Atlantic Gold

Appendix J.1

Noise Baseline and Predictive Modeling - Fifteen Mile Stream Gold Project, Wood Environment & Infrastructure Americas

Noise Baseline and Predictive Modeling
Fifteen Mile Stream Gold Project

Trafalgar, Nova Scotia
Project # TAV1987501

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1.0 ACOUSTIC ENVIRONMENT

A noise impact assessment was conducted for the proposed Fifteen Mile Stream (FMS) Gold Project (the Project) to identify and describe potential environmental noise effects of the Project, determine compliance with existing permissible sound levels, and to indicate whether additional noise control measures are required to mitigate any adverse environmental noise effects.

1.1 Project Setting

The Project is located in the Halifax County, close to (within 5 km) the Guysborough County line. The closest village, Sheet Harbor is located 33 km to the south of the mine site, and Upper Musquodoboit is located 30 km to the west. Fifteen Mile Stream is situated in an area of low topographic relief, climbing gently to the east from around 110 masl (meters above sea level) to 150 masl with scattered drumlins reaching 170 masl. Commercial activities in the area include widespread logging, including clear cutting in the immediate area of the Project. The proposed Project is more than 4.9 km from the nearest residence as shown in Appendix A.

The mine is planned as a surface operation with drill-and-blast, load-and-haul, and process-on-site activities based on 365 operating days per year with two 12 hour shifts per day. A total of 10.8 Mt of ore will be milled during the life of the mine to produce a concentrate for shipment to the Touquoy Mine Site for processing. Approximately 97% of the ore by weight will be disposed of as tailings in the FMS tailings management facility (TMF). Waste material will be deposited at a waste rock storage facility (WRSF).

1.2 Environmental Acoustics

Sound is mechanical energy transmitted by pressure waves through a medium such as air. Physically, there is no distinction between sound and noise. It is common practice to define noise simply as unwanted sound, thus, the terms sound and noise are often used interchangeably.

There are several measurement scales that are used to describe the intensity or level of the environmental sound at a particular location. The most common is the A-weighted sound level expressed in the decibel unit (dBA). The dBA scale gives greater weight to the frequencies of sound to which the human ear is most sensitive. There is a relationship between the subjective noisiness or loudness of a sound and its intensity. Each 10 dBA increase in sound level is perceived as approximately a doubling of loudness over a fairly wide range of intensities (Bell 1994).

In general, the more a new noise exceeds the previously existing ambient noise level, the less acceptable the new noise will be judged by those hearing it. Therefore, a new noise source will be judged more annoying in a quiet area than it would be in a noisier area. The following empirical relationships can be helpful in understanding the quantitative changes in noise levels (Cowan 1994):

- change of only 1 dB in sound level cannot be perceived;
- 3 dB change is considered a just-noticeable difference;

- change in level of at least 5 dB is required before any community response would be expected; and
- 10 dB change is subjectively heard as approximately a doubling in loudness, and would almost certainly cause an adverse community response.

These relationships take place in part because of the logarithmic nature of sound and the decibel system. This is why two noise sources do not combine in a simple additive fashion, but rather logarithmically. For example, if two identical noise sources produce noise levels of 50 dB, the combined sound level would be 53 dB, not 100 dB.

The measurement of sound level with standard instruments equipped with an A-weighting filter results in a de-emphasis of the very low and very high frequency components of sound in a manner similar to the frequency response of the human ear. This correlates well with subjective reactions to noise. All sound levels in this report are A-weighted, unless indicated otherwise.

Because sound levels can vary markedly over a short period of time, a method for describing the average character of the sound must be utilized. Most commonly, environmental sounds are described in terms of an average level that has the same acoustical energy as the summation of all the time-varying events. This energy equivalent sound/noise descriptor is called the sound equivalent level (L_{eq}). The most common averaging period is hourly; however, L_{eq} can describe any series of noise events for any selected duration.

To describe the time-varying character of environmental noise, statistical noise descriptors were developed. "L_{10}" is the A-weighted sound level equaled or exceeded during only 10% of the measurement time. The L_{10} provides a good measure of the maximum sound levels caused by intermittent or intrusive noise. "L_{50}" is the A-weighted sound level that is equaled or exceeded 50% of the measurement time period and represents the median sound level. The "L_{90}" is the A-weighted sound level equaled or exceeded 90% of the time. Since this represents "most" of the time, L_{90} generally has been adopted as a good indicator of the ambient baseline noise level.

1.3 Noise and Vibration Standards and Criteria

Noise is defined as an environmental contaminant in Section 2(c) of the *Environmental Protection Act* of the Province of Nova Scotia (NSE 1990). Nova Scotia Environment has established Provincial Guidelines for acceptable noise levels pertaining to human health at specific times, which are as follows:

- Leq of 65 dBA between 0700 to 1900 hours (daytime);
- Leq of 60 dBA between 1900 to 2300 hours (evening time); and
- Leq of 55 dBA Leq between 2300 to 0700 hours (nighttime, all day Sunday and statutory holidays).

The assessment criteria of the FMS project are the Provincial Guidelines listed above, these apply both at the mine site boundaries and at permanently occupied dwellings within the assessment area. Since the mine operations will be continuous over 24-hour periods, the more restrictive nighttime criterion L_{eq} of 55 dBA is used to evaluate compliance of the Project.

There are no legislated noise limits that apply to wildlife. The effects of noise on wildlife are dependent on both the type of noise and the wildlife species. The Environment Code of Practice for Metal Mines (EC 2012) recommends that ambient noise for wildlife should not exceed 45 dBA at night and 55 dBA during the day.

Nova Scotia blasting and vibration legislation includes the *General Blasting Regulations* made pursuant to the *Nova Scotia Occupational Health and Safety Act* (OHSA1996) and the *Nova Scotia Pit and Quarry Guidelines* (NSDEL 1999). The latter advises that the following criteria are not to be exceeded at or beyond mine boundaries:

- ground vibration of 12.5 mm/s (0.5 in/s) peak particle velocity measured below grade or less than 1 meter above grade; and
- concussion (air blast) noise of a maximum of 128 dBA within 7 meters of the nearest structure not located on the property where the blasting operations occur.

2.0 STUDY AREA BOUNDARIES

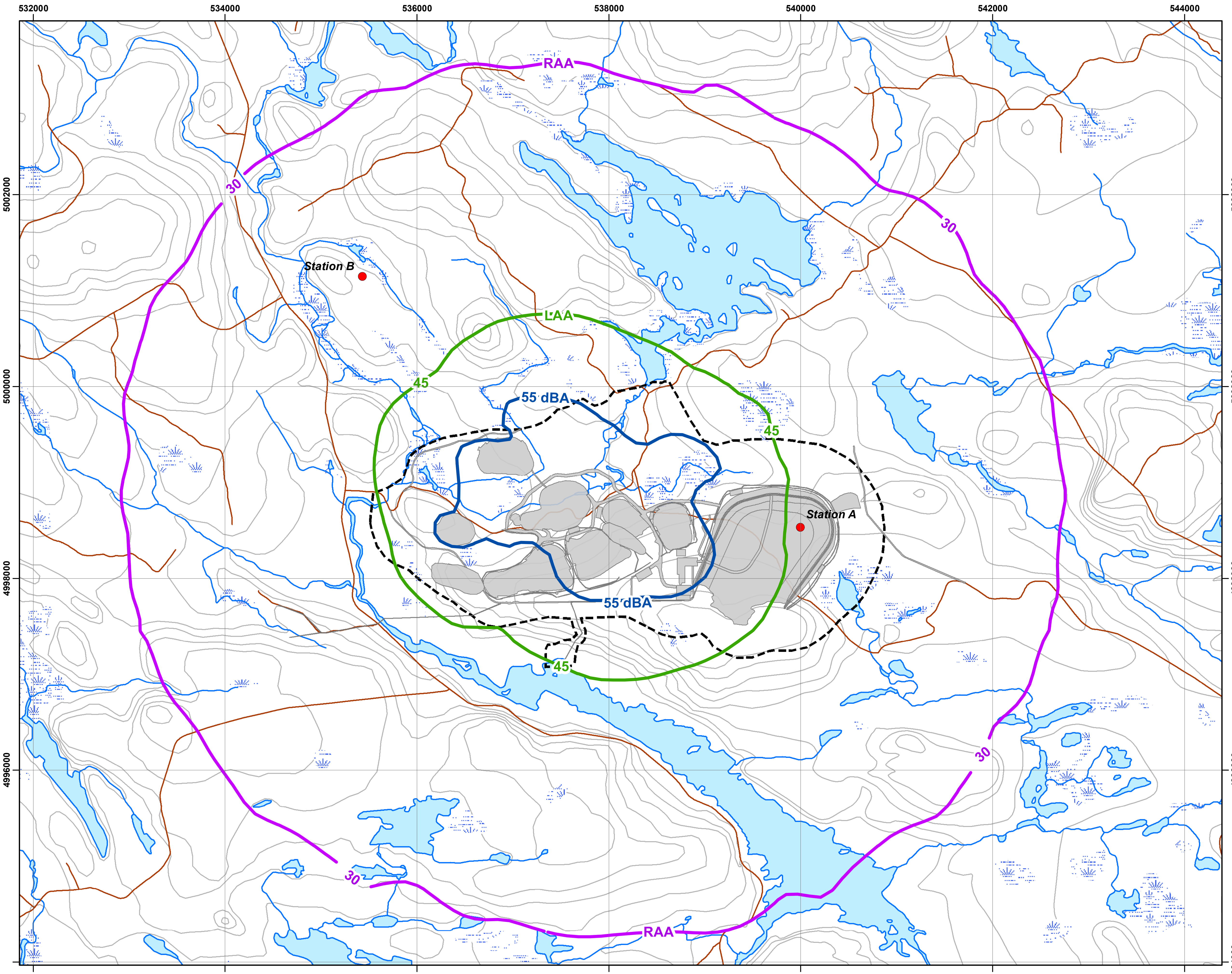
The proposed FMS Mine Site is defined as the area contained within the property boundary to be leased or owned by the proponent (refer to Figure 2-1). The spatial boundaries for the EIS Local Assessment Area (LAA) and Regional Assessment Areas (RAA) for the noise Valued Component (VC), as well as the temporal boundaries are defined in the following subsections.

2.1 Spatial Boundaries

The Local Assessment Area (LAA) for noise and vibration is defined by the location of the targeted equivalent sound level for wildlife of 45 dBA to be achieved at approximately 2 kilometers (km) from the center of the proposed mine production area (UTM NAD 83 Zone 20 coordinates 538000 m E, 4999000 m N). The FMS Mine Site and part of the local road infrastructure are approximately inside the LAA. There are no permanently occupied dwellings within the FMS Mine Site.

The Regional Assessment Area (RAA) for noise and vibration is defined by the 30 dBA noise contour which extends beyond the proposed LAA by approximately 2 km in all directions. The boundary was determined based on the approximately 4 to 5 km distance required for attenuation of the high-level mine noise to background levels in the surrounding environment. Complex topography and the forest cover of the area adjacent to the proposed FMS Mine Site will result in substantial reduction in noise levels. Additionally, 30 dBA threshold is commonly accepted as nightly noise exposure with no sleep interference (WHO 2009). The LAA (green contour) and RAA (purple contour) are shown in

Figure 2-1.

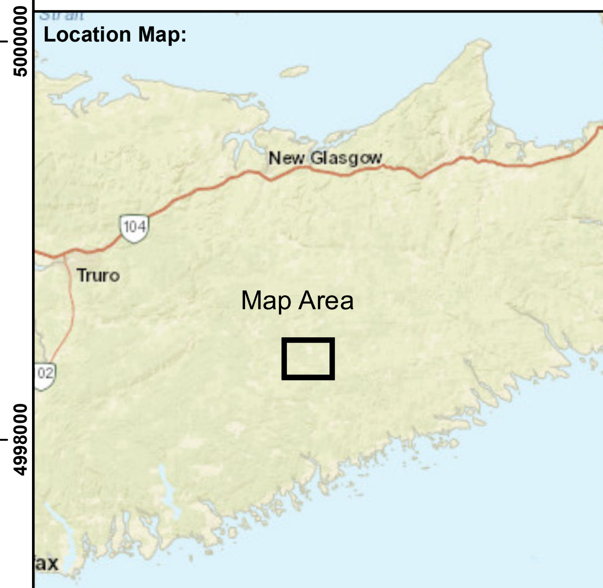


wood.

Legend

- FMS Mine Site
- Preferred Infrastructure Layout
- Sound Monitoring Stations
- Local Assessment Area
- NS Environment Nighttime Noise Criterion of 55 dBA
- Regional Assessment Area

Location Map:



Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 500 1,000 2,000 Meters

1:38,000

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Project:	Fifteen Mile Stream Trafalgar, NS
Title:	Environmental Noise Impact Assessment
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Figure No.	2-1

2.2 Temporal Boundaries

Temporal boundaries relate to periods during which planned Project activities are reasonably expected to increase noise levels. The potential impact of noise will be considered for peak periods during construction and operation phases of the Project when activity levels are at their maximum, thus generating the most noise. Therefore, noise is assessed as a snapshot during (i) construction and during (ii) full operation in Year 5 (worst-case scenario) to represent project impacts. No distinction is made between daytime and nighttime periods because construction and operational activities will be carried out continuously.

2.3 Administrative and Technical Boundaries

The administrative and technical boundaries and assessment criteria for noise impacts of the FMS project are established by:

- Section 2(c) of the Environmental Protection Act of the Province of Nova Scotia;
- Guidelines for Environmental Noise Measurement and Assessment. Nova Scotia Environment and Labour (NSE, 1990);
- Pit and Quarry Guidelines. Nova Scotia Environment and Labour (NSDEL, 1999); and,
- Blasting Safety Regulations made under Section 82 of the Occupational Health and Safety Act S.N.S. 1996 (OSHA, 1996).

These apply both at the mine boundaries and at permanently occupied dwellings within the assessment area.

3.0 BASELINE ACOUSTICAL ENVIRONMENT

Knowledge of background sound levels is a prerequisite to any noise impact assessment as the background noise will be added to the project-generated noise giving the cumulative environmental noise levels. Also, the background noise is important in assessing perception of sound, as a person's subjective reaction is to compare the new acoustic environment to the existing ambient noise levels.

Most environmental noise is a conglomeration of distant noise sources that results in a relatively steady background noise having no identifiable source. These distant sources may include wind in trees, birds and animal noise, rainfall, distant aircrafts, logging activities, traffic, etc. Background environmental sound is relatively constant from moment to moment. As natural forces change or as human activity follows its daily cycle, the sound level may vary slowly from hour to hour. Superimposed on this slowly varying background is a succession of identifiable noisy events of brief duration. These may include nearby activities such as helicopter pass by, snowmobile or ATV operation, hunting, aircraft flyover, etc. which cause the environmental noise level to vary from instant to instant. However, a high-level short-duration single noise event can be excluded from baseline noise characteristics if it deviates markedly from other observations in the measured sound levels.

3.1 Methodology

Background sound levels were measured continuously over a 24-hour period on November 20 - 22, 2017 at two monitoring sites located within the proposed FMS Mine Site at an elevation of approximately 120 masl. The survey time span included hours of daytime (7 am to 7 pm), evening (7 pm to 11 pm) and nighttime (11 pm to 7 am). Photos 1 and 2 show the sound meters at monitoring stations A and B, respectively. The locations are shown on Figure 2-1.

Photo 1: Sound Track LxT

Photo 2: Sound Meter System 824

The monitoring procedure adhered to the following guidelines for an environmental noise survey:

- American National Standard ANSI 1994: Procedures for Outdoor Measurement of Sound Pressure Level; and
- International Standard ISO/DIS 1996-1 & 1996-2.2 Acoustics – Description, Assessment and Measurement of Environmental Noise.

The survey data were recorded at predetermined intervals and stored in the instruments data logger. The logged parameters were downloaded to a computer and analyzed using dedicated software. Sound pressure levels (SPL) as L_{eq} were retrieved and exported to an Excel spreadsheet to determine:

- elimination of outliers (the Grubbs' test (Grubbs, 1969));
- daytime, evening, and nighttime equivalent sound pressure levels L_{eq};

- statistical descriptors (L_{90}, L_{50}, L_{10}); and,
- sound lowest L_{min} and highest L_{max} levels.

3.2 Instrumentation

The noise monitors used were the System 824 Sound Level Meter/Real Time Analyzer and the Sound Track Model LxT, both manufactured by Larson Davis, Inc. The instruments are battery-powered and can be operated continuously in several modes including integrated sound level meter (ISM) for recording numerous sound parameters. The measurement modes of both instruments included:

- Field calibration test;
- Slow Time Weighting;
- A-Scale;
- Enabled Data Storage;
- Energy Exchange Rate Q = 3; and,
- Internal reports.

Instruments specs and operational data are available online at:

System 824: www.larsondavis.com/products/soundlevelmeters/model824
Model LxT: www.larsondavis.com/products/soundlevelmeters/soundtracklxt

3.3 Meteorological Conditions

Generally, ambient noise surveys are not recommended when wind speeds exceed 4 m/s (15 km/h) at a height of 2 ± 0.2 m above the ground, during precipitation events (snow or rain), at sub-zero temperatures and at relative humidity over 99%. To assure that the required meteorological factors prevailed, a series of measurements were taken during the survey at monitoring stations A and B with a portable Kestrel 3000 weather meter. The instrument specification is available online at:

https://kestrelmeters.com/products/kestrel-3000-wind-meter.

The results for 20 to 22 November 2017 period are averaged in Table 3-1.

Table 3-1 Weather Data Collected in the Proposed FMS Mine Area

Parameter	Range	Average
Wind speed, m/s	0.4 – 1.9	1.2
Wind direction (from), deg.	181 - 276	244
Temperature, °C	0.6 – 7.3	3.2
Cloud cover (1 – 10 scale)	Clear (0/10) to Cloudy (4/10)	1/10
Precipitation, mm	Nil	Nil
Relative humidity, %	35 - 83	58

The weather observed at the surveyed sites during a three-day period was deemed acceptable for a noise survey.

3.4 Baseline Conditions

Collected comprehensive sound data sets were downloaded and reviewed for consistency, unity, and quality using Larson Davis software. The outstanding maximum data points which did not appear to fall within the recorded baseline sound distribution patterns were dismissed using an Excel-based algorithm if they failed the extreme studentized deviate statistical test for the true population (Grubbs 1969). A summary of the sound pressure level (SPL) results and logarithmic averages are shown in Table 3-2.

The logarithmic averages were calculated using the following formula:

$$L_{eq} = 10 \times \log \{\Sigma\, fi \times 10^{(Li / 10)}\}$$

where: fi = fraction of the total time the constant level Li was measured, i.e., 1 min over 720 min daytime

Li = corresponding 1 min SPL in dBA

Table 3-2 Summary of Background Noise Survey

Location	UTM Coordinates		Time	Monitor Type	Sound Pressure Level (dBA)					
	m E	m N			L_{eq}	L_{10}	L_{50}	L_{90}	L_{max}	L_{min}
Station A	539995	4998537	Day	824	36.3	39.7	34.5	27.3	45.3	21.5
			Evening		31.3	34.8	28.3	22.6	41.9	19.7
			Night		34.7	37.9	31.7	27.8	50.7	23.9
Station B	535431	5001152	Day	LxT	33.8	38.1	29.3	23.4	47.8	19.7
			Evening		30.6	32.0	29.5	25.8	42.4	24.1
			Night		27.9	29.1	27.0	24.9	45.0	23.4
Average SPL in FMS Area			Day		35.2	39.0	32.6	25.8	--	--
			Evening		31.0	33.6	29.0	24.5	--	--
			Night		32.5	35.4	30.0	26.6	--	--
			24-Hour		33.9	37.4	31.4	25.9	--	--

where Sound Pressure Levels (SPLs) are defined in Section 1.2 above.

As shown in Table 3-2, the long-term measurements revealed that at the FMS Mine Site the equivalent SPL's were as low as 27.9 dBA L_{eq} at nighttime (Station B). Logarithmic averages for the surveyed area (comprising Stations A and B) were 35.2 dBA at daytime, 31.0 dBA during evening hours and 32.5 dBA at nighttime. For comparison, in rural Alberta, the average rural ambient sound level is about 35 dBA at night (AER 2007). At the Touquoy Mine Site the background L_{eq} is in the range of 39.6 dBA at nighttime to 46.8 dBA at daytime (CRA 2007).

The L_{eq} comprises all noise from all sources, including sporadic intrusive anthropogenic sources (e.g. helicopter flyover or nearby ATVs). Therefore, L_{eq} does not typically reflect the natural sound level in the area. The L_{90} is considered a true representation of the overall residual or background noise as it represents the SPL 'most' (90%) of the time at the measurement site. In the FMS Mine Site, the average overall SPL (24h) L_{90} was 25.9 dBA and has been used in the noise model as the representative background noise level.

The baseline noise survey concludes that the sound levels and sound characteristics in the FMS Mine Site are low, typical of a quiet wilderness and are much lower than Nova Scotia ambient noise standards and criteria defined in Section 1.3 above.

3.5 Background Vibration

Background vibration does not occur at the proposed FMS Mine Site. Natural sources of ground vibration are usually related to volcanic activities and seismic activities caused by movements along the edges of the plates that make up the Earth's crust. No records of seismic or volcanic activity have been found for the proposed FMS Mine Site. Typical anthropogenic sources of background vibration in remote areas include:

- Seismic exploration for gas and oil developments, which use vibrations such as sound waves and shock waves in order to map the different layers of the ground;
- Movement of heavy trucks and earth moving equipment;
- Blasting; and,
- Timber harvesting and hauling by heavy machinery.

None of the above activity was taking place near the proposed FMS Mine Site during monitoring events.

4.0 NOISE AND VIBRATION SOURCES

Acoustic specifications and quantity of noise sources vary over the Project lifespan depending on the Project phase, including construction, operation, closure/decommissioning, and post closure.

Noise generation during the construction and operation phases will fall into three categories that include: (a) instant, (b) intermittent or (c) continuous periods, with levels that vary from low to high. The mining operation, including drilling, blasting, crushing, loading, hauling, waste disposal and ore processing will be the main source of instant or intermittent noise. Noise from vehicles will be intermittent, but it will also add to the continuous noise levels within the FMS Mine Site and along the haul route. Noise sources are described in more detail in Sections 4.1 and 4.2.

Ambient noise levels will vary almost continuously throughout the duration of the Project. Therefore, the approach for quantifying noise levels is to define representative levels of activity during selected periods of time. To ensure a conservative approach, a worst case scenario was analyzed (i.e. the year during which the largest amount of material will be mined, using the most equipment). This scenario is predicted to occur in Year 5 (Yr 5) when the total material mined will reach the maximum of 20 Mt.

Noise emissions for each phase are detailed in the following subsections.

Some ground vibration may occur due to blasting and heavy vehicle movement. Vibration sources of key concern are associated with the blasting activities, they are further discussed in Section 5.3 as part of the effects assessment.

4.1 Construction Phase

The planned start date for construction for the Project is May 2020 with a scheduled operations start-up in 2021. Construction noise emissions are expected to occur over several months due to the following activities:

- leveling and grading;
- vehicle/heavy equipment traffic;
- excavation;
- pile driving;
- concrete pouring;
- steel erection;
- mechanical installation; and,
- commissioning and start-up.

Typical construction equipment used during mine construction includes:

- crawler tractors and dozers;
- front end loaders;
- graders;
- earth haulers;
- dump trucks;
- mobile cranes;
- concrete mixers and pumps;
- impact equipment;
- jack hammers;
- pneumatic tools;
- generators;
- compressors;
- saws; and,
- vibrators.

The predominant noise sources from construction equipment are associated with internal combustion engines and impact equipment. Exhaust noise is usually the most important component of internal combustion engine noise. However, noise associated with the air intake, cooling fans, and the mechanical and hydraulic transmission and control systems may also be significant, depending upon the type and size of specific pieces of equipment.

Impacting equipment typically includes pile drivers, rock drills, and small hand-held pneumatically, hydraulically, or electrically powered tools. The primary noise source for conventional pile drivers is the impact of the hammer striking the pile. Engine-related noise sources, such as combustion explosion or release of steam at the head of some equipment, are usually secondary. The predominant sources of noise in pneumatic tools are the high-pressure exhaust and the impact of the tool bit against the material on which it acts.

4.2 Operations Phase

During operations, noise will be generated by heavy vehicles and equipment associated with mining, ore processing, haul truck movement and continuous disposal of waste material produced at the pit site and processing facilities.

Mobile noise sources include:

- front end wheel loaders;
- drills;
- truck dozers;
- haul trucks;
- rigid frame haulers;
- on-highway trucks;
- hydraulic excavators;
- compactors;
- graders; and,
- supporting vehicles.

Stationary noise sources include:

- crushers;
- mills;
- screens; and,
- conveyers.

A detailed inventory of the Project noise sources for the operations phase is provided in Appendix B.

Blasting noise is air overpressure traveling through the atmosphere. Blasting noise will be generated on a regular basis as all mined material requires drilling and blasting.

4.3 Closure and Decommissioning Phase

The closure and decommissioning phase of the project is dominated by reclamation activities, and therefore noise will emanate from vehicles and activities associated with the decommissioning of the mine site such as dismantling the infrastructure, land restoration, revegetation, open pit backfilling, and access and haul road decommissioning.

4.4 Post Closure

For the post closure phase, noise is not a concern as only occasional noise may occur due to activities associated with cross-discipline follow up and monitoring programs involving small vehicles.

5.0 EFFECTS ASSESSMENT – ACOUSTICS AND VIBRATION

Noise from the Project can be classified into two categories. The first category includes steady, continuous noise typically associated with the continuous operation of stationary equipment, e.g., primary crusher and process plant. This type of noise is expected to emanate from most sources located at the site. The second category is short-term, intermittent noise, typically associated with the effects of vehicles hauling ore and waste rock, drilling and blasting in the open pit mine.

5.1 Equipment Noise

5.1.1 Construction

During the construction phase scheduled for years 2020 and 2021, a large number of machines and trucks will work in small areas. Thus, the FMS Mine Site may be disturbed for several months by noise. Conservatively, sound levels of construction equipment are shown in the second and third columns of Table 5-1. Three typical cases of noise propagation for the construction equipment operating simultaneously in small areas are calculated in Table 5-1.

Table 5-1 Propagation Rate of the Construction Noise

Case	Loudest Equipment	L_{eq} @ 15 m (dBA)	Noise Level (dBA) at Distance (m)					
			15	100	500	1,000	1,500	3,000
A	Truck Grader Backhoe	88 83 80	89	73	59	53	49	43
B	Truck Backhoe Concrete Mixer	88 80 85	90	74	60	54	50	44

	Front-end Loader	85						
C	Grader	82	89	73	59	54	49	43
	Pneumatic Tools	86						

Noise levels are approximated assuming hemispherical spreading of sound with an attenuation rate at 6 dBA per doubling of distance from the sound source. For the above cases a daytime construction noise level of 65 dBA can be expected within approximately a 270 m distance from the construction site. The nighttime permissible level of 55 dBA will be met at a distance of approximately 1,000 m.

5.1.2 Operation

To examine the multiple operation noise issues such as sound propagation and attenuation in air, in combination with numerous noise sources of different acoustical properties, the noise prediction model SPM9613 developed by Power Acoustics Inc. was used. The model incorporates two subroutines:

- ISO 9613-1 specifically addressing atmospheric attenuation; and
- ISO 9613-2 that specifies an engineering method for calculating environmental noise from a variety of noise sources.

A detailed description of the modelling software is available online at: http://poweracoustics.com/software.html

Outdoor sound propagation between a noise source and a receptor (person listening) is affected by several sound attenuation mechanisms. These include:

- distance dissipation: sound naturally decreases with increasing distance from the source;
- ground attenuation: sound is absorbed by the ground as it passes over;
- atmospheric absorption: sound is absorbed by the atmospheres it passes through;
- barrier attenuation: sound is absorbed or blocked by physical barriers; and,
- meteorological conditions: temperature, humidity, wind direction and atmospheric inversion.

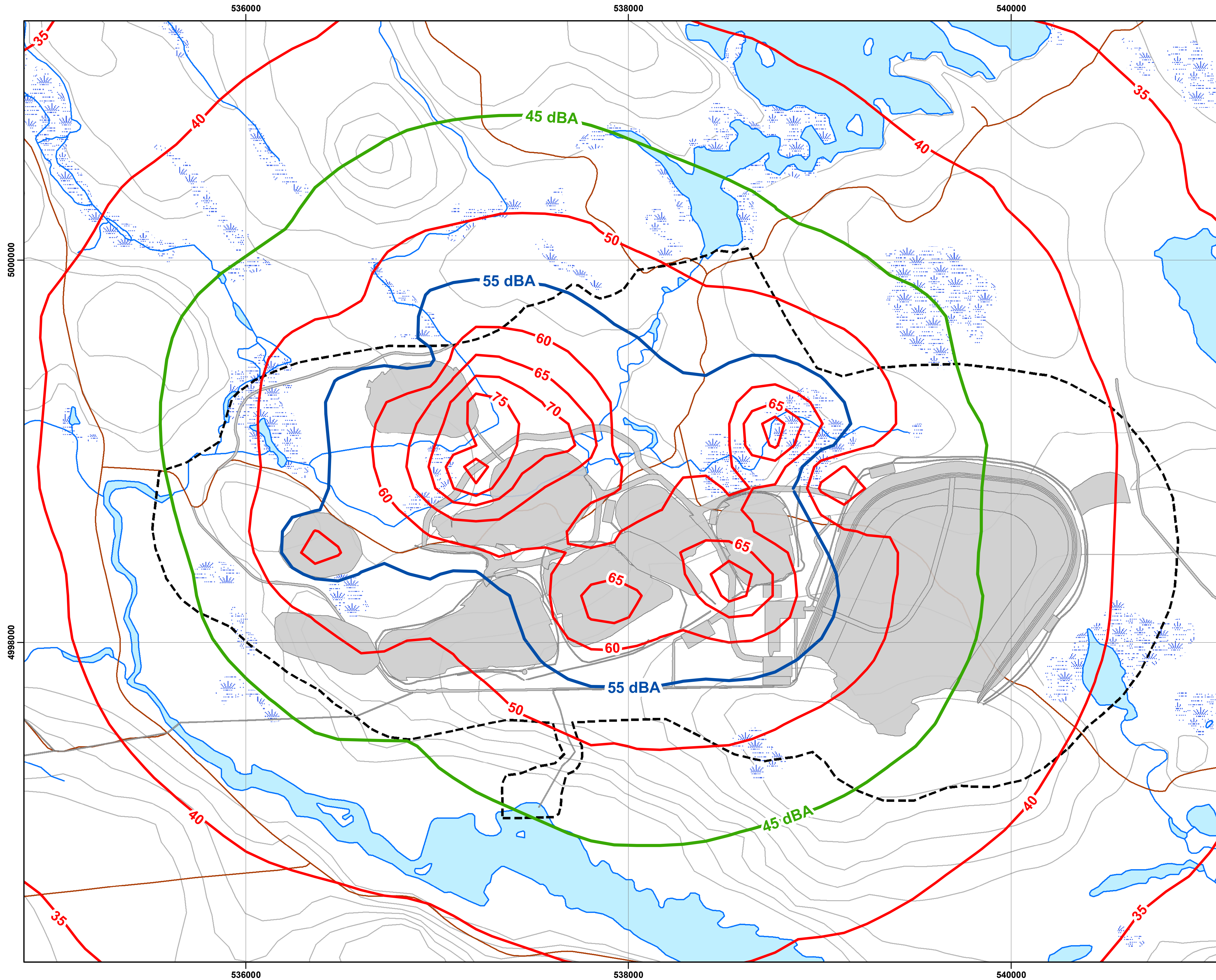
The operation noise modelling is based on the following assumptions:

- only significant noise sources are used in this study including the primary crusher, excavators, dozers, compactors, hydraulic drill, haul trucks;
- noise sources such as mills, grinders, screens, hydraulic separators enclosed in the process plant building are not modeled due to noise transmission losses in the steel walls resulting in low noise levels;
- noise barriers such as main buildings, waste rock stockpile and tailings dam were included in the model;

- maximum noise generated during mining based on equipment count in Year 5 operations (worst case scenario);
- the facility will operate continuously at a constant level on a 24/7 basis;
- octave bands spectrum provided for similar equipment are used for each type of noise source;
- all model input noise levels are in sound power level (PWL) spectrum dB Linear;
- the complex terrain is considered;
- average atmospheric conditions are assumed; and,
- the model grid size was defined to include the previously defined local and regional assessment areas.

The model input data included octave sound power levels for each noise source, locations, 3D dimensions of each source, meteorological parameters, ground attenuation, and the pit geometry. A total of over 20 significant noise sources were modeled. They are shown in Appendix B. Supporting vehicles and electrical motors were excluded because of infrequent use or quiet operation.

The sound level modelling results for the assessment areas are shown in Figure 5-1 as noise level contour plots for an area of 6 km by 5 km with the mine at its centre.



wood.

Legend

- FMS Mine Site
- Preferred Infrastructure Layout
- Noise Contours
- Wildlife Noise Criterion of 45 dBA and Local Assessment Area
- NS Environment Nighttime Noise Criterion of 55 dBA

Location Map:

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS
Units: Meter

0 250 500 1,000 Meters

1:19,000

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The noise contours (isopleths) are in 5 dBA intervals. Arbitrary selected X-Y axis have the 0-0 point located in geographical center of the mine production area with the UTM NAD 83 Zone 20 coordinates 538000 mE, 4999000 mN. Replacing the UTM with the Project related coordinates improves understanding of the spatial aspect of noise propagation as the real direct distances are easily comprehended. The nighttime permissible sound level (PSL) isopleth of 55 dB is shown as a blue line (see Figure 5-1), and is largely within the FMS Mine Site boundaries.

The Project operations noise will be attenuated to the measured background level of 26 dBA at approximately 4 to 5 km from Project facilities. Identified nearest receptors in the region are located beyond this distance, therefore they will not be impacted by the Project noise.

The results reveal that the major noise sources within the proposed FMS Mine Site will be inside the pit. Several equipment units will be simultaneously engaged in handling of overburden and waste material and extraction of ore (e.g., shovels, loaders, trucks, drills, etc.). The combined noise is predicted at approximately 80 dBA level. Due to the mitigation effect of the pit walls, the noise levels on the surface near the pit will be lower, descending outward. The Nova Scotia guideline for a nighttime acceptable noise level of 55 dBA is largely within the FMS Mine Site boundaries as shown by the blue contour.

The model predictions indicate that approximately 95% of the 55 dBA contour are within the FMS mine site boundaries, with one area along the north boundary that exceeds the 55 dBA noise level (refer to Figure 5-1). Therefore the Project predominantly complies with the Nova Scotia Environment permissible sound levels detailed in Section 1.3. The 45 dBA contour is also shown in Figure 5-1 (green contour), and is located at a distance not more than 1.5 km from the FMS Mine Site boundary.

Actual noise levels may vary somewhat due to unpredictable factors that may increase or decrease the propagation of sound. In general, these include:

- increase in trucking noise because of roughness of road surface;
- increase due to multiple reflections from vertical surfaces of the pit and process buildings;
- decrease due to trees;
- decrease because of barriers of all types, mainly hills;
- lower composite noise level because not all the equipment will be used at the same time; and,
- distant sources will be louder under downwind conditions or during atmospheric inversion and quieter during upwind conditions or during neutral conditions.

5.2 Blasting Noise

Blasting is the generation of air blasts which is air overpressure traveling through the atmosphere. The magnitude of the air blast overpressure measured in dBA depends on the explosive type, loading densities, weight, the spacing of blasting holes, the detonator delays and other factors. Ambient conditions such as cloud cover, high winds, and atmospheric temperature inversions also affects propagation of the blasting noise.

The noise from a blast can be loud if the listener is within a few hundred meters of the blast. Airborne pressure waves can cause annoyance because of hearing and feeling (particularly the low frequency component) the noise at levels above peak linear values of around 115 dBA. However, at a distance it is usually heard as a low rumble or thunder sound that lasts one or two seconds. If the wind is blowing away from the listener, there may be no audible sound. Some atmospheric conditions, such as low cloud cover, cause the sound waves to propagate over a greater distance and results in a more noticeable "bang" referred to as an "air blast".

Blast noise contains predominantly low frequency sound with most of the audible sound energy below 50 Hz. For this reason (low attenuation in air), it is omni-directional. Although localized "shadow zones" would occur behind topographic features such as berms and hills, low frequency sound would readily refract or bend around any such obstacles so that noise levels beyond the shadow zone would be similar to what they would have been without the localized barrier.

5.2.1 Construction

Occasionally, during construction, blasting will be required to break rocks into manageable pieces so that they can be excavated and used as tailings dam construction material. Blasting is achieved by first drilling holes into the rock at a prescribed depth and spacing. The holes are subsequently loaded with explosives and fired under carefully engineered guidelines. Increasing the amount of holes or explosives will cause the rock to break into smaller fragments but will also increase construction costs. Ammonium nitrate–fuel oil (ANFO) will be used during construction at the FMS Mine Site.

Sound effects associated with blasting for construction purposes are comparable to those associated with the mine operation, when blasting will occur on a regular basis. The expected sound levels associated with each blast are discussed below under "Operations".

5.2.2 Operations

During the operations phase blasting will take place on a regular basis as all mined material requires drilling and blasting. The initial development of the pit involves blasting close to the original elevation of the ground. However, the pit will be developed as a series of 10 m wide benches, each at the base of a near-vertical, 10 m high rock face. These rock faces will act as sound barriers resulting in blast noise outside the perimeter of the pit being attenuated by an amount dependent upon the depth of the pit.

According to Griffiths and Oates (1978), the additional attenuation to be expected for blast noise originating on the first and second benches below original ground level would be about 2 dB and 6 dB, respectively. Although additional shielding can be expected for blasts on lower benches, it is unlikely that the additional attenuation would ever exceed 15 dB even for very deep pits due to reflection of sound off the opposing faces of the pit.

Till and topsoil material will not require blasting. A typical powder factor of 0.23 kg/t is assumed for the FMS pit. The blasting activities are planned to fall under a contract service agreement with the explosives supplier.

Several empirical formulas have been developed for predicting the unweighted peak noise level from a blast. The prediction formula adopted for the FMS Mine Site is derived by Linehan and Wiss (1980) for the US Bureau of Mines which is:

$$P = 6.31\ e^{-B}\ (D/W^{1/3})^{-1.16}$$

where:

- P = peak overpressure, kPa
- e = base of natural logarithm (e = 2.7183)
- D = distance from blast to receiver
- W = maximum charge weight per delay (TNT equivalent), kg
- B = scaled depth of burial ($C/W^{1/3}$), $m/kg^{1/3}$
- C = depth to center of gravity of charge, m

The constants derived for the formula vary somewhat between mine sites, so to take a conservative approach, those constants that result in the highest predicted noise levels have been used for the Project.

The peak overpressures predicted by the formula above can be converted to unweighted peak SPL's, in decibels, using the following equation:

$$SPL = 20 \log P + 154$$

The maximum charge weight per delay represents the equivalent weight of TNT (an explosive). As per typical mining practice, the explosives will be about 70% ammonium nitrate and 30% fuel oil. Hence, an actual charge weight of 1,000 kg will be equivalent to about 411 kg of TNT. The above formula was derived from blast noise measurements ranging from 30 to 3,000 m.

The primary predictions assume sound propagation over ground. Table 5-2 shows unweighted peak sound pressure levels at different distances caused by the explosion of 1,000 kg of ANFO charge at a depth of 15 m.

Table 5-2 Predicted Blasting Noise Levels

Distance (m)	30	100	500	600	1,000	1,500	2,000	3,000
SPL (dBA)	137	125	109	107	102	98	95	91

Predicted blasting noise will meet the *Nova Scotia Pit and Quarry Guidelines (NSDEL 1999)* criteria of 128 dBA at approximately 100 metres from the blast location.

5.3 Transportation Noise

At Fifteen Mile Stream, ore will be transported to a crusher that will be located 1,500 m southeast of the pit, which will feed the process plant. Waste rock will be deposited into a waste rock storage facility (WRSF) to be situated 700 m south of the pit, or will be used as rock fill in construction of the tailings management facility (TMF) to be located 1,500 m east of the pit.

The administration office and plant site will be accessed via a 5 km mine access road from Highway 374. This road will utilize the existing Seloam Lake Road for approximately 1 km at which point a dedicated 4 km mine access road will be constructed. The road will allow for two-way traffic, one lane in each direction and will not be paved. The road will be used by:

- loaded haul trucks;
- empty haul trucks;
- service equipment (fuel, water, heavy maintenance trucks);
- explosive trucks;
- crew buses;
- emergency vehicles; and,
- light vehicles.

Road construction and operation will generate intermittent noise which will add to the background noise levels (refer to Section 4.1 and 4.2).

5.3.1 Construction

Access road construction will result in noise impacts generated by mechanized equipment such as excavators, loaders, bulldozers, crushers, compactors, graders, and hauling trucks. Borrow site activities will also contribute to construction noise. As well, occasional blasting can be expected. The noise emissions of various alternatives would likely differ somewhat depending on the types and number of pieces of mechanized equipment are in use at a given time and location and on the duration of construction and borrow site activities. Construction will take place on a 24/7 basis and noise sources will slowly move according to progress in completion of road sections.

Noise disturbance close to the road alignment can be expected for nearby wildlife (if present) and recreational areas. There are no residential properties in close proximity to the alignment. Due to the lack of road construction details at this early stage of the Project, detailed noise levels cannot be quantified. However, noise levels along the access road are expected to be comparable to the construction noise at the FMS Mine Site described in Section 5.1.

5.3.2 Operation

Concentrates from the Project will be transported to the Touquoy Mine Site process plant along a combination of existing public and private roads including a 5 km FMS access road. The trucks will complete approximately 8-11 return trips per day at the anticipated production rate. The majority of concentrate to be hauled will be floatation concentrate. Up to 105,000 t of flotation concentrate will be hauled on an annual basis in purpose-built side-dump haul trucks. They will be the prevailing noise sources. Other vehicles will be relatively quiet or used infrequently.

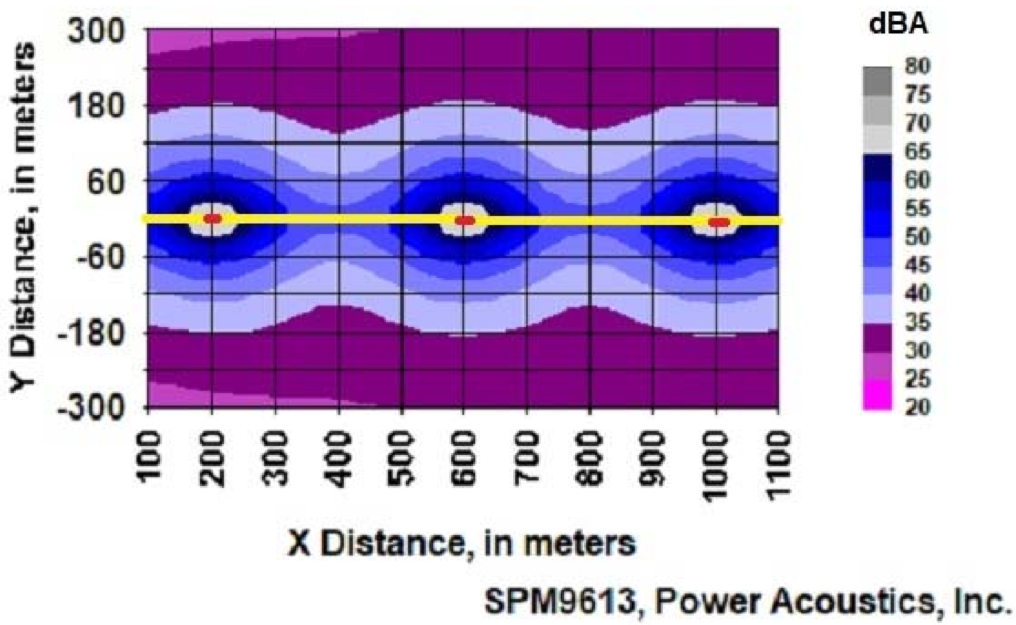
Transportation noise is generated by three sources: engine noise, exhaust system noise and tire noise. Engine noise can only be controlled by vehicle manufacturers and through proper maintenance. Exhaust noise is controlled by mufflers and relies on proper maintenance and upkeep by vehicle owners. Tire noise is caused by the interaction between tire and road surface. The type of pavement surface can have a profound effect on tire noise. The entire access road will be gravel surfaced. Tire noise predominates over engine or exhaust noise at speeds over 80 km/h. On the access road the hauling trucks will travel below 80 km/h. As a result, the predominant vehicle noise source will be the power train (engine, exhaust, cooling system).

Prediction of potential noise levels along the access road resulting from haul trucks was accomplished with the SPM9613 model described in Section 5.1.2. The following assumptions were applied to the model:

- only large haul trucks are modelled;
- average hourly traffic volume is less than ten vehicles per 1 km of the road;
- the traffic is flowing freely at constant speed, less than 80 km/h, when the tire-road noise is negligible in comparison with the truck power train;
- roadside barriers or other obstructions interfering with sound waves emitted from the truck are absent;
- much of the ground surface on both sides of the flat access road are covered with trees, grass, shrubs, or other vegetation; and,
- average atmospheric conditions are assumed.

The model output (unedited) as contours of 1-hour A-weighted equivalent sound pressure levels ($L_{eq\ 1h}$) along a 1 km section of the access road is shown in Figure 5-2.

Figure 5-2 Sound Level Contours in dBA in the Area of the Access Road



The modelling results indicate that approximately 75-80 dBA noise levels can be expected near trucks. Due to sound attenuation in air and absorption by surrounding forest, sound levels significantly decrease during outwards propagation. The Nova Scotia daytime objective of 65 dBA appears at around 40 m from the moving truck. Trucking noise will vanish at about 300 m from the road when the sound level is attenuated to the ambient level of 26 dBA.

As shown in Figure 5-2, noise of the nearest trucks will cumulate to the higher level depending on the trucks distance. The worst case scenario involves two passing trucks when moving in opposite direction. This would happen in a matter of seconds and the increase will only be by 3 dBA (to 78-83 dBA) as noise of two equal sources is added logarithmically. Therefore, noise of passing trucks can be disregarded in the assessment.

In conclusion, noise due to vehicular movement along the FMS access road will be intermittent, but will add to the background noise levels. Noise impact from vehicles traveling at speeds less than 80 km/h will be of a short duration with the peak noise lasting only seconds. Predicted daytime noise levels from the concentrate haul trucks will be in close proximity to the road centerline. Traffic noise will reduce to the background level at around 300 m from the road.

5.4 Vibrations

Blasting during construction and opetration is the key source of concern for ground vibration. The intensity of ground vibrations is measured in units of peak particle velocity. The unit of peak particle velocity is generally measured in millimeters per second (mm/s). The vibrations can be felt easily close to the blast but decrease in strength as they radiate outwards. Under typical conditions, the blasting vibration intensity diminishes with distance, at a rate of about one third of its previous value each time the distance from the vibration source is doubled. Estimated vibration levels for blasting in average rock to a free face under average field conditions at maximum charge mass per delay are shown in Table 5-3 (SLR 2015).

Table 5-3 Estimated Mean Blasting Ground Vibration

Receiver Distance (m)	Vibration (mm/s)
900	3.3
1000	2.8
1500	1.5
2000	0.9

The explosives in a blast pattern are never fired simultaneously but are sequenced over a second or two. Therefore, limiting the amount of explosives that are fired at any one instance can minimize the vibrations caused by blasting.

There are no structures in the vicinity of the FMS Mine Site that could be subject to damage by vibration in the blasting zone, thus no vibration issues due to blasting are expected.

6.0 MITIGATION

The following subsections provide noise management measures suitable for the Project to maintain acceptable noise levels.

6.1 Construction

The following mitigation measures should be considered to address effects associated with increases in noise levels during site preparation and construction of the Project:

- Schedule noisy construction activities during daytime hours to the extent possible;
- Perform regular inspection and maintenance of construction vehicles and equipment to ensure that they have quality mufflers and that worn parts are replaced;
- Restrict noise pollution by specifying and enforcing construction noise limits;
- Reduce power operation – use only necessary size and power of tools;
- Enforce vehicular speed limit;
- Substitute methods: use quieter methods and equipment when possible;
- Turn equipment off when not in use if practicable;
- Specify stringent noise emission limits, including shielding and installation of quality mufflers on construction and fixed equipment;
- Maintain project roads to reduce noise associated with vibration and vehicle noise;
- Enclose noisy equipment, and use baffles to reduce transmission of noise beyond the construction site; and,
- Replace or repair faulty parts generating excessive noise.

It is also appropriate to permit higher noise emission limit values for short-term temporary activities such as construction of screening bunds etc., where these activities will result in a considerable environmental benefit.

6.2 Operation

The following mitigation measures should be considered to address increases in noise levels during mine operations:

- Examine the noise mitigation strategy chosen by similar facilities with similar requirements for noise reduction;
- Purchase equipment powered by electric motors and diesel engines meeting acoustic industrial standards;
- Provide for enclosure and cladding of grinding and screening building to assure effective noise absorption by walls and roof material. Most likely material of pre-engineered plant buildings will be steel in the form of orthotropic or corrugated panels;
- Consider noise barriers, baffles or enclosures for particularly noisy equipment such as crushers, grinders, compressor, pumps, gearboxes, etc.;

- Maintain equipment to ensure that design noise-output specifications continue to be met;
- Select service vehicles with minimum noise output, including tire noise, exhaust and compressor and fan noise; and
- Perform regular inspection and maintenance of service vehicles to ensure that they have quality mufflers installed and worn parts are replaced.

6.3 Blasting and Vibration

The following measures should be considered to reduce the effects of blasting:

- Optimize blast design;
- Monitor blasts and revise blast design, as required;
- Limit ground borne vibration and minimize air over pressure by: (a) taking care in unusual situations e.g. corners, and (b) including geological considerations in blast design;
- Air overpressure is minimized through proper blast design;
- A blast must be carried out on a specified day as security concerns do not allow for explosives to be stored on site. In exceptional or unforeseen circumstances (e.g. late delivery, security, meteorological conditions such as significant temperature inversion and low cloud cover, etc.) a blast may be delayed or brought forward;
- Adequate stemming of holes;
- Use of downhole initiation with short delay detonators. This improves fragmentation whilst at the same time minimizes ground vibration which is directly related to Maximum Instantaneous Charge and not to the total charge in the blast; and,
- Ensure the correct blasting ratio is obtained. The blasting ratio is a measure of the amount of work expected per unit volume of explosives i.e. tonnes/kg.

7.0 CUMULATIVE ADVERSE EFFECTS

Audible cumulative effects are not expected due to the absence of existing or foreseeable new communal or industrial noise sources within the local and regional assessment areas which could add to the project noise levels. Contribution of existing background noise of 26 dBA to the pit or plant noise level of, for example, 55 dBA (the nighttime permissible level) will be negligible (less than 0.1 dBA). Therefore, the background noise level will not increase the Project noise at levels above 55 dBA.

8.0 RESIDUAL ADVERSE EFFECTS

Residual adverse impacts refer to those environmental effects predicted to remain after the successful application of all proposed mitigation measures. The Project will cause direct changes in the ambient noise levels near the mine and along the access road. Mitigation measures identified in Section 6.0 will minimize the extent of these alterations. Noise modelling demonstrates that, even without mitigation, noise levels at receptor locations during construction and operation can be expected to be predominantly below the legislated nighttime permissible sound level (PSL) of 55 dBA. The operational noise level (without blasting) is expected to decrease to a noise level of 45 dBA at a distance no more than 1.5 km from the FMS Mine Site property boundary. During operation (without blasting), and ambient background levels of 26 dBA at are expected to be met at approximately 5 km from the property boundary. Therefore, no significant adverse changes to ambient noise levels are likely to occur beyond 1.5 km of the FMS Mine Site and at identified potential receptor locations.

The planned blasting activities are also expected to cause ground vibrations. The vibrations will be felt easily close to the blast but decrease in strength as they radiate outwards. Since there are no structures in the vicinity of the FMS Mine Site that could be subject to damage by vibration in the blasting zone, no vibration impacts at receptor locations are expected. It is predicted that at a distance less than 900 m (refer to Table 5-3) the vibration levels will be below the applicable maximum ground vibration levels of 12.5 mm/s (0.5 in/s) prescribed in the *Nova Scotia Pit and Quarry Guidelines* (NSDEL 1999).

The noise and vibration assessment concludes that the proposed Project is unlikely to cause any significant residual adverse effects. At receptor locations, all maximum noise and vibration levels will comply with regulatory requirements.

9.0 MONITORING AND FOLLOW-UP

Follow-up noise monitoring will be conducted in response to complaints that may be filed with Atlantic Mining NS Corp. or NSE, or upon regulatory request. In case of any complaint, Atlantic Mining NS Corp. is committed to responding promptly to any noise complaint in adherence with recognized guidelines such as *BC OGC Noise Directive, Section 4: Noise Complaint Investigations (2009),* and to adjust mitigation measures, if required.

10.0 LIMITATIONS

Prediction confidence rating depends on quality of baseline data, confidence in analytical techniques and confidence in mitigation measures. There is a high level of confidence in all acoustic measurements taken for this proposed Project (i.e., baseline survey with Larson Davis Type 1 analyzers described in Section 3.2) and the computational capability of the noise model (no calculation errors). Low to moderate confidence is assigned to noise input parameters, due to assumptions made about equipment locations, timing of maximum noise generation, and atmospheric and topographic attenuation.

Prediction of noise levels involves some degree of uncertainty. According to *ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation (ISO 1996)*, the overall accuracy of the standard is ± 3 dB for distances between the source and receptor of up to 1,000 m. The accuracy for distances up to or over 1,500 m is not stated. Accuracy will also depend on the accuracy of the supplied noise data (PWL), which is often ± 2 dB for measured sources. Taking this into account, the expected accuracy of the predictions is ± 5 dB.

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APPENDIX A

Nearest Residences

Details of Closest Structures to the FMS Study Area

Structure ID	Structure Description	Coordinates (UTM 20T)	Receptor Y/N	Distance from driveway entrance on Hwy 374 to FMS Study Area (km)	Direction from FMS Study Area	Seasonal/Permanent Residence	Potable well (Y/N)	Well Type
1	Gated Residence (Lowe Property)	538964 4992589	Yes	4.9	South	Seasonal	N	N/A
2	Liscomb Camp	538981 4989308	No	7.9	South	Seasonal/Maybe never stayed in? Cabin structure but it is the gatehouse building	Unconfirmed	---
3	Civic 3411 Hwy 374 (Crowell Property)	539047 4989094	Yes	8.7	South	Seasonal but plans to make it a permanent dwelling in the future. Regularly used	Y	Dug well
4	Civic 3411 Hwy 374 (Rutledge Property)	539047 4989094	Yes	8.7	South	Seasonal. Use mostly July-Sept.	N	N/A

APPENDIX B

Acoustic Specification and Location of Noise Sources

Table B-1: Acoustic Specification and Location of Noise Sources

Unit			Symbol	Location (m)				PWL (dB) at Frequency (Hz)									PWL (dBA)
Name	#	Function		X	UTM, E	Y	UTM, N	31	63	125	250	500	1k	2k	4k	8k	
Diesel DTH tracked drill	2	Production drilling	D1	-614	537386	-105	4998895	98	107	114	114	115	119	119	121	118	126
			D2	-667	537333	-474	4998526	98	107	114	114	115	119	119	121	118	126
Diesel RC tracked drill	2	Bench scale exploration	D3	-351	537649	-123	4998877	-	109	118	113	113	113	112	110	104	118
			D4	-421	537579	-351	4998649	-	109	118	113	113	113	112	110	104	118
Hydraulic excavator (5 m^3 bucket)	3	Production loading	E1	-600	537400	-650	4998350	-	110	103	100	101	99	98	94	86	104
			E2	-270	537730	-310	4998690	-	110	103	100	101	99	98	94	86	104
			E3	-560	537440	-350	4998650	-	110	103	100	101	99	98	94	86	104
Wheel loader (7.0 m^3 backet)	1	Production loading, stockpile re-handle	L1	368	538368	-404	4998596	-	104	109	112	107	105	102	96	90	110
Haul truck (64 t payload)	9	Production hauling	T1	-474	537526	-228	4998772	-	109	114	117	112	110	107	100	95	116
			T2	-579	537421	-263	4998737	-	109	114	117	112	110	107	100	95	116
			T3	-700	537300	40	4999040	-	109	114	117	112	110	107	100	95	116
			T4	-175	537825	-263	4998737	-	109	114	117	112	110	107	100	95	116
			T5	491	538491	-860	4998140	-	109	114	117	112	110	107	100	95	116
			T6	614	538614	-1070	4997930	-	109	114	117	112	110	107	100	95	116
			T7	230	538230	-1050	4997950	-	109	114	117	112	110	107	100	95	116
			T8	-880	537120	-360	4998640	-	109	114	117	112	110	107	100	95	116
		In truck shop	T9	400	538400	-940	4998060										
Articulated haul truck (41t)	2	Production hauling	T10	-970	537030	-400	4998600	-	105	108	107	106	104	102	95	94	109
			T11	-1530	536470	-880	4998120	-	105	108	107	106	104	102	95	94	109
Motor grader	2	Haul road maintenance	G1	0	538000	-1228	4997772	-	115	120	123	118	116	113	107	101	121
			G2	900	538900	-220	4998780	-	115	120	123	118	116	113	107	101	121
Track dozer (233 kW)	2	Pit support/construction	DZ1	-667	537333	-200	4998800	-	101	106	109	104	102	99	83	87	107
			DZ2	-910	537090	-400	4998600	-	101	106	109	104	102	99	83	87	107
Track dozer (325 kW)	2	Dump maintenance	DZ3	0	538000	-600	4998400	-	101	106	109	104	102	99	83	87	107
			DZ4	900	538900	-650	4998350	-	101	106	109	104	102	99	83	87	107
Front end wheel loader (4.5 m^3)	1	Pit support and construction	L2	-456	537544	-175	4998825	-	104	109	112	107	105	102	96	90	110
Hydraulic excavator (3 m^3 bucket)	2	Utility excavator, breaker	E4	-500	537500	-50	4998950	-	110	103	100	101	99	98	94	86	104
			E5	-970	537030	-420	4998580	-	110	103	100	101	99	98	94	86	104
Primary jaw crusher	1	Production crushing	C1	719	538719	-1105	4997895	111	120	121	121	120	117	115	111	105	123

Figure B-1: Location of Noise Sources with Reference to Table B-1