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5.2.2 Noise and Vibration

5.2.2.1 Introduction

This section addresses environmental effects expected to result from Project-related disturbance to the Noise and Vibration Valued Component (VC). Ambient noise is recognized as an issue, because noise is defined as any unwanted sound, and the proposed Blackwater Gold Project (the Project) will change the noise levels in the study area.

Canadian and Provincial environmental regulators require that a noise impact assessment must be completed for any new permanent facilities where there is a reasonable expectation of a continuous noise source. The assessment would indicate if the noise levels from the facility at the nearest receptors meets applicable noise criteria. Noise and vibration objectives are specified in Environment Canada's (EC) Environmental Code of Practice for Metal Mines (2009).

The Project will generate noise as a result of the following broad categories of activities:

- Construction;
- Pre-stripping;
- Open pit mining;
- Ore and waste hauling;
- Tailings and waste rock disposal;
- Ore processing and gold recovery; and
- Construction and operation of supporting infrastructure including airstrip, access road, power transmission line, and water supply system (pump stations and pipeline).

Open pit mining, including blasting, and ore processing and gold recovery, will be the main source of noise. Ore processing and gold recovery will generate continuous noise particularly associated with ore crushing and grinding. Relatively lower levels of noise will be generated by the leaching, carbon-in-pulp operation, running of the stripping columns, and the regeneration kiln operation. Noise due to vehicular movement will be intermittent, but will also add to the background noise levels. Air traffic noise related to fixed-wing aircraft will occur approximately three times a week and be of short duration.

The following items were considered during the environmental assessment:

- Background noise;
- Construction noise;
- Operation noise, including airstrip noise and supporting infrastructure (access road, transmission line and water supply system);
- Closure, decommissioning, and post-closure noise;

- Noise legislation; and
- The effects of noise on the ambient environment, including humans and wildlife, in the relevant sections of the Application report.

Administrative boundaries presented in **Section 4, Subsection 4.3.1** do not apply for noise. In terms of technical boundaries, predicted effects of noise, while based on quantitative modelling relies, in some cases, on estimates of the number and location of equipment operating at a given time. Reasonable worst case scenarios were used based on experience with normal open pit mine operations. However there could be situations where equipment massing and atmospheric conditions could result in slightly higher than predicted noise levels.

To examine the multiple noise issues (such as sound propagation and attenuation in air) in combination with numerous noise sources with different acoustical properties, the appropriate noise modelling software must be used. According to British Columbia Noise Control Best Practices Guideline of BC Oil & Gas Commission (BC OGC, 2009), any model or hand calculations may be used to obtain the predicted sound level. However, the modelling must consider certain parameters specified in the Guideline. Analysis of AMEC in-house noise models (Sound Plan, Canada, and SPM9613) revealed that for this open pit mining project located in remote area the SPM9613 model developed by Power Acoustics Inc. should be used. The model is based on ISO 9613, Part 1 and Part 2. It predicts environmental noise levels in relation to the sound power level (PWL) of noise sources, topography, ground hardness, and effects of meteorological conditions, parameters required by the BC OGC Guideline. This model was used to predict noise levels at numerous mining projects in western Canada and was accepted by provincial and national regulators. Detailed description of the SPM9613 model is included in **Appendix 5.2.2A**.

Information on the background noise level was obtained by reviewing background monitoring results of similar open pit mining projects in the region. This was complemented by a 24-hour background survey at the Project study area. Information sources for the acoustical specifications of mobile sources and process equipment considered for the Project include information provided by the manufacturers, professional literature, noise assessment data available in non-confidential reports for similar open pit mining projects, and the acoustics design engineering software (ENC, 2004). The Project description, including schedule, proposed equipment, and design of the production facilities, were also used as information sources.

5.2.2.1.1 Legal Requirements

Noise and vibration objectives are specified in Environment Canada's Environmental Code of Practice for Metal Mines (ECPMM) (EC, 2009). With respect to noise, the Code requires that, in residential areas adjacent to mine sites, the equilibrium sound pressure level (L_{eq}) from mining activities should not exceed 55 A-scale decibel (dBA) during the day ($L_{eq\ D}$), and 45 dBA at night ($L_{eq\ N}$). Ambient noise can also affect wildlife, so sites in remote locations should also work to meet these objectives for off-site ambient noise levels.

With regards to vibration, the ECPMM advises that mines in areas where ground vibration and environmental noise from blasting are not regulated should design their blasts so that the following criteria are not exceeded at or beyond the boundaries of the mine property:

- Ground vibration of 12.5 mm/s peak particle velocity measured below grade or less than 1 metre (m) above grade; and
- Concussion noise of a maximum of 128 dBA.

Blasting conducted in or adjacent to any fish-bearing water body should be done in accordance with ECPMM for the Use of Explosives in or near Canadian Fisheries Waters, prepared by the Department of Fisheries and Oceans (DFO) (DFO, 1998). ECPMM defines setback distances from the centre of detonation of a confined explosive to fish habitat to achieve the 100 kPa guideline criteria.

For the camp indoor noise level, the World Health Organization (WHO) has established a guideline of 30 dBA inside a dwelling to avoid sleep disturbance (WHO, 1999).

Health Canada does not have noise guidelines or enforceable noise thresholds or standards. However, Health Canada's "Useful information for Environmental Assessment (HC, 2010) provides information to be considered for noise assessments.

5.2.2.2 Valued Component Baseline

An outline of the baseline noise assessment and baseline vibration analysis is presented in the following subsections. A detailed report is included in **Appendix 5.1.1.3A**.

5.2.2.2.1 Baseline Noise

The baseline noise parameters were examined for four similar open-pit mining projects located in northern BC. The results are summarized in **Table 5.2.2-1**.

In order to verify the results of the information sources desktop studies, a real-time baseline noise survey was undertaken during the last three days of July 2013 in the area of the Project. The survey included 37-hour continuous monitoring of ambient sound parameters in the vicinity of the proposed open pit mine (long-term survey), and spot sampling at the proposed airstrip area and at the nearest permanently occupied dwelling, located near the northern bank of Tatelkuz Lake (short-term survey). The results are shown in **Table 5.2.2-2** and **Table 5.2.2-3**.

The baseline noise survey results reveal that both the sound levels and sound characteristics in the Project area are low, typical of a quiet, remote environment, and meet all relevant ambient noise standards and criteria.

Table 5.2.2-1: Baseline Sound Parameters for Reference Projects in Northern BC

Project	UTM Location		Elevation (masl)	Sound Meter Type	Survey Date	Sound Parameters (dBA)					
	m E	m N				L_{eq}	L_{10}	L_{50}	L_{90}	$L_{90\ D}$	$L_{90\ N}$
Hillsborough Echo Hill Coal	639252	6138094	889	Quest 2900	18 – 19 Aug 2011	27.8	29.9	24.4	24.3	25.3	27.7
					19 – 20 Aug 2011	32.2	34.5	29.3	28.6	29.4	26.6
					25 – 26 Aug 2011	33.6	36.0	27.1	27.3	28.3	25.3
Mt. Milligan Copper-Gold	436322	6107600	1056	Larson Davis	12 – 13 Oct 2006	21.7	25.1	19.2	17.1	16.6	17.8
Bullmoose North Coal	600929	6118813	1092	Quest SE/DL	14 – 15 Aug 2012	36.1	38.1	34.9	34.5	34.4	34.6
Blackwater Gold	375400	5893000	1602	N/A	N/A	32.4	34.6	29.8	29.4	29.7	29.4

Note: masl = metres above sea level

Table 5.2.2-2: Summary of Long-Term Noise Survey Results at the Blackwater Pit Mining Area

Location	UTM Coordinates		Elevation (masl)	Sound Meter Type	Time	Sound Parameters (dBA)					
	m E	m N				L_{eq}	L_{10}	L_{50}	L_{90}	L_{max}	L_{min}
Pit Mining	377804	5894159	1424	Larson Davis	Day	31.0	30.9	29.1	28.0	67.6	26.1
					Night	31.1	32.1	30.8	30.0	43.8	26.5
					Overall	31.1	31.5	29.9	29.0	67.6	26.1

Note: masl = metres above sea level

Table 5.2.2-3: Summary of Short-Term Baseline Noise Survey Results at the Airstrip and Tatelkuz Lake Areas

Location	UTM Coordinates		Elevation (masl)	Sound Meter Type	Date	Sound Parameters (dBA)			
	m E	m N				L_{eq}	L_{10}	L_{50}	L_{90}
Airstrip	375141	5903953	1119	Larson Davis 824	29 Jul 2013	27.7	-	-	-
	-	-	-	-	31 Jul 2013	25.0	-	-	-
Tatelkuz Lake	384613	5907721	937	Quest SoundPro DL	31 Jul 2013	24.2	25.4	21.9	20.7

Note: masl = metres above sea level

5.2.2.2.2 Baseline Vibration

Natural sources of ground vibration are usually related to volcanic occurrences 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 Project area. Typical anthropogenic sources of background vibration at remote areas include:

- Seismic exploration for mining and oil and gas developments, which use vibrations such as sound waves and shock waves to map the different layers of the ground;

- Movement of heavy trucks and earth-moving equipment; and
- Timber harvesting and hauling by heavy machinery near the proposed mine site and processing facility areas.

None of the above activities are currently taking place within the Project footprint however; these activities are present within the region where the Project is located.

5.2.2.2.3 Past, Present and Future Projects and Activities

Section 4, Subsection 4.3.6.2, Table 4.3-11 shows the Summary Project Inclusion List developed for Cumulative Effects Assessment (CEA) (**Appendix 4C** contains the comprehensive Project Inclusion List). Any activities associated with industrial noise sources have the potential to impact the noise and vibration, including:

- Timber harvesting for CMTs and CHR sites;
- Forestry – logging;
- Road construction, including bridges;
- Mineral exploration;
- Mining, including road and trail construction, drill lines, drill pads, and mining infrastructure and ancillary facilities;
- Transmission line construction and maintenance; and
- Pipeline construction and maintenance.

5.2.2.2.4 Traditional Ecological or Community Knowledge

Local residents and Aboriginal groups and their members have also expressed interest in the proposed Project's potential effects from noise and vibration. These groups' comments during the engagement and consultation process have provided insights into traditional, ecological, or community knowledge, which is defined as a body of knowledge built up by a group of people through generations of living in close contact with nature. This includes unique knowledge about the local environment, how it functions, and its characteristic ecological relationships.

Community knowledge provided by local trappers and cattle ranchers indicate that a quiet environment is important to their livelihoods. They anticipate an increase in noise as a result of the proposed Project. Traditional knowledge suggests that a quiet, peaceful environment is important to Aboriginal groups, and that noise and vibrations may negatively affect Aboriginal and non-Aboriginal use and enjoyment of the land and environment, and disrupt wildlife and livestock. A local outfitter noted that noise/human activity related to power line construction and wildlife may be a problem during fall hunting (**Appendix 3.1.3C**).

Additional detail on comments and issues raised can be found in **Section 3** which contains the public and Aboriginal issues tracking tables for the Project. **Sections 14** through **Section 16** provide a summary of the Aboriginal background, rights, and interests for the Project.

5.2.2.3 Potential Project Effects of the Proposed Project and Proposed Mitigation

Potential effects of the Project on the acoustic environment are assessed by predicting noise and vibration levels in the study areas, and determining whether this will comply with relevant permissible levels. The activities presented in **Section 5.2.2.2.3** (Past, Present and Future Projects and Activities), including timber harvesting, road construction, forestry logging and mineral explorations have the potential to generate noise.

Potential interactions and potential key interactions of the Project on the VCs during the construction, operations, closure, and post-closure phases are presented in **Table 4.3-2** of **Section 4**. The following section discusses in detail the project interactions that generate noise during the different phases of the Project. The key interactions were identified to occur during the construction and operation phases and were subject to noise modelling presented in (**Appendix 5.2.2A** Noise Modelling Report). Noise during the closure phase has been conservatively assumed to be similar to noise generated during the construction phase. No noise-generating activities or equipment will be present during post-closure.

5.2.2.3.1 Noise and Vibration Sources

The following sections broadly characterize noise generation and vibration in each of the Project phases.

5.2.2.3.1.1 Construction Phase

During construction, there will be intensive activity at the mine site, along the power line, water supply system including pump stations and access road corridors. Different type of heavy machinery, vehicles and power generators driven by diesel engines will be used. No detailed inventory of construction equipment is available at this time as most of the work will be done by outside contractors. Typical mine construction activities include site preparation, earthworks construction, erection of plant buildings, process equipment installation, pit pre-stripping blasting, airstrip construction, access roads construction, pipe laying, and erection of transmission line. At this early stage of the Project development it is unknown how much of the construction activities will take place at night time, if any. **Appendix 5.2.2A**, Table 1, includes a description of the key issues identified for the construction phase of the Project.

5.2.2.3.1.2 Operations Phase

During operations, noise will be generated by heavy vehicles and equipment associated with mining, ore and waste movement, ore processing and store. Mobile noise sources include shovels, drills, trucks, excavators, graders, and supporting vehicles. Stationary noise sources comprise crushers, mills, screens, pumps, and conveyers. Offside infrastructure noise sources will comprise intermittent aircrafts, continuously operated intake and booster pump stations, and supply/service vehicles on access roads. **Appendix 5.2.2A**, Table 2, includes a detailed inventory of sources for the operations phase.

5.2.2.3.1.3 Closure and Decommissioning Phase

The closure phase of the Project is dominated by reclamation activities, and therefore noise will primarily be associated with vehicles and activities associated with the decommissioning of the mine site, such as dismantling infrastructure, land restoration, re-vegetation, access and haul road decommissioning and ongoing monitoring.

5.2.2.3.1.4 Post-Closure

Noise is not expected to be a concern for the post-closure phase, as only occasional, minor noise will occur due to some activities associated with ongoing monitoring and inspection programs involving small vehicles.

5.2.2.3.2 Effects Assessment

The permissible sound levels (PSLs) applicable to the Project have been defined to adhere to the Environment Canada's Environmental Code of Practice for Metal Mines (ECPMM) (EC, 2009) and from a review of three existing PSLs developed for commercial operations in remote areas; Kerr-Sulphurets-Mitchell (KSM) Project, Kitsault Mine Project and Mt. Milligan Copper-Gold Project.

The KSM Project applied Environment Canada's ECPMM guidelines, which propose a daytime PSL of 55 dBA and a nighttime PSL of 45 dBA for ambient noise levels for mining activities in residential areas.

The Kitsault Mine Project examined the Irish Environmental Protection Agency's (IEPA) Guideline Note for Noise in relation to Scheduled Activities, the Alberta Energy Resources Conservation Board (ERCB) Directive 038: Noise Control, and the World Bank Pollution Prevention and Abatement. The IEPA guidelines apply to the nearest noise-sensitive receptor, while the ERCB recommend PSLs are corrected for presence of seasonally occupied dwellings including hunting or recreational cabins. The World Bank standards refer to residential, institutional, and educational receptors. Based on these guidelines, the proposed PSLs for the Kitsault Mine Project were 55 dBA for daytime and 45 dBA for nighttime.

For the Mt. Milligan Copper-Gold Project, the IEPA and Alberta ERCB standards were compared and the more conservative Alberta ERCB values were proposed. The PSLs used for this project were 50 dBA for daytime and 40 dBA for nighttime. The receptors where the proposed PSLs would apply consist of dwellings located at distances greater than 500 m from heavily traveled roads or rail lines and not subject to frequent aircraft flyovers.

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 such as the primary crusher, the process plant and the Tatelkuz Lake pump station. 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, blasting in the open pit mine, airstrip operation and the access road traffic.

When comparing sound level values, the following general rules can be used (Cowan, 1994):

- A difference in sound level of less than 3 dBA is barely perceptible to the human ear;
- A difference of 5 dBA is noticeable;
- A difference of 10 dBA corresponds to a halving or doubling in perceived loudness; and
- A 20 dBA difference corresponds to a four-fold difference in perceived loudness.

5.2.2.3.2.1 Construction

Impact construction equipment typically includes piledrivers, rock drills, and small, hand-held, pneumatic, hydraulic, or electric powered tools. The primary noise source for conventional piledrivers is the impact of the hammer striking the pile. Engine-related noise sources, such as combustion explosion or the 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. Welding noise is generally negligible; the main sources of noise are the generators that support the welding equipment.

An effects assessment has been carried out for a typical construction scenario where common equipment types are used. The prediction of sound pressure levels at different distances from the mine's central location where most of the equipment would be located (reasonable worst-case scenario) is shown in **Table 5.2.2-4**.

Table 5.2.2-4: Propagation Rate of Construction Noise

Case	Loudest Equipment	Leq @ 15 m (dBA)	Noise Level (dBA) at Distance (m)					
			15	100	500	1,000	1,500	3,000
A	Truck	88	89	73	59	53	49	43
	Grader	83						
	Backhoe	80						
B	Truck	88	90	74	60	54	50	44
	Backhoe	80						
	Concrete Mixer	85						
C	Front-End Loader	85	89	73	59	54	49	43
	Grader	82						
	Pneumatic Tools	86						

The noise emissions of various alternatives likely would differ somewhat depending on the types and number of pieces of mechanized equipment in use at a given time and location and on the duration of construction activities (the usage factor). With use of the typical construction equipment the noise levels are expected to be similar to those shown in **Table 5.2.2-4** which refers to the worst case scenario involving the noisiest equipment operated at full power.

The construction camp will be located approximately 3,000 m from the open pit and the plant site. Therefore, based on results shown in **Table 5.2.2-4**, construction noise levels outside of the camp building will likely be around 40 dBA. Additional construction noise information is presented in **Appendix 5.2.2A**, Section 1.

Construction of transmission line, water supply pipeline and access road will look much like a moving assembly line. The construction will be broken into manageable lengths, called construction spreads, to be served by a fully equipped, highly specialized qualified workgroup. Each spread will be composed of various crews, each with its own set of responsibilities. As one crew completes its work, the next crew will move into position to complete its piece of the construction process. Construction of Tatelkuz Lake pump station and booster station buildings will generate noise. However, installation of pumps, electric motors and auxiliary equipment will occur inside buildings. The building walls would serve as a noise barrier and help to reduce off-site noise impacts.

Construction phase noise impacts would result largely from noise generated by mechanized equipment such as loaders, bulldozers, sidebooms, generators, and trucks. For specific construction activities, like blasting, stream crossings, pipe welding, utility poles and power lines installation, additional equipment and service personnel will be temporary present at the site.

The airstrip construction will be at the fixed area within which the permanent and mobile noise sources will be located. The noise impacted area will be adjacent to the airstrip site.

5.2.2.3.2.2 Operation

The following subsections describe and assess the main noise sources and operations likely to occur during operation phase of the Project. The assessment is based on the professional literature, relevant EIA reports, computer modelling and experience of team members from similar projects.

5.2.2.3.2.2.1 Mine and Processing Plant

Project activities and resulting noise levels will vary continuously for the duration of the Project. For this reason, a conservative, worst-case scenario has been analyzed, defined as the highest potential number of equipment units in operation at one time. A full list of equipment units considered as potential noise sources is shown in **Appendix 5.2.2A**, Table 2.

The predicted changes to ambient sound level resulting from Project noise sources during operation were determined using the SPM9613 noise model previously mentioned. The model includes two subroutines: ISO 9613-1, specifically addressing atmospheric attenuation, and ISO

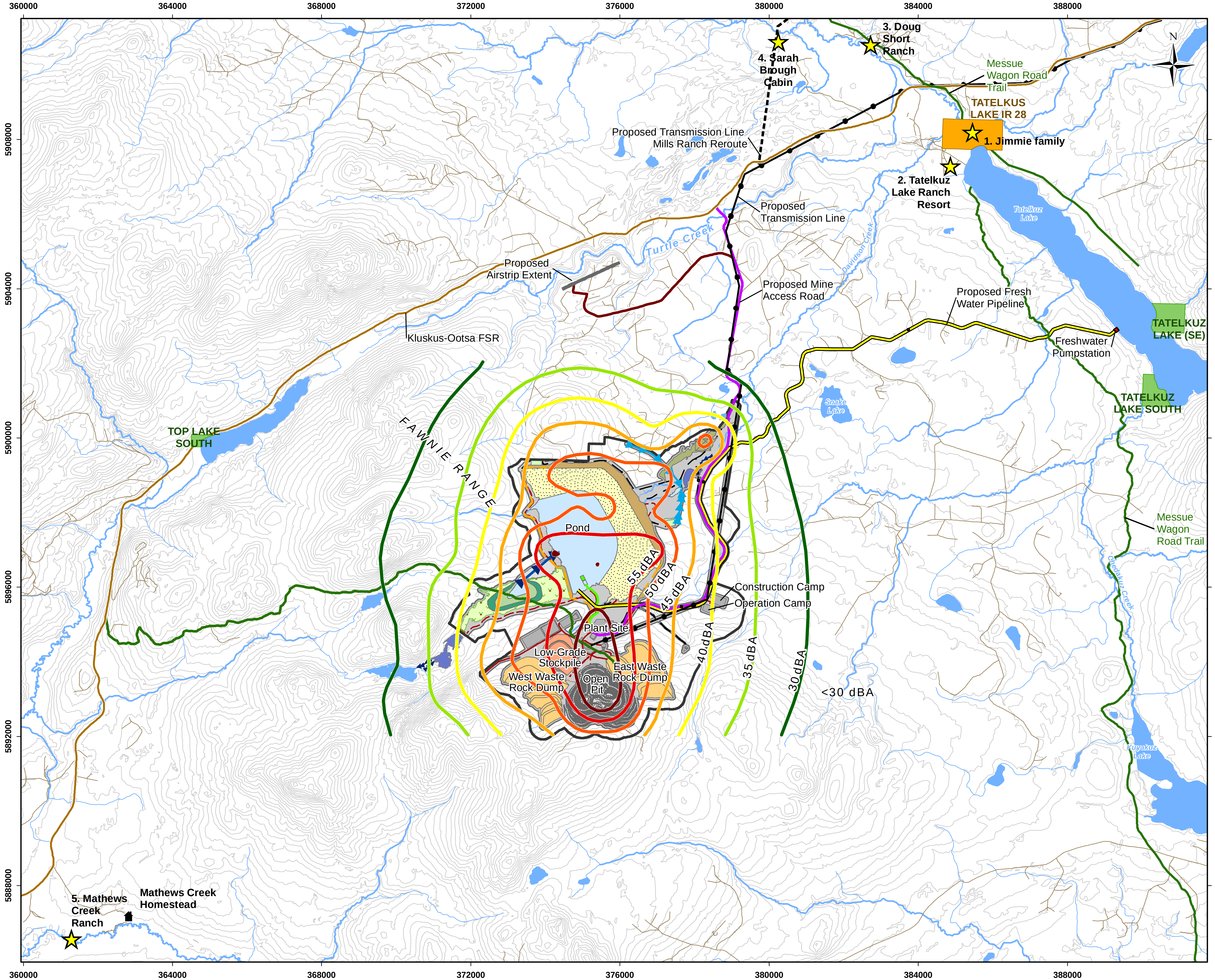
9613-2, which specifies an engineering method for calculating environmental noise from a variety of noise sources by prescribing methods to determine the various attenuation effects observed during outdoor sound propagation. The model incorporates the following parameters:

- Geometric spreading;
- Barrier effects;
- Atmospheric absorption;
- Ground attenuation;
- Specific wind speed and direction;
- Source size and location; and
- Acceptance of sound power level and sound pressure level spectrum data.

The operation noise modelling is based on the following assumptions:

- Only major noise sources are used in this study, including the primary crusher, excavators, dozers, compactors, hydraulic drill, haul trucks, and the grinding/screening building process plant;
- The maximum noise generated during mining is based on equipment count;
- The facility will operate continuously at the same level on a 24/7 basis;
- The processing building noise is presented as a computed combined source;
- Ore/overburden trucks will operate continuously, mainly in the pit;
- Octave bands spectra provided for similar equipment are used for each type of noise source;
- All model input noise levels are in sound power level spectrum dB linear (not dBA);
- The complex terrain is considered;
- Average atmospheric conditions are assumed; and
- The grid size was selected to include both the local and regional study areas, to include both nearby and distant noise levels.

The model input data included octave sound power level (PWL) for each noise source, their locations, 3D dimensions of each source, meteorological parameters, ground attenuation, and the pit geometry. A total of over 60 noise sources are detailed in **Appendix 5.2.2A**, Table 3.



Legend

- Kluskus-Ootsa FSR
- Exploration Road
- Existing Road
- Contour (20 m)

Project Components

- Proposed Mine Access Road
- Proposed Transmission Line
- Mills Ranch Reroute
- Proposed Fresh Water Pipeline
- Proposed Airstrip Access Road
- Construction Haul Road
- Mine Haul Road
- Flow Direction
- Seepage Collection Trench
- Spillway
- Tailings Pipeline
- Water Reclaim Pipeline
- Messue Wagon Trail
- Proposed Airstrip Extent
- Proposed Mine Footprint
- Proposed Mine Site

Potential Sensitive Receptors

- Sensitive Receptor Location
- Mathews Creek Homestead
- Indian Reserve
- Recreation Sites

Noise Contours from Mine Site

- 30 dBA
- 35 dBA
- 40 dBA
- 45 dBA
- 50 dBA
- 55 dBA
- 60 dBA

Mine Site Area

- Bog / Wetland Area
- Borrow Source
- Construction Site
- Embankment fill
- Emergent Vegetation Wetland
- Esker Borrow Source
- Fresh Water Reservoir
- Low-Grade Stockpile
- NAG Waste Rock / Overburden
- Open Pit
- Pond
- Reclaim System
- Pumpstation
- Tailings Beach
- Top Soil
- Upland Beach

0 1 2 4
Kilometres
Scale:1:100,000

Reference
BC Government GeoBC Data Distribution
Knight Piésold Consulting Engineers

CLIENT: newgold

PROJECT: Blackwater Gold Project

Noise Contours from Mine Site

DATE: October, 2014	ANALYST: KA	Figure 5.2.2-1
JOB No: VE52095	QA/QC: AP	PDF FILE: 12-200-001_NoiseIsopleths_Minesite_minsite.pdf
GIS FILE: 12-200-001_NoiseIsopleths_Minesite.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	amec

Y:\GIS\Projects\VE\VE52095_Richfield_Blackwater\Mapping\12_noise\EIA\12-200-001_NoiseIsopleths_Minesite.mxd

The sound level modelling results are shown in **Figure 5.2.2-1** as noise level contour plots for the Project area, including the pit area, overburden, and waste rock dump, low-grade stockpile, and the plant area. The noise contours are in 5 dBA intervals. Arbitrarily selected X-Y axes have the 0-0 point located in the center of the primary crusher (the highest open area noise source), with the UTM NAD 83, Zone 10 coordinates 375533 mE, 5894467 mN. Replacing the UTM with the Project-related coordinates improves understanding of the spatial aspect of noise propagation, as direct distances are shown.

The modelling results reveal that the major noise sources within the Project area will be inside the pit, where equipment (e.g., shovels, loaders, trucks, drills, etc.) will be simultaneously removing overburden and waste ore and extracting the high grade ore. Due to the close proximity of the major pieces of equipment, the combined noise level will be higher than the individual equipment noise levels. Because of the mitigation effect of the pit walls, noise levels on the surface near the pit will be much lower, descending outward. The model predictions are that levels outside the fence line will be 45 dBA or lower. Therefore, the Project will comply with sound permissible levels (SPL) of 45 dBA for night time ($L_{eq,\ N}$), and 55 dBA for daytime ($L_{eq\ D}$). The operations noise will be attenuated to the background level of 31 dBA at approximately 4 km to the east and west, and 6 km to the north and south. The nearest inhabited residence to the project site is 10 km away (Eagles family). The nearest recreation site is located 17 km away (Entiako Park).

As the Project is at a relatively remote location, a camp will be provided for personnel on site. The operations camp will include standalone, dormitories designed to house 400 personnel and core services facilities. It is important that the noise levels in dormitory rooms be at or below the Health Canada and WHO guidelines of 30 dBA to ensure comfortable sleeping conditions. The modelling results show ambient noise levels outside of building structures at the camp location will be approximately 40 dBA. The camp will be constructed as prefabricated modules, made of metal-clad walls with thick thermal insulation. Because of this, the walls will serve as effective noise barriers. Their octave band noise reduction and transmission loss has been estimated with engineering acoustics program (ENC, 2004), which estimates an overall transmission loss of 20 dBA. An outdoor sound level of 40 dBA will therefore be reduced to an indoor sound level of 20 dBA, in compliance with the Health Canada and WHO guidelines.

Actual noise levels at affected points may vary somewhat, as several unpredictable factors may increase or decrease the propagation of sound. In general, these can be summarized as:

- Increase in trucking noise due to roughness of road surface;
- Increase due to multiple reflections from vertical surfaces;
- Decrease due to trees;
- Decrease due to barriers of all types, mainly hills; and
- Lower composite noise level, as not all equipment will be used at the same time.

5.2.2.3.2.2.2 Tatelkuz Lake Pump Station

Fresh water for the project will be sourced from Tatelkuz Lake, which is located approximately 20 km northeast of the mine site. The water will be conveyed via pipeline and pump stations from the lake to the project site. Detailed description of the water supply system is provided in **Section 2.2.4.3**.

Pump stations can be the source of vibration and noise problems. The vibration is usually minimal due to well-balanced rotating components or attenuated within the enclosure structure by spring-type or rubber-in-shear vibration isolators, if necessary. Therefore, assessment of pump stations vibration is unwarranted. However, noise can emanate from electric motors, pumps, and transformers. The higher noise can be expected at intake pump and two booster stations because each will accommodate four 450 kW or 525 kW electric motors. The worst case scenario is represented by Tatelkuz Lake intake pump station because of location on the shore line so noise can propagate freely over the water surface in semicircular directions. In addition, the nearest and most sensitive receptor Tatelkuz Lake (SE) Recreation Reserve is located directly across the lake, approximately 900 m away.

Noise from electrical equipment such as motors and transformers is characterized generally as a discrete low-frequency hum. Electric motor noise intensity defined by the PWL at octave band frequency spectrum (from 16 Hz to 8000 kHz) depends on the motor power (kW) and number of rotations per minute (rpm). For the pump station 525 kW motor operating at 1,783 rpm the PWL was obtained using engineering noise control design software (ENC, 2004). Cumulative noise generated inside the pump station shown in **Appendix 5.2.2A** Section 2.5 Figure 5: Noise Contours Inside Pump Station, will be mitigated by the concrete walls that act as sound barriers before entering the ambient environment. The level of noise mitigation depends on the type of material and walls thickness and is quantified by transmission losses (TL). The octave-band sound TL of the concrete pump house was obtained using noise control design software (ENC, 2004). The PWL and TL data are given in **Appendix 5.2.2A** Section 2.5 Table 6: Pump Station Sound Data.

Prediction of noise levels is accomplished with the SPM9613 model considering outdoor PWL accounting for transmission losses through the walls of the building. Figure 5.2.2-2shows contour isopleths in dBA from the highest noise level outside of the station wall up to locations where pump station noise is mitigated to the background level of approximately 30 dBA. Distribution of noise contours around the pump station as the model output graphic is shown in **Figure 5.2.2-2**.

Predicted noise levels will be approximately 50 dBA near the pump building and will be attenuated in air to 30 dBA background value at the distance of 200 m over ground and 300 m over water where sound propagates freely with no obstructions. Noise level on the shore of Tatelkuz Lake (SE) Recreation Reserve will be at approximately 19 dBA as shown in model-generated **Table 5.2.2-5**.

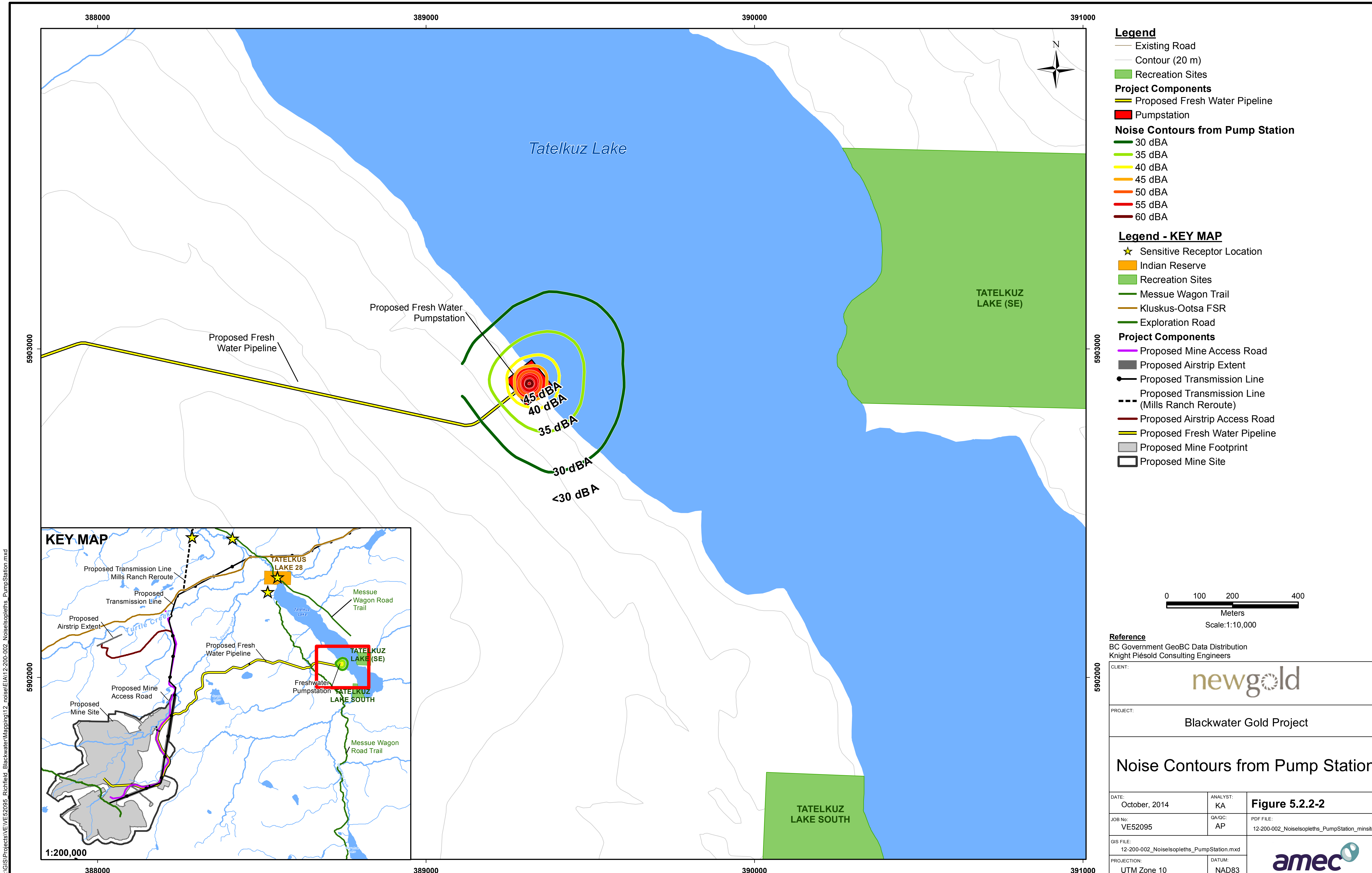


Figure 5.2.2-2 Noise Contours from Pump Station

Table 5.2.2-5: Sound Pressure Level at Tatelkuz Lake Recreation Reserve in Frequency Spectrum (dB) and Overall (dBA)

Frequency (Hz)	31.5	63	125	250	500	1000	2000	4000	8000	SPL (dBA)
SPL (dB)	20	22	23	21	18	14	9	0	0	19

The night-time permissible sound pressure level defined for this Project is 45 dBA therefore compliance at the recreation reserve is confirmed.

5.2.2.3.2.2.3 Aircraft Noise

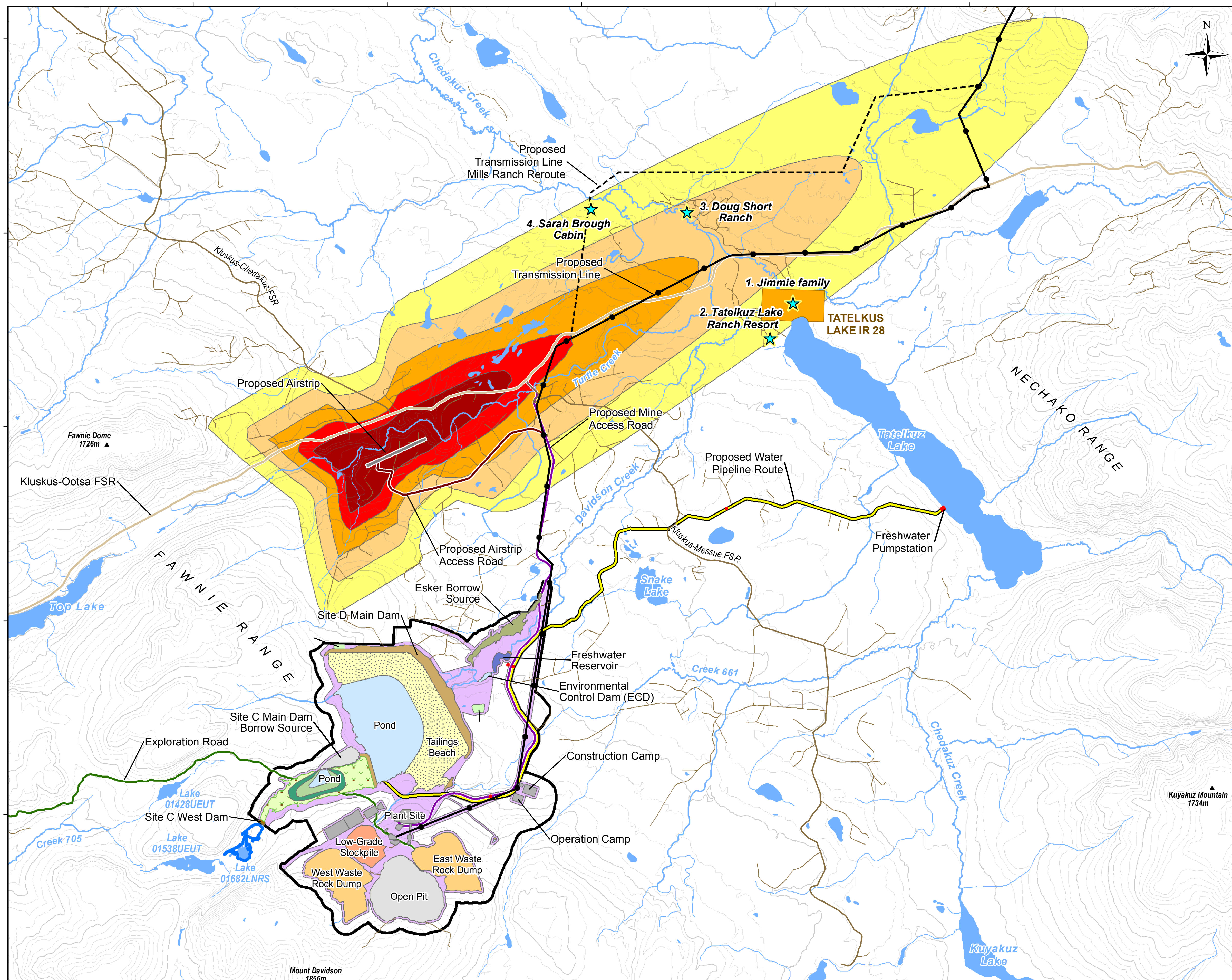
Oversight of aviation noise is provided by Transport Canada, which verifies that the policies and procedures associated with aircraft noise comply with relevant standards and guidelines[1]. In this area, Transport Canada operates in conjunction with third parties, including Health Canada, NAV Canada, and the International Civil Aviation Organization (ICAO). Transport Canada uses a Noise Exposure Forecast (NEF) system to provide a measurement of the actual and forecasted aircraft noise in the vicinity of airports. This system factors in the subjective reactions of the human ear to specific aircraft noise stimulus, including loudness, frequency, duration, time of occurrence, and tone. The aircraft noise assessment for the Project follows the Transport Canada computer model NEFCalc Version 206.

The potential impact of airstrip noise and related perceptions are delineated by noise contour lines representing various daytime noise levels that depend upon the type of plane, size of the airstrip, prevalent wind directions, topography, and so forth. Noise contours highlight existing or potential areas of significant aircraft noise exposure. The areas within the 65, 70, and 75 dBA noise contours are considered the most impacted by aircraft-generated noise. Results of airstrip noise predictions of sound exposure levels using NEF Calc, in the form of noise contours, are shown in **Figure 5.2.2-3** and **Figure 5.2.2-4**.

A NEF was predicted using NEF Calc model. It showed that the NEF isopleth of 25 is located very close to the airstrip. No annoyance is experienced for a NEF below the 25 level.

Based on sound exposure level and NEF predictions, and the short-term durations of landings and takeoffs (no more than one flight per day), none of the five families living in the Project region will be exposed to noise levels above the permissible criteria, i.e., a daytime PSL of 45 dBA and NEF of 25. Details of the airstrip noise impact assessment are shown in **Appendix 5.2.2B**.

[1] Transport Canada web page: www.tc.gc.ca/eng/civilaviation/standards/aerodromeairnav-standards-noise-menu-923.htm



Legend

- Sensitive Receptors
- Indian Reserve
- Kluskus FSR
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Existing Road

Project Components

- Exploration Road
- Proposed Airstrip Access Road
- Proposed Mine Site Access Road
- Proposed Transmission Line
- Proposed Transmission Line (Mills Ranch re-route)
- Proposed Mine Footprint
- Proposed Mine Site

Site Facilities

- Bog / Wetland Area
- Borrow Source
- Construction Site
- Embankment fill
- Emergent Vegetation Wetland
- Esker Borrow Source
- Fresh Water Reservoir
- Low-Grade Stockpile
- Freshwater Pumpstation
- NAG Waste Rock / Overburden
- Open Pit
- Pond
- Reclaim System
- Tailings Beach
- Top Soil
- Upland Beach

Noise Modeling

- 85 dBA
- 80 dBA
- 75 dBA
- 70 dBA
- 65 dBA

Scale:1:100,000

0 0.5 1 2 3 4 5

Kilometres

Reference

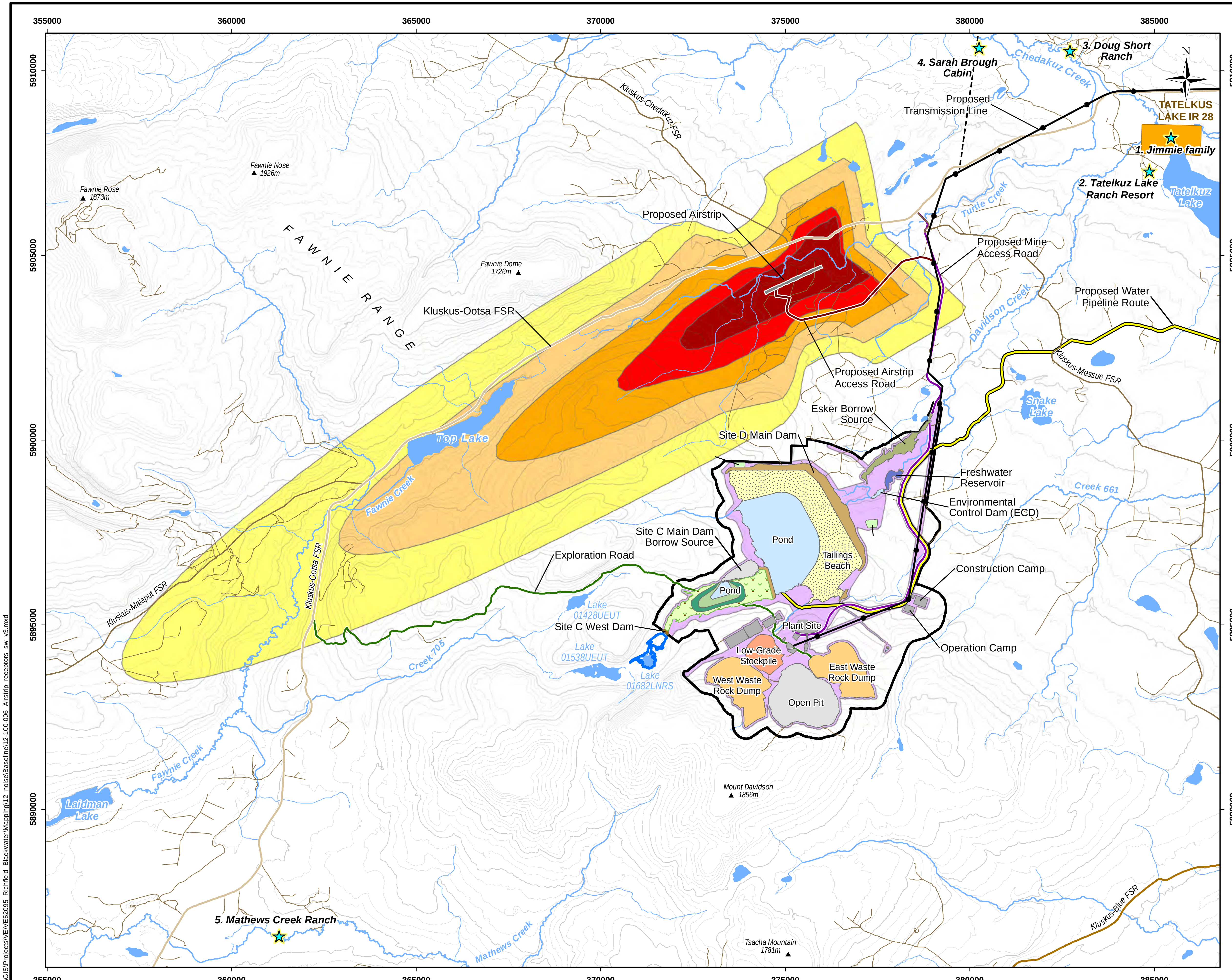
BC Government GeoBC Data Distribution

CLIENT: newgold

PROJECT: Blackwater Gold Project

Noise Modeling for Airstrip with Sensitive Receptors
Boeing 737 Takeoff to the Northeast

DATE: September, 2014	ANALYST: MY	**Figure** 5.2.2-3
JOB No: VE52420	QA/QC: AP	PDF FILE: 12-100-005_Airstrip_receptors_ne_v3_minsite.pdf
GIS FILE: 12-100-005_Airstrip_receptors_ne_v3.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	amec



Legend

- Sensitive Receptors
- Indian Reserve
- Kluskus FSR
- Kluskus-Blue FSR
- Kluskus-Ootsa FSR
- Existing Road

Project Components

- Exploration Road
- Proposed Airstrip Access Road
- Proposed Mine Site Access Road
- Proposed Transmission Line
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- Proposed Mine Footprint
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Site Facilities

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- Construction Site
- Embankment fill
- Emergent Vegetation Wetland
- Esker Borrow Source
- Fresh Water Reservoir
- Low-Grade Stockpile
- NAG Waste Rock / Overburden
- Open Pit
- Pond
- Reclaim System
- Tailings Beach
- Top Soil
- Upland Beach

Noise Modeling

- 85 dBA
- 80 dBA
- 75 dBA
- 70 dBA
- 65 dBA

Scale:1:100,000

0 0.5 1 2 3 4 5

Kilometres

Reference

BC Government GeoBC Data Distribution

CLIENT: newgold

PROJECT: Blackwater Gold Project

Noise Modeling for Airstrip with Sensitive Receptors
Boeing 737 Takeoff to the Southwest

DATE: October, 2014	ANALYST: MY	**Figure 5.2.2-4**
JOB No: VE52420	QA/QC: AP	PDF FILE: 12-100-006_Airstrip_receptors_sw_v3_minsite.pdf
GIS FILE: 12-100-006_Airstrip_receptors_sw_v3.mxd		
PROJECTION: UTM Zone 10	DATUM: NAD83	amec

5.2.2.3.2.2.4 Blasting Noise and Vibration

Blasting will required to break rock as part of the mining process and during construction. Blast noise is predominantly low frequency sound, with most of the audible sound energy below 50 Hz. For this reason (low attenuation in air), it is omnidirectional. Although localized "shadow zones" will occur behind topographic features, such as pit walls, berms and hills, low frequency sound will readily refract or bend around any such obstacles, so that noise levels beyond the shadow zone will be similar to what they would have been without the localized barrier.

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, or atmospheric temperature inversions affect the propagation of blasting noise. The noise from a blast can be loud if the listener is within a few hundred metres of the blast. Airborne pressure waves can cause annoyance due to 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 "popping" 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, caused the sound waves to propagate over a greater distance, resulting in a more noticeable "bang," referred to as an "air blast." To mitigate blasting noise effects, a safety zone will be established around the blasting site to keep construction crews at the distance where the noise levels will be safe.

Blast noise levels at different distances caused by the explosion of 1,000 kg of ANFO charge at a depth of 15 m have been calculated using the Linehan and Wiss equation published by the US Bureau of Mines (Linehan and Wiss, 1980). Calculation details are shown in **Appendix 5.2.2A**, Section 2.4. A summary of results are shown in **Table 5.2.2-6**.

Table 5.2.2-6: 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

The Explosives Regulations (Government of Canada 2009) require any person intending to fire blasting explosives to take precautions to ensure that people near the blasting area (including workers and the public) are at a safe distance, or provided with and using appropriate blasting shelters to protect from fly rock. This blast exclusion zone represent a noise buffer in which the blasting noise would be reduced to lower levels as shown in the above table.

The environmental impacts of blasting include ground vibration, defined as the speed of excitation of particles within the ground resulting from vibratory motion. The intensity of ground vibrations are measured in units of peak particle velocity. The unit of peak particle velocity is generally measured in millimetres per second (mm/s). Under typical conditions, 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. Ground-borne vibrations can cause annoyance above levels of about 5 mm/s because of the perception of movement. Structural damage may also occur at significantly higher levels, about 50 mm/s. However, no structures will be present in the blasting vibration zone that could be damaged; therefore, vibration modelling was deemed to be unwarranted. Additional information is included in **Appendix 5.2.2A**, Section 2.4.

Vibration caused by moving trucks will be negligible. Trucks are supported on flexible suspension systems and pneumatic tires, and are therefore not an efficient source of ground vibration. Any vibration caused by a truck hitting a pothole or other obstruction will be localized, dropping off rapidly with distance. Project roads will be maintained on a regular basis to assure the smooth travelling of vehicles, including trucks.

The effect of vibrations on fish was analyzed with reference to DFO's Guideline for the Use of Explosives In or Near Canadian Fisheries Waters (DFO, 1998), provided under the *Fisheries Act*. The setback distance between the centre of detonation at the open pit and the nearest fish habitat will be in compliance.

5.2.2.3.2.2.5 Off-site Infrastructure

In addition to airstrip and water intake pump station discussed in specific subsections, off-site infrastructure includes a transmission line, freshwater supply system and a mine access road.

Operation of a 140-km, 230 kV power transmission line system will be noise-free except some minor occurrences involving corona, insulator, and Aeolian noise. During relatively dry conditions, corona noise typically results in continuous noise levels of 40 to 50 dBA at the edge of the 40 m wide right-of-way. This noise level is similar to ambient noise conditions in the environment. During wet or high humidity conditions, corona noise levels typically increase to 60 dBA or even higher. Insulator noise is similar to corona noise but it is not dependent on weather. It is caused by faulty insulators. New polymer insulators minimize this type of noise. Aeolian noise is caused by wind blowing through the conductors and/or structures. This type of noise is usually infrequent and depends on wind velocity and direction. Wind must blow steadily and perpendicular to the lines to set up an Aeolian vibration, which can produce resonance if the frequency of the vibration matches the natural frequency of the line. Dampeners can be attached to the lines to minimize Aeolian noise. The environmental impact is hardly noticed because blowing wind generates higher background noise which could be higher than the Aeolian noise.

No noise will be generated along the 20 km long freshwater supply pipeline during operation, as liquid flow is silent. There will be some minor residual noise associated with the continuous operation of the Tatelkuz Lake intake pump station and in the boost stations. Based on noise modelling of the intake pump station, noise above the baseline level will be audible as a discrete low-frequency hum in the close proximity to pump stations decreasing to the background level within approximately 200 m radius from the source.

Vehicular traffic along a new 15 km long mine access road will be the noise source. Traffic 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 the Proponent or subcontractor. Tire noise is caused by the interaction between tire and road surface (gravel) and is insignificant at a posted speed of 60 km/h. Because of low traffic volume (17 one-way trips per day), mitigated engine noise and negligible tire noise, access road impact on environmental acoustic will be low.

5.2.2.3.2.3 Closure and Decommissioning

Noise sources during the closure phase will be similar to the construction phase impacts. However, noise effects will be lower because high-level noise sources such as drills and blasting will be absent. Therefore, the construction phase noise assessment can be used as a conservative assessment of noise during the closure phase.

5.2.2.3.2.4 Post-Closure

No post-closure impacts are anticipated, since no noise-generating activities or equipment will be present once the Project is decommissioned.

5.2.2.3.3 Past, Present and Future Projects and Activities

Potential interactions and potential key interactions of the Project on the VCs during the construction, operations, closure, and post-closure phases are presented in **Table 4.3-2** of **Section 4**. Past, present and future projects and activities that potentially interact with the Project as a result of spatial or temporal overlap will be used in the assessment of potential cumulative effects (**Section 5.2.2.2.3**) if residual effects assessed for the Project are classified as significant. **Table 5.2.2-7** presents an overview of potential adverse effects associated with past, present and future projects and activities.

Table 5.2.2-7: Potential Adverse Effects Resulting from Past, Present and Future Projects and Activities

Past, Present and Future Projects and Activities	Potential Adverse Effect	General Mitigation
Timber harvesting for CMTs and CHR sites;	Increase in ambient noise level.	Use of equipment provided with noise control devices such as mufflers.
Forestry – logging;	Increase in ambient noise level.	Limit logging activities to daytime hours when permissible levels are higher.
Road construction, including bridges;	Increase in ambient noise level.	Adherence to permissible noise level at the workplace.
Mineral exploration;	Increase in ambient noise level.	Limit activities to daytime hours.
Mining, including road and trail construction, drill lines, drill pads, and mining infrastructure and ancillary facilities;	Increase in ambient noise level.	As per **Section 5.2.2.3.4.1**.
Transmission line construction and maintenance; and	Increase in ambient noise level.	As per **Section 5.2.2.3.4.1**.
Pipeline construction and maintenance;	Increase in ambient noise level.	As per **Sections 5.2.2.3.4.1** and **5.2.2.3.4.2**.

Due to the absence of heavy industrial noise sources within the local and regional study areas that could add to the Project, there are no overlaps in time and space with other projects or activities. The background noise generated by existing activities is already captured in the baseline conditions summarized in **Section 5.2.2.2.1**.

5.2.2.3.4 Mitigation

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

5.2.2.3.4.1 Construction Phase

Construction phase mitigation measures, grouped by activity or equipment, are shown in Table **Table 5.2.2-8**.

Table 5.2.2-8: Construction Phase Mitigation Measures

Road traffic	• During maintenance, check that noise abatement devices are in good order (e.g., brakes, exhaust mufflers, engine hoods) • Select vehicles with industry standard noise abatement technology, including exhaust and compressor/fan noise
Impact equipment (piledrivers, jackhammers, drills, pneumatic tools)	• Use a noise-attenuating jacket around the jackhammer
Stationary equipment (compressors, generators, pumps)	• Position noisy equipment in sheltered or enclosed locations if practicable
Material-handling equipment (crushers, concrete mixers, cranes)	• Maintain equipment in good working condition • Turn equipment off when not in use if practicable
Earthmoving equipment (trucks, loaders, dozers, scrapers)	• Select equipment with industry standard noise abatement technology, including exhaust, and compressor/fan noise • Operate equipment within specifications and capacities (i.e., do not overload machines)
Other internal combustion engine powered equipment	• Select equipment with industry standard noise abatement technology, including exhaust, and compressor/fan noise • Equipment maintenance: maintain equipment on a regular basis, replace worn parts, lubricate as required

5.2.2.3.4.2 Operations Phase

Operations phase mitigation measures, grouped by activity or equipment, are shown in **Table** 5.2.2-9.

Table 5.2.2-9: Operations Phase Mitigation Measures

Road traffic	• Select vehicles with industry standard noise abatement technology, including exhaust, and compressor/fan noise • Set up the camp in distant location that minimize noise disturbance by road traffic, mine equipment and airstrip • Perform regular inspections and maintenance of material-handling vehicles and equipment, ensuring that noise abatement components are working as intended, worn parts replaced, and lubricants applied, so that manufacturers' noise output specifications continue to be met • Implement speed limits as appropriate for noise and vibration, fugitive dust and safety reasons
Outdoor material-handling equipment (crushers, conveyers)	• Turn equipment off when not in use if practicable • Place the main crusher and other aggregate handling equipment in sheltered or enclosed locations
Earthmoving equipment (trucks, loaders, dozers, scrapers)	• Operate equipment within specifications and capacities (i.e., do not overload machines) • Use noise-abatement accessories, such as sound hoods and mufflers
Primary plant facilities (gyratory primary crusher, SAG mill, ball mill)	• Maintain equipment on a regular basis, replace worn parts, lubricate as required • Minimize the height from which material drops from plant and machinery
Utilities and services	• Operate utilities and provide services in adherence to relevant standards and guidelines (e.g., pump stations, wastewater treatment plant, fuelling station)

5.2.2.3.4.3 Construction/Operation Camp

Proposed mitigation of noise exposure in the camp's rooms will be achieved through several means, including:

- Locating the camp away from noise sources; and
- Assembling the camp's prefabricated modular structure using metal-clad walls with thick thermal insulation; based on evaluation of typical camp structures at mining sites, the walls would decrease outdoor noise of approximately 40 dBA by 20 dBA to the indoor level of approximately 20 dBA, depending on the frequency of the noise (refer to **Section 5.2.2.2**).

5.2.2.3.4.4 Blasting

The purpose of pit blasting is to appropriately fracture or fragment rock mass so to enable excavation for the productive operation while minimizing costs. A certain level of air overpressure (noise) and ground vibration (seismic waves) are inevitable side effects of blasting operations. The following measures will be implemented to control noise and vibration effects of blasting:

- Undertake adequate site reconnaissance and rock face surveys in advance of blast design;

- Ensure that blast design incorporates the appropriate burden, spacing and stemming of holes to control the direction of the energy to minimize the wall damage for long term stability;
- Ensure the correct blasting ratio is obtained (the blasting ratio is a measure of the amount of work expected per unit volume of explosives, e.g., t/kg);
- Conduct blasting on day shift;
- Use downhole initiation with short delay detonators; and
- Minimize the maximum instantaneous charges (MICs).

5.2.2.3.4.5 Airstrip

Noise mitigation measures for the airstrip include:

- Implement airstrip construction noise mitigation measures the same as those for the mine site, wherever relevant;
- Avoid low altitude flights except on final approach and take off;
- Use smaller aircraft (e.g., Dash 8-100) instead of larger (Boeing 737) whenever possible;
- Limit taxiing time; and
- Use low-noise supporting ground equipment (e.g., power generator with muffler).

5.2.2.3.4.6 Effectiveness of Mitigation

Table 5.2.2-10 provides ratings for effectiveness of mitigation measures to avoid or reduce potential effects on noise and vibration during mine site development.

Table 5.2.2-10: Mitigation Measures and Effectiveness of Mitigation to Avoid or Reduce Potential Effects on Noise and Vibration during Mine Site Development

Likely Environmental Noise Source	Project Phase	Mitigation/Enhancement Measure	Effectiveness of Mitigation Rating
Road traffic	Construction	During maintenance, check that noise abatement devices are in good order (e.g., brakes, exhaust mufflers, engine hoods)	High
		Select vehicles with industry standard noise abatement technology	High
	Operations	Select vehicles with industry standard noise abatement technology, including exhaust, and compressor/fan noise	High
		Set up the camp in distant location that minimize noise disturbance by road traffic, mine equipment and airstrip	High

Likely Environmental Noise Source	Project Phase	Mitigation/Enhancement Measure	Effectiveness of Mitigation Rating
		Perform regular inspections and maintenance of material-handling vehicles and equipment, ensuring that noise abatement components are working as intended, worn parts replaced, and lubricants applied, so that manufacturers' noise output specifications continue to be met	High
		Implement speed limits as appropriate for noise and vibration, fugitive dust and safety reasons	High
Impact equipment (e.g. jackhammers, drills, and pneumatic tools)	Construction	Use a noise-attenuating jacket around the jackhammer	High
Stationary Equipment (e.g. compressors, generators, and pumps)	Construction	Position noisy equipment in sheltered or enclosed locations if practicable	High
Material-handling equipment (e.g. crushers, concrete mixers and cranes)	Construction	Maintain equipment in good working condition	High
		Turn equipment off when not in use if practicable	High
Earthmoving equipment (e.g. trucks, loaders, dozers and scrapers)	Construction, Operations	Select equipment with industry standard noise abatement technology, including exhaust, and compressor/fan noise	High
		Operate equipment within specification and capacities (i.e., do not overload machines)	High
		Use noise-abatement accessories, such as sound hoods and mufflers	High
Other internal combustion engine powered equipment	Construction	Select equipment with industry standard noise abatement technology, including exhaust, and compressor/fan noise	High
		Equipment maintenance: maintain equipment of a regular basis, replace worn parts, lubricate as required	High
Outdoor material-handling equipment (e.g. crushers and conveyors)	Operations	Turn equipment off when not in use if practicable	High
		Place the main crusher and other aggregate handling equipment in sheltered or enclosed locations	High
Primary plant facilities (e.g. gyratory primary crusher, SAG mill and ball mill)	Operations	Maintain equipment on a regular basis, replace worn parts, lubricate as required	High
		Minimize the height from which material drops from plant and machinery	High
		Place pebble crusher and grinding circuits in insulted steel structures	High
Utilities and services	Operations	Operate utilities and provide services in adherence to relevant standards and guidelines (e.g., pump stations, wastewater treatment plant, fuelling station)	High
Blasting	Operations	Undertake adequate site reconnaissance and rock face surveys in advance of blast design	High

Likely Environmental Noise Source	Project Phase	Mitigation/Enhancement Measure	Effectiveness of Mitigation Rating
		Ensure that blast design incorporates the appropriate burden, spacing and stemming of holes to control the direction of the energy to minimize the wall damage for long term stability	High
		Ensure the correct blasting ratio is obtained (the blasting ratio is a measure of the amount of work expected per unit volume of explosives, e.g., t/kg)	High
		Conduct blasting on day shift only	High
		Use downhole initiation with short delay detonators	High
		Minimize the MICs	High
Aircraft	Construction, Operations	Implement airstrip construction noise mitigation measures the same as those for the mine site, wherever relevant	High
		Avoid low altitude flights except on final approach and take off	High
		Use smaller aircraft (e.g., Dash 8-100) instead of larger (Boeing 737) whenever possible	High
		Limit taxiing time	High
		Use low-noise supporting ground equipment (e.g., power generator with muffler)	High

Note: MIC = maximum instantaneous charge

In summary, a low success rating means mitigation has not been proven successful, a moderate success rating means mitigation has been proven successful elsewhere, and a high success rating means mitigation has been proven \ effective. The effectiveness of mitigation measures is rated high because the proposed mitigation measures are the technology is widely used in mining and other industries and has proven over a long period of time to reduce noise emissions and ground vibrations.

5.2.2.4 Residual Effects and their Significance

Residual noise effects exist when implementation of mitigation measures do not result in facility compliance with permissible sound levels. The Project will cause direct changes in the ambient noise levels near the mine, along the access road, and at the airstrip. The mitigation measures identified in **Section 5.2.2.3.4** will minimize the extent of these alterations. Results of the noise modelling indicate that noise levels during construction and operations will be below 45 dBA (night time permissible sound pressure level) along the Project boundary. The only exceptions are blasting and aircraft noise. However, they would have an insignificant impact on equivalent sound pressure level (daytime PSL is 55 dBA), due to their very short duration.

The likelihood that there will be project-related noise above background, as measured in the on-site surveys and from literature, is certain. There is some uncertainty about the level of noise above the background as explained further below.

The prediction confidence rating depends on the quality of baseline data, confidence in analytical techniques, and confidence in mitigation measures. There is a high level of confidence in all of the acoustic measurements taken for this Project (i.e., the baseline survey using a Larson Davis System 824 Sound Level Analyzer Type 1, described in **Appendix 5.1.1.1A**) and the computational capability of the noise model (no calculation errors). 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. It has been assumed that no major changes in equipment used as input to the noise model will be made during the life time of the Project.

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 (PWLs), which is often ±2 dB for measured sources. Taking this into account, the expected accuracy of the predictions is ±5 dB.

For construction and closure phases the assessment of residual effects is low due to the uncertainty about noise sources, particularly coincidence of noise from sources and thus there is some risk that noise levels will be higher than predicted. Since reasonable worst case scenarios were modelled, the risk that standards will be exceeded at receptors is judged to be low.

A summary of the potential residual effects and their significance after mitigation is assessed using the significance criteria for noise and vibration that are defined in **Section 4.3.5** (Evaluating Residual Project Effects) and shown in **Table 5.2.2-11** and **Table 5.2.2-12**.

Table 5.2.2-11: Residual Effects Assessment by Project Development Phase for the Mine Site

Parameter	Stage of Development/Rating		
	Construction	**Operations**	**Closure**
Residual Effect	Noise above baseline	Noise above baseline	Noise above baseline
Effect Attribute			
Magnitude	Low	Moderate	Low
Geographic Extent	Local	Local	Local
Duration	Medium-term	Long-term	Medium-term
Context	Low	Low	Low
Frequency	Continuous	Continuous	Continuous
Reversibility	Yes	Yes	Yes
Likelihood Determination	High	High	High
Statement of the level of Confidence for Likelihood	High	High	High
Significance Determination	Not significant (minor)	Not significant (minor)	Not significant (minor)
Statement of the level of confidence for Significance	Medium	Medium	Medium

Note: There will be no residual effects on ambient noise in the post-closure phase

Table 5.2.2-12: Residual Effects Assessment by Project Development Phase for the Off-site Infrastructure

Parameter	Stage of Development/Rating		
	Construction	**Operations**	**Closure**
Residual Effect	Noise above baseline	Noise above baseline	Noise above baseline
Effect Attribute			
Magnitude	Low	Moderate	Low
Geographic Extent	Local	Regional	Local
Duration	Medium-term	Long-term	Medium-term
Context	Low	Low	Low
Frequency	Continuous	Continuous	Continuous
Reversibility	Yes	Yes	Yes
Likelihood Determination	High	High	High
Statement of the level of Confidence for Likelihood	High	High	High
Significance Determination	Not significant (minor)	Negligible	Not significant (minor)
Statement of the level of confidence for Significance	Medium	Medium	Medium

Note: There will be no residual effects on ambient noise in the post-closure phase

5.2.2.5 Cumulative Effects

Audible cumulative effects are not expected, due to the absence of community or industrial noise sources within the local and regional study areas that could add to the Project noise. Cumulative effects associated with the existing background noise of 31 dBA added to the pit or plant noise level of, for example, 45 dBA (the night time permissible level) will be as low as +0.2 dBA, resulting in a cumulative noise level of 45.2 dBA: this change is beyond detection by the human ear. Therefore, background noise will not increase the Project noise at levels above 45 dBA.

No other present and future projects or activities emitting noise/vibration will overlap in time and space with the Project; therefore, no CEA is required.

5.2.2.6 Limitations and Assumptions

Predicted effects of noise, while based on quantitative modelling relies, in some cases, are limited by accuracy of estimates of the number and location of equipment operating at a given time. Reasonable worst case scenarios were used based on experience with normal open pit mine operations. However there could be situations where equipment massing and atmospheric conditions could result in slightly higher than predicted noise levels.

Noise modelling is based on the following assumptions:

- The facility will operate continuously at the same level on 24/7 basis;
- Buildings indoor noise is presented as a combined source resulting from addition of individual sources;
- 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 spectrum dB Linear;
- Atmospheric conditions that would maximize sound attenuations are not taken into account (conservative approach);
- The grid size includes both the local study and regional areas to include near-by and distant noise levels; and
- The project design data is sufficient to develop model input data including octave sound power level for each noise source, their locations, 3D dimensions of each source, ground attenuation, and the pit geometry.

5.2.2.7 Conclusion

Noise and vibration impact on the ambient environment was determined in the following steps:

- Determining baseline noise levels in defined local and regional study areas;

- Defining permissible sound levels applicable to the Project based on relevant guideline and legislation;
- Establishing the noise levels in determined local and regional study areas with desktop study and on-site monitoring;
- Predicting the amount of sound generated by the major sources of the Project; and
- Evaluating the resulting noise levels in the Project study area.

No issues related to non-compliance with permissible levels resulting from the high-level noise of blasting and airstrip noise and vibration are expected due to short lasting. Aircraft operations will be infrequent and the blasting noise will be instantaneous and limited only to daytime period. The mine noise sources will be mitigated by naturally occurring noise absorbers such as hills, trees and bushes and off-site infrastructure systems including transmission line, water pipeline and access road will operate quietly. It should be noted that no human receptors live in the area affected by the Project noise.

In a conclusion, based on the results of the study it has been determined that the Project will comply with established ambient sound and vibration criteria. Significance of residual effects is rated as not significant (minor), or negligible, principally because recognized standards (discussed earlier in this section) will not be exceeded.