker may be exposed to noise levels exceeding 82 dBC Lex employers must monitor those noise levels according to standards of the Canadian Standards Association (CSA). If noise exceeds either daily or peak noise standards an employer must establish a noise control and hearing conservation program and adopt other measures as described in Sections 7.5 through 7.8 of the OSHR-WCA such as engineered noise control and noise hazard signage. Noise calculation methods are provided in the Basic Noise Calculations (WorkSafe BC 2007).

1.3.3 Local and Regional Standards

This subsection provides information on the local and regional standards for the City of Coquitlam, the District of Squamish, the Squamish-Lillooet Regional District and the Sunshine Coast Regional District, as they relate to the Acoustic Environment.

1.3.3.1 *City of Coquitlam Noise Regulation No. 1233, 1982*

This bylaw states that no one is allowed to create a level of noise that may disturb others. Construction is limited to the hours of 0700 – 2200, and no one can drive piles into the ground before 0900 hours or after 1700 hours on a Saturday. Construction that causes any sound disturbance is not permitted at any time on Sundays. When it is considered impossible or impractical to comply with these bylaw provisions, an exception may be granted by the city council or by the General Manager of Engineering and Public Works.

1.3.3.2 *District of Squamish Noise Regulation Bylaw No. 2312, 2014*

On March 18, 2014 the District of Squamish Noise Regulation Bylaw No. 2312, 2014 was adopted and the previous noise bylaw, District of Squamish Noise Regulation Bylaw No. 1901, 2005, was repealed. This new bylaw makes it an offence for construction noise to be made from construction activity during the following hours:

- before 0700 or after 2100 on any day other than Saturday, Sunday or a statutory holiday; or;
- before 0800 or after 1900 on Saturdays, Sundays or statutory holidays.

Construction noise means any noise, sound or vibration made on or associated with a construction site including one's own property:

- in carrying on work in connection with the construction, reconstruction, alteration, repair or demolition of any building structure or thing;
- in carrying on any excavation, filling or other operation; or
- in moving, or operating any machine, engine or equipment.

A Temporary Noise Exemption Permit may be obtained for construction activities that are exceptionally noisy or for construction activity that must extend beyond the allowable hours because of exigent circumstances (District of Squamish 2014)

1.3.3.3 Squamish-Lillooet Regional District, Electoral Area D Noise Regulation Bylaw No.1234, 2011

This bylaw states that no individual or owner of real property is allowed to make noise that disturbs the quiet, peace, rest, enjoyment, comfort or convenience of individuals or the public. Noise from the

operation of machinery or equipment and noise made during construction activities is prohibited before 0700 and after 2100 on days that are not holidays, and before 0900 and after 1800 on any holiday.

1.3.3.4 *Sunshine Coast Regional District, Noise Control Bylaw No. 597, 2008*

This bylaw states that no person shall cause, permit or allow to be caused any noise which disturbs the quiet, peace, rest, enjoyment, comfort, or convenience of any person or persons in the neighbourhood or vicinity. No individual or owner of real property is allowed to make noise that disturbs the quiet, peace, rest, enjoyment, comfort or convenience of individuals or the public. Noise from the operation of machinery or equipment and noise made during construction activities is prohibited between the hours of 2200 and 0700 on weekdays, and between the hours of 2200 and 0800 on weekends and holidays.

1.4 Goal of the Report

The goal of this study is to evaluate the proposed Project's interactions with the Acoustic Environment, following regulatory standards and objectives (Section 1.3).

1.5 Acoustic Environment Program Team

The Acoustic Environment Technical Report was prepared by SNC-Lavalin Inc. (SNC-Lavalin) with direction of TERA, a CH2M HILL Company. The SNC-Lavalin team that carried out the technical work are listed below with their affiliations.

Mr. John Lindner, M.Sc., led the acoustic team. He is a Project Scientist in the Acoustics, Air and Climate Change group at SNC-Lavalin Inc. in Vancouver, BC. Mr. Lindner joined SNC-Lavalin in 2011 and has worked on greenhouse gas projects, emissions inventories, environmental assessments, and various ambient air quality and noise field measurements. His acoustics experience includes monitoring and modelling for pipelines, terminals and mines. Mr. Lindner has managed two recent policy studies, one for the BC Climate Action Secretariat and one for Metro Vancouver. Mr. Lindner has also worked on emission inventory projects for Port Metro Vancouver, Environment Canada, Transport Canada and the Province of Newfoundland, collecting data from tenants and developing database models.

Mr. Roger Ord, MBA, P.Eng. is SNC-Lavalin's Director of Acoustics, Air and Climate Change services for Western Canada located in Victoria, BC. Mr. Ord delivers specialized consulting services in Greenhouse Gas and Climate Change Adaptation Management as well as Air Quality Regulatory Engagement. He uses his more than 25 years of experience in the regulatory, oil and gas, energy, mining and waste sectors to provide practical approaches to environmental problems and opportunities. Mr. Ord is a professional engineer in both Alberta and BC, holds a Master of Business Administration from the University of Victoria and is an Environment Canada and CSA-recognized GHG verifier.

Mr. Chamberland is an engineer with more than 25 years of experience in noise and vibration. His expertise is oriented toward the realization of studies in the fields of environment, industry, transportation, building and construction. He gains his experience at all levels of studies such as field survey, analysis, simulation, impact assessment, recommendation and specification of mitigation measures, feasibility and cost evaluation, follow-up. He has developed a particular expertise in the impact assessment of industrial and transportation projects as the person in charge of noise control during the engineering phase of large projects and in vibration analysis.

Mr. Mike Collicutt, B.Sc., M.A., is an acoustics and noise control consultant with experience in the area of environmental noise and acoustics. He obtained his B.Sc. in physics at McMaster University in Hamilton, Ontario, in 2007, and a M.A. in Music Technology from McGill University in 2011. Since joining SNC-Lavalin Inc., he has been gaining experience in the acoustics and vibrations fields by being involved in various projects. He has experience in carrying out field surveys and measurements, analyzing measurement data, performing simulations using specialized software, determining conformity with respect to applicable regulations, and developing recommendations for noise mitigation measures when required.

1.6 Traditional Land Use

Traditional Land Use (TLU) information was not available at the time of writing to inform the acoustic assessment. Refer to Volume 1, Part C – Aboriginal Groups Information Requirements for information on TLU.

2.0 EXISTING CONDITIONS AND LITERATURE REVIEW

This section summarizes existing literature on the acoustic environment in the proposed Project area.

2.1 Existing Conditions at Compressor Stations

The proposed Project is a natural gas pipeline from the area north of the Coquitlam Watershed, in Metro Vancouver, to Woodfibre, southwest of Squamish, BC. The proposed Project also includes the installation of additional compression at existing compressor stations located at Eagle Mountain in Coquitlam (V1) and Port Mellon (V3) north of Gibsons, as well as construction of a new compressor station (V2) located in Squamish, BC. Brief summaries of the existing Acoustic Environments around the three compressors are provided in Table 2.1-1 below. According to FortisBC, no residential complaints have been received about noise at the V1 or V3 compressor stations. There are currently no compressors at V2.

TABLE 2.1-1

ACOUSTIC ENVIRONMENT AROUND THREE PROPOSED COMPRESSOR SITES

Proposed compressor site	Sounds in existing Acoustic Environment
Eagle Mountain (V1)	Vehicle traffic, wildlife noises, golf course sounds, airplane flyovers, existing compressor station (turbines, compressors, cooling fans, etc.), and periodic impulse sounds from industrial electrical breakers at BC Hydro substation
Squamish (V2)	Rail yard, industrial noise, vehicle traffic, wildlife noise
Port Mellon (V3)	McNair Creek, vehicle traffic, wildlife noise, compressor station, industrial noise

Volume 1, Part B, Section 3.9.1.1 lists the existing projects and activities that might lead to human-caused changes in the environment of the proposed Project. Many previous activities and developments have altered the existing conditions in the Acoustic Environment LSA around the existing or proposed compressor stations at Eagle Mountain (V1), Squamish (V2) and Port Mellon (V3). Urban and rural residential development, as well as transportation, have increased the ambient sound levels (ASLs) of the Acoustic Environment LSA over the last century, mostly due to increased vehicle traffic, construction and assorted building noises (fans, heat pumps, etc.). Forestry and utility activities have also increased the ASLs of the Acoustic Environment LSA over the last century, with different changes based on location. For example, forestry-related operations near the existing Port Mellon compressor station (V3) have increased the sound levels of the Acoustic Environment LSA around Port Mellon. Similarly, the BC Hydro sub-station near the existing Eagle Mountain compressor station (V1) has increased the ASL of the area over the past century. Agriculture, mining, and oil and gas development are not conducted in the Acoustic Environment LSA of the compressor stations so did not affect the ASL.

A list of reasonably foreseeable developments/activities were identified from the BC Environmental Assessment Office website and reviewed for their potential impact on the Acoustic Environment LSA and RSA; none of the developments/activities identified would act in combination with the proposed Project and cause adverse effects on the Acoustic Environment Valued Component (VC).

2.2 Literature Sources

Noise studies in the proposed Project Acoustic Environment LSA/RSA for the existing FortisBC pipeline are limited. However, there was a noise survey conducted at the Eagle Mountain (V1) compressor station in November 2013 (Matrix Projects Limited 2013). Sound levels were measured with a Larson & Davis LXT unit and were presented as a 5-min Leq. Compressor #1 was operating during the readings. Measured values were between 55 dBA (at the entrance gate) and 66 dBA (in front of compressor building).

3.0 CONSULTATION

Table 3.0-1 provides information on the summary of consultation activities related to the Acoustic Environment. Limited consultation was required for this study because the regulatory guidelines and objectives are clearly defined and most of the technical work was desktop work.

TABLE 3.0-1

SUMMARY OF CONSULTATION ACTIVITIES RELATED TO THE ACOUSTIC ENVIRONMENT

Stakeholder Group/Agency Name	Name and Title of Contact	Method of Contact	Date of Consultation Activity	Reason For Consultation	Issues/Concerns	Commitments/ Follow-Up Actions/ Comments
PROVINCIAL AGENCY CONSULTATION						
Oil and Gas Commission	James Gladysz, James Nazareth	email, telephone	October 1 to 7, 2014	Confirmation that PSL can be adjusted if night time ASL is above 40 dBA.	n/a	n/a
LOCAL/REGIONAL CONSULTATION						
District of Squamish	Ron Vickerson, Engineering Technician	email	May 21 to 23, 2014	Arranging work permit to conduct noise monitoring on municipal property.	n/a	n/a
Metro Vancouver	Kathy Preston, Daryl Wakeland	meeting	August 2014	Discussion around electric vs. gas motor drive options.	n/a	n/a
Metro Vancouver	Kathy Preston, Daryl Wakeland	meeting	September 11, 2014	Apprised MV that the proposed Project will be using electric motor drives. MV's interest was reduced.	n/a	Potential for minor administrative changes to permit

4.0 METHODS

This section provides information on the study methodology, including proposed Project interactions, selection of VCs and key indicators (KIs), study area boundaries, pre-field work, field data collection, construction equipment noise levels, acoustic modelling and data limitations.

4.1 Project Interactions

Increased sound levels can potentially impact nearby residents, particularly during the night when people are sleeping. The proposed Project is most likely to generate noise during the construction and operation phases. Specific noise sources during construction will include equipment and vehicles moving around the Project Footprint, as well as increased vehicle traffic on nearby roads. Operational noise is primarily from the compressor stations. Noise during the decommissioning (or abandonment) phase is expected to be similar to or less than the construction phase and is thus considered during the construction noise discussions.

4.2 Selection of Valued Components and Key Indicators

The Acoustic Environment has been selected as a VC because activities of the proposed Project will generate noise that has the potential to affect the health and well-being of humans and wildlife. The KI identified for this VC is sound levels. Table 4.2-1 provides information on the KIs, rationale and measureable parameters for the Acoustic Environment VC.

TABLE 4.2-1

KEY INDICATORS, RATIONALE AND MEASURABLE PARAMETERS FOR ACOUSTIC ENVIRONMENT VALUED COMPONENT

VC	KI	Rationale	Measureable Parameter
Acoustic Environment	Sound levels	**Rationale** Acoustic environment was selected as a VC to capture potential Proposed Project effects related to noise. Sound levels were identified as a key indicator to facilitate the analysis of the proposed Projects interaction with the Acoustic Environment. **Construction** • Construction-related increased sound levels **Operation** • Increased sound levels at compressor station sites	Sound levels

4.3 Spatial Boundaries for Acoustic Environment

Various study area scales were developed for the purpose of assessing impacts on the Acoustic Environment. Study area boundaries are important to define the amount of information to be relied upon in effects assessments and in characterizing the zone of influence related to specific proposed Project activities or related environmental effects.

4.3.1 Project Footprint

The Project Footprint is the land area directly disturbed by the proposed Project construction and clean-up activities, including associated physical works and activities (*e.g.*, permanent right-of-way, temporary construction camps and temporary workspaces for construction). The Project Footprint represents the area from which sound may be emitted and was used to define the Acoustic Environment LSA and RSA.

4.3.2 Local Study Area

The Acoustic Environment LSA is an area extending 1.5 km from the Project Footprint in each direction. This distance is the maximum potential extent from a facility fence line where permissible sound levels must be met, according to the BC OGC Guideline.

4.3.3 Regional Study Area

The Acoustic Environment RSA is an area extending 5 km from the proposed Project Footprint in each direction, and included any other residences that may be affected. This area was set to account for potential adverse cumulative effects occurring due to the existence of other developments and activities.

4.4 Scope of Work and Assumptions

The Acoustic Environment Technical Report is based on the proposed Project description in Section 1.1 with the following assumptions:

- the new compressors (V1B) proposed to be installed at the Eagle Mountain (V1) compressor station (to complement the existing gas turbine drive compressors) will be electric powered;
- the new compressors proposed to be installed at the Squamish (V2) compressor station will be electric powered;
- only one of the two compressors proposed to be installed at the Squamish (V2) compressor station will operate at a time (the second is backup and will only operate when the primary is down for maintenance); and
- the new compressor proposed to be installed at the Port Mellon (V3) compressor station (in addition to the existing gas turbine drive compressors) will be a gas turbine drive compressor and is not expected to operate at the same time as the existing compressor.

The scope of this study, using the above assumptions as well as the proposed Project interactions, VC and KI identification, and the study area boundaries, includes the following:

1. sensitive receptors were defined for the Acoustic Environment LSAs of the existing Eagle Mountain (V1) compressor station, the proposed Squamish (V2) compressor station, and the existing Port Mellon (V3) compressor station;
2. an evaluation of construction noise was conducted for the proposed pipeline and the three compressor stations;
3. noise monitoring was conducted around the existing Eagle Mountain (V1) station, the proposed Squamish (V2) compressor station, and the existing Port Mellon (V3) compressor station:
    - noise monitoring was not conducted along the proposed pipeline route because it is expected that the pipes will be underground so any pipeline noises are expected to be negligible;
4. an evaluation was conducted of expected changes in sound levels due to the installation of the proposed compression capacity at the Port Mellon (V3) compressor station;
5. noise modelling was conducted for the proposed compressor units (V1B) at the existing Eagle Mountain (V1) compressor station and for the proposed Squamish compressor station (V2):
    - noise modelling at Eagle Mountain (V1) in Coquitlam included the proposed construction of a dedicated electrical sub-station at the nearby BC Hydro sub-station but did not include noise modelling of the existing Eagle Mountain (V1) compressor station because the Acoustic Environment around that station was assessed during noise monitoring, with and without the operation of the station; and
    - noise modelling was not conducted for the Port Mellon (V3) compressor station because the results of Task 2 indicated that the sound levels are expected to drop as the new compressor unit will be smaller or have a lower horsepower than the existing compressor.

Tasks 1, 2 and 4 are described in Section 4.5; Task 3 is described in Section 4.6 and Task 5 is described in Section 4.7.

4.5 Pre-Field Work

Pre-field work focused on identifying sensitive noise receptors, determining the permissible sound limits, assessing the sound levels associated with the proposed new Port Mellon (V3) compressor equipment, and evaluating the expected noise levels during construction.

4.5.1 Sensitive Receptors

Sensitive noise receptors are locations where humans live and can include residential homes, seniors' homes, hospitals, daycares and hotels (Health Canada 2010). The identification of sensitive noise receptors was conducted using geographic information for land use, zoning and building locations, as well as satellite imagery. The sensitive receptors are mapped in Section 5.1, and Table 5.1-1 shows the distance from the existing or proposed compressor stations to the nearest sensitive receptor.

4.5.2 Determination of Permissible Sound Limit

The PSL was set for the existing Eagle Mountain (V1) compressor station, the proposed Squamish (V2) compressor station, and the existing Port Mellon (V3) compressor station. It was determined for the nearest or most impacted dwelling and assigned to that dwelling unit following the BC OGC Guideline as outlined in Table 1.3-1. Table 4.5-1 presents the characteristics used to calculate each PSL, and Table 4.5-2 presents calculated PSLs.

TABLE 4.5-1

CHARACTERISTICS USED TO CALCULATE PERMISSIBLE NOISE LEVELS

Area	Dwelling unit density per quarter section*	Proximity of dwellings to heavily travelled roads**	Subject to frequent aircraft flyovers	Seasonal adjustment (Class A1)	Facility operation
Eagle Mountain (V1)	9 – 160	> 30m and < 500m	no	no – summer time conditions considered	continuous
Squamish (V2)	9 – 160	> 30m and < 500m	no	no – summer time conditions considered	continuous
Port Mellon (V3)	1 – 8	> 500m	no	no – summer time conditions considered	continuous

* BC OGC defines dwelling density per quarter section of land, which corresponds to one-fourth of a square mile, or approximately 0.65 km^2.
** According to the BC OGC, heavily travelled roads are roads with more than 10 vehicles per hour during the night time.

TABLE 4.5-2

CALCULATION OF PERMISSIBLE NOISE LEVELS

Compressor site	BSL (dBA)	Daytime adjustment (dBA)	Class A adjustment (dBA)	Class B adjustment (dBA)	PSL – night-time 2200 – 0700 (dBA)	PSL – day-time 0700 – 2200 (dBA)
Eagle Mountain (V1)	48	10	0	0	48	58
Squamish (V2)	48	10	0	0	48	58
Port Mellon (V3)	40	10	0	0	40	50

As can be seen in the table, the permissible sound level at night-time was determined to be 48 dBA at all dwellings within the Acoustic Environment LSA of the existing Eagle Mountain (V1) and proposed Squamish (V2) compressor stations, and 40 dBA at all dwellings within the Acoustic Environment LSA of the existing Port Mellon (V3) compressor station.

It is important to note that the PSL of 48 dBA is used as the sound limit if the night-time ASL in those areas is equal to or above 40 dBA.

4.5.3 Port Mellon (V3) Compressor Station Evaluation

A qualitative evaluation was conducted of expected changes in sound levels due to the installation of the proposed new compressor unit at the Port Mellon (V3) compressor station. SNC-Lavalin was provided the equipment specifications or sound levels for the compressor-turbines and the after-cooler fans for the proposed new equipment at V3. The sound power levels for the equipment were estimated as described and compared to sound power levels determined from the noise monitoring conducted in September 2014, as described in Section 5.2.3.

4.5.4 Construction Noise

Construction noise was evaluated by a review of the equipment expected to be used during the construction phase of the proposed Project, and comparing to the expected sound levels associated with these types of equipment.

Physical construction activities are anticipated to last 16 months, starting in Q2 2015. Specific construction stages are as follows:

- logging and clearing operations: three months (Q4 2015);
- pipeline construction: 16 months (Q2 2015 to Q4 2016); and
- facilities construction (compressor and electrical substations): 16 months (Q2 2015 to Q4 2016).

Construction activities will generally occur on a schedule of 10 hours per day, 6 days per week, throughout the construction period. Construction materials will be moved by barge, truck and rail.

A summary of the construction equipment expected to be used during construction is provided in Table 4.5-3. An evaluation of the associated sound levels is described in Section 5.2.1.

TABLE 4.5-3

EXPECTED EQUIPMENT FOR VARIOUS CONSTRUCTION PHASES OF PROPOSED PROJECT

Equipment type	Logging and clearing	Pipeline construction	Facilities construction
Ambulance	X	X	X
Backhoe	X	X	X
Barge	X	X	X
Cable crane	X	X	
Concrete mixer trucks			X
Crane		X	X
Delimber	X		
Dozer	X	X	
Dump trucks			X
Excavator	X	X	X
Feller/buncher	X		
Grader		X	
Horizontal directional drill		X	
Loader		X	
Lowbed truck	X	X	X
Pickup/crew truck	X	X	X
Skidder	X		
Welder		X	X
Vacuum trucks		X	X

4.6 Field Data Collection

Monitoring of sound level parameters at twelve sites (1 to 12) was conducted in May, June and September 2014, inside the Acoustic Environment LSA of the existing Eagle Mountain (V1) and Port

Mellon (V3) compressor stations, and the proposed Squamish (V2) compressor station. The monitoring equipment used for the monitoring program is summarized in Table 4.6-1.

TABLE 4.6-1

NOISE MONITORING EQUIPMENT USED DURING FIELD PROGRAM

Area	Sound level meters (SLMs)	Averaging period (s)	Monitoring period(s)	Audio recordings
Eagle Mountain (V1)	3 Larson & Davis (LD) 831 SLMs	5	24 hours	all stored on Roland R-05
Squamish (V2)	3 LD 831 SLMs	5	24 hours	all stored on Roland R-05
Port Mellon (V3)	1 LD 831 SLM, and 1 LD LxT1L	5	10 hours with 831, 5 minutes with LxT1L	831 audio stored on Roland R-05

The continuous audio data stored on the Roland R-05 recorders provided a time-stamped audible record of the noise events during the SLM measurements. The shorter readings with the LxT1L in Port Mellon were sufficient to characterize the Acoustic Environment LSA because there were a limited number of noise sources so the background levels were stable. The SLMs were field calibrated with a Larson & Davis CAL200 calibrator at the beginning and end of each set of measurements; calibrations were accurate to within +/- 0.5 dBA. SLMs are also calibrated by an independent laboratory every 12 months. The microphone of the SLM was mounted on a tripod approximately 1.5 m above the ground, the average height of a person.

Table 4.6-2 lists the noise monitoring locations and the specific sampling dates. Locations 10 and 11 were monitored in Port Mellon but the results were not required for the analysis so they are not reported in the table. Selected photographs of the monitoring sites are included in Appendix A. Maps of the Coquitlam, Squamish and Port Mellon monitoring sites are shown in Figures 4.6-1, 4.6-2 and 4.6-3, respectively.

TABLE 4.6-2

NOISE MONITORING LOCATIONS

Area	Monitoring site	Monitoring dates	UTM Easting*	UTM Northing*	Distance to compressor (m)	Description	Notes
Eagle Mountain (V1)	1	May 27, 2014	514589	5462410	690	east of compressor, off Parkway Blvd	existing compressor off from 1600 to 2200.
	2	May 27, 2014	486059	5461487	810	behind parking lot of Westwood Golf Academy	existing compressor off from 1600 to 2200.
	3	May 27, 2014	512888	5461702	950	FortisBC right-of-way above Platinum Lane	existing compressor off from 1600 to 2200.
Squamish (V2)	4	May 30 and June 1, 2014	488689	5508143	580	west end of Pioneer Way	
	5	May 30, 2014	489145	5508123	660	Sandman Hotel, Discovery Way	
	6	May 30 and June 1, 2014	489810	5507404	450	Magee Street	
	7	June 1, 2014	488864	5506874	970	Loggers Lane, north of Finch Drive	
Port Mellon (V3)	8	September 22, 2014	464070	5484672	350	north end of Dunham Road	existing compressor on from 1700 on Sept 22 to 0100 on Sept 23.
	9	September 22, 2014	463904	5484557	150	open field north of Port Mellon Highway	existing compressor on from 1700 on Sept 22 to 0100 on Sept 23.
	12**	September 22, 2014	464189	5484682	480	south end of Dunham road	existing compressor on from 1700 on Sept 22 to 0100 on Sept 23.

* WGS84 Datum, Zone 10, recorded on a Garmin 60-CSx series handheld GPS unit.
** Note: Locations 10 and 11 were monitored for QA purposes but were not used for analysis so were not reported.

The monitoring locations were selected with the following considerations (where possible):

- near to dwellings and/or sensitive receptors;
- at least 3 m from sound reflecting objects such as walls, fences, etc.;
- away from air conditioning units, heat pumps, water features, etc.; and
- toward the existing or proposed compressor station.

Two days of monitoring were conducted around the proposed Squamish (V2) compressor station because two sites in Squamish were initially considered and the extra day of monitoring was to provide adequate coverage at both sites. The noise was monitored for one day at the existing Eagle Mountain (V1) and Port Mellon compressor stations.

Figure 4.6-1 Noise monitoring locations in Coquitlam.

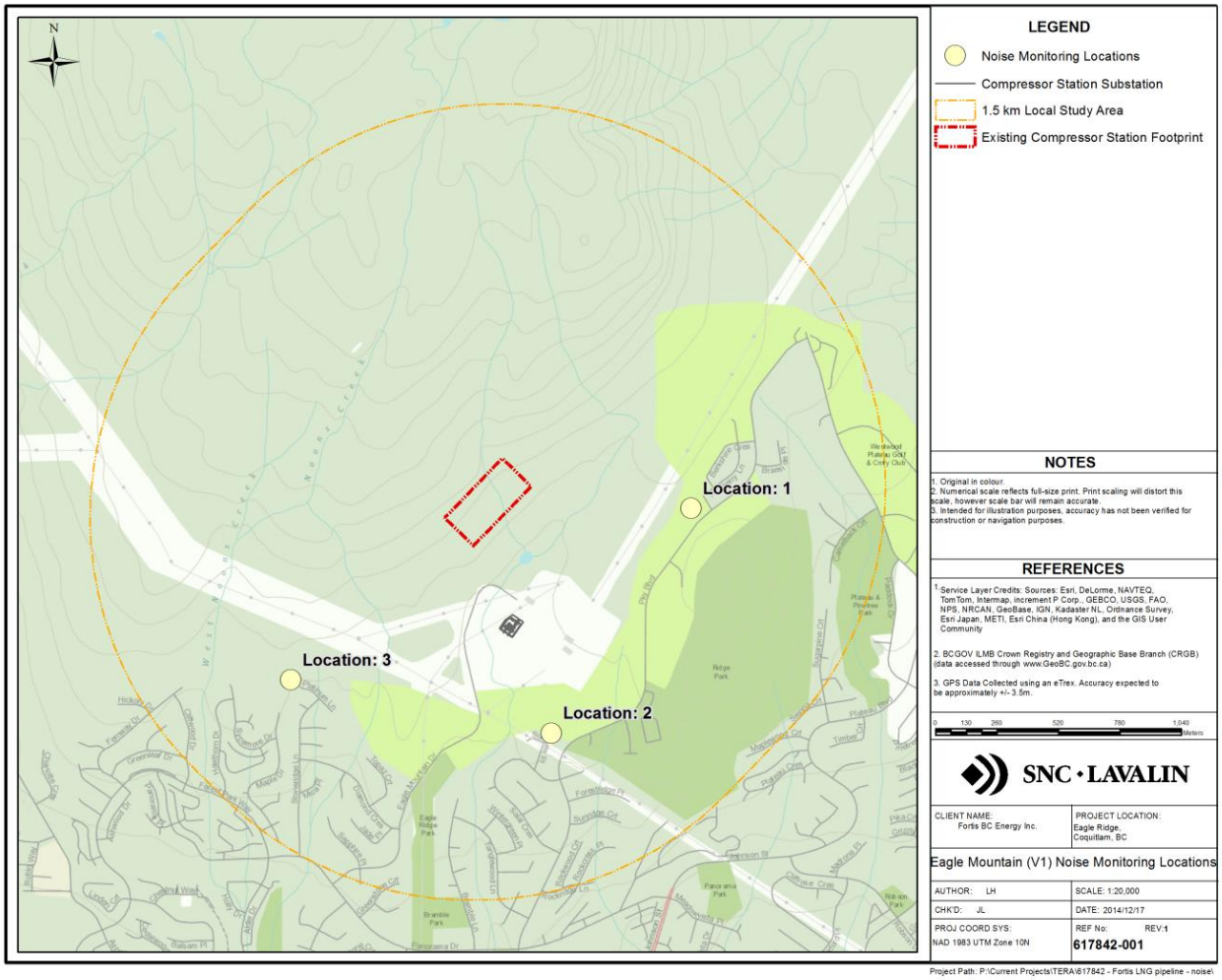


Figure 4.6-2 Noise monitoring locations in Squamish.

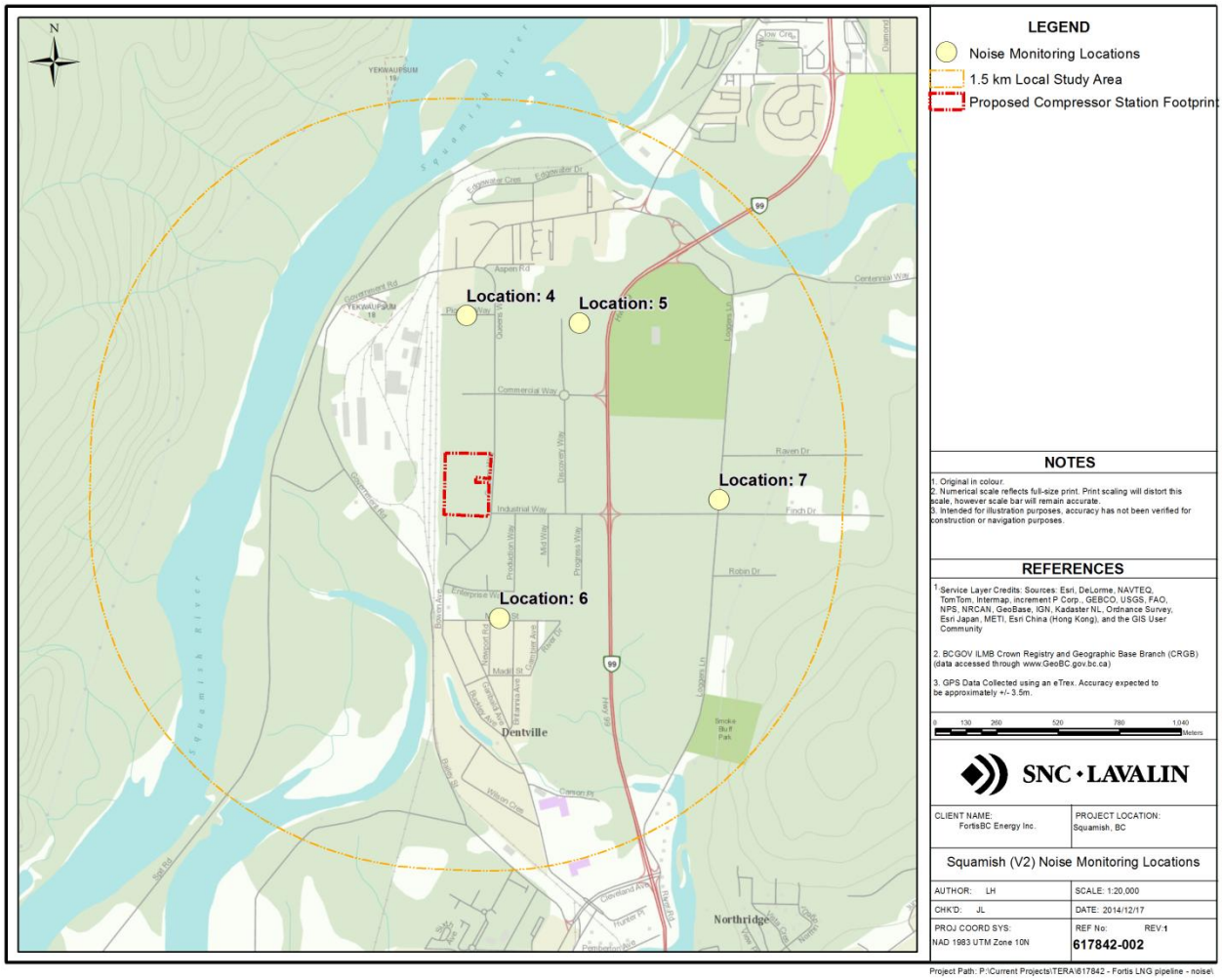
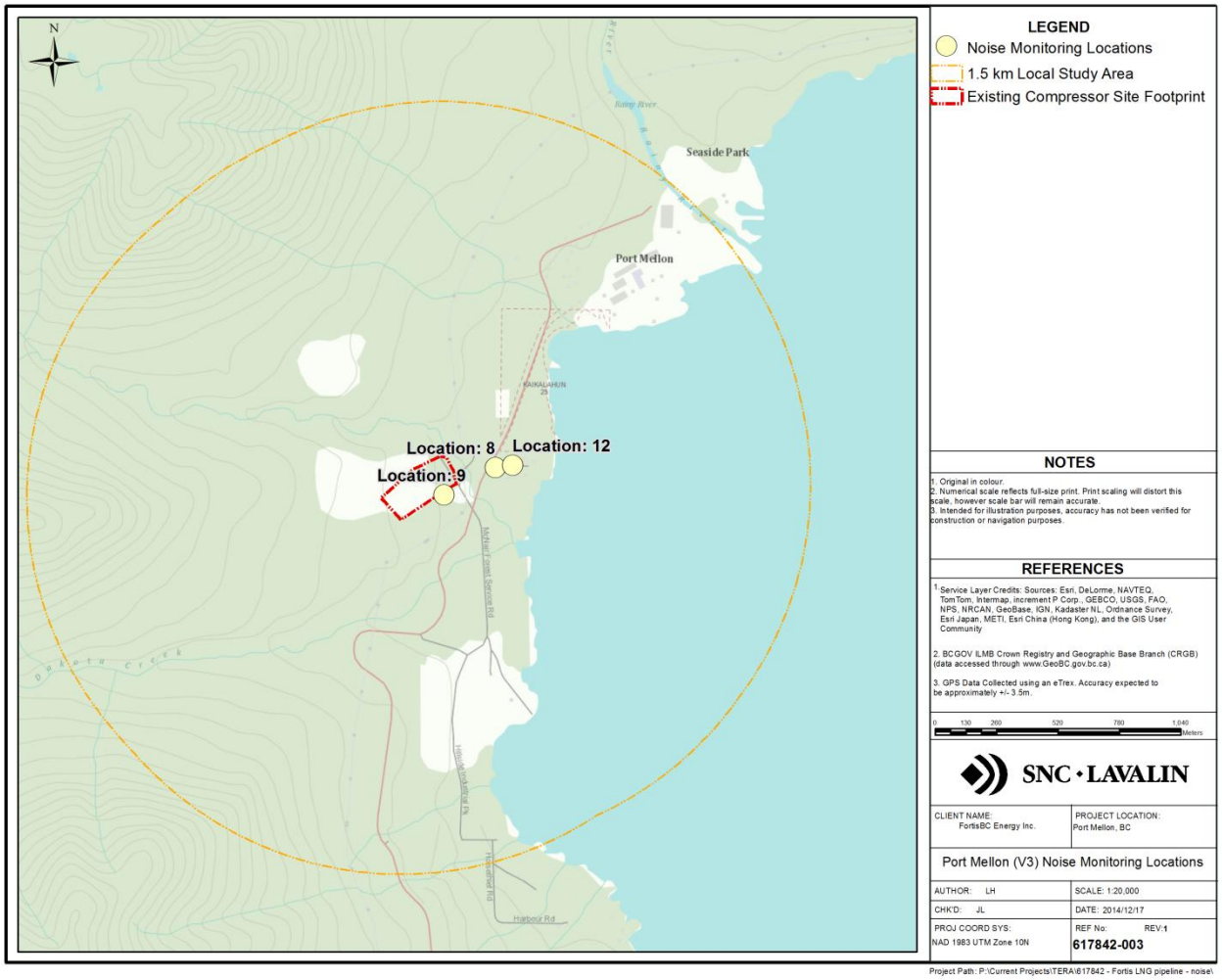


Figure 4.6-3 Noise monitoring locations in Port Mellon.



The monitoring dates were selected to ensure suitable meteorological conditions:

- wind speed did not exceed 20 km/h;
- lack of precipitation and dry roads; and
- temperature above -10 degrees C.

Table C-1 in Appendix C summarizes the weather conditions (wind speed and precipitation) in Coquitlam, Squamish and Port Mellon during the measurements, based on nearby Environment Canada monitoring stations. The conditions were suitable for noise monitoring except for periods on September 22 when it was raining (noted by SNC-Lavalin technicians but not recorded by relevant Environment Canada weather station). As such, readings before 1900 on September 22 were ignored.

4.7 Acoustic Modelling

Acoustic modelling assessed whether the operational phase of the proposed Project is likely to cause an exceedence of the PSL at sensitive receptors for the proposed new electric-powered compressor station in Eagle Mountain (V1B) and the proposed new electric-powered compressor station in Squamish (V2).

Noise generating equipment such as electric drive motors and gas turbine drive compressors will be located inside insulated buildings during operation. The major outdoor sources of noise from facility operations are the gas cooler fans, exposed sections of pipe, ventilation fans and transformers. As

previously indicated in Section 4.4, the V1B model included a proposed sub-station next to the BC Hydro Meridian sub-station.

The locations of the major sources of noise at the proposed new Eagle Mountain (V1B) and Squamish (V2) compressor stations are presented in Figures 4.7-1 and 4.7-2, respectively.

Figure 4.7-1 Locations of major noise sources at proposed Eagle Mountain Compressor Station expansion (V1B).

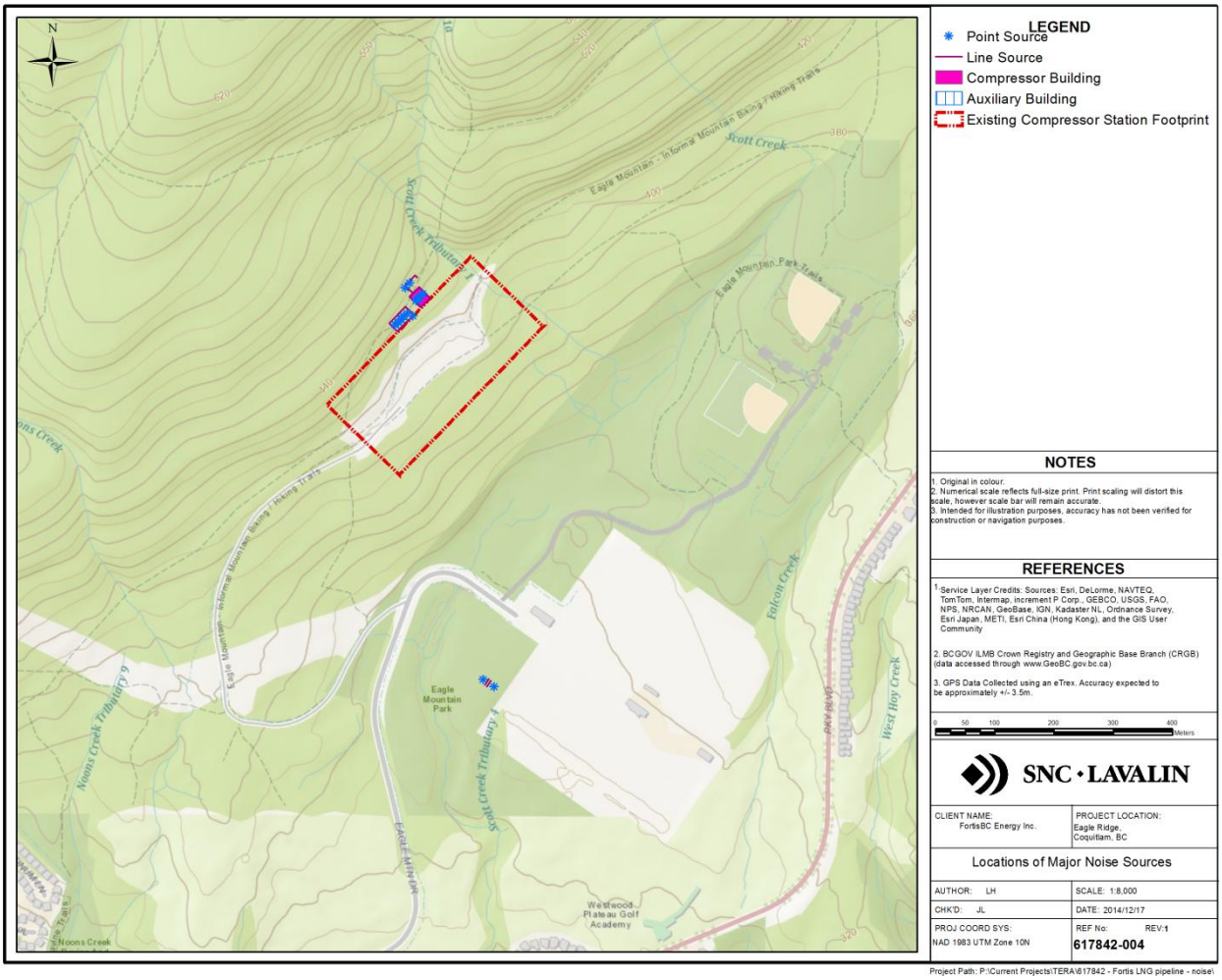
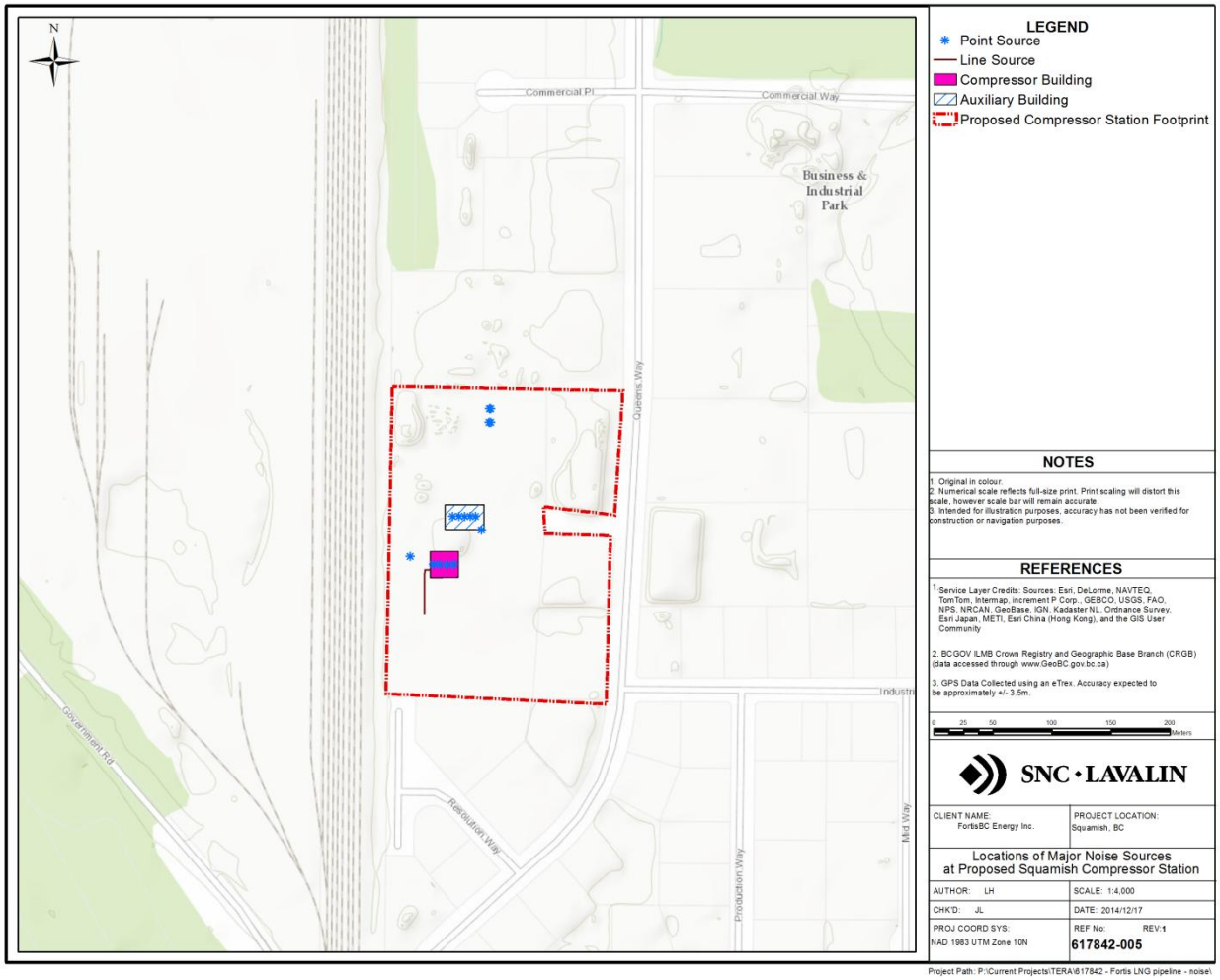


Figure 4.7-2 Locations of major noise sources at proposed Squamish Compressor Station (V2).



The noise levels of the major sources of noise are shown in Table 4.7-1. They were derived from engineering estimates based on the characteristics of the source (type, power, flow, etc.) or from SNC-Lavalin's in-house database for similar equipment.

TABLE 4.7-1
SOUND POWER LEVELS OF COMPRESSOR STATION EQUIPMENT (OPERATION)

Compressor station	Area	Equipment description	Quantity	Sound emission level (dBA)
Eagle Mountain (V1)	inside	compressor skid	2	Lp: 89 dBA at 1 m, Lw: 109 dBA, estimated from manufacturer data
		piping	2	Lw: 109 dBA, estimated from manufacturer data
	outside	cooling fan, stage 1	2	Lw: 105 dBA, estimated from cooling capacity and similar equipment
		cooling fan, stage 2	2	Lw: 102 dBA, estimated from cooling capacity and similar equipment
		transformer	2	65 dBA rating, Lw: 87 dBA estimated from manufacturer data
		piping	2	Lw: 116 dBA, estimated from compressor data and pipe specification
		ventilation fan	10	Lw: 95 dBA, estimated from similar equipment
		HVAC	1	Lw: 95 dBA, estimated from similar equipment
Squamish (V2)	inside	compressor skid	1	Lp: 90 dBA at 1 m, Lw: 107 dBA, estimated from manufacturer data
		piping	1	Lw: 107 dBA, estimated from manufacturer data
	outside	cooling fan	2	Lw: 103 dBA, estimated from manufacturer data
		transformer	2	65 dBA rating, Lw: 86 dBA estimated from manufacturer data
		piping	1	Lw: 112 dBA, estimated from compressor data and pipe specification
		ventilation fan	10	Lw: 95 dBA, estimated from similar equipment
		HVAC	1	Lw: 95 dBA, estimated from similar equipment

Note: Lp corresponds to sound pressure level (*i.e.*, sound level at a distance); Lw corresponds to sound pressure level (*i.e.*, the intrinsic sound level of a source).

The acoustics model was developed with the following assumptions:

- compressor stations operate continuously, 24 hours per day, and 7 days a week;
- all equipment operates under normal conditions;
- standby or spare equipment is not operating;
- doors and windows of enclosures and buildings are closed; and
- emergency situations and process upsets are excluded from normal operation.

The operating conditions considered in the modelling are representative of the normal continuous operation of the compressor station. It is applicable to the daytime and night-time operation of the facility.

Noise was modelled accordingly to the International Standards Organization (ISO) 9613-2 methodology using SoundPLAN® software, version 7.3. The SoundPLAN® software, developed by Braunstein + Berndt GmBH, was first released in 1986 and is widely used for noise evaluations. It is a proven software platform providing accurate calculation and control features.

The ISO 9613-2 methodology calculates the attenuation of sound when propagating in free field, in order to forecast the sound pressure level at a given distance from various noise sources, under meteorological conditions favourable to the propagation of the sound towards the receiver. These conditions consist of a downwind propagation or moderate temperature inversion propagation, as commonly happens at night. The methodology takes into account geometric spreading due to distance, atmospheric attenuation, ground and barrier effects, reflection from surfaces, and propagation through dwellings, vegetation and industrial sites. It is applicable to most situations concerning industrial noise.

Noise levels of the facility were calculated for specific receptors and for a grid to produce noise contour maps. The results are representative of the continuous equivalent sound pressure level Leq using the A filter, also noted as LAeq (dBA).

Table 4.7-2 shows the acoustics modelling parameters used in the acoustics modelling.

TABLE 4.7-2

ACOUSTIC MODELLING PARAMETERS

Item	Model Parameters	Model Setting
1	temperature (degrees C)	10
2	relative humidity (%)	70
3	wind speed	downwind (1 to 5 km/h) from the source towards the receptor
4	noise source types	point sources, lines sources and area sources for building envelope
5	noise source data	Table 4.7-1
6	noise propagation calculation standard	ISO 9613-2
7	ground attenuation	Project footprint: reflective (0.0), Rest of LSA: average (0.6)
8	terrain parameters	topographic data: 5 m interval, forest neglected
9	orders of reflection	3

In addition, the acoustic modelling was conducted assuming the following engineering measures will be implemented:

- The compressor building wall and ceiling shall have a minimum transmission loss (TL ASTM E90) as follows:

Frequency (Hz)	63	125	250	500	1k	2k	4k
TL (dB) - Wall & ceiling	9	15	20	26	28	38	43

- The compressor building will be constructed to have less than 0.1% open area. Any large openings (0.1 m^2 or larger) shall have appropriate silencing, equivalent to the building transmission loss. All doors shall be designed to reduce transmission of sound to the environment.

- The compressor building interior wall and ceiling will have acoustic absorptive treatment such that 85% of the ceiling area and 30% of the wall area have a minimum sound absorption coefficient (ASTM C423) as follows:

Frequency (Hz)	63	125	250	500	1k	2k	4k
Absorption coefficient – wall and ceiling	0.2	0.3	0.5	0.6	0.9	0.9	0.8

In addition, FortisBC has indicated that noise mitigation will be applied as necessary to the station recycle valves.

4.8 Data Limitations and Technical Boundaries

Data limitations and technical boundaries include:

- results are based on data provided by FortisBC and the proposed Project team. If errors exist in the data provided, the conclusions provided by SNC-Lavalin may be incorrect; and

- the study focused on noise and not vibration because equipment is not expected to generate vibrations.

Additional assumptions are described in Section 4.4.

5.0 RESULTS OF ACOUSTIC ENVIRONMENT TECHNICAL REPORT

This section describes the results of the Acoustic Environment Technical Report, following the methodologies described in the previous section. The general Acoustic Environment is described first then the sound levels associated with construction and operations are described.

5.1 General Acoustic Environment Information

This subsection describes the general Acoustic Environment based on field observations, and provides a summary of the locations of sensitive receptors in the Acoustic Environment LSA of the compressor stations.

In general the Acoustic Environment at all sites is a function of traffic density and short-term construction activities. The major noise sources around V1, V2 and V3 are summarized in Table 2.1-1.

The sensitive receptors around the three compressor stations are shown in Figures 5.1-1 to 5.1-3. The majority of sensitive receptors are residences; Table 5.1-1 describes the nearest receptors to each existing or proposed compressor station.

Figure 5.1-1 Locations of sensitive receptors around the Eagle Mountain (V1) compressor station.

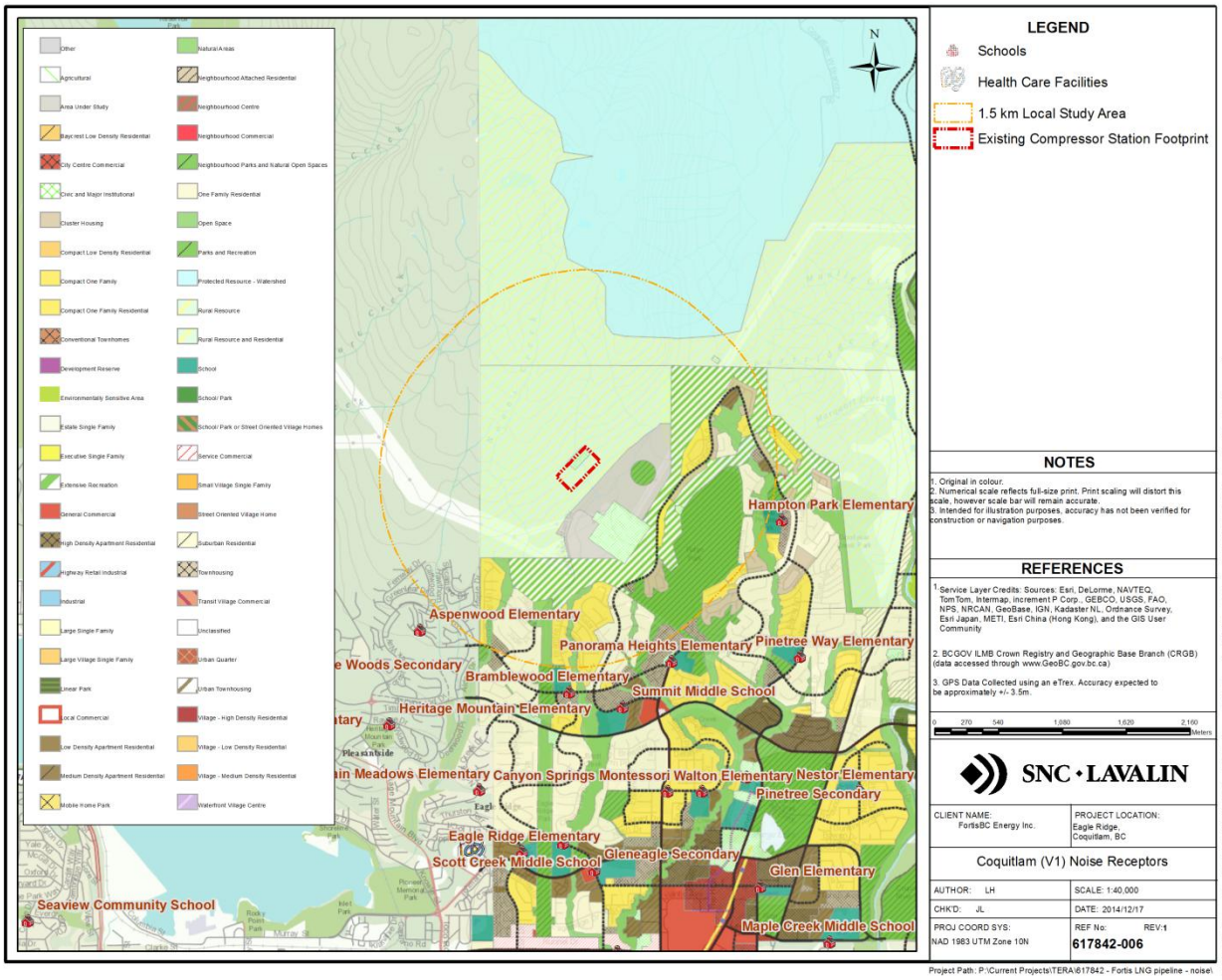


Figure 5.1-2 Locations of sensitive receptors around the Squamish (V2) compressor station.

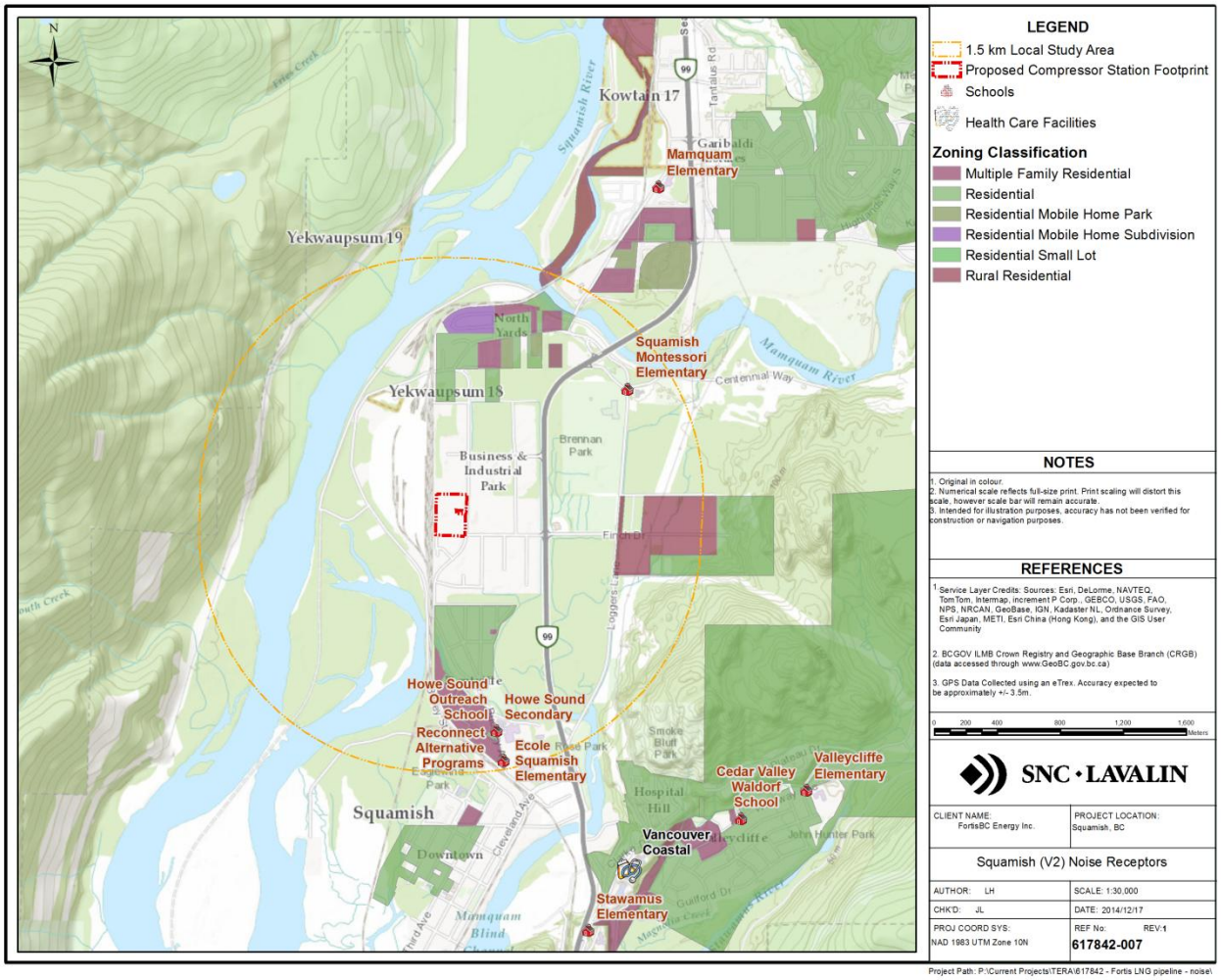


Figure 5.1-3 Locations of sensitive receptors around the Port Mellon (V3) compressor station.

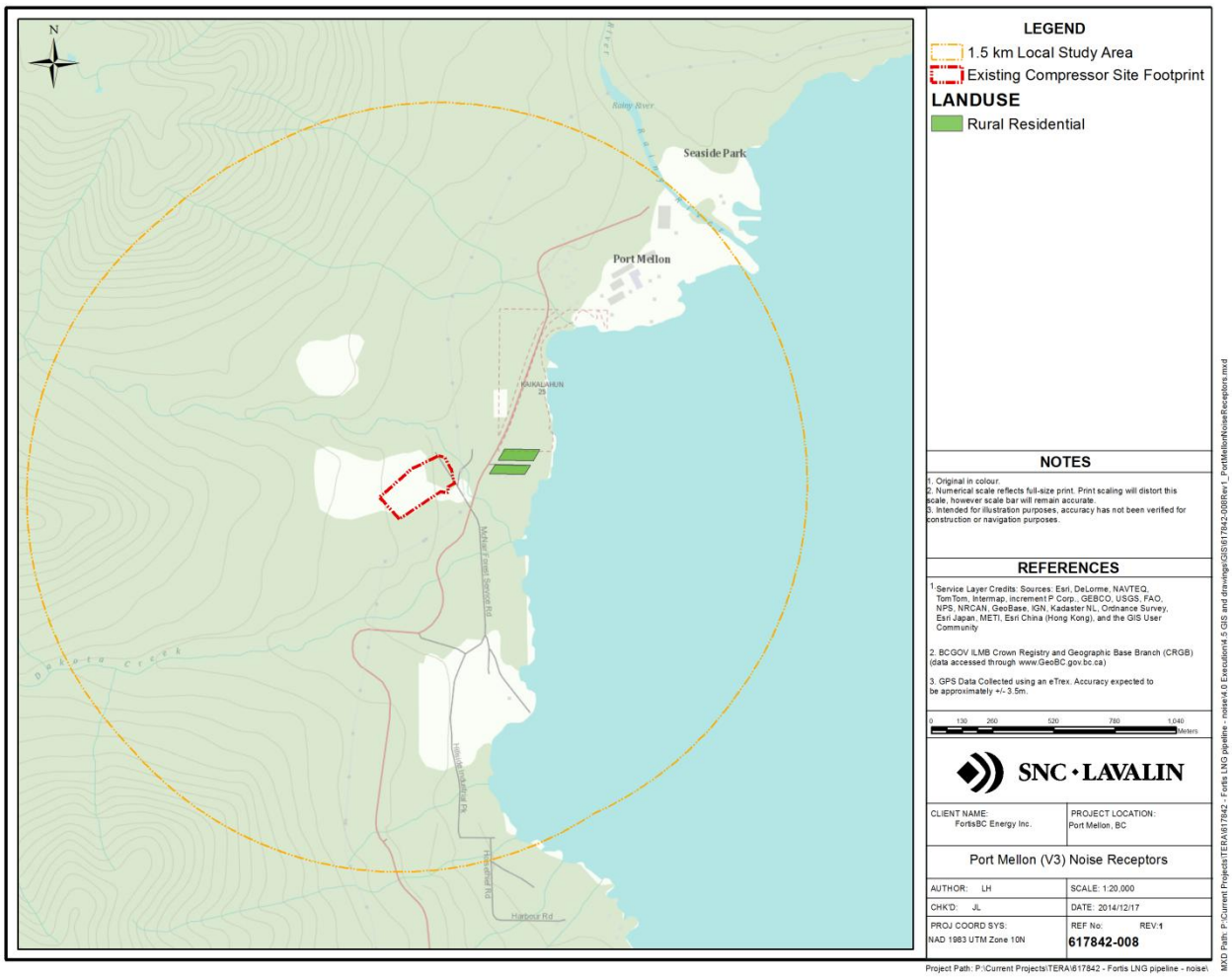


TABLE 5.1-1

NEAREST SENSITIVE RECEPTORS TO THE EXISTING AND PROPOSED COMPRESSOR STATIONS

Existing or Proposed Compressor station	Distance to nearest sensitive receptor (m)	Approximate number of sensitive receptors in area	Classification of nearest receptors	Comments
Eagle Mountain (V1)	700	800	Single family residences in urban subdivision	Sensitive receptors are located downhill and south of the existing compressor station.
Squamish (V2)	450	300	Single family residences in urban subdivision	Sensitive receptors are located north, east and south of the proposed compressor station.
Port Mellon (V3)	300	15	Single family residences on rural street.	Sensitive receptors are on rural street east of existing compressor station

5.2 Sound Level Findings

This section describes the VC of the Acoustic Environment with a focus on evaluating the KI of sound levels. Evaluations include construction noise, noise monitoring, Port Mellon (V3) and acoustic modelling.

5.2.1 Construction Noise

Section 4.5.4 describes the equipment expected to be used during the construction phase of the proposed Project. Table 5.2-1 summarizes the expected sound levels associated with the expected equipment to be used during construction (Table 4.5-3). In general, the expected sound levels are around 80 dBA to 85 dBA at 15 m. There are no PSLs applicable to the construction noise from federal, provincial or local regulators.

TABLE 5.2-1

EXPECTED SOUND LEVELS OF EQUIPMENT DURING CONSTRUCTION PHASE OF PROPOSED PROJECT

Equipment type	Lmax at 15 m (dBA)*
ambulance	**
backhoe	80
barge	**
cable crane	85
crane	85
concrete mixer trucks	85
delimber	85
dozer	85
dump trucks	84
excavator	85
feller/buncher	85
grader	85
horizontal directional drill	80
loader	80
lowbed truck	85
pickup/crew truck	55
skidder	85
welder	73
vacuum trucks	85

* Lmax = Maximum sound pressure level over a time period.
** Data unavailable.
Data source: US Department of Transportation (2006).

5.2.2 Noise Monitoring

Noise monitoring was conducted as described in Section 4.6 at the monitoring sites listed in Table 4.6-2. The primary noise sources monitored in Coquitlam, Squamish and Port Mellon were the same as the sound observed by SNC-Lavalin staff (Table 2.1-1).

Noise monitoring results are provided in Appendix D: Figures D-1 to D-3 show the noise monitoring results around the existing Eagle Mountain compressor station; Figures D-4 to D-9 show the noise monitoring results around the proposed Squamish compressor station site (V2); and Figure D-10 shows the noise monitoring result around the existing Port Mellon compressor station. The spikes in the sound levels are primarily caused by vehicle traffic with some wildlife noise. Several features in the noise levels should be noted:

- the reduction in sound level seen between approximately 1600 and 2100 at Site 1 (Figure D-1) started when the sound level meter was moved closer to a residence (away from a road) and ended when evening wildlife (frog) sounds began; and
- the changes in sound level amplitudes seen at Site 4 (Figures D-4 and D-7) were caused by locomotives at the nearby rail yard.

Table 5.2-2 summarizes the average day time (0700 to 2200) and night time (2200 to 0700) sound levels of the seven monitoring sites in Coquitlam and Squamish.

TABLE 5.2-2

NOISE MONITORING RESULTS FROM COQUITLAM AND SQUAMISH

Date	Sound level metric* (dBA)	Monitoring site						
		Coquitlam			Squamish			
		1	2	3	4	5	6	7
May 27, 2014	Ld	57	47	45	-	-	-	-
	Ln	56	41	40	-	-	-	-
	Ldn	63	49	48	-	-	-	-
	LAF90	35	36	36	-	-	-	-
May 30, 2014	Ld	-	-	-	56	58	56	-
	Ln	-	-	-	53	49	49	-
	Ldn	-	-	-	60	58	57	-
	LAF90	-	-	-	39	39	34	-
June 1, 2014	Ld	-	-	-	55	-	56	62
	Ln	-	-	-	53	-	47	52
	Ldn	-	-	-	60	-	57	62
	LAF90	-	-	-	45	-	37	36

***** Ld = Leq measured during day time hours (0700-2200); Ln = Leq measured during night time hours (2200-0700); Ldn = day-night equivalent level is the 24-hr Leq where Ln is increased by 10 dBA to account for greater sensitivity to noise at night; LAF90 = Sound level that is equalled or exceeded for 90% of the 24-hr measurement time period.

Table 4.6-2 noted that the existing Eagle Mountain (V1) compressor was shut down between 1600 and 2200 on May 27, 2014, to assess the impact of the existing compressor on the Eagle Mountain Acoustic Environment. Under the BC OGC Guideline, the ASL in a given area is the average Acoustic Environment without contribution from any energy-related activities, such as a compressor station. It was not operationally possible to shut down the existing compressor station for a complete 24-hour period. For the six-hour period when the existing compressor was turned off, the Leq sound levels at sites 1, 2 and 3 were 55, 47 and 46 dBA, respectively. These Leq values were approximately equal to the Leq for the day time period. More importantly the LAF90 sound level (representative of the continuous sound level audible 90% of the time) on Figures D-1 to D-3 was not affected by the shutdown of the compressor station. This demonstrates that the existing compressor station does not substantially contribute to the ASL at those locations and that the ASL is controlled by other sound sources. Figures 5.2-1 and 5.2-2 map the noise monitoring results from Table 5.2-2 for the Coquitlam and Squamish monitoring sites, respectively.

In addition, the night time sound level (Ln) measured at the nearest receptors was equal to or above the BC OGC 40 dBA default night time PSL. As such, the adjusted PSL for the Acoustic Environment LSA around the existing Eagle Mountain (V1) and proposed Squamish (V2) compressor stations is 48 dBA, as described in Section 4.5.2. The PSL for the Acoustic Environment LSA around the existing Port Mellon (V3) compressor station is still 40 dBA due to the lower population density.

Figure 5.2-1 Noise monitoring results in Coquitlam.

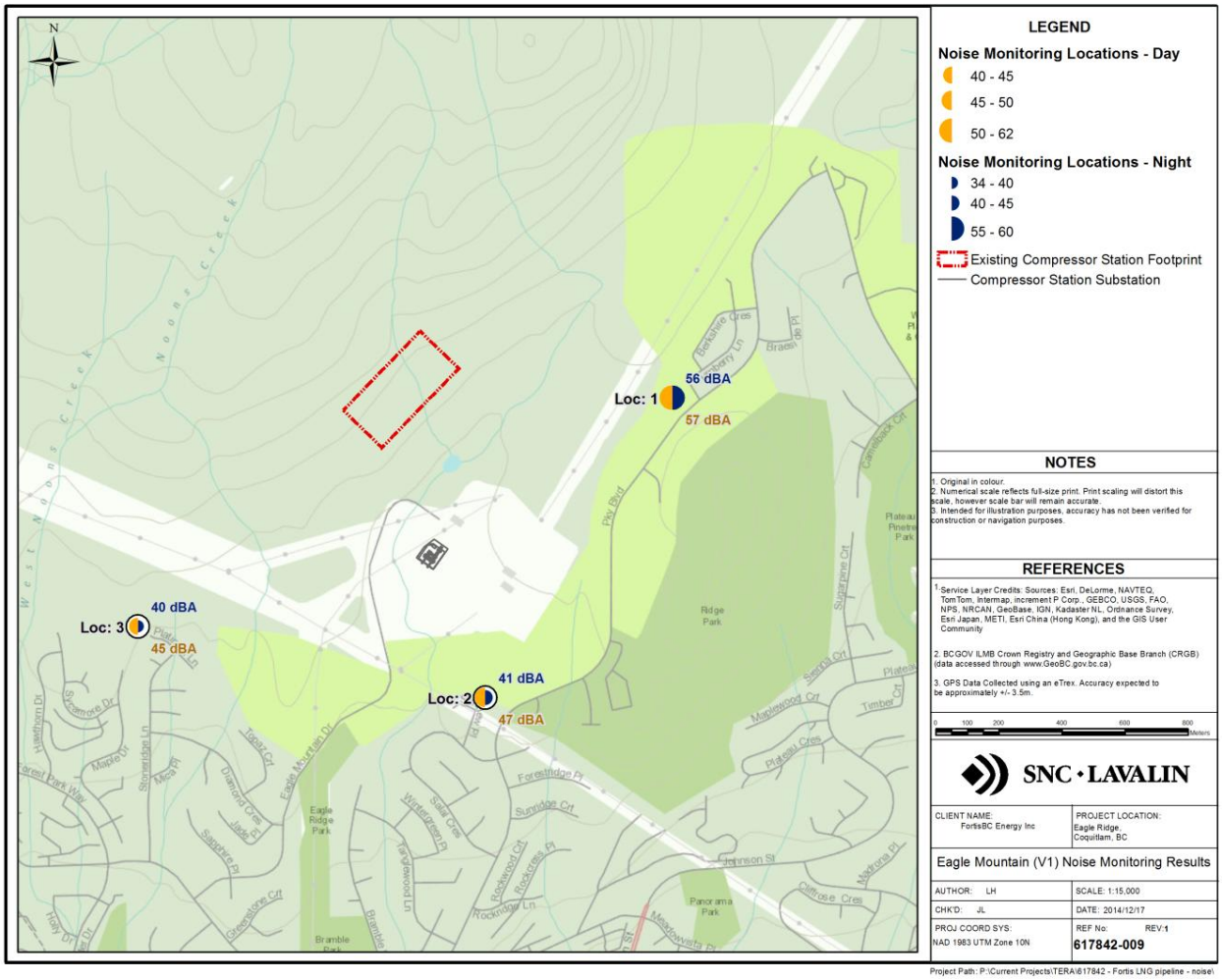


Figure 5.2-2 Noise monitoring results in Squamish.

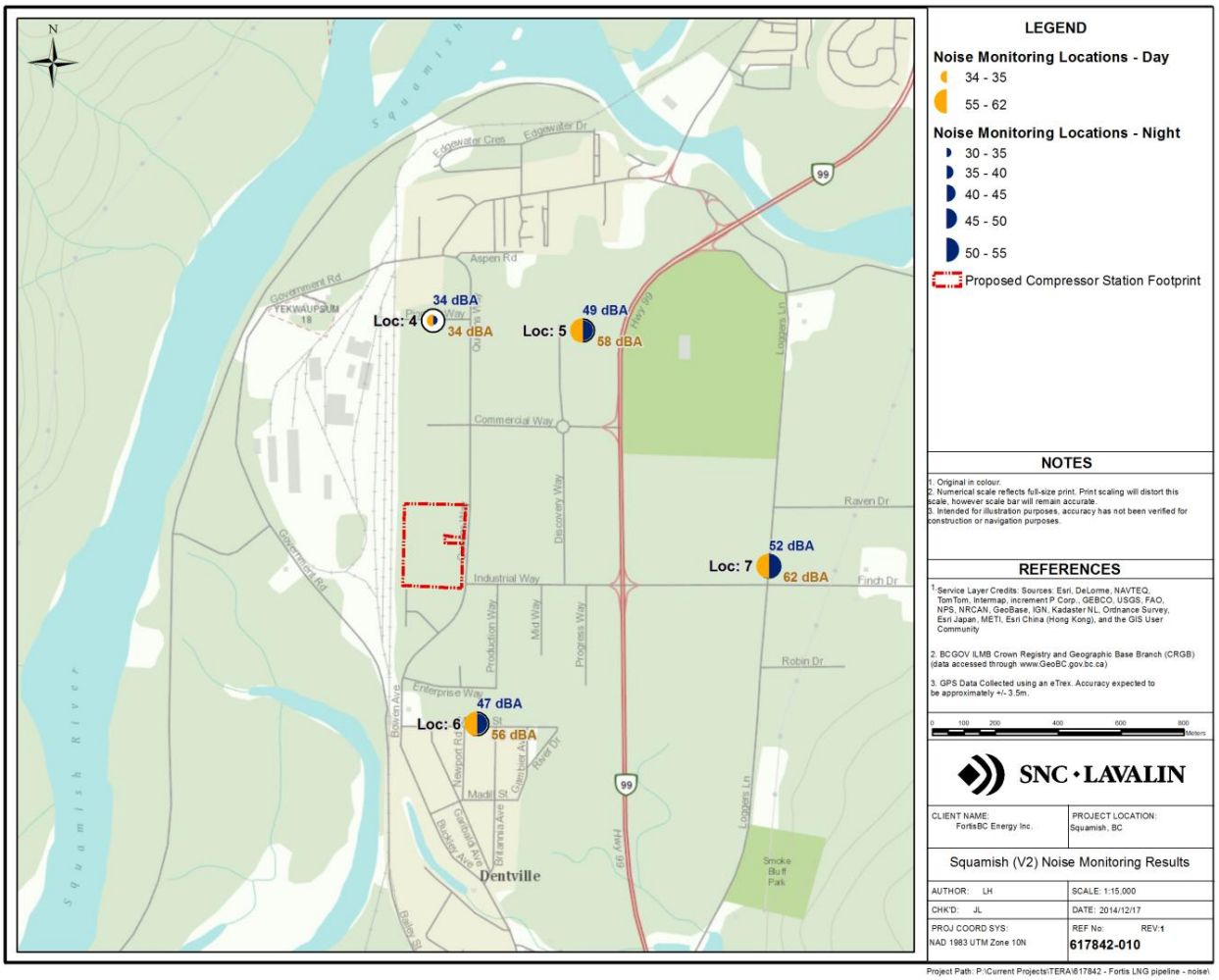


Table 5.2-3 summarizes the noise monitoring results from Port Mellon. Since the Port Mellon readings were shorter, only the background level is listed in the table (equivalent to the LAF90 value listed in Table 5.2-2).

TABLE 5.2-3

NOISE MONITORING RESULTS AT PORT MELLON

Monitoring site	Background level* with compressor station operating (dBA)	Background level* without compressor station operating (dBA)
8	43	43
9	47	38
12	40	38

* Background sound level was the sound level without vehicle traffic.

The sound level of the existing Port Mellon compressor station is the difference between sound levels measured with and without the compressor station operating. Given that sound levels are compared logarithmically (Appendix B), the compressor station noise is 46 dBA at Monitoring Site 9 (150 m from the compressor station; Table 4.6-2). This implies that the compressor station noise at Monitoring Site 8 and 12 (the nearest dwellings) are approximately 39 dBA and 36 dBA, which is below the PSL for the Port Mellon Acoustic Environment LSA (Table 4.5-2).

5.2.3 Port Mellon (V3) Noise Evaluation

An evaluation was conducted of expected changes in sound levels due to the installation of the proposed new compressor unit at the Port Mellon (V3) compressor station.

The existing compressor at the Port Mellon (V3) station is a 7,200-hp Taurus 60 gas turbine drive compressor package manufactured by Solar Turbines (a Caterpillar company). The proposed new compressor at V3 is a 6,130-hp Centaur 50 gas turbine drive compressor package also manufactured by Solar Turbines (or equivalent). In general, equipment sound levels correlate with capacity so the sound levels at sensitive receptors were expected to be lower as the proposed new compressor unit will be smaller or have less horsepower than the existing compressor.

Table 5.2-4 summarizes the estimated sound levels of the existing and proposed new major sound sources at the Port Mellon (V3) compressor station. Three of the sound levels were estimated based on the power rating of the new turbine/compressor unit and the cooling capacity of the existing and new after coolers (Bolt Beranek and Newman Inc. 1981). The sound level of the existing compressor-turbine package was measured during the monitoring program. Based on the data provided, the proposed compressor is expected to produce lower sound levels than the existing compressor; therefore, the new compressor will not result in an increase in sound levels, and no further investigations are required.

TABLE 5.2-4

ESTIMATED AND MEASURED SOUND LEVELS OF EXISTING AND PROPOSED NEW MAJOR SOUND SOURCES AT PORT MELLON (V3) COMPRESSOR STATION

Component	Specifications
Existing after-cooler fans	Horizontal forced draft fin tube cooler, 17.2 MMBTU/hr, Lw*: 102 dBA, estimated from manufacturer data
Existing compressor-turbine package	108 dBA at 2 m, inside a building, with turbine air intake and exhaust silencer, measured data
New after-cooler fans	Horizontal forced draft fin tube cooler, 13 MMBTU/hr, Lw: 100 dBA, estimated from manufacturer data
New compressor-turbine package	90 dBA at 1 m, inside a building, with turbine air intake and exhaust silencer, manufacturer data

* Lw: Sound power level.

5.2.4 Acoustic Modelling

The sound levels at the Coquitlam monitoring (receptor) sites due to the proposed compressor units (V1B) are presented in Table 5.2-5 and Figure 5.2-3. The sound levels at the Squamish monitoring (receptor) sites due to the proposed compressor station are presented in Table 5.2-6 and Figure 5.2-4. Each contour in the figures corresponds to a line of constant predicted sound level. In general, the sound level contours decrease with distance from the noise sources. Variations in the sound level contours are due to the relative location and orientation of the noise sources, ground attenuation and terrain effects. Terrain and barrier effects explain the lower sound levels predicted at Receptor 1 due to the proposed Eagle Mountain compressor units (V1B).

The predicted facility sound levels with expected engineering measures are lower than the PSL and compliant with the BC OGC noise limits. Furthermore, the change in the calculated percentage of highly annoyed persons (%HA) does not exceed 6.5% at any receptor so there is no need for additional engineering controls.

TABLE 5.2-5

PREDICTED SOUND LEVELS AT COQUITLAM MONITORING LOCATIONS DUE TO PROPOSED NEW COMPRESSOR UNITS (V1B).

Receptor site	Predicted facility sound level Leq (dBA)	Permissible sound level Leq (dBA)	BC OGC compliant?	ASL, Ldn (dBA)	Cumulative sound level, Ldn (dBA)	Increase in highly annoyed persons (%)
1	37	48	yes	63	63	0.1
2	32	48	yes	48	48	0.1
3	21	48	yes	48	48	0.0

TABLE 5.2-6

PREDICTED SOUND LEVELS AT SQUAMISH MONITORING LOCATIONS DUE TO PROPOSED NEW COMPRESSOR STATION (V2).

Receptor site	Predicted facility sound level Leq (dBA)	Permissible sound level Leq (dBA)	BC OGC compliant?	ASL, Ldn (dBA)	Cumulative sound level, Ldn (dBA)	Increase in highly annoyed persons (%)
4	40	48	yes	59	59	0.2
5	33	48	yes	58	58	0.0
6	39	48	yes	57	57	0.2
7	34	48	yes	62	62	0.0

Figure 5.2-3 Predicted sound contour levels due to proposed new Eagle Mountain (V1B) compressor units.

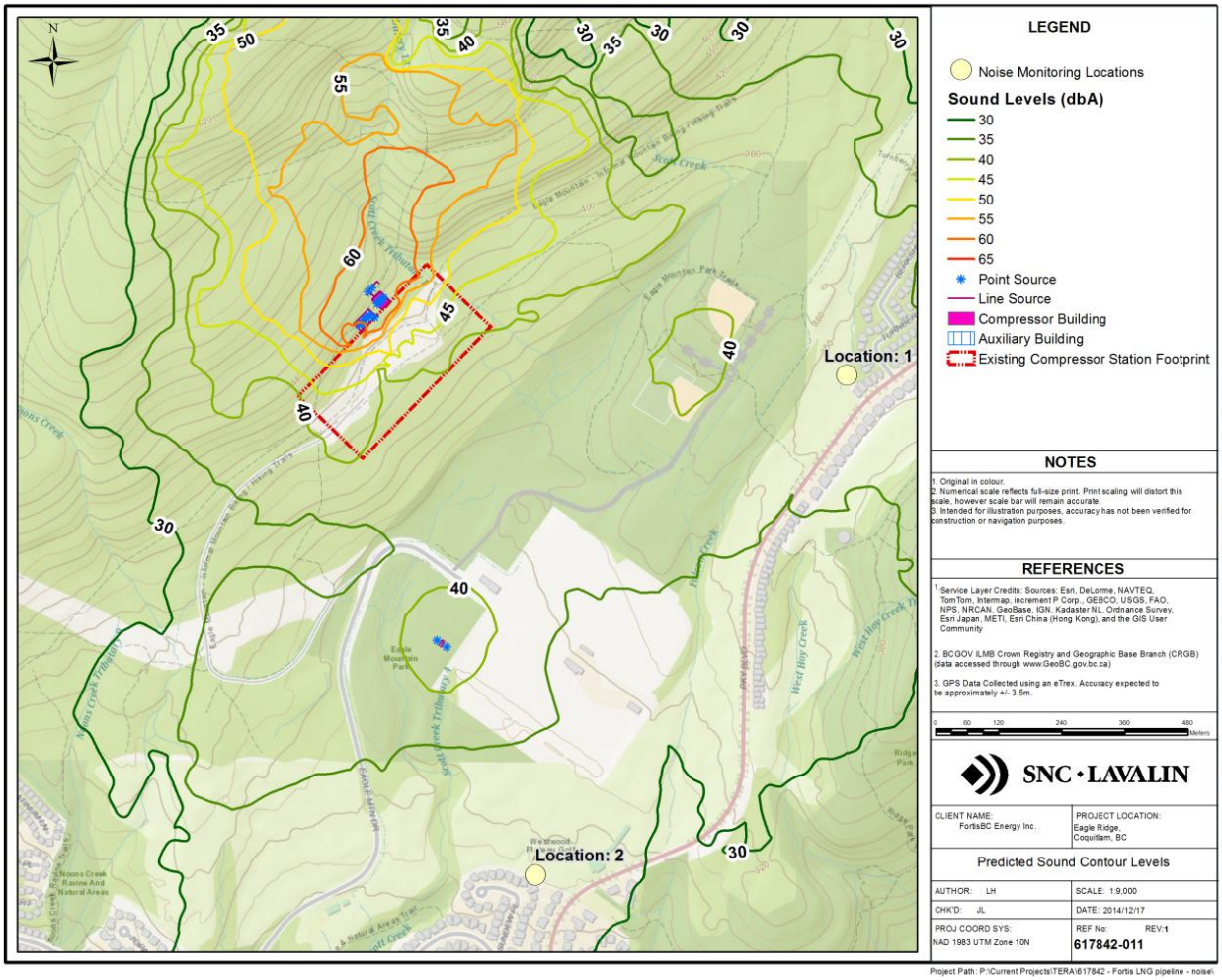
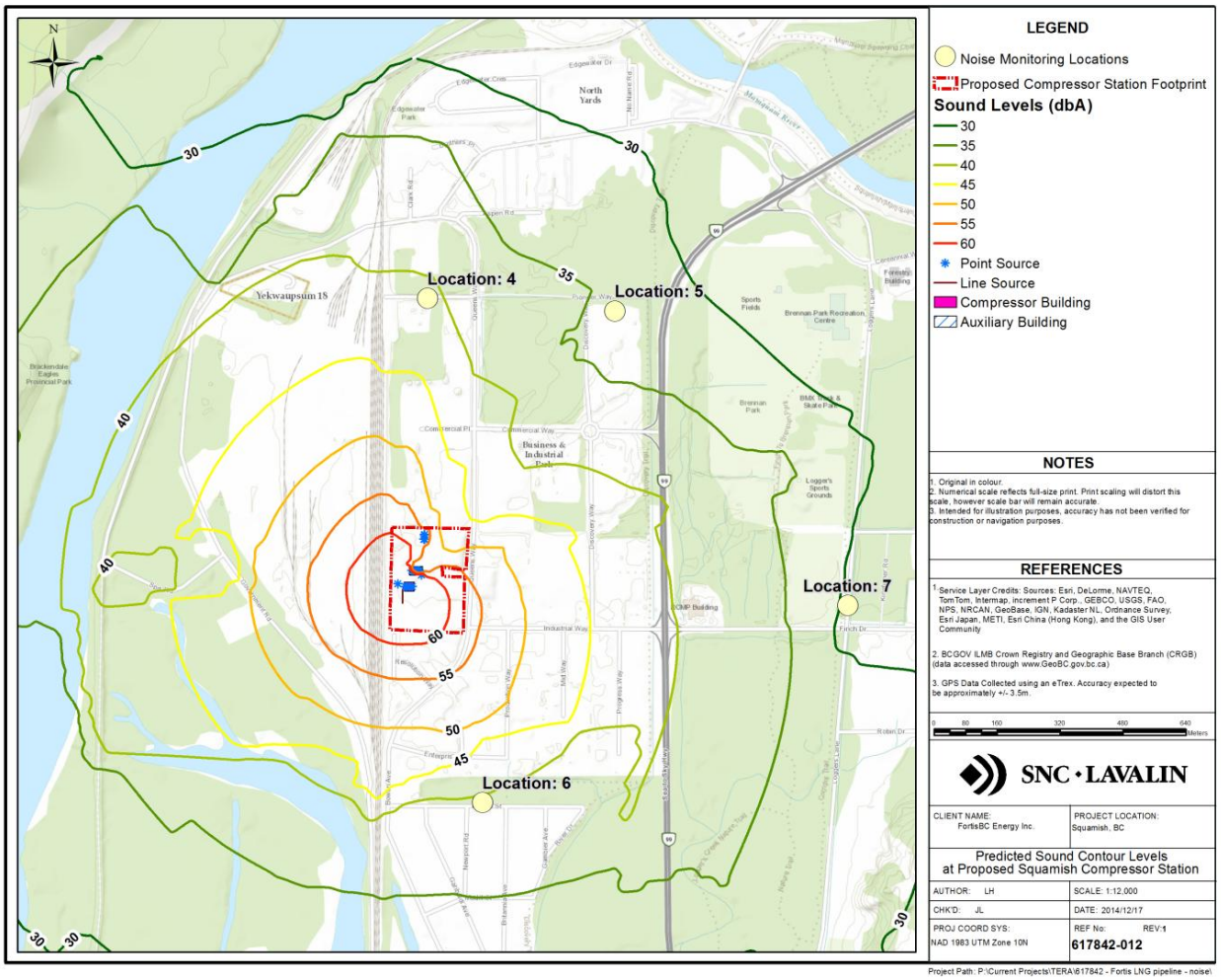


Figure 5.2-4 Predicted sound contour levels due to proposed Squamish compressor station (V2).



6.0 CONCLUSIONS

The key findings of this study are:

- the existing Acoustic Environment around the proposed and existing compressor stations is composed of vehicle traffic, industrial activities, creeks, rail lines, wildlife and the existing compressor stations;
- no reasonably foreseeable developments/activities were identified within the Acoustic Environment LSA or RSA that would act in combination with the proposed Project and cause adverse effects on Acoustic Environment VC;
- the existing compressor station at Eagle Mountain (V1) does not substantially contribute to the ASL in the Acoustic Environment LSA;
- the existing compressor station at Port Mellon (V3) does not substantially contribute to the ASL in the Acoustic Environment LSA;
- construction-related noise is not expected to be substantial and should be managed using controls consistent with best practices;
- the permissible sound level at all dwellings within the Acoustic Environment LSA of the existing Eagle Mountain (V1) compressor station is 48 dBA at night;
- the permissible sound level at all dwellings within the Acoustic Environment LSA of the proposed Squamish (V2) compressor station is 48 dBA at night;
- the permissible sound level at all dwellings within the Acoustic Environment LSA of the existing Port Mellon (V3) compressor station is 40 dBA at night;
- the proposed components to be installed at the Eagle Mountain (V1B) compressor station with expected engineering measures are predicted to produce sound levels below the permissible sound level recommended by the BC OGC, and the change in the calculated %HA at the receptors does not exceed Health Canada guidelines;
- the proposed components to be installed at the Squamish (V2) compressor station with expected engineering measures are predicted to produce sound levels below the permissible sound level recommended by the BC OGC, and the change in the calculated %HA at the receptors does not exceed Health Canada guidelines; and
- the proposed components to be installed at the Port Mellon (V3) compressor station are expected to produce lower sound levels than the existing compressor unit which are lower than the PSL.

Table 6.2-1 summarizes the day-night equivalent sound level from noise monitoring for the receptor locations in Coquitlam and Squamish.

TABLE 6.2-1
NOISE MONITORING AND MODELLING RESULTS

Compressor station	Receptor location	Measured Ldn* (dBA)	Modelled Ldn* (dBA)
Eagle Mountain (V1)	1	63	37
	2	48	32
	3	48	21
Squamish (V2)	4	59	40
	5	58	33
	6	57	39
	7	62	34

* Ldn = day-night equivalent level is the 24-hr Leq where Ln is increased by 10 dBA to account for greater sensitivity to noise at night.

7.0 REFERENCES

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APPENDIX A

SELECTED FIELD PHOTOS

Plate 1 Noise monitoring site 1 looking west off of Parkway Boulevard, Coquitlam, BC (May 27, 2014).

Plate 2 Noise monitoring site 2 looking southwest at Westwood Golf Academy, Coquitlam, BC (May 27, 2014).

Plate 3 Noise monitoring site 4 looking south at west end of Pioneer Way, Squamish, BC (May 30, 2014).

Plate 4 Noise monitoring site 6 looking north on Magee Street, Squamish, BC (May 30, 2014).

Plate 5 Noise monitoring site 8 looking north to Port Mellon Highway, Port Mellon, BC (September 22, 2014).

APPENDIX B

NOISE TERMINOLOGY

Acoustic environment	Combination of natural and anthropogenic sound within a given area.
Ambient noise	The all-encompassing noise existing in a given situation at a given time, usually a composite of noise from several sources, near and far.
A-weighting	A weighting curve that emphasizes the middle frequency components similar to the response of the human ear. dBA = A weighted dB
Energy equivalent sound level (Leq)	The equivalent continuous sound pressure level for a time interval. It represents the average value of the sound pressure. At our present state of knowledge, it is this level that seems the best to use in assessing the annoyance caused by exposure to a long-term noise.
Noise	All sounds perceptible by the human ear. Noise is generally associated with nuisance.
Sound	Auditory sensation produced by a sound wave (*e.g.*, an air vibration). Such vibrations are very small in comparison to the atmospheric pressure of the air.
Sound power level	A unit of measure of sound power emitted by a sound source. It is an inherent property of the source. Sound power level = 10 Log (W/W_0) (dB or dBA) W = sound power (Watt) W_0 = reference sound power 10^{-12} (Watt)
Sound pressure level	A unit of measure of sound pressure. The threshold of hearing is 0 dB. The threshold of pain is 140 dB. Generally, an increase of 5 to 10 dB is perceived as twice as loud. Sound pressure level = 10 Log (p^2/p_0^2) (dB or dBA) p = sound pressure (Pa) p_o = reference sound pressure 2 x 10^{-6} (Pa)

APPENDIX C

METEOROLOGICAL CONDITIONS DURING NOISE MONITORING

TABLE C-1
METEOROLOGICAL CONDITIONS DURING NOISE MONITORING

Hour of day	May 27, 2014*		May 30, 2014**		June 1, 2014**		September 22, 2014***	
	Precipitation	Wind speed (km/h)	Precipitation	Wind speed (km/h)	Precipitation	Wind speed (km/h)	Precipitation	Wind speed (km/h)
00 (midnight)	None	12	None	2	None	2	None	28
01	None	10	None	1	None	2	None	29
02	None	13	None	0	None	1	None	27
03	None	7	None	0	None	2	None	34
04	None	8	None	0	None	2	None	36
05	None	7	None	0	None	1	None	31
06	None	5	None	1	None	1	None	32
07	None	5	None	2	None	2	None	32
08	None	9	None	3	None	2	None	35
09	None	14	None	5	None	3	None	30
10	None	12	None	4	None	2	None	26
11	None	18	None	7	None	4	None	23
12 (noon)	None	16	None	13	None	15	None	24
13	None	17	None	17	None	17	None	26
14	None	21	None	14	None	15	None****	26
15	None	18	None	11	None	10	None****	22
16	None	16	None	13	None	13	None****	26
17	None	14	None	11	None	11	None****	12
18	None	12	None	8	None	8	None****	7
19	None	8	None	9	None	7	None	3
20	None	11	None	2	None	2	None	2
21	None	7	None	2	None	1	None	2
22	None	6	None	3	None	3	None	3
23	None	11	None	0	None	3	None	2
24	None	12	None	2	None	2	None	-

** Source: Environment Canada "Vancouver Intl A" station (2014)*
*** Source: Environment Canada "Squamish Airport" station (2014)*
**** Source: Environment Canada "Point Atkinson" station (2014)*
**** SNC-Lavalin technician noted that it was raining at site during these periods.

APPENDIX D

NOISE MONITORING RESULTS

Figures D-1 to D-10 show the noise monitoring results for the existing Eagle Mountain (V1), proposed Squamish (V2) and existing Port Mellon (V3) compressor stations. More details are provided in Sections 4.6 and 5.2.2.

Figure D-1 Noise monitoring at Eagle Mountain (V1) Site 1 on May 27, 2014.

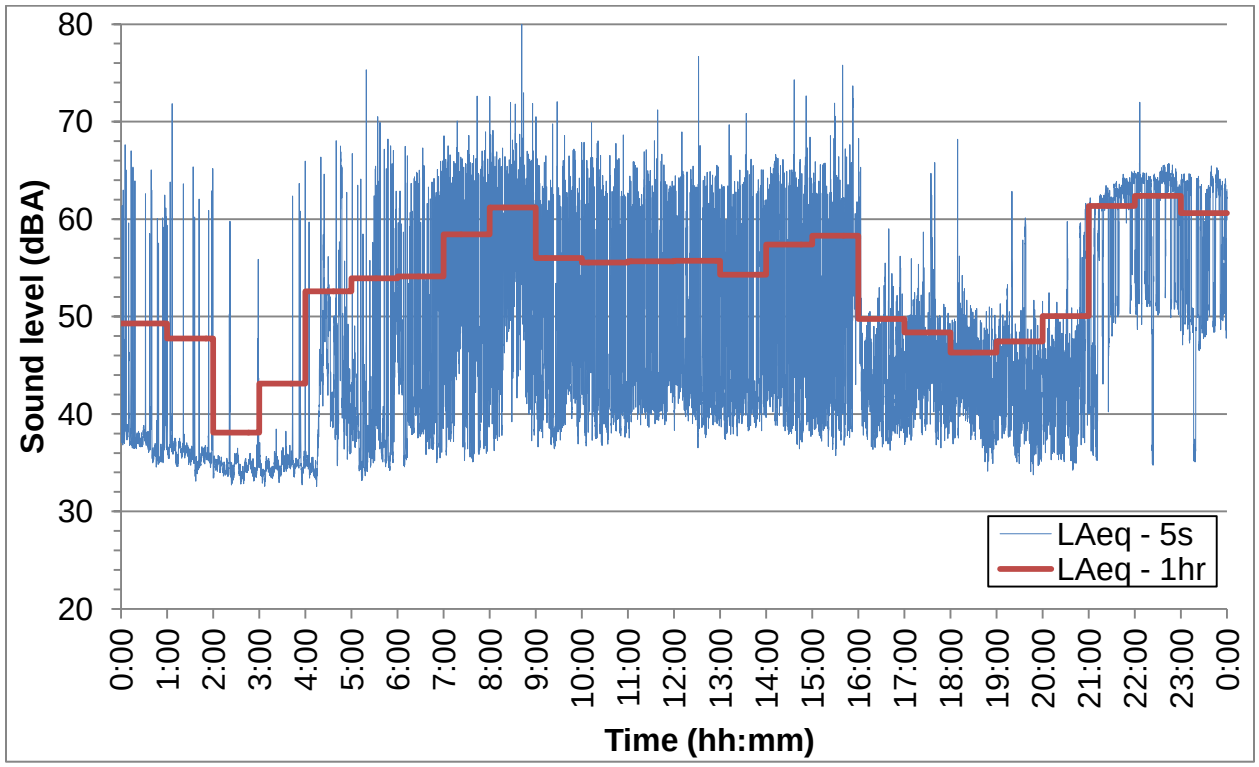

Figure D-2 Noise monitoring at Eagle Mountain (V1) Site 2 on May 27, 2014.

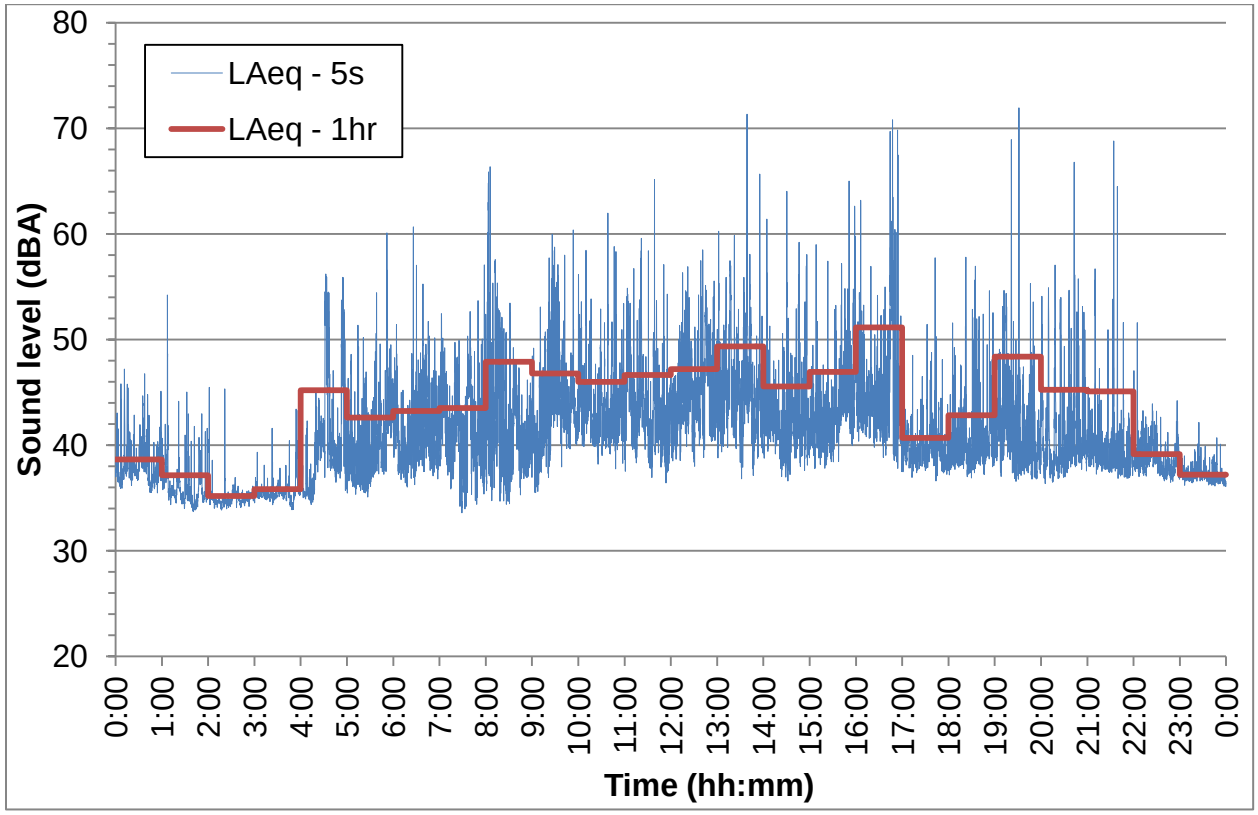

Figure D-3 Noise monitoring at Eagle Mountain (V1) Site 3 on May 27, 2014.

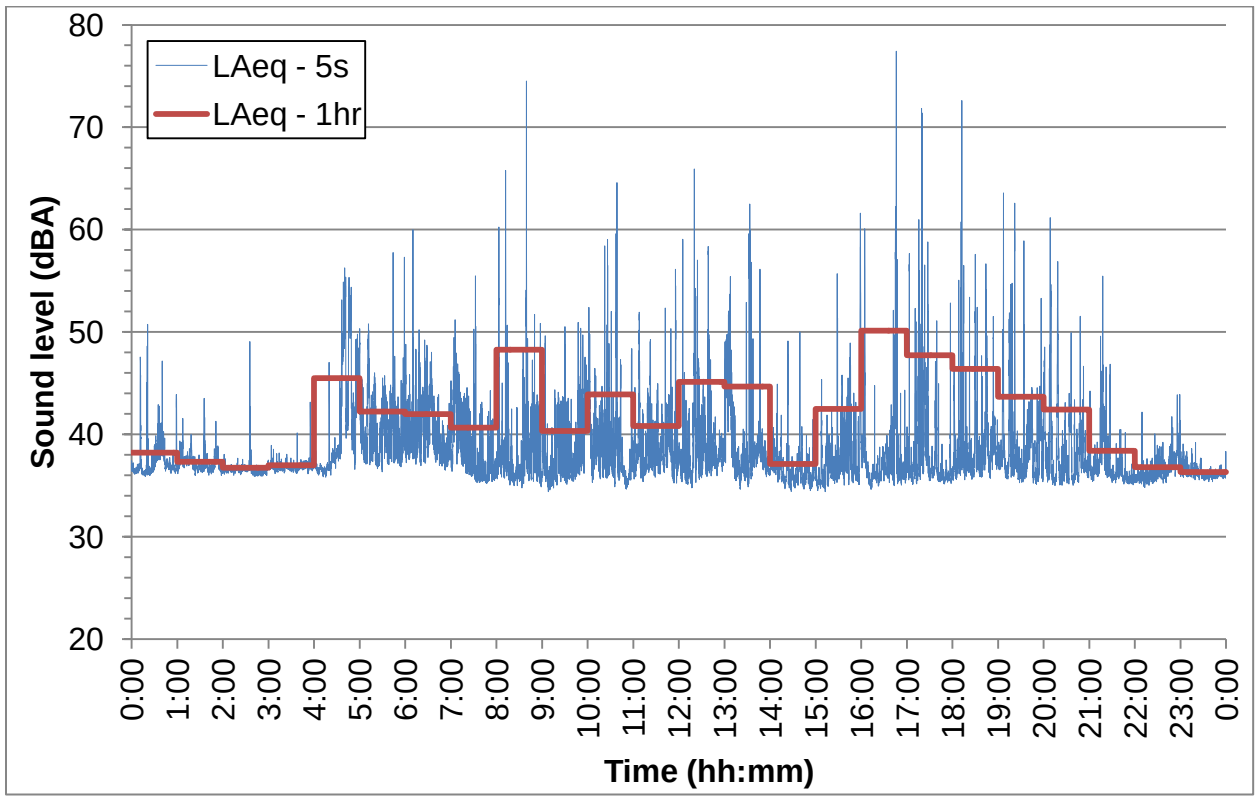

Figure D-4 Noise monitoring at Squamish (V2) Site 4 on May 30, 2014.

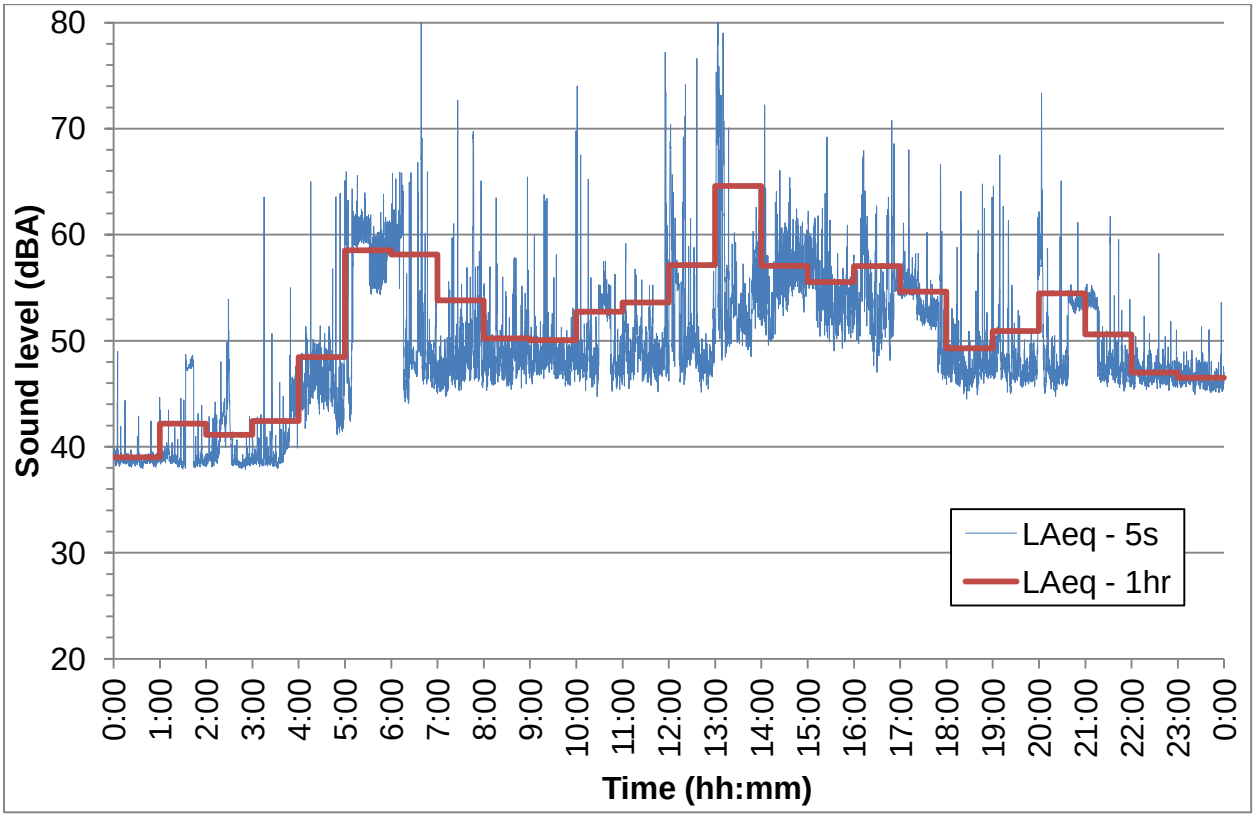

Figure D-5 Noise monitoring at Squamish (V2) Site 5 on May 30, 2014.

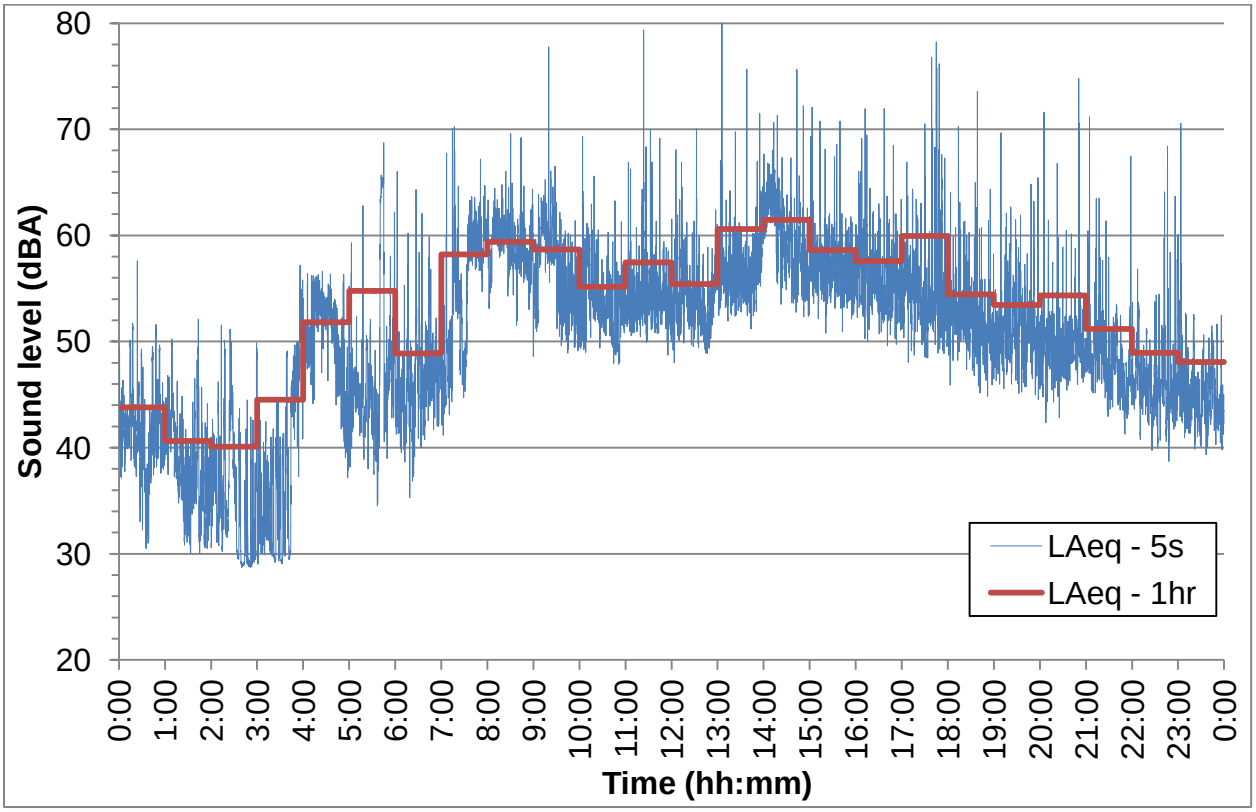

Figure D-6 Noise monitoring at Squamish (V2) Site 6 on May 30, 2014.

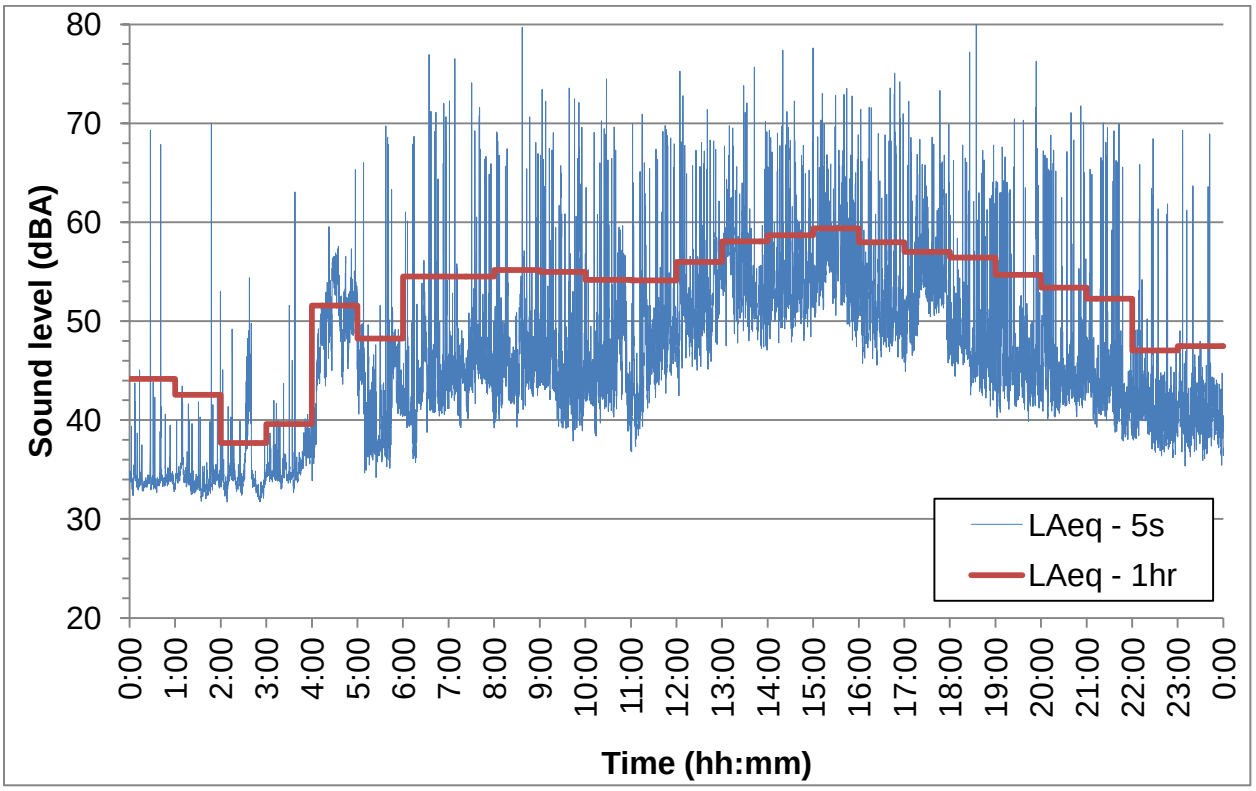

Figure D-7 Noise monitoring at Squamish (V2) Site 4 on June 1, 2014.

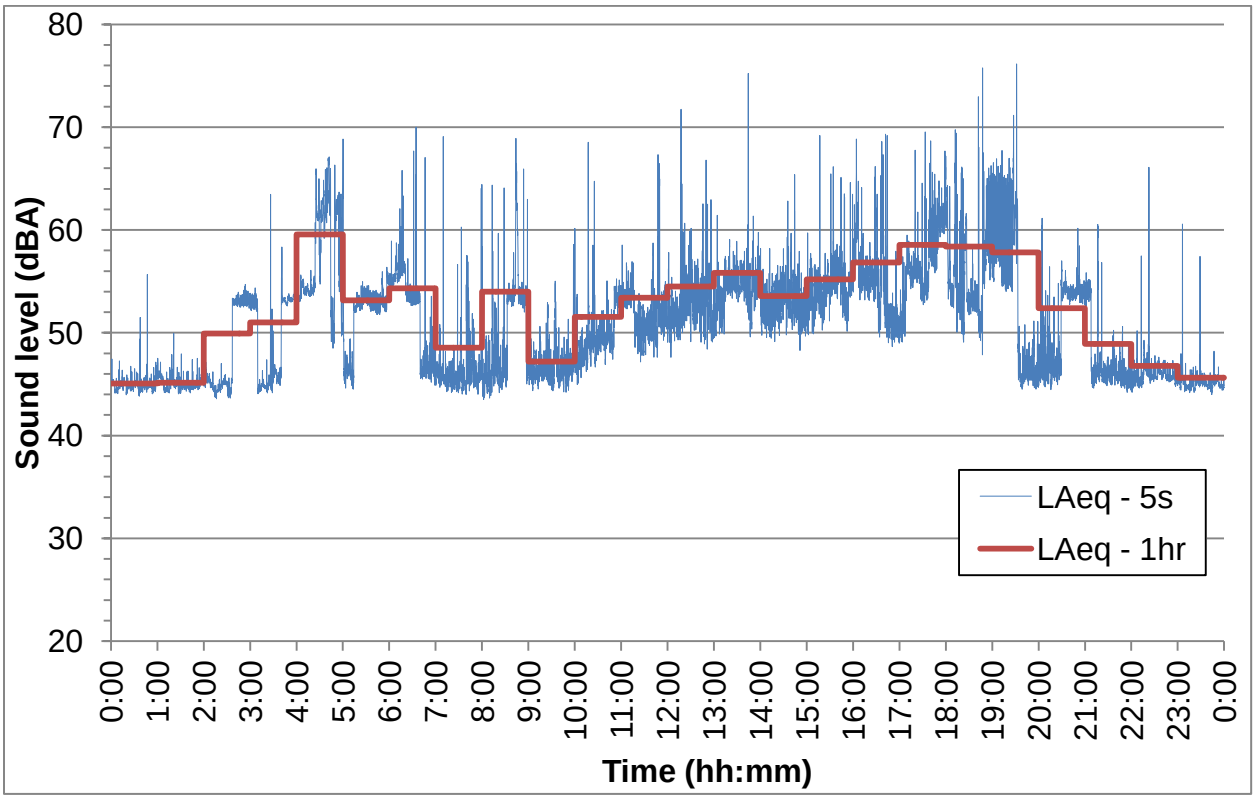

Figure D-8 Noise monitoring at Squamish (V2) Site 6 on June 1, 2014.

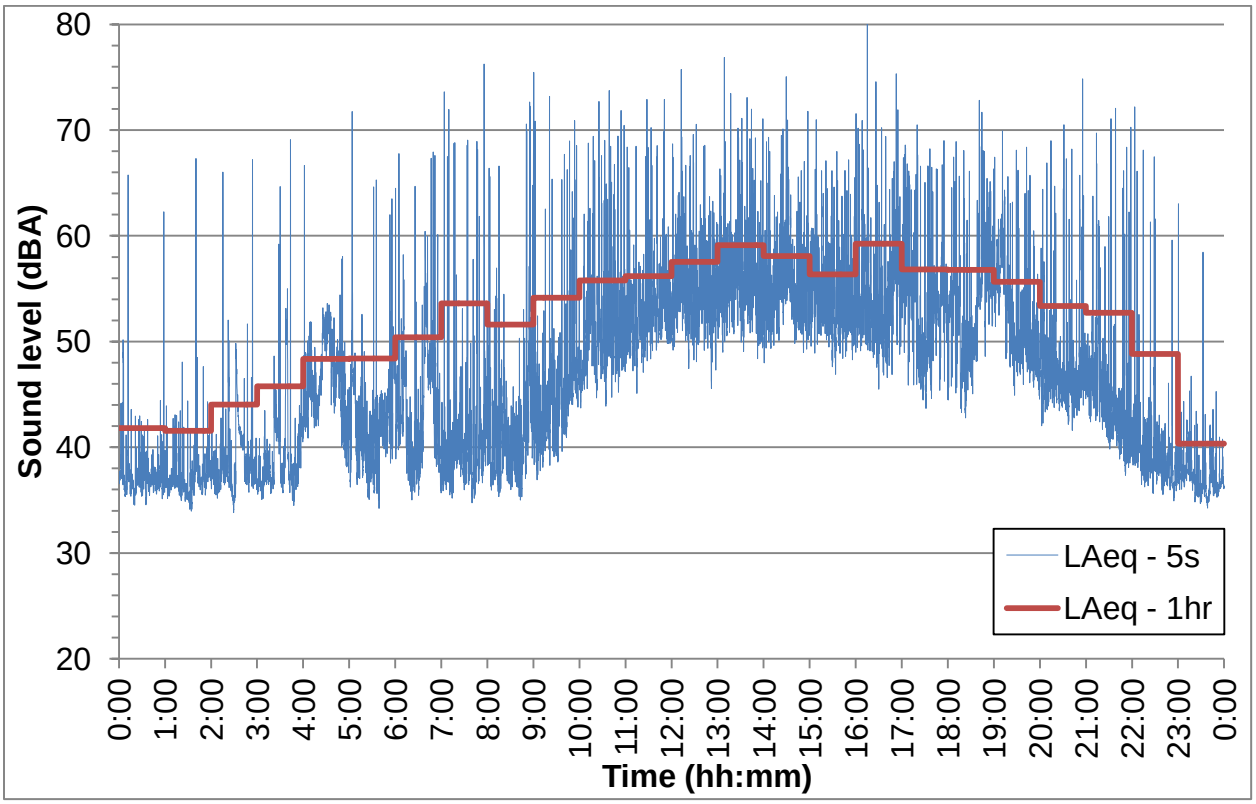

Figure D-9 Noise monitoring at Squamish (V2) Site 7 on June 1, 2014.

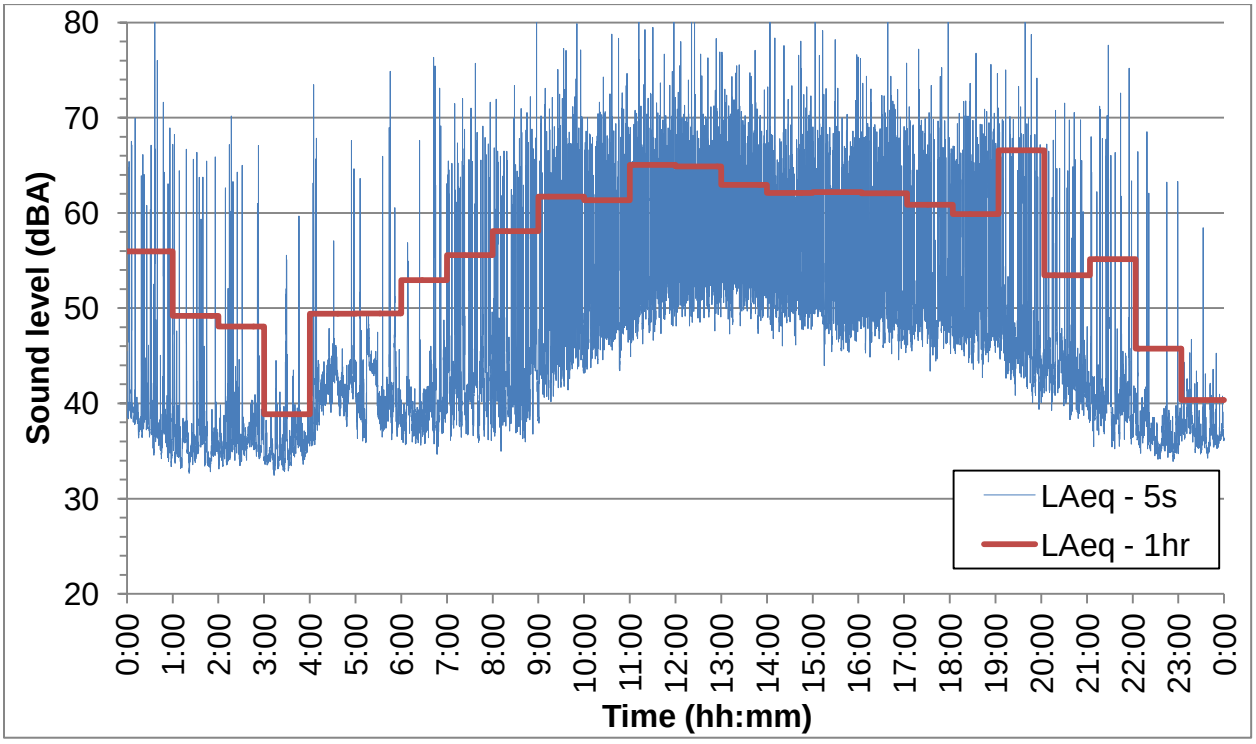

Figure D-10 Noise monitoring at Port Mellon (V3) Site 8 on September 22, 2014.