8. Noise Predictive Study

8.1 INTRODUCTION

Noise, generally defined as undesirable sound, is characterized in terms of the pressure of the sound wave. It has intrinsic importance to employees, local residents, and fauna as noise can directly affect the health of humans and wildlife. Noise may result in psychological and physiological effects in humans, as well as avoidance behaviour in wildlife populations that causes them to not access important habitats.

The Construction, Operation, and Closure phases of the Brucejack Gold Mine Project (the Project) will produce a variety of noises, including continuous noise from fans, tonal noise from backup alarms, event noise from passing helicopters/vehicles, and impulse noise (non-continuous) from blasting.

The potential impacts of noise make it an important factor with cause-effect pathways to other Valued Components (VCs), namely wildlife and human health. This chapter summarizes the baseline and predictive noise studies conducted as part of the Application for an Environmental Assessment Certificate/Environmental Impact Statement (Application/EIS) for the Project. Assessment of the residual impacts of predicted noise levels on wildlife and human health is reported in Chapters 18 and 21, respectively.

Human perception of sound pressure is non-linear; a 10-fold increase in sound pressure is perceived as a doubling of sound level by the average person. This non-linearity is reflected in the use of the decibel (dB), a logarithmic measure of sound level. Noise is typically monitored as a sound pressure level in A-weighted decibels (dBA), where the A-weighting is designed to match the average frequency response of the human ear. Typical noise levels are:

- **0 dBA:** the threshold of human hearing (roughly a mosquito flying 3 m away);
- **10 dBA:** rustling leaves;
- **20 to 40 dBA:** very calm room with humming of refrigerator;
- **40 to 60 dBA:** normal conversation;
- **60 to 80 dBA:** passenger car at 10 m;
- **80 to 90 dBA:** major road at 10 m;
- **100 dBA:** jackhammer at 1 m;
- **110 to 130 dBA:** jet takeoff at 100 m; and
- **130 dBA:** human pain threshold.

If the decibels are not weighted the amplitude is averaged across all frequencies within the measurement range. This is referred to as Z-weighting (or “zero” weighting) and noise levels are expressed as dBZ.

Due to the non-linear nature of the dB scale, sound levels cannot simply be added. Instead the logarithm has to be inverted before adding and then applied to the sum (Alberta EUB 2007):

$$L_{total} = 10\log_{10}(10^{\frac{L_1}{10}} + 10^{\frac{L_2}{10}})$$

For example, people talking (50 dBA) in a very quiet room (35 dBA) do not increase the noise level in the room to a noise level close to that of a major road (85 dBA). In fact, the 35 dBA background noise will no longer be audible once people start talking. Adding the noise levels in this example will raise total noise levels to 50.1 dBA; the 0.1 dBA increase is much lower than the 3 dBA difference required by the average person to notice any alteration in noise level. For the noise source to be audible it has to be at least as loud as the background.

Sound levels are often presented as continuous equivalent sound level over a time period (logarithmic average [L_{eq}]). The L_{eq} comprises all noise from all sources, including anthropogenic sources such as helicopters and aircraft. Therefore, L_{eq} does not typically reflect the natural noise level conditions in the area. An alternative statistic is L_{90}, the ninetieth percentile level, or the sound pressure level which is exceeded 90% of the time during the measurement period. The L_{90} provides a better indication of the natural noise levels in an area, since discrete events generated by anthropogenic sources are usually excluded from the measurement period.

The standard nomenclature also includes the weighting used. For example, the hourly L_{Aeq} is the A-weighted noise level logarithmically averaged over a 1-hour period. Commonly used noise metrics are defined in Table 8.1-1.

Table 8.1-1. Common Noise Metrics

Noise Metric	Definition
L_{Aeq} or L_{eq}	Continuous equivalent sound level over a time period in A-weighting.
L_{A90} or L_{90}	Sound level exceeded for 90% of the measurement period in A-weighting.
L_{Ad} or L_d	Equivalent day time sound level in A-weighting equivalent during the day time (07:00 to 20:00).
L_{An} or L_n	Equivalent night time sound level in A-weighting during the night (20:00 to 07:00).
L_{Adn} or L_{dn}	Day-night equivalent sound level in A-weighting over 24 hour period, with 10 dB penalty added to the night time sound level.
L_{Afmax} or L_{max}	The maximum sound level recorded over a stated time period.
L_{peak}	The peak sound level. There is no time constant applied to L_{peak} and therefore it is not the same as L_{max}.
L_{AE}	Sound exposure level
%HA	Percent highly annoyed

8.2 REGULATORY AND POLICY FRAMEWORK

There is no federal or provincial legislation that specifically stipulates noise levels for mine development projects in terms of either human or wildlife impacts. Impacts of noise on wildlife are often species specific, with some species particularly susceptible to noise disturbance, while others appear to become acclimatized to noise over time. Furthermore, it can be difficult to separate the effects of noise from the effects of human presence.

The Ungulate Winter Range U-6-002 (BC Order U-6-002) under the *Government Action Regulation* (BC Reg. 582/2004) states that the potential effects on mountain goats should be taken into account when carrying out activities close to the range (BC MOE 2002). Although noise thresholds are not specified in relation to ungulate winter range, noise-generating activities such as helicopter and road traffic should be limited or avoided when possible. Based on threshold values identified for wildlife resulting in flight responses, a sound exposure level due to helicopter activity of 75 dBA is considered an appropriate threshold (Knight and Gutzwiller 1995; Efroymson and Sutter 2001).

Guidance for evaluating noise impacts on human health in environmental assessment is being drafted by Health Canada (2011); however, since this is a draft document, individual references have been used instead of this compilation of guidance.

In the absence of specific noise legislation, this assessment takes into account current best practice and the following relevant guidelines and documents:

- World Health Organization (WHO) *Guidelines for Community Noise* (1999);
- BC Oil and Gas Commission *British Columbia Noise Control Best Practices Guideline* (2009);
- Alberta Energy and Utilities Board *Directive 38: Noise Control* (2007);
- Health Canada's *Useful Information for Environmental Assessments* (Section 6: Noise Effects [2010]);
- Ontario Ministry of Environment *NPC 119: Blasting* (1978);
- Environment Canada's *Environmental Code of Practice for Metal Mines* (2009);
- *Using a Change in Percentage Highly Annoyed with Noise as a Potential Health Effect Measure for Projects under the* Canadian Environmental Assessment Act (Michaud, Bly, and Keith 2008); and
- *BS 5228: Code of Practice for Noise and Vibration Control on Construction and Open Sites* (British Standards Institution 2009).

Noise is a fairly broad term and it is important to select the correct measurable parameters in order to assess the potential changes of the Project on the receiving environment. Project-generated noise levels for this assessment were selected based on a range of the potential impacts listed here and are described in more detail below:

- impact on humans:
  - sleep disturbance;
  - interference with speech communication;
  - complaints;
  - high annoyance;
- impacts on wildlife:
  - loss of wildlife habitat; and
  - disturbance to wildlife.

8.2.1 Noise Level Metrics Considered for Impact on Humans

8.2.1.1 Sleep Disturbance

Sleep disturbance includes the following effects of noise: difficulty falling asleep, awakenings, curtailed sleep duration, alterations of sleep stages or depth, and increased body movements during sleep (WHO 1999). WHO recommends that in quiet, rural areas and for susceptible populations, such as those in hospitals or convalescent or senior homes, the threshold for sleep disturbance of an indoor night-time sound level (L_n, L_{Aeq}, 22:00 to 07:00 hours) is no more than 30 dBA for continuous noise (WHO 1999).

In addition, for a good sleep, it is generally considered that indoor sound pressure levels should not exceed approximately 45 dBA L_{Afmax} more than 10 to 15 times per night (WHO 1999). Sensitivity to noise disturbance varies considerably between individuals, and this guideline is taken to apply to the entire population; therefore, the vast majority of the population would not suffer sleep disturbance above higher levels. Using a 45 dBA maximum limit not to be exceeded more than 10 to 15 times a night is thus a conservative criterion not generally applicable to EAs, but does provide a point of reference from which to understand potential noise impacts on humans. Studies around airports have shown that aircraft noise levels below approximately L_{AE} 90dB (approximately L_{Amax} 80 dB) have little effect on the general population sleeping nearby.

As the Project is expected to operate 24 hours a day on two 12-hour shifts, sleep disturbance at the Project worker's camp may occur throughout the day and night. As a conservative assumption, recommended WHO limits are compared to L_n values.

Sound is attenuated as it is transmitted indoors and the amount of reduction mostly depends on whether windows are open. This assessment assumes an outdoor-to-indoor noise reduction of 15 dBA if windows are open and 27 dBA if windows are closed (US EPA 1974).[1] The actual reduction depends on construction materials, geometry, etc., of the room. Given that the Project is located in a low temperature climate, building shells will be built more airtight, and actual noise reduction levels are expected to be higher. Moreover, technology has advanced since the noise reduction level was published in 1974, and the buildings at the Project site will be constructed with adequate sound insulation; therefore, the noise attenuation from outdoor-to-indoor for mine site living quarters is anticipated to be higher than 27 dBA.

Normally, changes to noise are only assessed at human receptors outside of the Project boundaries. However, in line with current best practices, this assessment includes sleep disturbance at on-site mine camps.

8.2.1.2 Interference with Speech Communication

If continuous Project noise indoors or outdoors is high enough, the Project could interfere with speech communication, such that speakers will need to increase their vocal effort or move closer to each other. US EPA (1974) advises that an indoor vocal level of 40 dBA or an outdoor vocal level of 55 dBA or greater would be required for good speech comprehension.

8.2.1.3 Complaints

The likelihood of a complaint is directly linked to the ability or willingness of an individual to make a complaint and his or her expectation that the complaint will result in noise reduction. Therefore, there is not always a strong link between the disturbance and the complaint. However, widespread complaints have been found to be more likely above an L_{dn} of 62 dBA and vigorous community action should be expected if the project L_{dn} is greater than 75 dBA (US EPA 1974).

8.2.1.4 High Annoyance

The response to noise is subjective and is affected by many factors such as the:

- difference between the specific sound (sound from the Project) and the residual sound (noise in the absence of the specific sound);

[1] An attenuation of 27 dBA is typically assumed in cold climates where building shells are more airtight than structures in warmer climates, meaning that the noise attenuation rates are higher. The Project is located in a cold climate.

- characteristics of the sound (if it contains tones, impulses, etc.);
- absolute level of sound;
- time of day;
- local attitudes to the Project; and
- expectations for quiet.

Health Canada (2010) suggests that the "percentage highly annoyed" (%HA) metric, which is calculated using the adjusted L_{dn} pre- and post-Project, is "an appropriate indicator of noise-induced human health effects for project operational noise and for long-term construction noise exposure."

Health Canada (2010) also suggests that adjustments should be made to account for more annoying sound characteristics; specifically, if the sound at the receptor location can be characterized as having tones, impulses, or strong low-frequency content. The penalty for tones and regular impulsive sound is a + 5 dBA adjustment to the predicted, calculated, or measured sound pressure level. The penalty for highly impulsive noise is a + 12 dBA adjustment. The penalties for high-energy impulsive sound (e.g., blasting) and sound with strong low-frequency content are variable and calculated according to the American National Standards Institute (ANSI) standard S12.9-2005/Part 4 (ANSI 2005). The penalty for sound with strong low-frequency content should only be considered if the C-weighted sound pressure level is more than 10 dB higher than the A-weighted sound pressure level.

Health Canada (2010) advises that "noise mitigation measures be considered when a change in the calculated %HA at any given receptor exceeds 6.5%" or if the Project L_{dn} exceeds 75 dBA.

8.2.2 Noise Level Metrics Considered for Impacts on Wildlife

8.2.2.1 Loss of Wildlife Habitat and Disturbance of Wildlife

The potential effects on wildlife are described in terms of the following responses resulting in loss of habitat:

- reduction in biodiversity and population numbers due to above threshold continuous noise levels; and
- flight response, freezing, or strong startle response due to event noise levels (helicopter and blasting).

Project-related noise was considered and assessed based on noise levels predicted for the Construction and Operation phases. The following limits were used:

- continuous Project noise during the night (45 dBA);
- helicopter overflight A-weighted sound exposure level (L_{AE}; 75 dBA); and
- peak blasting noise levels (L_{peak}; 108 dB L_{peak} for disturbed habitat and 120 dB L_{peak} for functional habitat loss).

Based on the previous identification of potential changes, criteria have been chosen to rate potential changes in terms of their acceptable limits (Table 8.2-1). All of these criteria are for off-site receptors except for sleep disturbance, where on-site mine camps have been assessed with the assumption that windows would be closed at all times.

Table 8.2-1. Project Noise Impact Criteria

Project Metric	Description	Limit
	Human Receptors	
L_d	Daytime noise level for assessing speech interference	55 dBA
L_n	Nighttime noise level for assessing sleep disturbance outside the Project boundary	30 dBA
	Noise level for assessing sleep disturbance inside the Project boundary (i.e., windows closed)[1]	57 dBA[2]
L_{AE}	Noise level for assessing sleep disturbance outside the Project boundary	90 dBA
	Noise levels for assessing sleep disturbance inside the Project boundary (i.e., windows closed)	120 dBA
L_{dn}	Assessing the likelihood of complaints	62 dBA
	Project noise mitigation required due to excessive annoyance	75 dBA
Δ %HA	Increase in %HA metric before and after Project initiation	6.5%
L_{peak}	Peak sound pressure level for assessing human sensitivity to impulsive blasting noise	120 dB
L_{Afmax}	Sleep disturbance level not to be exceeded more than 10 to 15 times per night outside the Project boundary	45 dBA
	Sleep disturbance level not to be exceeded more than 10 to 15 times per night inside the Project boundary	72 dBA[2]
	Wildlife Receptors	
L_n [3]	Project noise level for assessing wildlife habitat loss	45 dBA
L_{AE}	Sound exposure level for assessing wildlife sensitivity to helicopter noise	75 dBA
L_{peak}	Peak sound pressure level for assessing wildlife sensitivity to impulsive blasting noise (disturbance of wildlife)	108 dB
	Peak sound pressure level for assessing wildlife sensitivity to impulsive blasting noise (functional habitat loss)	120 dB

Notes:
[1] Project construction and operations are assumed to occur 24 hours a day; therefore, workers may be sleeping during the day. To account for this, sleep disturbance limits for Project workers' accommodation locations are also compared with daytime (L_d) noise levels.
[2] This is an external noise level and assumes that internal noise levels are in the order of 27 dBA lower with closed windows (which would be the expected normality in the Project's climate). In addition, WHO (1999) recommends that internal sound levels should not exceed approximately 45 dBA more than 10 to 15 times per night.
[3] Guidance suggests using a daytime (L_d) limit of 55 dBA and a nighttime (L_n) limit of 45 dBA.

8.3 BASELINE CHARACTERIZATION

8.3.1 Regional Overview

The Project region is a relatively remote and undisturbed area. The regional noise environment is characterized by natural noise sources, such as wildlife and wind, with small areas of increased noise levels close to anthropogenic sources, such as roads and mine exploration.

The Alberta Energy and Utilities Board Directive 038 (Alberta EUB 2007) provides estimated baseline nighttime noise levels for rural areas of 35 dBA (L_n). Daytime ambient sound levels (L_d) are commonly 10 dBA L_{eq} higher than nighttime levels (WHO 1999). Therefore, daytime rural sound levels are considered to be approximately 45 dBA. There are no baseline levels established for rural areas in British Columbia (BC); however, the Alberta baseline rural noise levels are considered representative of the regional noise levels.

Background noise monitoring has been conducted for several other mineral development projects in the region, including the Kitsault Mine Project in 2009 (AMEC 2011) and the Schaft Creek Mine Project in 2007 (RTEC 2008). The overall L_{90} at the Kitsault Mine Project was 40 dBA (AMEC 2011), while the overall L_{90} values at the Shaft Creek Mine Project ranged from 31 to 39 dBA (RTEC 2008). These levels are comparable to those estimated in the Alberta Energy and Utilities Board Directive 038 (Alberta EUB 2007) and are representative of the majority of the regional environment that is not impacted by local anthropogenic sources.

8.3.2 Historical Activities

Several historical and current human activities are within close proximity to the proposed Project. These include mineral exploration and mine production, hydroelectric power generation, forestry, and road construction and use.

The Granduc Mine was a copper mine located approximately 25 km south of the Project, and was in operation from 1970 to 1978 and 1980 to 1984. The mine included underground workings, a mill site near Summit Lake, and an 18.4-km tunnel connecting them. In addition, a 35-km all-weather access road was built from the communities of Stewart, BC and Hyder, Alaska to the former mill site near Summit Lake. The area of the former mill site near Summit Lake is currently used as staging for several mineral exploration projects in the region. The terminus of the Granduc Access Road is 25 km south of the proposed Brucejack Mine Site and is currently used by mineral exploration traffic and tourists accessing the Salmon Glacier viewpoint.

The Sulphurets Project was an advanced underground exploration project of Newhawk Gold Mines Ltd. located at the currently proposed Brucejack Mine Site. Underground workings were excavated between 1986 and 1990 as part of an advanced exploration and bulk sampling program. Reclamation efforts following the Newhawk Gold Mines Ltd. advanced exploration work included deposition of waste rock and ore within Brucejack Lake.

The exploration phase of the proposed Brucejack Gold Mine Project commenced in 2011 and has included a drilling program, bulk sample program, construction of an exploration access road from Highway 37 to the west end of Bowser Lake, and rehabilitation of an existing access road from the west end of Bowser Lake to the Brucejack Mine Site.

In 2010, construction began on the Long Lake Hydroelectric Project which is located approximately 42 km south of the Project. It included redevelopment of a 20-m-high rockfill dam located at the head of Long Lake, and a new 10-km-long 138-kV transmission line.

Historical forestry activities occurred within the immediate Project area between Highway 37 and Bowser Lake, south of the Wildfire Creek and Bell-Irving River confluence. Additional details regarding historical and current human activities nearby the Project are included in Chapter 1, Project Overview.

Since noise does not persist once the noise causing activities cease, historical activities do not affect current noise levels. However, noise sources from the Brucejack exploration activities were recorded in the baseline monitoring. These activities will have ceased by the Operation phase of the Project and therefore should not be included in the baseline noise levels for this project.

8.3.3 Baseline Studies

The baseline noise study was undertaken:

- to determine the existing noise conditions in the vicinity of the Project; and
- to provide input to the noise assessment modelling.

Baseline studies were conducted in line with the relevant methodologies described in the Application Information Requirements (AIR; Rescan 2013d) and EIS Guidelines (CEA Agency 2013a) and draw on the following information:

- monitoring undertaken specifically for the Project; and
- historical noise monitoring undertaken for projects in the region.

8.3.3.1 Data Sources

Due to the localized and short-lived nature of noise, noise levels are not routinely monitored at a regional scale. To gain an understanding of existing noise levels, a noise monitoring program was set up specifically for the Project. Noise was monitored at six locations in 2012 and the results are summarized in Section 8.4.

In addition, noise levels monitored for other nearby projects can help define the background noise levels in the Project area. Noise monitoring from the following projects in the region has been used to support the noise monitoring programme undertaken specifically for this Project and are incorporated into this baseline assessment:

- Kitsault Mine Project, which is located approximately 130 km south of the Project (AMEC 2011); and
- Schaft Creek Mine Project, which is located approximately 100 km north of the Project (RTEC 2008).

8.3.3.2 Methods

This section briefly outlines the noise monitoring undertaken for this Project. Full details of the baseline monitoring are given in Appendix 8-A, Brucejack Gold Mine Project: 2012 Noise Baseline Report.

<u>Baseline Study Area</u>

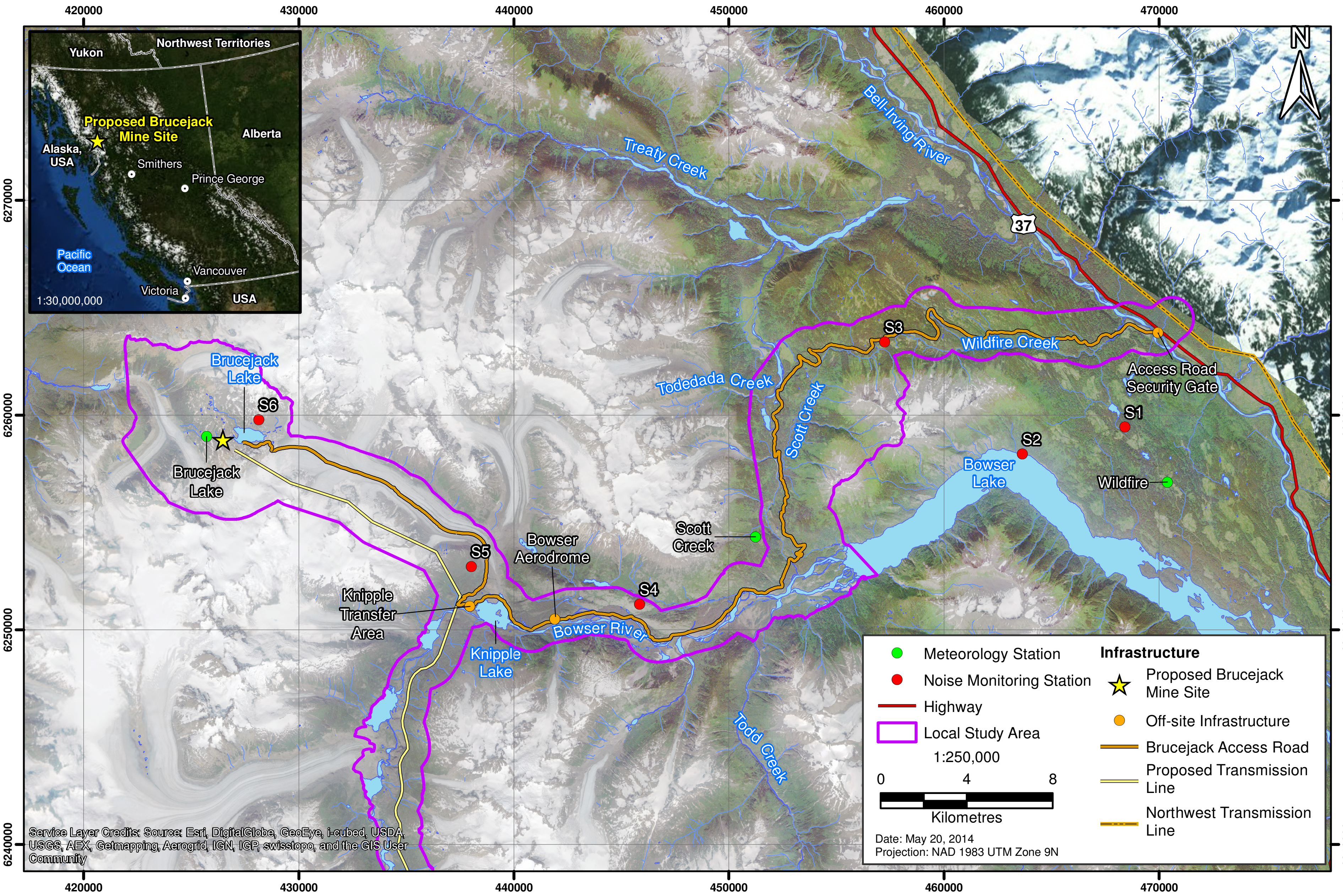
Noise effects diminish with distance from a source. Most human-generated noise is undetectable at a distance of 10 km from a large industrial source. The baseline assessment focused on areas expected to be changed by the primary noise emission sources of the Project, namely the mine site area near Brucejack Lake, the exploration access road, the proposed transmission line, and the proposed Bowser Aerodrome. The baseline Local Study Area (LSA) was adapted from the wildlife characterization and wildlife baseline programs (Rescan 2013b, 2013c) since wildlife could potentially be affected by noise.

<u>Noise Monitoring</u>

Project baseline noise monitoring was conducted at six locations (numbered S1 to S6) across the LSA during 2012 (Figure 8.3-1). These locations were selected to characterize the range of baseline conditions around the Project area based on their proximity to proposed infrastructure locations where future mining activities are expected and the relevance to potential sensitive receptors. Noise monitoring was not conducted along the proposed transmission line; however, noise monitored at other locations is considered to be representative of conditions along the transmission line.

The monitoring periods were chosen to encompass both winter and summer periods. Winter monitoring was completed in March while summer monitoring was completed in September or October, depending on the station. Specific information regarding each station can be found in Appendix 8-A, Brucejack Gold Mine Project: 2012 Noise Baseline Report (Rescan 2013a).

Figure 8.3-1
Noise Monitoring Locations



Baseline noise levels were monitored using Brüel & Kjær Model 2250 sound level meters capable of logging data. These instruments have operating ranges from 16.7 to 140 dBA (at 1 kHz pure tone signal) that capture low sound levels, which are typical for undisturbed wilderness areas, as well as high sound levels. Each instrument's microphone was protected by a wind screen/weather shield and bird spikes. Other than the ground, all surfaces or obstacles were at least 3 m from the stations. A weather-resistant case protected the meter and battery pack, and provided a stable base for each kit.

The average, minimum, and maximum sound levels were measured using the A-weighted frequency rating. Relevant weather parameters, such as wind speed and precipitation, were also noted during the monitoring period.

The noise meters were set up and operated in such a manner as to obtain reliable data given the on-site conditions. Noise monitoring site visits were conducted by experienced technicians to ensure proper documentation and field observations. All data were subjected to a thorough quality assurance and control process.

8.3.4 Characterization of Noise Baseline Condition

The monitored noise baseline results are summarized in Table 8.3-1. The summer monitoring periods had higher noise levels than the winter monitoring periods. This is primarily due to noise from increased wind and rain; however, ground cover conditions also played a role. In March, the ground was covered in snow which serves to reduce noise levels.

Table 8.3-1. 24-hour Noise Monitoring Data

	Sound Level (dBA)					
	Winter (March)			Summer (September/October)		
Station	L_{90}	L_d	L_n	L_{90}	L_d	L_n
S1	17	26	16	21	32	25
S2	17	29	17	44	45	40
S3	16	26	16	34	42	33
S4	18	33	21	38	46	38
S5	16	25	17	36	40	39
S6	20	34	24	40	50	47

Stations S1 and S2 were located in relation to previously proposed infrastructure and the general noise sources were aircraft, wind, rain, and animals. Stations S3, S4, and S5 were all located near the exploration access road and the general sources of noise observed were aircraft and wind during both winter and summer months. Due to the close proximity of station S6 to the existing Brucejack Camp, the slightly higher noise levels were affected by anthropogenic noises associated with the Camp, for example, reversing trucks and construction activities such as hammering and sawing. As such, the noise levels monitored at S6 do not provide true baseline noise levels for the Project.

The L_{90} results are similar to background noise levels recorded at the two other mine projects in the region, the Kitsault Mine Project (overall L_{90} value of 40 dBA) and the Schaft Creek Mine Project (L_{90} values ranged from 31 to 39 dBA).

The L_{90} values representing baseline noise without significant anthropogenic sources were also below the Alberta Energy and Utilities Board and WHO estimate baseline level of 45 dBA for rural areas (Alberta EUB 2007; WHO 1999).

8.4 ESTABLISHING THE SCOPE OF THE ASSESSMENT FOR NOISE

This section includes a description of the scoping process used to identify potentially changed intermediate components that are a pathway to receptor VCs, and to select assessment boundaries. Scoping is fundamental to focusing the Application/EIS on those issues where there is the greatest potential to cause significant adverse effects. The scoping process for the assessment of noise consisted of the following three steps:

- *Step 1:* scoping process to select intermediate components, sub-components, and indicators based on a consideration of the Project's potential to interact and/or change noise;
- *Step 2:* consideration of feedback on the results of the scoping process; and
- *Step 3:* defining assessment boundaries for noise.

These steps are described in detail below.

8.4.1 Selecting Intermediate Components

Issues scoping is undertaken to focus the Application/EIS on the issues of highest concern. To be considered for assessment, a component must be of recognized importance to society, the local community, or the environmental system, and there must be a perceived likelihood that the component will be affected by the proposed Project. Intermediate components are specific attributes of the biophysical environment that if changed (i.e., there is a positive or negative change in the baseline condition), act as a pathway to pass on those changes to other components of the environment, thereby having the potential to also affect or change the baseline condition of receptor VCs. Intermediate components are scoped during consultation with key stakeholders, including Aboriginal communities and the Environmental Assessment (EA) Working Group[2]. Consideration of certain components may also be a legislated requirement, or known to be a concern because of previous project experience.

Noise has been selected as an intermediate component through the scoping process due to the potential impacts on humans (workers and users of the area) and wildlife.

As an intermediate component, a description of potential of the Project to change noise levels, relevant mitigation measures, and predicted changes to noise levels are provided in this chapter. The determination of significance of changes to noise is presented in:

- Chapter 18, Assessment of Potential Wildlife Effects; and
- Chapter 21, Assessment of Potential Health Effects.

8.4.1.1 Potential Interactions between the Project and Intermediate Components

As described in Chapter 6, Assessment Methodology, a scoping exercise was conducted during the development of a draft AIR to explore potential Project interactions with candidate intermediate components and receptor VCs, and to identify the key potential adverse effects associated with that interaction. The results of the scoping exercise were circulated for review and comment on by the EA Working Group, and feedback from that process has been integrated into the Application.

[2] The EA Working Group is a forum for discussion and resolution of technical issues associated with the proposed Project, as well as providing technical advice to the BC EAO and CEA Agency, who remain ultimately responsible for determining significance. It comprises representatives of provincial, federal, and local government, and Aboriginal groups.

Table 8.4-1 provides an impact scoping matrix of Project components and physical activities that have a possible or likely interaction with noise. A full impact scoping matrix for all candidate intermediate and receptor VCs is provided in Table 6.4-1 (Chapter 6, Assessment Methodology). Interactions between the Project and a noise were assigned a colour code as follows:

- not expected (white);
- possible (grey); and
- likely (black).

Table 8.4-1. Interaction of Project Components and Physical Activities with Noise

Project Components and Physical Activities by Phase	**Noise**
Construction Phase	
Activities at existing adit	
Air transport of personnel and goods	
Avalanche control	
Chemical and hazardous material storage, management and handling	
Construction of back-up diesel power plant	
Construction of Bowser Aerodrome	
Construction of detonator storage area	
Construction of electrical tie-in to the BC Hydro grid	
Construction of electrical substation at mine site	
Construction of equipment laydown areas	
Construction of helicopter pad	
Construction of incinerators	
Construction of Knipple Transfer Area	
Construction of local site roads	
Construction of mill building (electrical induction furnace, backfill paste plant, warehouse, mill/concentrator)	
Construction of mine portal and ventilation shafts	
Construction of Brucejack Operations Camp	
Construction of ore conveyer	
Construction of tailings pipeline	
Construction and decommissioning of Tide Staging Area construction camp	
Construction of truck shop	
Construction and use of sewage treatment plant and discharge	
Construction and use of surface water diversions	
Construction of water treatment plant	
Development of the underground portal and facilities	
Employment and labour	
Equipment maintenance/machinery and vehicle refuelling/fuel storage and handling	
Explosives storage and handling	
Grading of the mine site area	

(continued)

Table 8.4-1. Interaction of Project Components and Physical Activities with Noise (continued)

Project Components and Physical Activities by Phase	Noise
Construction Phase (cont'd)	
Helicopter use	
Installation and use of Project lighting	
Installation of surface and underground crushers	
Installation of the transmission line and associated towers	
Machinery and vehicle emissions	
Potable water treatment and use	
Pre-production ore stockpile construction	
Procurement of goods and services	
Quarry construction	
Solid waste management	
Transportation of workers and materials	
Underground water management	
Upgrade and use of exploration access road	
Use of Granduc Access Road	
Operation Phase	
Air transport of personnel and goods and use of aerodrome	
Avalanche control	
Backfill paste plant	
Back-up diesel power plant	
Bowser Aerodrome	
Brucejack Access Road use and maintenance	
Brucejack Operations Camp	
Chemical and hazardous material storage, management, and handling	
Concentrate storage and handling	
Contact water management	
Detonator storage	
Discharge from Brucejack Lake	
Electrical induction furnace	
Electrical substation	
Employment and labour	
Equipment laydown areas	
Equipment maintenance/machine and vehicle refuelling/fuel storage and handling	
Explosives storage and handling	
Helicopter pad(s)	
Helicopter use	
Knipple Transfer Area	
Machine and vehicle emissions	
Mill building/concentrators	

(continued)

Table 8.4-1. Interaction of Project Components and Physical Activities with Noise (continued)

Project Components and Physical Activities by Phase	Noise
Operation Phase (cont'd)	
Non-contact water management	
Ore conveyer	
Potable water treatment and use	
Pre-production ore storage	
Procurement of goods and services	
Project lighting	
Quarry operation	
Sewage treatment and discharge	
Solid waste management/incinerators	
Subaqueous tailings disposal	
Subaqueous waste rock disposal	
Surface crushers	
Tailings pipeline	
Truck shop	
Transmission line operation and maintenance	
Underground backfill tailings storage	
Underground backfill waste rock storage	
Underground crushers	
Underground: drilling, blasting, excavation	
Underground explosives storage	
Underground mine ventilation	
Underground water management	
Use of mine site haul roads	
Use of portals	
Ventilation shafts	
Warehouse	
Waste rock transfer pad	
Water treatment plant	
Closure Phase	
Air transport of personnel and goods	
Avalanche control	
Chemical and hazardous material storage, management, and handling	
Closure of mine portals	
Closure of quarry	
Closure of subaqueous tailings and waste rock storage (Brucejack Lake)	
Decommissioning of Bowser Aerodrome	
Decommissioning of back-up diesel power plant	
Decommissioning of Brucejack Access Road	

(continued)

Table 8.4-1. Interaction of Project Components and Physical Activities with Noise (completed)

Project Components and Physical Activities by Phase	Noise
Closure Phase (cont'd)	
Decommissioning of camps	
Decommissioning of diversion channels	
Decommissioning of equipment laydown	
Decommissioning of fuel storage tanks	
Decommissioning of helicopter pad(s)	
Decommissioning of incinerators	
Decommissioning of local site roads	
Decommissioning of mill building	
Decommissioning of ore conveyer	
Decommissioning of Project lighting	
Decommissioning of sewage treatment plant and discharge	
Decommissioning of surface crushers	
Decommissioning of surface explosives storage	
Decommissioning of tailings pipeline	
Decommissioning of transmission line and ancillary structures	
Decommissioning of underground crushers	
Decommissioning of waste rock transfer pad	
Decommissioning of water treatment plant	
Employment and labour	
Helicopter use	
Machine and vehicle emissions	
Procurement of goods and services	
Removal or treatment of contaminated soils	
Solid waste management	
Transportation of workers and materials (mine site and access roads)	
Post-closure Phase	
Discharge from Brucejack Lake	
Employment and labour	
Environmental monitoring	
Procurement of goods and services	
Subaqueous tailings and waste rock storage	
Underground mine	

Notes:
White = interaction not expected between Project components/physical activities and an intermediate component
Grey = possible interaction between Project components/physical activities and an intermediate component
Black = likely interaction between Project components/physical activities and an intermediate component

Interactions coded as not expected (white) are considered to have no potential for adverse change to noise, and are not considered further.

8.4.1.2 Consultation Feedback on Intermediate Components

Noise-related consultation feedback is mainly linked to the potential impacts of noise on wildlife. Comments that have been received related to noise suggest that helicopter noise in the region may be causing bears to change their habits and become more nocturnal, that the increased vehicle traffic on Highway 37 may have negative impacts on the wildlife, and that goats have likely moved out of the Bell Creek area due to helicopter noise.

Concerns about the potential impact of Project noise on wildlife and users of the area supports the selection of noise as an intermediate component. The findings from the consultations have been incorporated into the scope of the noise assessment.

8.4.1.3 Summary of Intermediate Components Included/Excluded in the Application/EIS

Table 8.4-2 shows the rationale for inclusion of the noise sub-components in the Application/EIS. None of the identified sub-components have been excluded.

Table 8.4-2. Noise Intermediate Components Included in the Application/EIS

Intermediate Component	Identified by*				Rationale for Inclusion
	AG	G	P/S	IM	
Noise			x	x	Project activities will emit sounds that will change local noise levels which in term may lead to effects on receptor VCs including those related to human health and wildlife. Milligan Outfitting Ltd. (Coast Mountain Outfitters) has noted that increased helicopter and vehicle traffic in the region may cause bears to become nocturnal.

**AG = Aboriginal Group; G = Government; P/S = Public/Stakeholder; IM = Impact Matrix*

8.4.2 Assessment Boundaries for Noise

Assessment boundaries define the maximum limit within which changes to intermediate components will be evaluated. They encompass the areas within and times during which the Project is expected to interact with the intermediate components; the constraints that may be placed on the assessment of those interactions due to political, social, and economic realities (administrative boundaries); and limitations in predicting or measuring changes (technical boundaries). The definition of these assessment boundaries is an integral part of the assessment process of noise. The definition of assessment boundaries encompasses all possible direct, indirect, and induced changes to noise, as well as the trends in processes that may be relevant.

8.4.2.1 Spatial Boundaries

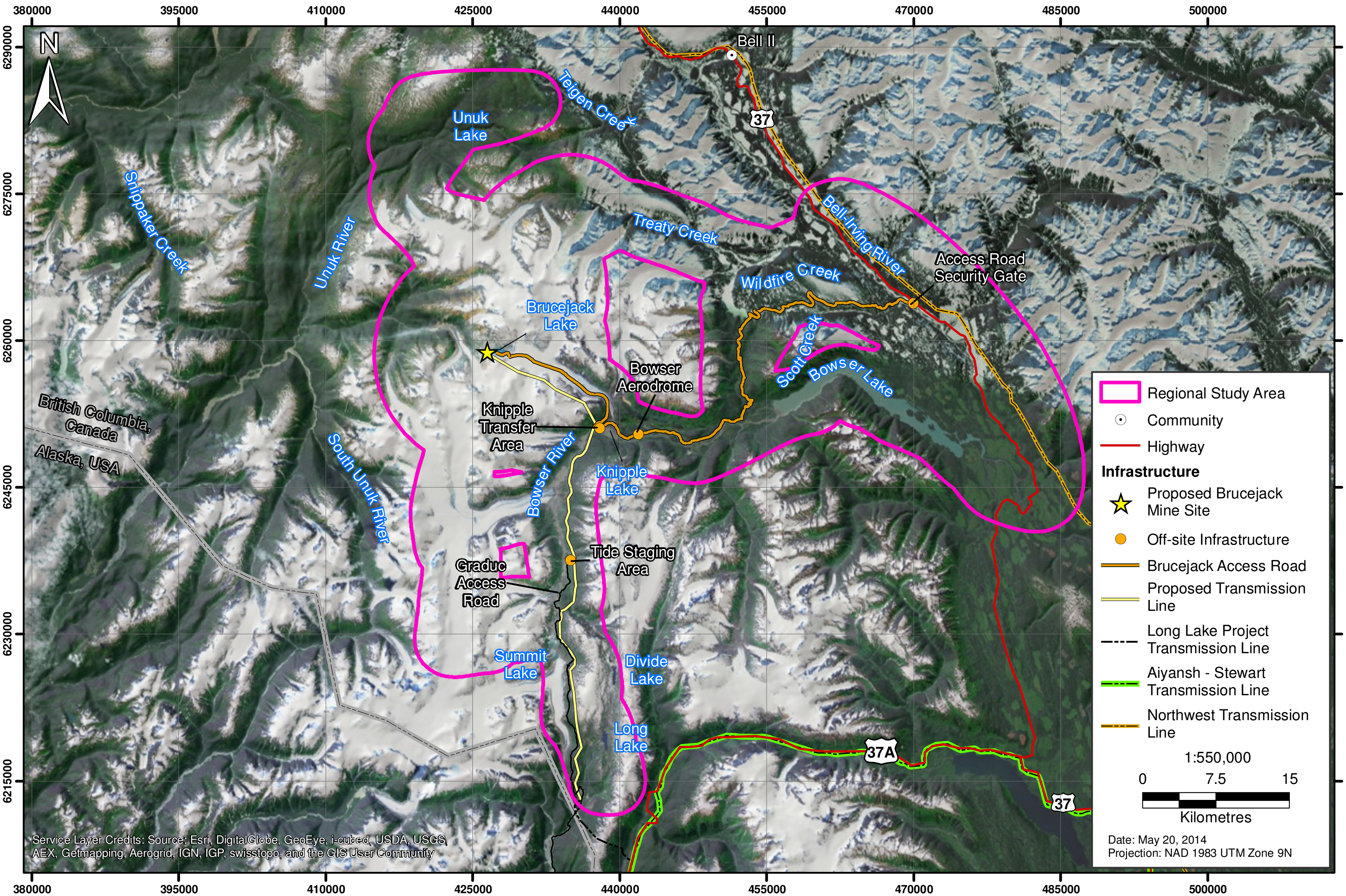
<u>Regional Study Area</u>

The Regional Study Area (RSA) was established based on the "zone of influence" beyond which the residual changes of the Project are expected to diminish to a negligible state. The expected zone of influence was determined using baseline studies, consultation, and expert knowledge. The RSA includes any LSAs relevant to noise and vibration.

Based on professional judgment, and other assessments in similar regions, Project-related noise may be audible under calm conditions at a distance of up to 10 km from the source (Golder 2002). As such, the RSA (Figure 8.4-1) was defined to include the following regions:

- 2 km from either side of the access road;

Figure 8.4-1
Regional Study Area for Noise Modelling



- a zone with a radius of 12 km around the mine site;
- a zone with a radius of 2.5 km around the Knipple Transfer Area and Bowser Aerodrome; and
- 3 km from either side of the assumed helicopter and aircraft flight paths.

This area was selected so that noise contours could be predicted to levels 5 to 10 dB below the relevant criteria limits.

The RSA was used as the modelling domain for the computational noise modelling. No other spatial boundaries are required for the noise assessment.

8.4.2.2 Temporal Boundaries

A temporal boundary is the period of time when the Project is expected to have an effect on the environment. Potential of each of the following Project phases to alter noise have been considered:

- Construction phase: 2 years;
- Operation phase: 22 years;
- Closure phase: 2 years; and
- Post-closure phase: minimum of 3 years.

Project noise levels during the Closure and Post-closure phases are expected to be substantially lower than those experienced during the Construction and Operation phases. As the changes to noise levels during Construction and Operation are predicted to be not significant on wildlife (Chapter 18, Assessment of Potential Wildlife Effects) or human health (Chapter 21, Assessment of Potential Health Effects), predictive noise modelling studies for Closure and Post-closure are not warranted.

The noise assessment considers the Construction and Operation phases of the Project, as follows:

- Construction year: The modelled Construction year was chosen to be the year in which the highest numbers of mobile and fixed equipment units are expected to be in use; and
- Operation year: During the life of the mine, the production and mining activities are expected to be fairly consistent. Therefore, an average typical year was chosen to represent the Operation phase.

8.4.3 Identifying Key Potential Changes to Noise

The next step in the scoping process is to identify which of the potential Project interactions identified in Table 8.4-1 are likely to change noise levels. Using Table 8.4-3, the potential Project interactions have been ranked based on the potential impacts.

Table 8.4-3. Ranking Potential Effects on Noise

Project Components and Physical Activities by Phase	Change in Noise Levels
Construction Phase	
Activities at existing adit	● (green)
Air transport of personnel and goods	● (yellow)
Avalanche control	● (green)
Chemical and hazardous material storage, management and handling	○

(continued)

Table 8.4-3. Ranking Potential Effects on Noise (continued)

Project Components and Physical Activities by Phase	Change in Noise Levels
Construction Phase (cont'd)	
Construction of back-up diesel power plant	🟡
Construction of Bowser Aerodrome	🟡
Construction of detonator storage area	🟡
Construction of electrical tie-in to the BC Hydro grid	🟢
Construction of electrical substation at mine site	🟡
Construction of equipment laydown areas	🟡
Construction of helicopter pad	🟡
Construction of incinerators	🟡
Construction of Knipple Transfer Area	🟡
Construction of local site roads	🟡
Construction of mill building (electrical induction furnace, backfill paste plant, warehouse, mill/concentrator)	🟡
Construction of mine portal and ventilation shafts	🟡
Construction of Brucejack Operations Camp	🟡
Construction of ore conveyer	🟡
Construction of tailings pipeline	🟡
Construction and decommissioning of Tide Staging Area construction camp	🟡
Construction of truck shop	🟡
Construction and use of sewage treatment plant and discharge	🟡
Construction and use of surface water diversions	🟡
Construction of water treatment plant	🟡
Development of the underground portal and facilities	🟡
Employment and labour	○
Equipment maintenance/machinery and vehicle refuelling/fuel storage and handling	○
Explosives storage and handling	○
Grading of the mine site area	🟡
Helicopter use	🟡
Installation and use of Project lighting	🟢
Installation of surface and underground crushers	🟢
Installation of the transmission line and associated towers	🟢
Machinery and vehicle emissions	🟡
Potable water treatment and use	○
Pre-production ore stockpile construction	🟡
Procurement of goods and services	○
Quarry construction	🟡
Solid waste management	🟢
Transportation of workers and materials	🟡
Underground water management	○

(continued)

Table 8.4-3. Ranking Potential Effects on Noise (continued)

Project Components and Physical Activities by Phase	Change in Noise Levels
Construction Phase (cont'd)	
Upgrade and use of exploration access road	🟡
Use of Granduc Access Road	🟡
Operation Phase	
Air transport of personnel and goods and use of aerodrome	🟡
Avalanche control	🟢
Backfill paste plant	○
Back-up diesel power plant	🟢
Bowser Aerodrome	○
Brucejack Access Road use and maintenance	🟡
Brucejack Operations Camp	○
Chemical and hazardous material storage, management, and handling	○
Concentrate storage and handling	🟡
Contact water management	○
Detonator storage	○
Discharge from Brucejack Lake	○
Electrical induction furnace	🟡
Electrical substation	○
Employment and labour	○
Equipment laydown areas	○
Equipment maintenance/machine and vehicle refuelling/fuel storage and handling	○
Explosives storage and handling	○
Helicopter pad(s)	○
Helicopter use	🟡
Knipple Transfer Area	🟡
Machine and vehicle emissions	🟡
Mill building/concentrators	🟡
Non-contact water management	○
Ore conveyer	🟡
Potable water treatment and use	○
Pre-production ore storage	○
Procurement of goods and services	○
Project lighting	○
Quarry operation	🟢
Sewage treatment and discharge	○
Solid waste management/incinerators	🟢
Subaqueous tailings disposal	○
Subaqueous waste rock disposal	○
Surface crushers	🟡

(continued)

Table 8.4-3. Ranking Potential Effects on Noise (continued)

Project Components and Physical Activities by Phase	Change in Noise Levels
Operation Phase (cont'd)	
Tailings pipeline	○
Truck shop	○
Transmission line operation and maintenance	○
Underground backfill tailings storage	○
Underground backfill waste rock storage	○
Underground crushers	○
Underground: drilling, blasting, excavation	🟢
Underground explosives storage	○
Underground mine ventilation	🟡
Underground water management	○
Use of mine site haul roads	🟡
Use of portals	🟢
Ventilation shafts	○
Warehouse	○
Waste rock transfer pad	○
Water treatment plant	○
Closure Phase	
Air transport of personnel and goods	🟢
Avalanche control	🟢
Chemical and hazardous material storage, management, and handling	○
Closure of mine portals	○
Closure of quarry	🟢
Closure of subaqueous tailings and waste rock storage (Brucejack Lake)	○
Decommissioning of Bowser Aerodrome	🟢
Decommissioning of back-up diesel power plant	🟢
Decommissioning of Brucejack Access Road	🟢
Decommissioning of camps	🟢
Decommissioning of diversion channels	🟢
Decommissioning of equipment laydown	🟢
Decommissioning of fuel storage tanks	🟢
Decommissioning of helicopter pad(s)	🟢
Decommissioning of incinerators	🟢
Decommissioning of local site roads	🟢
Decommissioning of mill building	🟢
Decommissioning of ore conveyer	🟢
Decommissioning of Project lighting	🟢
Decommissioning of sewage treatment plant and discharge	🟢
Decommissioning of surface crushers	🟢

(continued)

Table 8.4-3. Ranking Potential Effects on Noise (completed)

Project Components and Physical Activities by Phase	Change in Noise Levels
Closure Phase (cont'd)	
Decommissioning of surface explosives storage	●
Decommissioning of tailings pipeline	●
Decommissioning of transmission line and ancillary structures	●
Decommissioning of underground crushers	●
Decommissioning of waste rock transfer pad	●
Decommissioning of water treatment plant	●
Employment and labour	○
Helicopter use	●
Machine and vehicle emissions	●
Procurement of goods and services	○
Removal or treatment of contaminated soils	●
Solid waste management	●
Transportation of workers and materials (mine site and access roads)	●
Post-closure Phase	
Discharge from Brucejack Lake	○
Employment and labour	○
Environmental monitoring	○
Procurement of goods and services	○
Subaqueous tailings and waste rock storage	○
Underground mine	○

Notes:
○ = *No interaction anticipated*
● (green) = *Negligible to minor adverse effect expected; implementation of best practices, standard mitigation and management measures; no monitoring required, no further consideration warranted.*
● (yellow) = *Potential moderate adverse effect requiring unique active management/monitoring/mitigation; warrants further consideration.*
● (red) = *Key interaction resulting in potential major adverse effect or significant concern; warrants further consideration.*

Interactions that are marked red or yellow in Table 8.4-3 will be carried forward for additional analysis. Interactions that are green will not be discussed further except to identify standard operating practices and mitigation measures that are well known and understood and will be used to address these minor concerns.

8.4.3.1 Construction

Table 8.4-3 shows that the key changes of the Project on noise during the Construction phase are expected to be due to construction equipment and activities associated with the construction of the Brucejack Mine Site, quarry, Knipple Transfer Station and Bowser Aerodrome, diesel power generation, exploration access road activities, helicopter use and other air traffic, and blasting. Introduction of these noise sources during the Construction phase may adversely change noise levels at the identified human and wildlife receptors. These noise sources are accounted for in the noise modelling (Section 8.5).

Noise generated from existing activities at the adit and avalanche control are expected to have a negligible to minor change to noise levels and have therefore not been considered further in this assessment.

8.4.3.2 Operation

The key changes of the Project to noise during the Operation phase are expected to be due to the operation of the Brucejack Mine Site, Knipple Transfer Station and Bowser Aerodrome, Brucejack Access Road activities, helicopters and other aircraft. Note that helicopter use is limited to emergency purposes only during the operation phase. Introduction of these noise sources during the Operation phase may adversely change noise levels at the identified human and wildlife receptors. These noise sources are accounted for in the noise modelling (Section 8.5).

8.4.3.3 Closure

Noise generated during the Closure phase is expected to be less than that generated during the Construction and Operation phases. Noise changes from the Closure phase are expected to be negligible to minor and have therefore not been considered further in this assessment.

8.4.3.4 Post-closure

No interactions between the Project's Post-closure phase and noise were identified and therefore this phase has not been considered further in this assessment.

8.5 PREDICTIVE STUDY METHODS FOR NOISE

Noise modelling was conducted to predict noise levels within the LSA for input into the wildlife and human health effects assessments (Chapter 18, Assessment of Potential Wildlife Effects, and Chapter 21, Assessment of Potential Health Effects, respectively). The noise modelling was used to predict noise levels (L_{Aeq}, L_d, L_n, and L_{dn}) from continuous noise sources during the Construction and Operation phases and to predicted sound exposure levels (L_{AE}) and peak noise levels (L_{peak}) from single events (aircraft, helicopters, and blasting). Full details of the noise modelling methodology and results are included in Appendix 8-B, Brucejack Gold Mine Project: Final Environmental Noise Modelling Study, and summarized here.

Project noise levels were predicted using the following standards:

- ISO 9613-2 (ISO 1996) methodology for calculating the attenuation of sound during propagation outdoors in order to predict levels of environmental noise at a distance for a variety of sources;
- ICAN 2009 (Probst, Huber, and Vogelsang 2009) to predict aircraft noise using flight paths and grouped emission data of different aircraft types; and
- ANSI S12.17 (ANSI 1996) and ANSI S2.20 (ANSI 1983) to calculate blasting noise.

These standards were implemented in the outdoor sound propagation software Cadna/A (version 4.3).

The ISO 9613 calculations standard is recommended for use in the European Community (WG-AEN 2007). These standards and the Cadna/A software are widely used and accepted across Canada.

The acoustic properties of the ground surface can have a considerable effect on the propagation of noise; for example, flat non-porous surfaces such as calm water and concrete can be highly reflective whilst soft, porous surfaces such as foliage and fresh snow can be highly absorptive to noise. This factor was accounted for in the modelling by assuming that water bodies and ice-covered ground are highly reflective whilst forested areas are assumed to absorb noise.

The effects of terrain, buildings, and large equipment on noise propagation were included in the modelling. An average temperature of 10˚C and a relative humidity of 80% were input to the model.

These values were selected to represent a typical worst case and were based on available meteorological data and professional judgement. Note that the mine site area has been assumed to be a reflective surface in the assessment. During the winter, the area will have snow accumulation and snow would absorb noise; therefore, the predicted noise levels during the winter may be less.

8.5.1 Sensitive Receptors

Noise levels were predicted at relevant human and wildlife receptors within the RSA. Human receptors included on-site workers' accommodation camps and existing cabins which were identified from the Skii km Lax Ha Traditional Knowledge/Traditional Use studies. The human receptors are summarized in Table 8.5-1 and presented in Figure 8.5-1. A detailed inventory of the receptors is included in Appendix 8-B, Brucejack Gold Mine Project: Final Environmental Noise Modelling Study.

Table 8.5-1. Summary of Sensitive Receptors

Receptor Type	Number of Receptors	Potential Effects
Human Receptors		
Workers' accommodation camps	9 [a]	Sleep disturbance
Human cabin/camping	3 [b]	Speech interference, complaints, sleep disturbance, annoyance

[a] *All within the Project footprint*
[b] *One within the Project footprint and two outside the Project area*

8.5.2 Construction Phase Noise Sources

The Construction phase was modelled using several noise sources that each represented a larger group of equipment. The operating time and area of operation for each piece of equipment were incorporated into the calculation of the sound power levels. Table 8.5-2 lists the noise sources and sound power levels modelled for each of the Project construction source groups. Note that sound power level is the total sound energy emitted by a source per unit time. It is not measurable and is calculated. The sound power is dispersed and sound level at the receptor is predicted based on the terrain and the distance from the source. Detailed noise emission data for each piece of construction equipment is included in Appendix 8-B, Brucejack Gold Mine Project: Final Environmental Noise Modelling Study.

Aircraft were included in the Construction phase modelling scenario but noise from blasting activities was considered separately. Table 8.5-3 shows the aircraft data used in the modelling.

Two blast sites were modelled during the Construction phase; one at the planned site for the mill building at the Brucejack Mine Site and one at the quarry. Table 8.5-4 summarizes the input data used to calculate the blasting noise levels.

8.5.3 Operation Phase Noise Sources

The Operation phase was modelled in the same way as the Construction phase (Section 8.5.1.2). Table 8.5-5 lists the Operation phase noise sources and Table 8.5-6 shows the operation aircraft data used in the modelling. Detailed noise emission data for each operation phase noise source are included in Appendix 8-B, Brucejack Gold Mine Project: Final Environmental Noise Modelling Study.

Figure 8.5-1
Human Health Receptor Locations for Noise

ERM

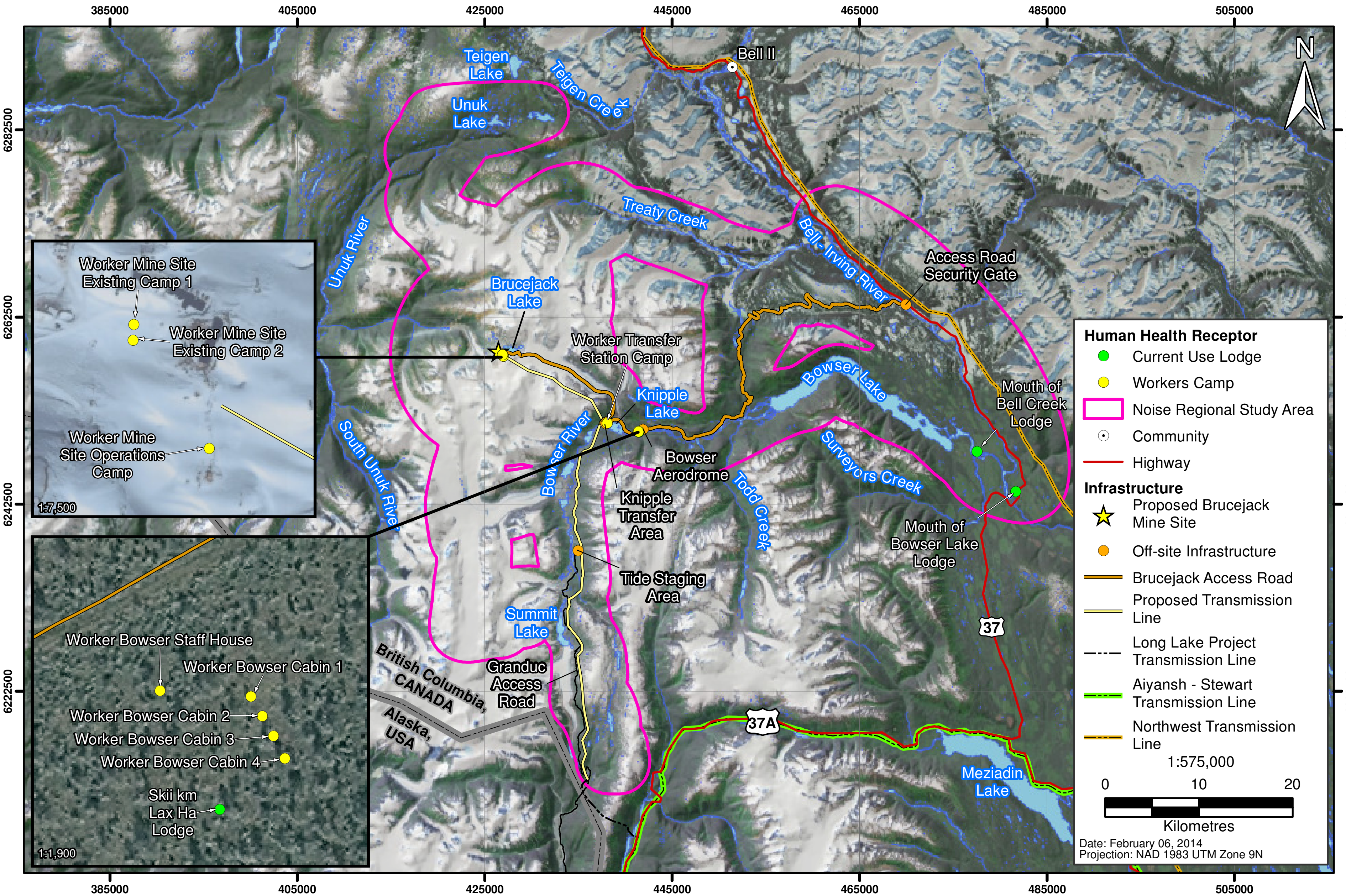


Table 8.5-2. Construction Phase Noise Sources

Source	Sound Power Level (dBA) Day	Sound Power Level (dBA) Night	Modelling Description
Construction Equipment and Activities			
Brucejack Mine Site construction noise sources	125	122	Area source covering Brucejack Mine Site
Quarry construction noise sources, including crushers and screen	134	130	Area source covering quarry
Knipple Transfer Area construction noise sources	124	0	Area source covering Knipple Transfer Area
Bowser Aerodrome construction noise sources	124	0	Area source covering Bowser Aerodrome
500 kW diesel generator	99	99	Point sources at Brucejack Mine Site and Knipple Transfer Area
250 kW diesel generator	96	96	Point sources at Bowser Aerodrome and Knipple Transfer Area
Brucejack Access Road Activity			
Between Highway 37 entry and quarry	123	114	Line source along Brucejack Access Road between Highway 37 entry and quarry
Between quarry and Brucejack Mine Site	125	121	Line source along exploration access road between quarry and Brucejack Mine Site
Alternate access route between quarry and Brucejack Mine Site	125	121	Line source along alternate access road between quarry and Brucejack Mine Site

Table 8.5-3. Aircraft Activity during Construction Phase

Aircraft Type	ICAO[1] Group	ICAO Definition	Maximum No of Flights per Day
10-passenger helicopter[2]	H 1.2	Civil and military helicopters with MTOM[3] from 3.0 to 5.0 tonnes	5

[1] *ICAO = International Civil Aviation Organization*
[3] *No flight is expected after 6 pm.*
[3] *MTOM = Maximum Take-off Mass*

Table 8.5-4. Blasting Input Data

Input	Value
Explosive per hole (kg)	27.5
TNT [1] mass equivalent per hole (kg)	22
Holes per delay	1
Charge burial depth (m)	4

[1] *Trinitrotoluene*

8.5.4 Outdoor-to-Indoor Transmission Loss

Some noise criteria such as sleep disturbance, are to be compared to indoor instead of outdoor noise levels. It is assumed that the outdoor-to-indoor transmission loss with doors closed and windows partially open is 15 dBA (US EPA 1974). Fully closed windows are assumed to reduce outdoor sound levels by approximately 27 dBA (US EPA 1974). For the workers accommodations, it is assumed that the doors and windows will be closed, providing a noise reduction of 27 dB. For the off-site human receptors, it is assumed that the doors will be closed with windows slightly open, resulting in an outdoor-to-indoor noise reduction of 15 dB.

Table 8.5-5. Operation Phase Noise Sources

Source	Sound Power Level (dBA) Day	Night	Modelling Description
Operation Equipment and Activities			
Brucejack Mine Site operation noise sources	126	125	Area source covering Brucejack Mine Site
Knipple Transfer Area operation noise sources	116	114	Area source covering Knipple Transfer Area
Bowser Aerodrome operation noise sources	125	123	Area source covering Bowser Aerodrome
500-kW diesel generators	99	99	Point sources at Knipple Transfer Area
250-kW diesel generators	96	96	Point sources at Bowser Aerodrome and Knipple Transfer Area
Baghouses	114	114	Point sources at Brucejack Mine Site
Scrubbers	113	113	Point sources at Brucejack Mine Site
Portal heaters	112	112	Point sources at Brucejack Mine Site
Primary fans	108	108	Point sources at Brucejack Mine Site
Return air raises (exhaust fan)	111	111	Point sources at Brucejack Mine Site
Indoor equipment reverberant level	85	85	Area source covering mill building and water treatment plant
Brucejack Access Road Activity			
Between Highway 37 entry and quarry	123	114	Line source along access road between Highway 37 entry and quarry
Alternate access route between quarry and Brucejack Mine Site	102	100	Line source along alternate access road between quarry and Brucejack Mine Site

Table 8.5-6. Aircraft Activity during Operation Phase

Aircraft Type	ICAO [1] Group	ICAO Definition	Maximum Number of Flights per Day
10-passenger helicopter[3]	H 1.2	Civil and military helicopters with MTOM[2] from 3.0 to 5.0 tonnes	3
Propeller aircraft	P 2.2	Propeller aircraft with MTOM above 5.7 tonnes	1

Notes:
[1] *ICAO = International Civil Aviation Organization*
[2] *MTOM = Maximum Take-off Mass*
[3] *Helicopter usage is limited to emergency purposes only and is expected to be less than 3 trips monthly.* No flight is expected after 6pm

Note that the 27 dBA reduction from outdoor to indoor was based on the US EPA's *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (US EPA 1974). It should be noted that the noise reduction with today's building technology can easily exceed 27 dBA.

8.5.5 Limitations

For sound levels calculated using the ISO 9613-2 standard (ISO 1996), the indicated accuracy is ± 3 dBA at the source to receptor distances of up to 1,000 m. The uncertainty is unknown at distances greater than 1,000 m.

The estimated sound power levels for equipment were based on documented average noise levels for similar equipment. In general, for individually modelled noise sources, the estimated accuracy is ± 5 dBA. However, with many different sources combined, the total sound power level is likely to be more accurate than this.

8.6 PREDICTIVE STUDY RESULTS FOR NOISE

Full noise modelling results are included in Appendix 8-B, Brucejack Gold Mine Project: Final Environmental Noise Modelling Study, and are summarized here.

8.6.1 Project Construction

8.6.1.1 Human Receptors

Figures 8.6-1 and 8.6-2 show the average predicted external noise levels across the RSA due to construction activities during the day and night, respectively. Tables 8.6-1 and 8.6-2 present the predicted noise levels during the Construction phase at the worker accommodation receptors and the existing off-site human receptors, respectively.

Table 8.6-1. Predicted Construction Noise Levels at the Workers Accommodation Receptors

Receptor	Construction Noise Levels (dBA)		
	Average Noise L_d	Average Noise L_n	Vehicle Pass-by Noise L_{max}
Relevant impact criteria	*57*	*57*	*72*
Worker Bowser cabin 1	62	55	80
Worker Bowser cabin 2	61	52	79
Worker Bowser cabin 3	60	51	77
Worker Bowser cabin 4	59	49	76
Worker Bowser staff house	64	60	84
Worker Brucejack Mine Site existing camp 1	58	54	67
Worker Brucejack Mine Site existing camp 2	57	54	68
Worker transfer station camp	71	55	83

Table 8.6-2. Predicted Construction Noise Levels at Existing Off-site Human Receptors

Receptor	Brucejack Mine Site Blasting L_{peak}	Quarry Blasting L_{peak}	Average Noise L_d	Average Noise L_n	Total L_{dn}	%HA	Δ%HA
	dBZ	dBZ	dBA	dBA	dBA	%	%
Relevant impact criteria	*120*	*120*	*55*	*45*	*75*	*-*	*6.5*
Outlet of Bell Creek	63	63	14	11	45	1.1	0.0
Outlet of Bowser Lake	64	64	14	11	36	1.3	0.2
Skii km Lax Ha Lodge	74	75	59	45	58	11.1	10.0

Since some workers may sleep during the day, nighttime noise criterion for sleep disturbance was used for both L_n and L_d for the workers accommodations. For the vehicle pass-by noise presented in Table 8.6-1, three out of the nine receptors did not exceed the criterion. However, the vehicle pass-by noise will not be continuous, and the prediction was done based on the loudest vehicle.

Figure 8.6-1
Predicted Daytime Noise Levels during Construction

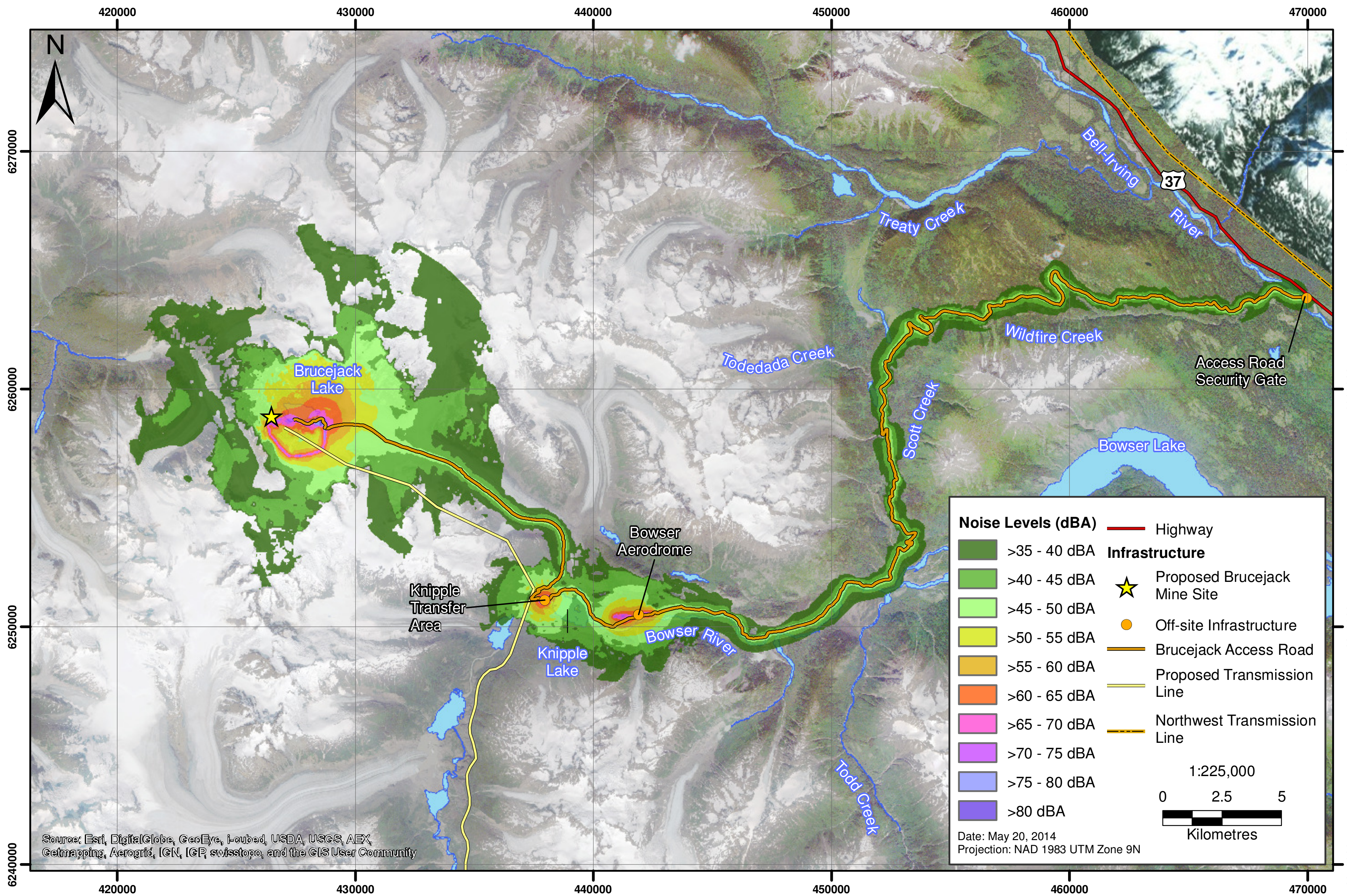
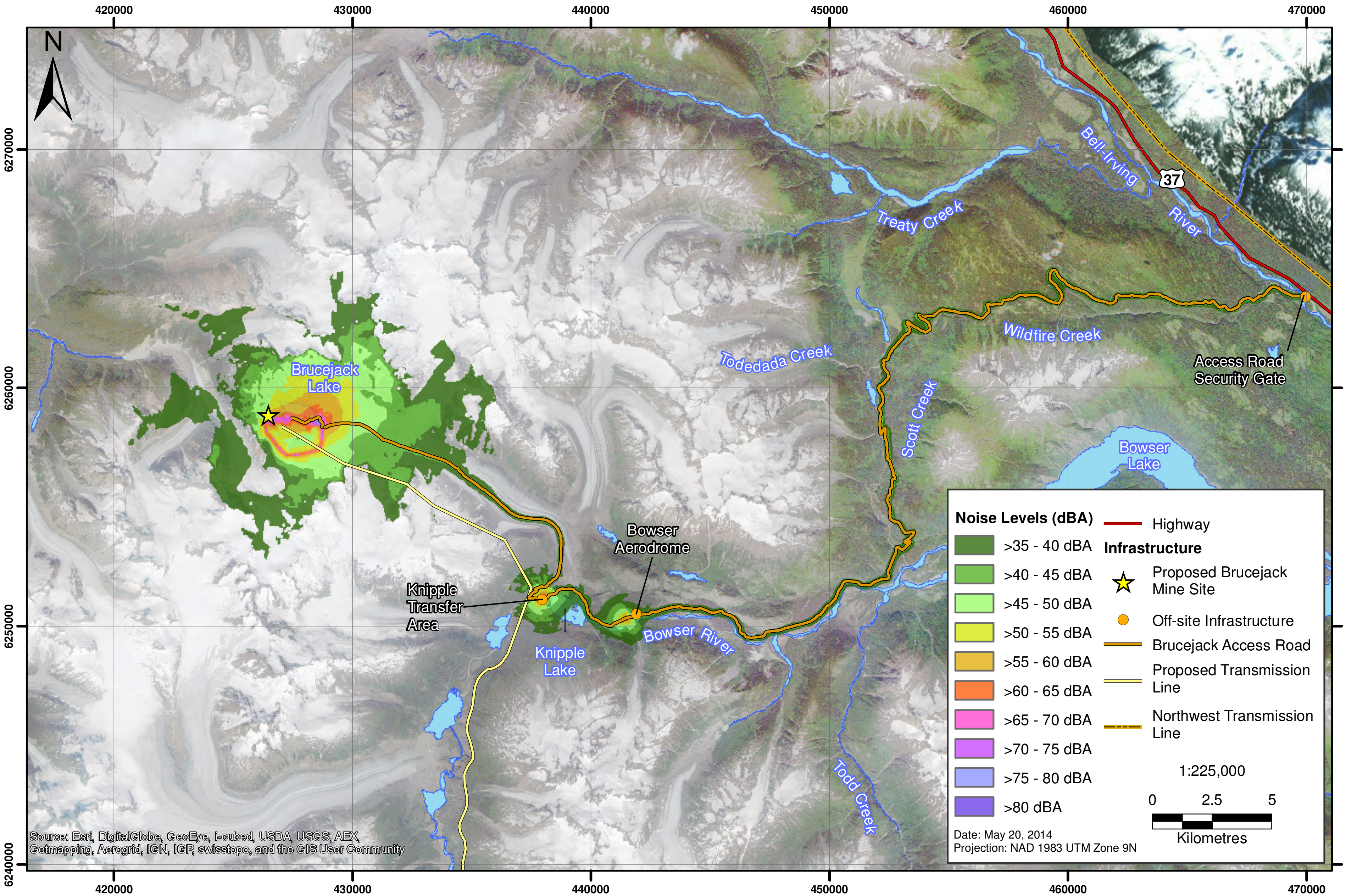


Figure 8.6-2
Predicted Nighttime Noise Levels during Construction



The maximum predicted daytime noise exceedance at a relevant on-site human receptor is 14 dBA at the workers camp at the Knipple Transfer Area followed by 7 dBA at the Worker Bowser staff house. The workers transfer station camp will be built during stage 1 of the Construction phase. After it is built, it will be used to accommodate short visitor stays in the event of adverse weather conditions that prevent the transportation of personnel to the mine site. This camp will not be used as long-term accommodation during the Construction phase.

For off-site human receptors shown in Table 8.6-2, there are no predicted exceedances for blasting. The only exceedance predicted is located at the Skii km Lax Ha lodge, with daytime noise levels over the speech interference criterion occurring. The Skii km Lax Ha lodge was built with triple paned windows and insulated walls of two by six inch structural timber and with two inch foam insulation (G. Simpson, pers. comm.). The noise attenuation from outdoor to indoor is likely to be higher than assumed using US EPA noise reduction factors.

The potential impact of these predicted noise levels on human health is discussed in Chapter 21, Assessment of Potential Health Effects.

8.6.1.2 Wildlife

A single helicopter was modelled passing through all possible routes to predict noise exposure levels (L_{AE}) across the modelled area. Figure 8.6-3 displays the predicted noise levels and shows that when flying at an assumed 600 m altitude, the helicopter creates an approximate 3-km-wide noise path on the ground that exceeds 75 dBA L_{AE}.

Figures 8.6-4 and 8.6-5 display the predicted peak sound levels for blasting at the Brucejack Mine Site and the quarry, respectively. These show that there is a small area close to the blast site where the L_{peak} is predicted to exceed 120 dBA. The 108 dBA L_{peak} limit for wildlife is predicted to be exceeded up to approximately 1 km from the blast site.

Figure 8.6-6 shows the predicted noise levels from a vehicle pass by. It shows that the 75 dBA criteria for wildlife may be exceeded up to 1 km from the road. The predicted noise levels are sensitive to the assumed ground surface (hard or soft ground) and the vehicle type.

The potential impacts of helicopter, blasting, and vehicle noise levels on wildlife are discussed in Chapter 18, Assessment of Potential Wildlife Effects.

8.6.2 Operation Phase

8.6.2.1 Human Receptors

Figures 8.6-7 and 8.6-8 show the average predicted noise levels across the RSA due to Operation phase activities during the day and night, respectively. Tables 8.6-3 and 8.6-4 present the predicted noise levels during the Operation phase at the worker accommodation receptors and the existing off-site human receptors, respectively. As previously mentioned, the nighttime noise criterion for sleep disturbance was used for both L_d and L_n since some workers may be sleeping during the day. The camp at the Bowser Transfer Station predicted noise levels above the sleep disturbance limit for both day and night. Since the methods used to predict vehicle pass-by for the Construction and Operation phases are the same and used the same loudest vehicle, results for both phases are identical; therefore, the vehicle pass-by results are not repeated in the Operation phase tables.

Figure 8.6-3
Predicted Helicopter Sound Exposure Level

ERM

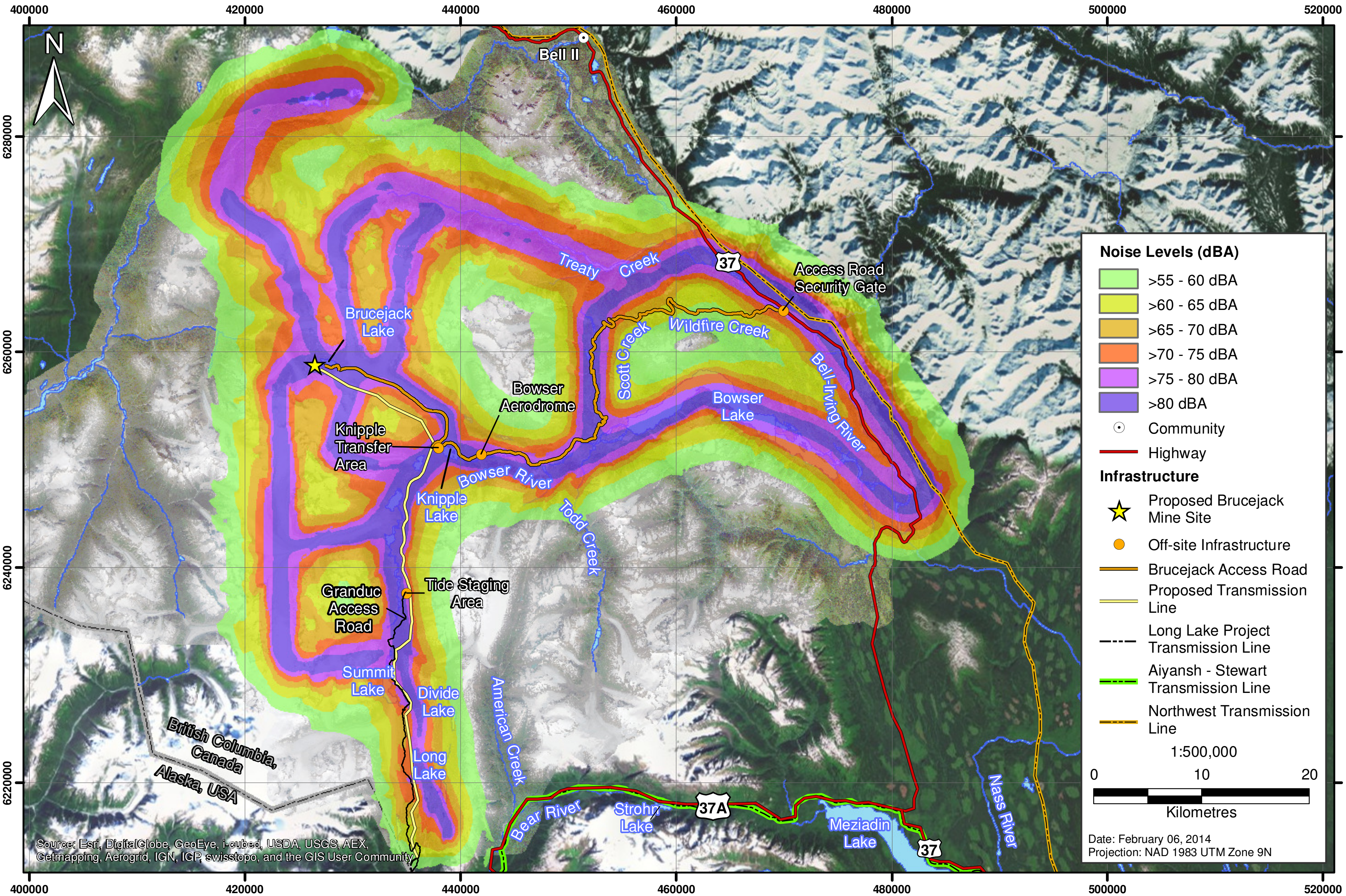


Figure 8.6-4

Predicted Blasting L_{peak} Noise from Brucejack Mine Site during Construction

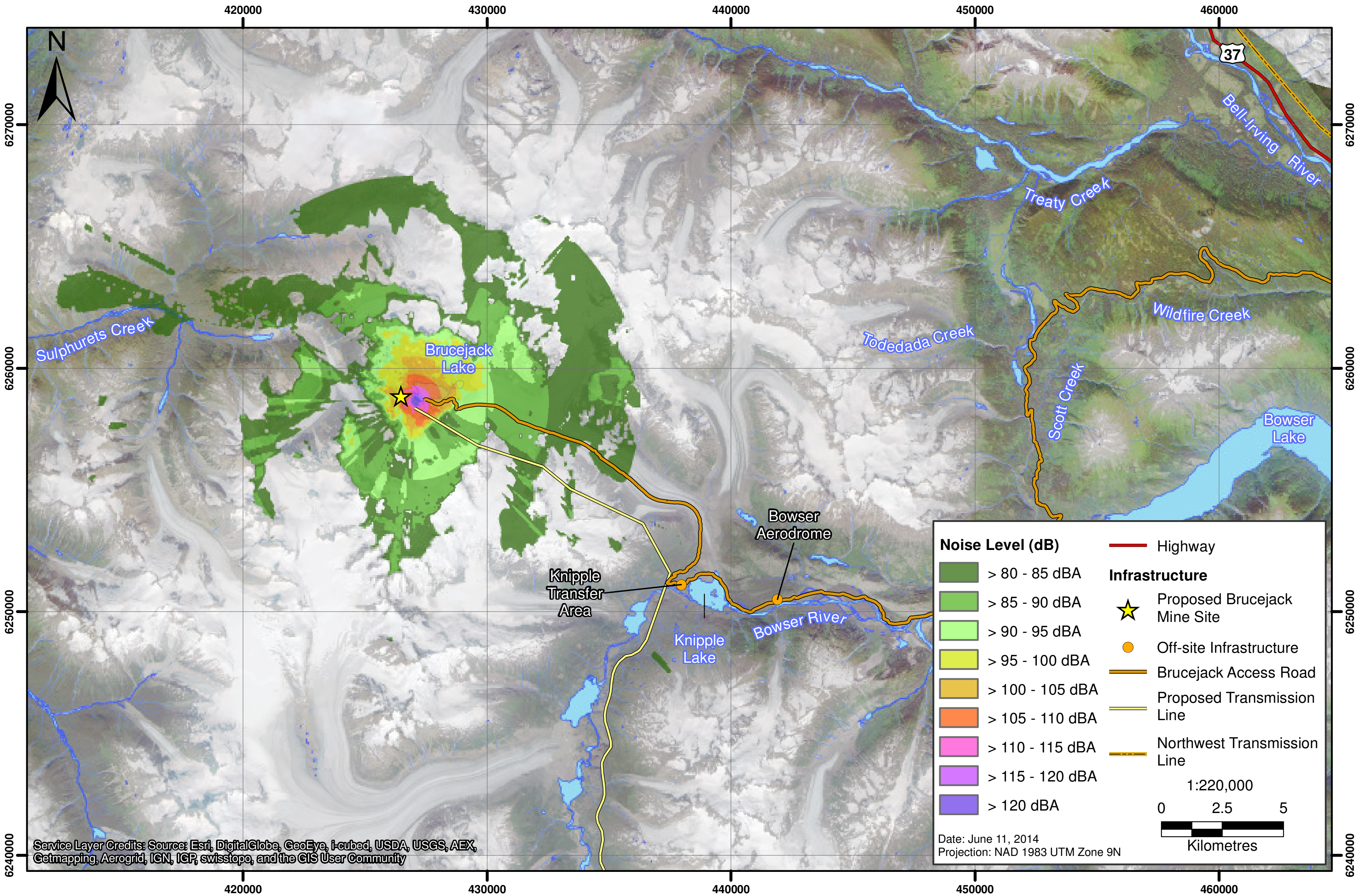


Figure 8.6-5
Predicted Blasting L_{peak} Noise from Quarry during Construction

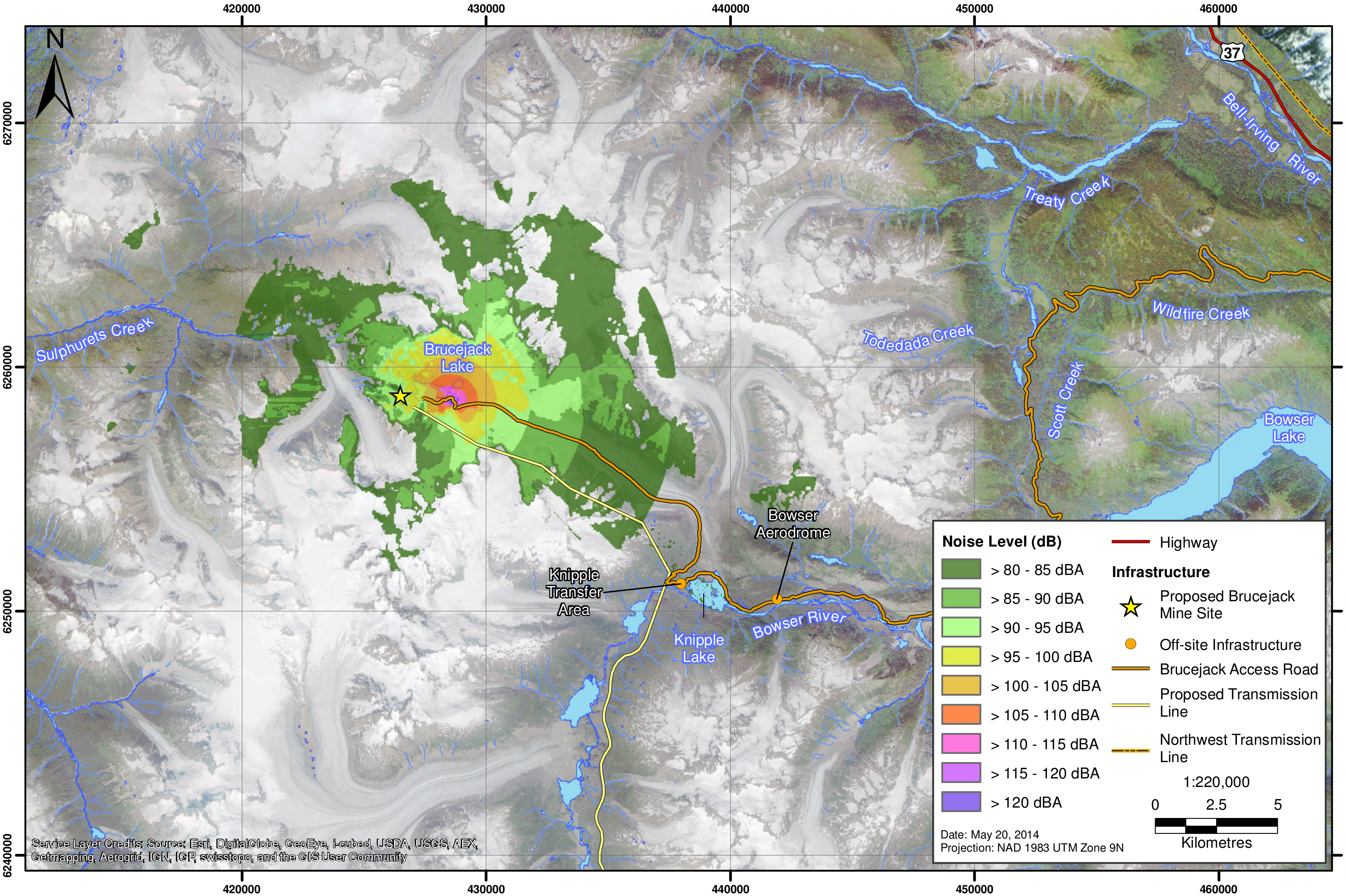


Figure 8.6-6
Predicted Sound Exposure Level from Access Road Traffic

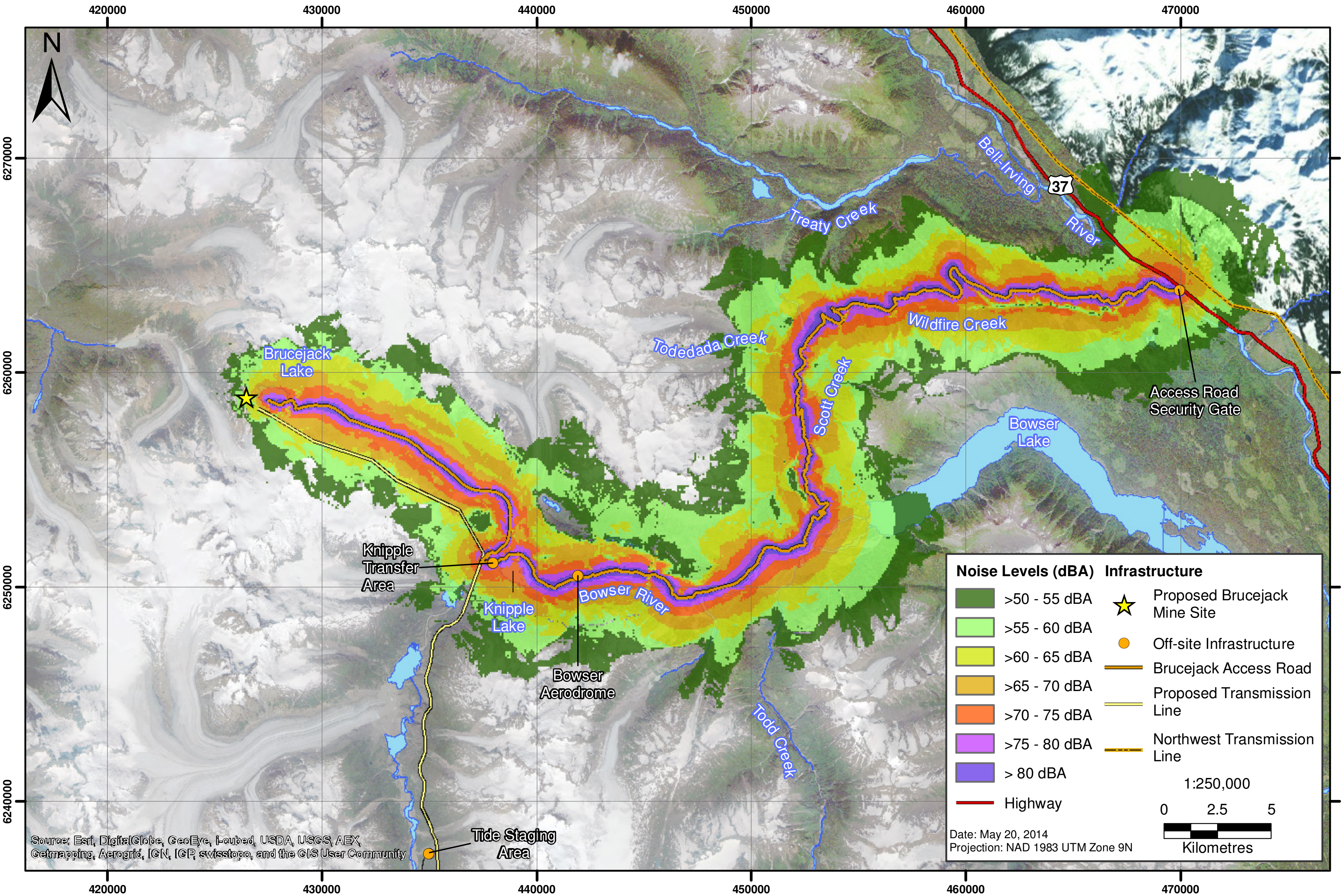


Figure 8.6-7
Predicted Daytime Noise Levels during Operation

ERM

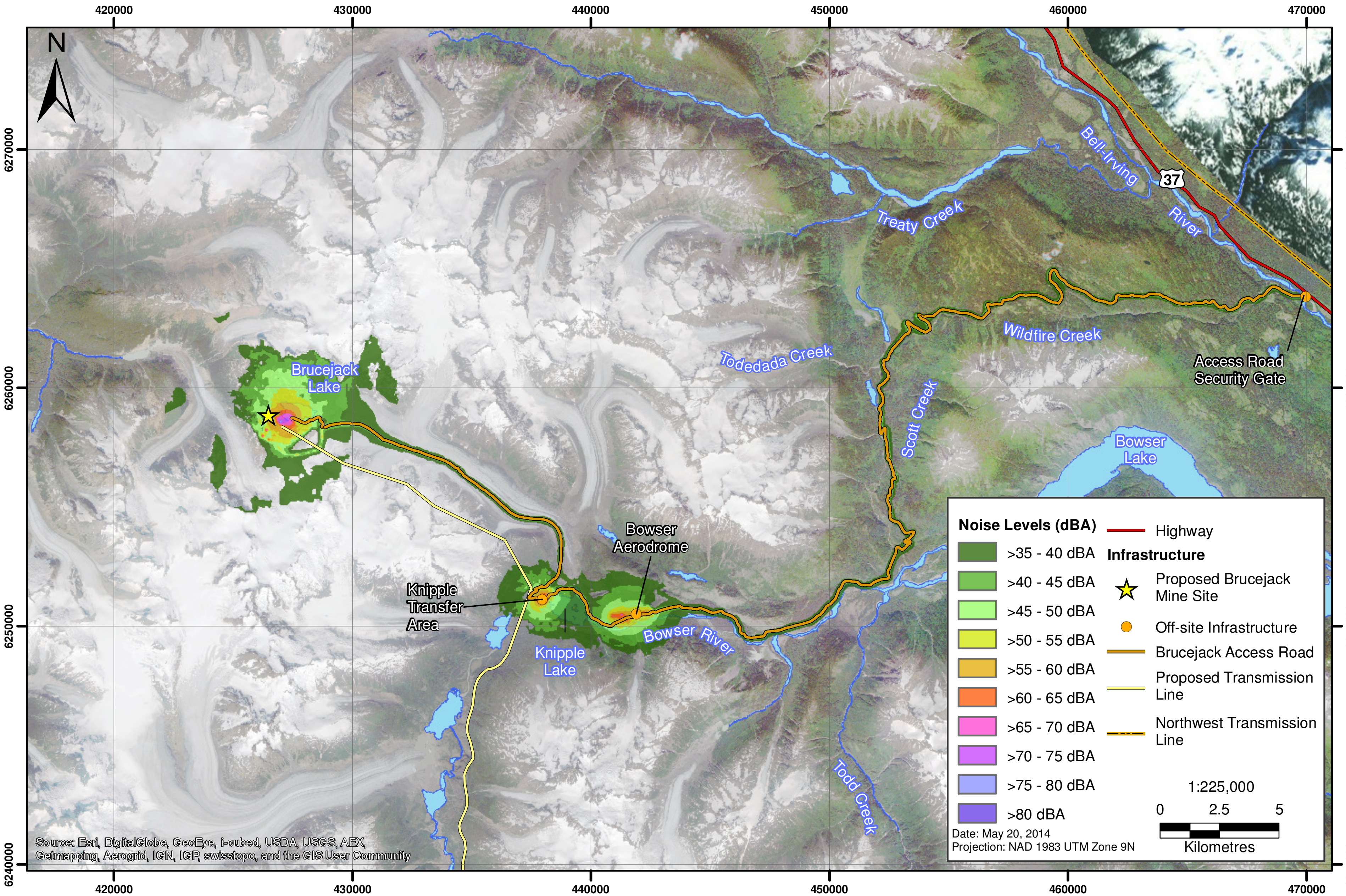


Figure 8.6-8
Predicted Nighttime Noise Levels during Operation

ERM

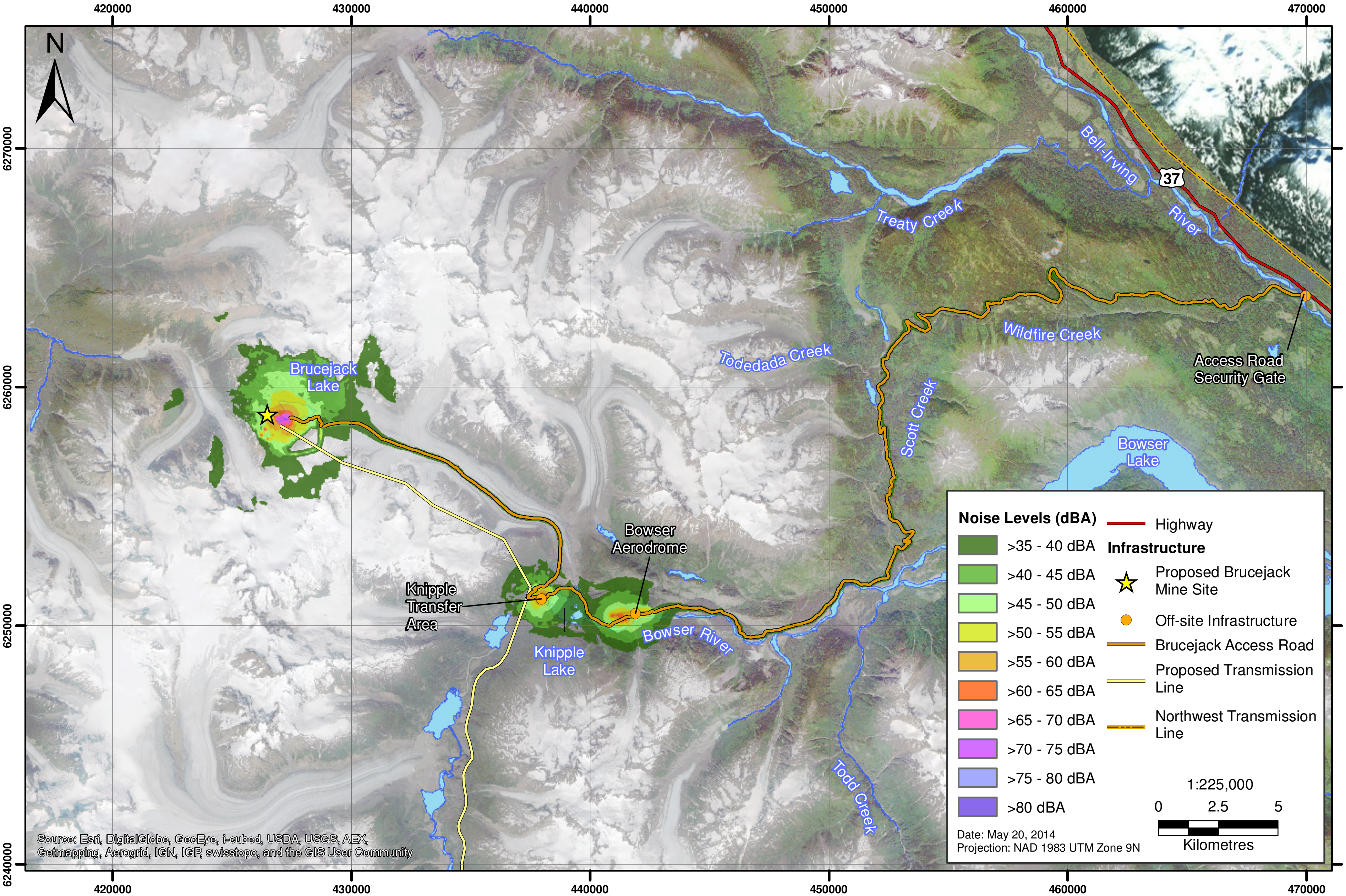


Table 8.6-3. Predicted Operation Phase Noise Levels at the Workers Accommodation Receptors

Receptor	Operation Noise Levels (dBA)	
	Average Noise L_d	Average Noise L_n
Relevant impact criteria	*57*	*57*
Worker Brucejack Mine Site operations camp	55	55
Worker transfer station camp	63	61

Table 8.6-4. Predicted Operation Phase Noise Levels at Existing Off-site Human Receptors

Receptor	Average Noise L_d	Average Noise L_n	Total L_{dn}	%HA	Δ%HA
	dBA	dBA	dBA	%	%
Relevant impact criteria	*55*	*45*	*75*	-	*6.5*
Outlet of Bowser Lake	6	6	46	1.3	0.2
Outlet of Bell Creek	**7**	7	47	1.5	0.4
Skii km Lax Ha Lodge	53	51	64	12.4	11.3

During the Operation phase, only the Mine Site operations camp and Knipple Transfer Station camp will be used. The Knipple Transfer Station camp noise levels are predicted to exceed the sleep disturbance limit during both day and night. These predicted exceedances could be mitigated through adequate window glazing and construction design. Additionally, the structure will be built with adequate sound insulation and the noise attenuation from outdoor-to-indoor is anticipated to be higher than 27 dBA.

For the off-site human receptors, nighttime noise level was predicted to exceed the sleep disturbance limit by 6 dBA. As previously mentioned, the Skii km Lax Ha lodge was built with sufficient insulation that noise attenuation from outdoor to indoor is likely to be higher than assumed using US EPA noise reduction factors.

The potential impact of these predicted noise levels on human health is discussed in Chapter 21, Assessment of Potential Health Effects.

8.6.2.2 Wildlife

Predicted noise levels due to helicopters will be identical to these modelled during the Construction phase (Figure 8.6-3). However, it is expected that helicopter use will be substantially less during the Operation phase in relation to the Construction phase since it is limited for emergency purposes only.

Single-event sound exposure levels (L_{AE}) were modelled for aircraft departure. Aircraft departure noise levels are predicted to exceed 75 dBA L_{AE} for approximately 50 km along the flight path and up to 6 km on either side of the flight path. Approaching aircraft are typically quieter than departing aircraft and therefore the impacts of approaching aircraft have not been modelled. Note that no flight is expected after 6 pm.

Discussion of the potential impacts of these predicted noise levels on wildlife is included in Chapter 18, Assessment of Potential Wildlife Effects.

8.7 MITIGATION MEASURES FOR NOISE

A conceptual Noise Management Plan (see Section 29.11) has been developed to provide measures to control the noise sources, i.e., to reduce the overall noise from the Project. The Noise Management Plan (Section 29.11) is summarized here.

The objectives of the plan, in conjunction with the other human health and wildlife management and monitoring plans, are to:

- ensure all relevant regulatory requirements and published best practice recommendations are met;
- manage and minimize the changes to noise from mining operations on possible human receptors and the environment so that no reasonable noise complaints are received;
- maintain an effective response mechanism to deal with any issues and complaints to ensure that any complaints are followed up promptly and a plan to investigate and address the issue is developed as soon as feasible; and
- ensure that the results of noise monitoring comply with applicable criteria.

There are three main mitigation strategies for noise control: controlling noise at the source, controlling the noise pathway, and controlling noise at the receptor. These noise mitigation strategies should follow a hierarchy of control, with source control always the preferred option where reasonable and feasible, and control at the receptor the least favourable option.

Controlling noise at the source can be achieved through management. There are two approaches applicable to controlling the noise pathway: using barriers and land-use controls. An example of the latter would be attenuating noise by increasing the distance between the source and the receptor. Controlling noise at the receptor is the least-preferred control option and is applied when other methods of noise control have been evaluated and implemented and further improvements are still required for the receptor. If further controls are required, the most effective options should be evaluated by a noise specialist in order to maximize the effectiveness of mitigation. This would be undertaken on an as-needs basis and could include noise mitigation measures such as increasing the thickness of window glazing; reviewing heating, ventilation, and air conditioning systems; and improving the construction of exterior facades.

The Noise Management Plan focuses on the first of these noise control strategies (controlling noise at the source). Measures to control the noise pathway and noise at the receptor are addressed in the management and monitoring plans that address human health and wildlife.

The following mitigation methods will be considered for implementation:

- considering noise ratings when selecting equipment;
- adequately maintaining equipment to minimize noise, including lubrication and replacement of worn parts, especially exhaust systems;
- optimizing the operation of equipment to minimize noise, e.g., reducing vehicle speeds;
- optimizing the site layout to minimize noise impact, e.g., through use of natural screens such as buildings, locating doors away from noise sources and facing away from relevant receptors, minimizing the need for mobile equipment to use their backup alarms;
- optimizing site procedures to minimize noise changes, e.g., keeping doors closed;

- conducting loud procedures indoors, where possible;
- turning off equipment when not in use to avoid unnecessary idling of motors;
- fitting all diesel-powered vehicle with mufflers meeting manufacturers' recommendations for optimal attenuation, and maintaining these silencers in effective working condition;
- avoiding blasting configurations that could result in more than seven holes detonating simultaneously;
- ensuring that blast holes are stemmed to at least 6 m;
- ensuring that all equipment located indoors does not exceed an interior reverberant level of 85 dBA, or a level specified by occupational noise limits; and
- developing and maintaining a complaint procedure and register.

In addition, monitoring will be conducted as per regulations and to address complaints should they occur.

8.8 PREDICTED CHANGES TO NOISE LEVELS

The Project is predicted to increase noise levels at relevant human and wildlife receptors during the Construction and Operation phases. These changes are summarized in Table 8.8-1.

Table 8.8-1. Summary of Predicted Changes after Mitigation for Noise

Intermediate Component	Project Phase (timing of effect)[1]	Project Component / Physical Activity	Description of Cause-Effect[2]	Description of Mitigation Measure(s)	Description of Predicted Change(s)
Noise	Construction and Operation	Construction and operational equipment, road activity	Project Construction and Operation noise sources are predicted to increase noise levels at Project workers' accommodation, existing off-site human receptors and wildlife	Adequate maintenance, reducing vehicle speed, and avoid idling, construction design, site layout	Predicted exceedance of noise criteria limits at Project workers' accommodation by up to 7 dBA during Construction and up to 4 dBA during Operation. Predicted exceedance of noise criteria limits for sleep disturbance, complaints, and %HA at one existing human receptor. Predicted exceedances of noise criteria for habitat loss and disturbance for wildlife.

[1] Refers to the Project phase or other timeframe during which the effect will be experienced by the intermediate component.
[2] "Cause-effect" refers to the relationship between the Project component/physical activity that is causing the change or effect in the condition of the intermediate component, and the actual change or effect that results.

The impact for workers will be a maximum increase of 14 dBA above criteria, medium in duration and sporadic in frequency. For humans, other than the workers at the mine site, the impact is considered high in magnitude, medium in duration due to infrequent exceedance over the criteria, and regular in frequency. For wildlife, the impact is considered medium in duration and sporadic in frequency. At times, there may be high noise levels due to construction and operation activities, these occurrences will be sporadic and each occurrence short. Since the changes will cease once the project activities cease, the changes are considered reversible short term. The Construction and Operation phases were assessed for the busiest year of construction and a year representing typical operations.

8.9 NOISE AS A PATHWAY TO RECEPTOR VALUED COMPONENTS

Noise was identified as an intermediate component with the following potential impacts on humans and wildlife (summarized in Figure 8.9-1):

- impact on humans:
  - sleep disturbance,
  - interference with speech communication,
  - complaints,
  - high annoyance;
- impact on wildlife:
  - loss of wildlife habitat, and
  - wildlife disturbance.

Noise modelling has predicted increases in noise levels due to noise generated by the Project at relevant human and wildlife receptors during both the Construction and Operation phases. Mitigation measures will reduce the noise generated from the Project; however, noise levels at relevant receptors are still expected to increase as a result of the Project.

The potential impacts of increased noise levels on humans and wildlife are assessed in Chapters 21, Assessment of Potential Health Effects, and 18, Assessment of Potential Wildlife Effects, respectively.

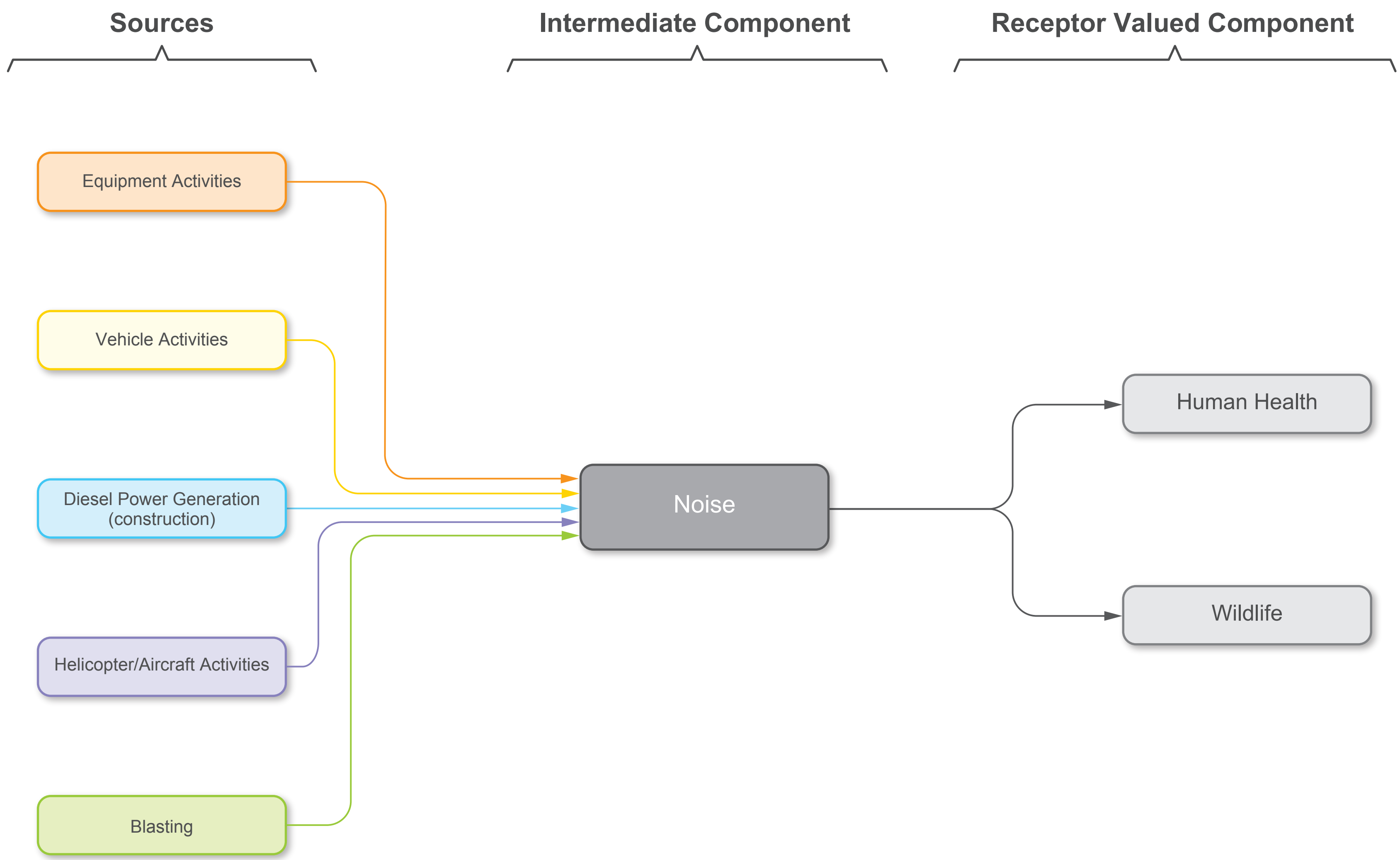
8.10 CUMULATIVE CHANGE ASSESSMENT FOR NOISE

Cumulative changes relate to changes "which are likely to result from the designated project in combination with other projects and activities that have been or will be carried out." This definition follows that for cumulative changes in section 19(1) of the *Canadian Environmental Assessment Act, 2012* (2012) and is consistent with the International Finance Corporation Good Practice Note on Cumulative Impact Assessment (ESSA Technologies Ltd. and IFC 2012), which refers to consideration of other existing, planned, and/or reasonably foreseeable future projects and developments. This cumulative change assessment provides information to supplement the Cumulative Effects Assessment (CEA) for the receptor VCs, which is a requirement of the AIR and the EIS Guidelines (CEA Agency 2013a).

The assessment method adopted here complies with the Canadian Environmental Assessment Agency (CEA Agency) Operational Policy Statement *Assessing Cumulative Environmental Effects under the Canadian Environmental Assessment Act, 2012* (CEA Agency 2013b) and the *Guideline for the Selection of Valued Components and the Assessment of Potential Effects* (BC EAO 2013). The method involves the following key steps which are further discussed in the proceeding sub-sections:

- scoping;
- analysis;
- identification of mitigation measures;
- identification of residual cumulative changes; and
- characterization of residual cumulative changes.

Figure 8.9-1
Linkage between Noise and Receptor Valued Components



8.10.1 Establishing the Scope of the Cumulative Change Assessment

The scoping process involves identification of the intermediate components for which residual changes are predicted, definition of the spatio-temporal boundaries of the assessment, and an examination of the relationship between the residual changes of the Project and those of other projects and activities.

8.10.1.1 Identifying Intermediate Components for the Cumulative Change Assessment

Intermediate components included in the noise CEA were selected using four criteria following BC EAO (2013):

- there must be a residual change as a result of the Project being proposed;
- that predicted change in the condition of the intermediate component must be demonstrated to interact cumulatively with residual environmental effects from other projects or activities;
- it must be known that the other projects or activities have been or will be carried out and are not hypothetical; and
- the cumulative environmental change must be likely to occur.

The noise modelling predicted that Project noise sources may result in exceedances of the noise criteria limits at the Project workers' accommodation, at one existing human receptor, and at a number of wildlife receptors.

8.10.1.2 Boundaries of the Cumulative Change Assessment

The CEA boundaries define the maximum limit within which the assessment is conducted. They encompass the areas within, and times during, which the Project is expected to interact with the intermediate component and with other projects and activities; the constraints that may be placed on the assessment of those interactions due to political, social, and economic realities (administrative boundaries); and limitations in predicting or measuring changes (technical boundaries).

The definition of these assessment boundaries is an integral part of the noise CEA, and encompasses possible direct, indirect, and induced changes of the Project on noise.

<u>Spatial Boundaries</u>

Noise impacts are typically restricted to within 10 km of the noise source; therefore, the cumulative change assessment focuses on projects within 10 km of the Project.

<u>Temporal Boundaries</u>

Noise levels will immediately return to baseline levels after a project's noise sources are removed. Therefore, the CEA considers projects with construction and/or operation phases that overlap with the Project phases. As such, the CEA does not consider past projects or activities.

8.10.1.3 Potential Interaction of Projects and Activities with the Brucejack Gold Mine Project for Noise

A review of the interaction between predicted changes from the Project and effects of other projects and activities on noise was undertaken. The review assessed the projects and activities identified in Section 6.9.2 of the Assessment Methodology, including:

- regional projects and activities that are likely to affect the intermediate component, even if they are located outside the direct zone of influence of the project;

- effects of past and present projects and activities that are expected to continue into the future (i.e., beyond the changes reflected in the existing conditions of the intermediate component); and
- activities not limited to other reviewable projects, if those activities are likely to affect the intermediate component cumulatively (e.g., forestry, Aboriginal harvest, mineral exploration, and commercial recreational activities).

There are no current projects or major activities within 10 km of the Project and therefore there are no potential noise interactions between the Project and other current projects or activities. There are potentially hunting, trapping fishing and other recreational activities in the area; however, these activities are not expected to generate appreciable noise levels that will cause an interaction with the Project noise. Therefore, no cumulative change between the recreational activities and the Project is expected.

The only foreseeable future project or activity within 10 km of the Project is the proposed KSM Project. The KSM Project may impact noise levels at human or wildlife receptors which are affected by the Project, resulting in exceedances of relevant noise criteria (Table 8.10-1).

Table 8.10-1. Potential Cumulative Changes between the Brucejack Gold Mine Project Noise and Other Projects and Activities

Intermediate Component	Brucejack Gold Mine Project	Past Project or Activity	Existing Project or Activity	Reasonably Foreseeable Future Project or Activity	Type of Potential Cumulative Effect
Noise	X			KSM Project	Additive

8.10.2 Analysis of Cumulative Changes

The KSM Project Application/EIS (Rescan 2013e) predicted that the project's noise effects on humans would be largely contained within the project boundary. Due to the logarithmic nature of reduction in noise levels with distance from a source, and the distance between the project sites, there are no expected measureable cumulative effects on noise levels at human receptors.

The main potential cumulative change is expected to occur at the wildlife receptors, especially those located between the Project and the KSM Project. Blasting during the KSM Project operational phase was identified as one of the key sources of noise on the KSM Project. However, given that the KSM Project blasting only occurs for a few seconds once per day and that blasting only occurs during the Project's Construction phase, the likelihood of both mines blasting simultaneously is negligible.

The main potential noise sources to consider are helicopters and aircraft, as these changes typically occur furthest from the Project footprint. If flight paths from the KSM Project and the Brucejack Gold Mine Project intersect then the frequency of exceedances of relevant noise criteria at nearby wildlife receptors may increase. Given that there will only be a few flights per day for each of the projects it is considered unlikely that two flights will occur simultaneously, i.e., it is unlikely that the magnitude of exceedances will increase or that new exceedances will occur.

These potential cumulative changes are discussed in greater details in Chapter 18, Assessment of Potential Wildlife Effects.

8.10.3 Mitigation Measures to Address Cumulative Predicted Changes

There are no specific mitigation or management measures proposed to explicitly address potential cumulative changes. Mitigation measures provided in Section 8.7 and Chapters 18 and 21 and the associated management and monitoring plans are applicable to the potential cumulative changes.

8.10.4 Predicted Cumulative Changes for Noise

Predicted cumulative changes are those effects remaining after the implementation of all mitigation measures and are summarized in Table 8.10-2.

Table 8.10-2. Summary of Predicted Cumulative Changes on Noise

Intermediate Component	Timing of Predicted Cumulative Change	Description of Cause-Effect	Description of Additional Mitigation (if any)	Description of Predicted Cumulative Change
Noise	Construction and Operation	Potential for loss of wildlife habitat and wildlife disturbance due to increased noise levels	None	Intersecting flight paths may increase the frequency of predicted exceedances

8.10.5 Characterizing Predicted Cumulative Changes for Noise

The predicted cumulative changes for each intermediate component were characterized by considering the Project's incremental contribution to the predicted cumulative change under two scenarios:

1. Future case without the Project: a consideration of residual effects from all other past, existing, and future projects and activities on a sub-component without the Project (scenario 1).
2. Future case with the Project: a consideration of all residual effects from past, existing, and future projects and activities on a sub-component with the Project (scenario 2).

This approach helps predict the relative influence of the Project on the residual cumulative change for each intermediate component, while also considering the role of other projects and activities in causing that change.

For scenario 1 — the future case without the Project — the future predicted noise levels at the Brucejack Mine Site would be affected by the KSM Project only. As mentioned above, the KSM Project Application/EIS (Rescan 2013e) predicted that, with the exception of blasting and aircraft/helicopter noise, the noise effects are largely contained within the KSM Project area. Therefore, for scenario 1, the predicted noise levels at the Project area would be comparable to background levels with occasional single noise events, such as aircraft or helicopter pass by. For scenario 2, the predicted noise levels at the Project are presented in Section 8.6.

Noise levels fall off rapidly with distance from the source and, as such, the noise levels across the Project area from any cumulative changes would be dominated by the Project.

8.10.6 Noise as a Pathway for Interaction with Receptor Valued Components

8.10.6.1 Noise Pathway for Interaction with Human Health

As mentioned in Section 8.10.2, Analysis of Cumulative Changes, it is unlikely that there will be any cumulative effects from noise on human health. Chapter 21, Assessment of Potential Health Effects, provides a full discussion of potential cumulative effects on human health.

8.10.6.2 Noise Pathway for Interaction with Wildlife

As discussed in Section 8.10.2, the cumulative changes of the Brucejack Gold Mine Project and the KSM Project may result in increased frequency of noise exceedances. The potential cumulative effects on wildlife are assessed fully in Chapter 18, Assessment of Potential Wildlife Effects.

8.11 SUMMARY AND CONCLUSIONS FOR NOISE

The assessment of the Project-generated noise has been undertaken in line with relevant guidance and legislation and current best practices. The main sources of Project related noise will be:

- equipment activities;
- vehicle activities;
- diesel power generation (Construction phase);
- helicopter/aircraft activities; and
- blasting.

Predictions using detailed noise modelling showed that Project-generated noise during the Construction and Operation phases exceed criteria for sleep disturbance at the majority of the Project workers' accommodation receptors and at the Skii km Lax Ha Lodge.

Noise generated by helicopters is predicted to cause exceedances of relevant wildlife criteria at goat, moose and grizzly receptors and continuous Project construction noise is predicted to cause exceedances of relevant wildlife criteria at one modelled receptor.

As an intermediate component, a description of potential changes of the Project on noise, relevant mitigation measures, and predicted changes to noise are provided in this chapter. The determination of significance of changes to noise on relevant receptor VCs is presented in:

- Chapter 18, Assessment of Potential Wildlife Effects; and
- Chapter 21, Assessment of Potential Health Effects.

A Noise Management Plan (see Section 29.11) provides measures to control the noise sources, i.e., to reduce the overall noise generated by the Project.

A summary of the predicted changes to noise is given in Table 8.11-1.

Table 8.11-1. Predicted Changes to Noise

Predicted Changes	Project Phase(s)	Mitigation Measures	Predicted Changes	Cumulative Changes	Receptor VCs Affected
Change in noise level	Construction and Operation	Noise Management Plan	Noise levels exceeding human health criteria at worker camps (sleep disturbance)	None	Human health
Change in noise level	Construction and Operation	Noise Management Plan	Noise levels exceeding human health criteria at off-site human receptor (sleep disturbance, complaints, and high annoyance)	None	Human health
Change in noise level	Construction and Operation	Noise Management Plan	Noise levels exceeding (or not exceeding) relevant noise criteria (aircraft)	Additive	Wildlife

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<u>Personal Communications</u>

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