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Environmental Noise Assessment

Brown's Range Project

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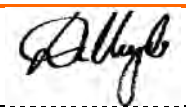
Prepared By:	Daniel Lloyd 
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1 INTRODUCTION

Northern Minerals Limited (NML) proposes to develop a rare earths mine and mineral processing operation at a location approximately 160km southeast of Halls Creek and approximately 300km south of Kununurra, Western Australia. The project area is adjacent to the Western Australian/Northern Territory border (*Figure 1-1*).

Figure 1-1 Proposed Mine Location

The proposed Browns Range Rare Earths Project ("the Project") comprises:

- mining of xenotime ore from four deposits, initially using open cut mining methods, then transitioning to underground mining to access deeper ore bodies;
- treatment of ore to produce a mixed rare earth oxide product, and
- transport of product by road to an export facility at Wyndham.

In addition to mining and processing of ore and shipment of rare earth product, the Browns Range Project involves a range of related activities, including:

- excavation and storage of overburden and waste rock;
- storage of wastes from ore processing (tailings);
- mine dewatering and the construction and operation of a water supply borefield;
- transport, storage and use of fuels and reagents;

- construction and operation of process water supply and evaporation ponds;
- construction and operation of a mine accommodation village, power generating facilities, an airstrip, water and sewage treatment facilities;
- upgrade or construction of mine access and haul roads; and
- mine decommissioning, rehabilitation and closure

The operations consist of open-cut and underground mining which will occur 24 hours a day, 7 days a week. The proposed mine layout is provided in *Figure 1-2*.

Appendix A contains a description of some of the terminology used throughout this report.

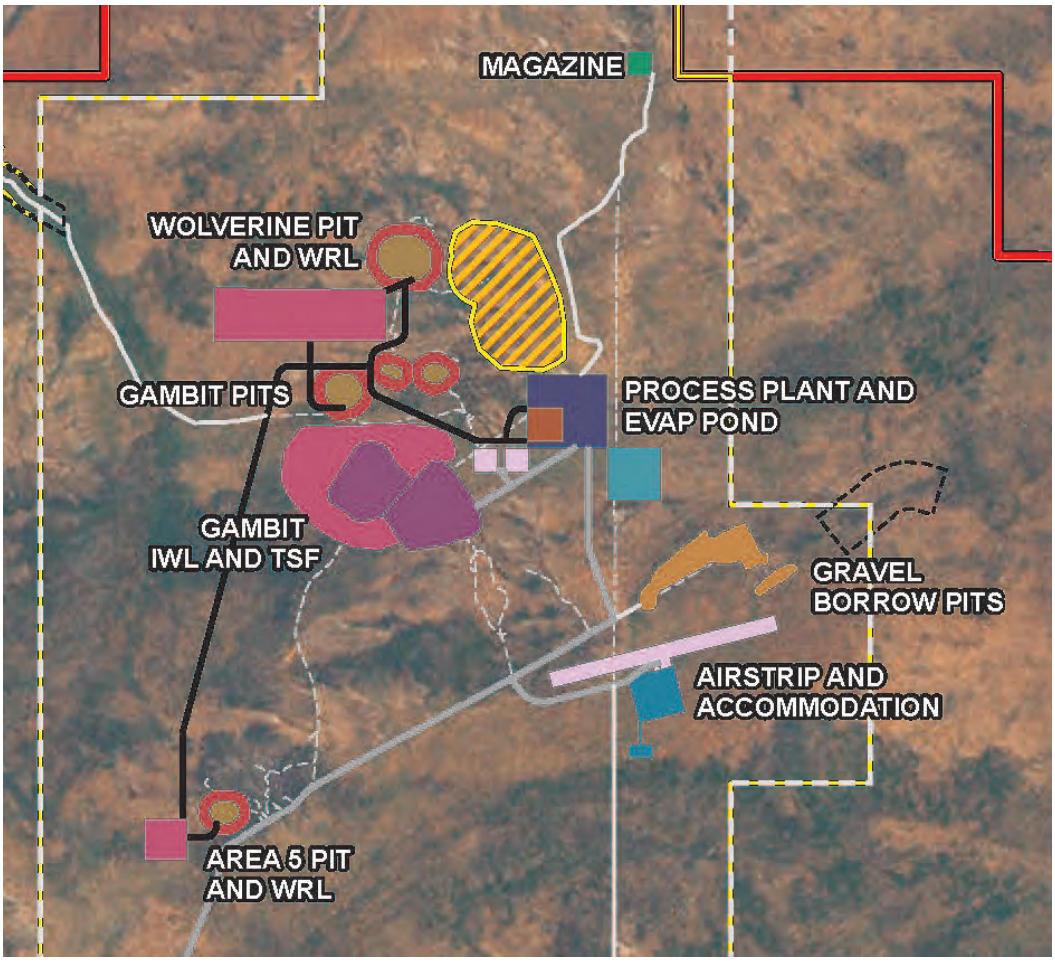


Figure 1-2 Proposed Mine Layout

2 CRITERIA

2.1 Noise

Environmental noise in Western Australia is governed by the *Environmental Protection Act 1986*, through the *Environmental Protection (Noise) Regulations 1997* (the Regulations).

Regulation 7 defines the prescribed standard for noise emissions as follows:

- "7. (1) Noise emitted from any premises or public place when received at other premises must not cause or significantly contribute to, a level of noise which exceeds the assigned level in respect of noise received at premises of that kind; and
- Must be free of:
  - Tonality;
  - Impulsiveness; and
  - Modulation".

A "…noise emission is taken to *significantly contribute to* a level of noise if the noise emission exceeds a value which is 5dB below the assigned level…"

Tonality, impulsiveness and modulation are defined in Regulation 9. Noise is to be taken to be free of these characteristics if:

a) The characteristics cannot be reasonably and practicably removed by techniques other than attenuating the overall level of noise emission; and

b) The noise emission complies with the standard after the adjustments of *Table 2-1* are made to the noise emission as measured at the point of reception.

Table 2-1 Adjustments for Intrusive Characteristics

Tonality	Modulation	Impulsiveness
+ 5dB	+ 5dB	+ 10dB

Note: The above are cumulative to a maximum of 15dB.

The baseline assigned levels (prescribed standards) are specified in Regulation 8 and are shown below in *Table 2-2*.

Table 2-2 Baseline Assigned Noise Levels

Premises Receiving Noise	Time of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise Sensitive[1]	0700 to 1900 hours Monday to Saturday (Day)	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays (Sunday)	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days (Evening)	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	35 + influencing factor	45 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise Sensitive[2]	All hours	60	75	80

Notes: 1. Applies within 15 metres of a building associated with a noise sensitive use, as defined in Schedule 1, Part C.

2. Applies at a noise sensitive premise greater than 15 metres from a building associated with a noise sensitive use.

In regards to the noise to the accommodation village, the Regulations apply from one premise to another and therefore, the accommodation village, being on the same premise as the mine, is not required to comply. However, EPA *Guidance for the Assessment of Environmental Factors No.8 Environmental Noise draft (EPA Guidance No.8)* sets out aspirational goals for noise to construction and accommodation villages. These goals are as follows:

> *With regard to construction camps, it is the EPA's view that, if a construction camp is located on the same premises as the proposal, then compliance with the assigned levels is not required. In this case, the EPA policy is that an aspirational goal based on indoor levels inside the accommodation sleeping areas of $L_{A\,10}$ 40dB(A) and $L_{A\,max}$ 50dB(A) should be considered.*
>
> *With regard to camps for operational staff, the EPA policy is that these should be located and designed so as to achieve compliance with the assigned levels and acceptable standards.*

For noise sensitive premises, excluding the accommodation village, we have assumed an influencing factor of zero. For the accommodation village, we believe an influencing factor of +5 dB is appropriate, as this is equivalent to 50% of industrial land use within 450m of the village but none within 100m.

2.2 Airblast

Airblast levels are covered by Regulation 11, which provides the following criteria:

Subject to subregulation (5), no airblast level resulting from blasting on any premises or public place, when received at any other premises between 0700 hours and 1800 hours on any day, may exceed —

(a) for an airblast level received at noise sensitive premises —

(i) when received at a sensitive site — 120 dB $L_{Z\ peak}$; or

(ii) when received at a location other than a sensitive site — 125 dB $L_{Z\ peak}$;

or

(b) for an airblast level received at any other premises — 125 dB $L_{Z\ peak}$.

(5) The levels specified in subregulation (4) do not apply in respect of an airblast level when received at premises, or a part of premises, on which the blaster believes on reasonable grounds no person is present at the time of the blast.

(6) Despite subregulation (4), airblast levels for 9 in any 10 consecutive blasts (regardless of the interval between each blast), when received at any other single premises between 0700 hours and 1800 hours on any day, must not exceed —

(a) for airblast levels received at noise sensitive premises —

(i) when received at a sensitive site — 115 dB $L_{Z\ peak}$; or

(ii) when received at a location other than a sensitive site — 120 dB $L_{Z\ peak}$;

or

(b) for airblast levels received at any other premises — 120 dB $L_{Z\ peak}$.

(7) For the purposes of subregulation (6), an airblast level for a blast that would, but for this subregulation, exceed a level specified in subregulation (6)(a)(i) or (ii) or (b) is taken not to exceed that level when received at premises, or a part of premises, on which the blaster believes on reasonable grounds no person is present at the time of the blast.

(8) Subject to subregulation (9), no airblast level resulting from blasting on any premises or public place, when received at other premises outside the periods between 0700 hours and 1800 hours on any day, may exceed 90 dB $L_{Z\ peak}$ except where that blasting is carried out in accordance with the *Mines Safety and Inspection Regulations 1995* regulation 8.28(4).

(9) The level specified in subregulation (8) does not apply in respect of an airblast level when received at premises, or a part of premises, on which the blaster believes on reasonable grounds no person is present at the time of the blast.

(10) Where blasting is carried out in accordance with the *Mines Safety and Inspection Regulations 1995* regulation 8.28(4) outside the periods between 0700 hours and 1800 hours on any day —

(a) the blasting is taken to be carried out between 0700 hours and 1800 hours; and

(b) subregulations (4), (5), (6) and (7) apply accordingly.

2.3 Ground Vibration

There are no legislated criteria regarding ground vibration levels at sensitive receivers. However, *AS 2187.2-2006 Explosives - Storage and use - Use of explosives* [Appendix J Table J4.5(A)] states that for a sensitive site with blasting lasting longer than 12 months or 20 blasts, a level of 5 mm/s for 95% of blasts and a maximum level of 10 mm/s is acceptable. These criteria will be applied to Accommodation Village.

3 METHODOLOGY

Computer modelling has been used to predict the noise levels resulting form the project operations. The software used was *SoundPLAN 7.3* with the CONCAWE algorithms selected. These algorithms have been selected as they include the influence of wind and atmospheric stability. Input data required in the model are:

- Meteorological Information;
- Topographical data;
- Ground Absorption; and
- Source sound power levels.
- Meteorological Information

Meteorological information utilised is based on that specified in EPA *Guidance No.8* and are shown below in *Table 3-1*.

Table 3-1 Modelling Meteorological Conditions

Parameter	Night (1900-0700)	Day (0700-1900)
Temperature (^{o}C)	15	20
Humidity (%)	50	50
Wind Speed (m/s)	3	4
Wind Direction*	All	All
Pasquil Stability Factor	F	D

Note: The modelling package used allows for all wind directions to be modelled simultaneously.

Note that the above conditions approximate the typical worst-case for enhancement of sound propagation. The EPA policy is that compliance with the assigned noise levels needs to be demonstrated for 98% of the time, during the day and night periods, for the month of the year in which the worst-case weather conditions prevail. In most cases a positive wind (from the source to the receiver) will occur at all sensitive receivers for more than 2% of the time and therefore this meteorological condition must be used.

At wind speeds greater than those shown above, sound propagation may be further enhanced, however background noise from the wind itself and from local vegetation is likely to be elevated and dominate the ambient noise levels.

3.1 Topographical Data

Topographical data was based on that provided by Northern Minerals. The contours are in 1 metre intervals and cover the project area.

3.2 Ground Absorption

Ground absorption varies from a value of 0 to 1, with 0 being for an acoustically reflective ground (e.g. water or bitumen) and 1 for acoustically absorbent ground (e.g. grass). In this instance, a value of 1 has been used.

3.3 Sensitive Receivers

The closest sensitive receiver (excluding the accommodation village) is at the Ringer Soak community, approximately 35 km to the west-northwest of the mine.

3.4 Sound Sources

The number of significant mobile and fixed noise sources assumed in the modelling is provided in *Table 3-2.* The scenario assumed in the modelling is both Wolverine and Gambit pits being mined with all mobile and fixed plant operational.

Table 3-2 Noise Sources Assumed in Model

Plant Item	Number Assumed in model
190t Excavator	2
Cat 777 Haul Truck	16
Cat D9 Dozer	2
Cat 16M Grader	2
Water Truck	2
Cat 930 FEL	2
AC ROC 8 Drill	8
Primary Crusher	1
SAG Mill	1
Ball Mill	1
Vibrating Screen	10
Conveyor	5
Conveyor transfer	5
Process Plant Power Station	1
Flotation Blower	2
Process Pump	20+
Rotary kiln	2

3.5 Source Sound Levels

Table 3-3 shows the sound power levels used in the modelling.

Table 3-3 Source Sound Power Levels, dB(A)

Description	Octave Band Centre Frequency (Hz)								Overall
	63	125	250	500	1k	2k	4k	8k	
190t Excavator	87	103	107	108	111	109	105	99	116
777 Haul Truck	89	99	107	112	111	110	103	94	117
D9 Dozer	86	101	106	103	107	104	99	89	112
G16 Grader	77	88	91	90	95	98	94	86	102
Water Truck	75	93	96	98	102	101	95	85	106
930 FEL	76	96	95	102	104	103	99	92	109
Drill	88	87	95	103	110	114	112	109	118
Crusher	89	101	108	112	111	108	107	96	121
	95	102	111	112	110	108	102	93	
	100	103	112	111	109	107	99	88	
SAG Mill	83	88	95	100	103	102	96	90	107
Ball Mill	64	75	85	92	92	93	87	-	102
	66	75	88	91	92	92	83	-	
	72	80	89	91	93	90	78	-	
Vibrating Screen	82	84	92	99	103	106	109	104	117
	80	88	93	101	104	107	107	100	
	78	90	93	101	105	108	106	95	
Conveyor (std idlers)	58	73	73	83	83	80	75	64	88
Process Plant Power Stn	108	112	108	107	106	104	99	94	116
Flotation Blower	88	90	94	105	103	92	91	85	107
Conveyor Transfer	72	83	88	91	88	86	78	66	95
Process Pumps	59	73	81	91	97	98	95	87	110
	74	82	83	96	101	104	91	85	
	74	78	84	94	104	96	87	83	

Data from Lloyd George Acoustics library.

3.6 Airblast Assessment

Only confined blasting has been considered in the assessment of airblast levels to the nearest noise sensitive receivers being the accommodation village. From information obtained from the Nothern Minerals, we have assumed the following maximum charge mass:

- Confined blasting assumed to be 250 kg per hole

Airblast is calculated using equations provided in *Australian Standard AS 2187.2-2006 Explosives - Storage and use - Use of explosives* and equations developed by Orica Explosives Australia (Orica).

Confined Charge

$$P = K_a\left(\frac{R}{Q^{1/3}}\right)^a$$

where

P = pressure, in kilopascals
Q = explosives charge mass, in kilograms
R = distance from charge, in metres
K_a = site constant
a = site exponent

Unconfined blasting is not proposed except for unusual situations such as large rock removal from machinery or access paths after blasting. It is assumed that these blasts will be managed appropriately.

3.7 Ground Vibration Assessment

For ground vibration, it is assumed that the blasting conditions are for 'free-face average rock' formation. In the absence of specific blast vibration measurements at this site, the following scaled distance site law has been used:

$$PPV = 1140\left(\frac{\sqrt{m}}{D}\right)^{1.6}$$

Where:

PPV = Peak particle velocity (mm/s)
m = Charge mass per hole or per delay (kg)
D = Distance from blast (m)

4 RESULTS

The predicted noise, airblast and ground-borne vibration levels associated with the project are provided in *Table 4-1*. Noise level contours to the accommodation village are shown in *Figure 4-1*.

Table 4-1 **Results of Assessment During Operational Phase**

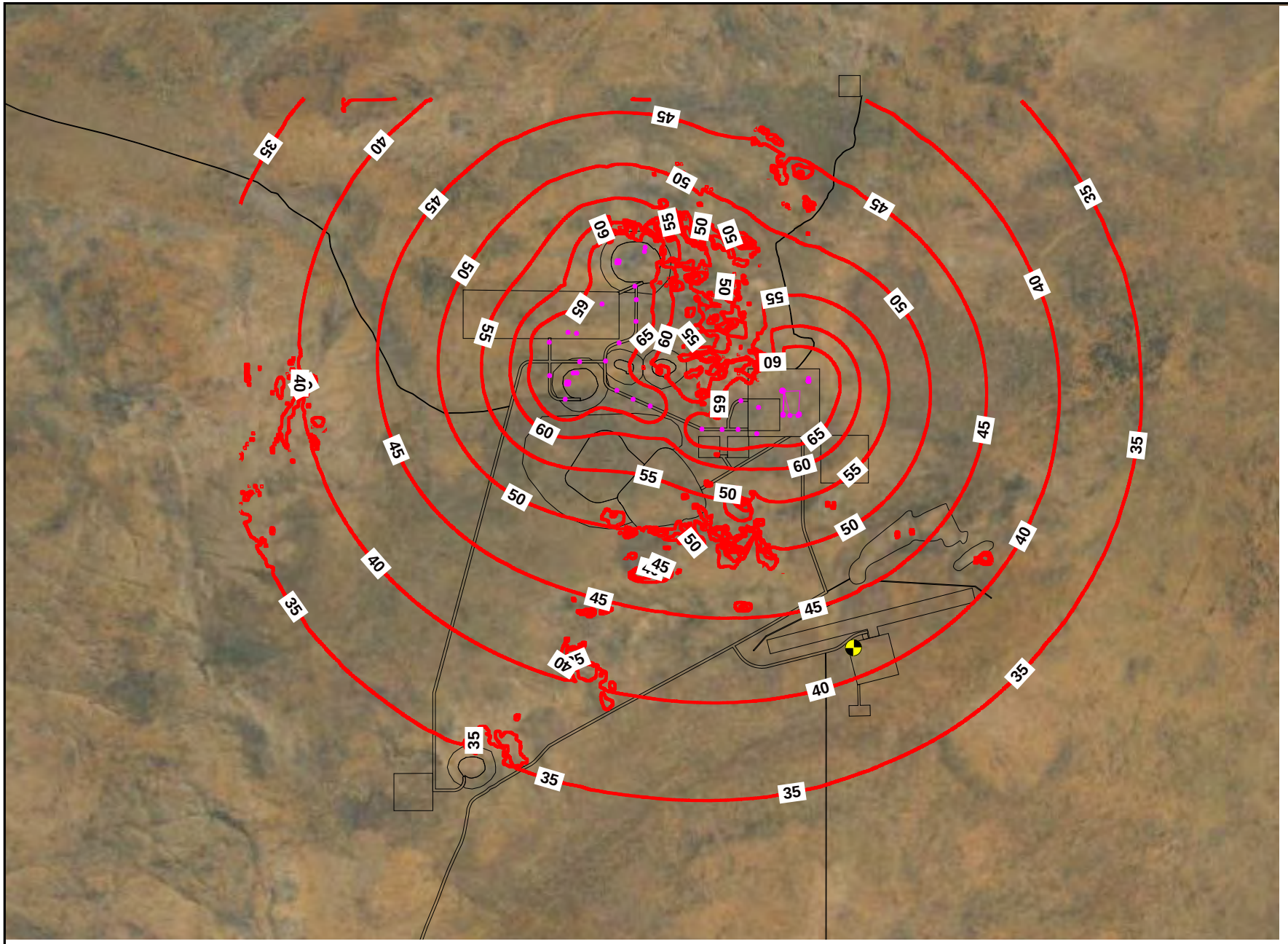
Impact	Sensitive Receiver		Guidance (refer Section 2)	Comments
	Accomm Village	Ringer Soak		
Noise	L_{A10} 42 dB	L_{A10} 0 dB	L_{A10} 50 dB – Day L_{A10} 45 dB – Evening L_{A10} 40 dB – Night	Complies with the aspirational goal at accommodation village during the night period. Inaudible at Ringer Soak
Airblast	$L_{Z\,peak}$ 99 dB	$L_{Z\,peak}$ 75 dB	$L_{Z\,peak}$ 115 dB (0700-1800) $L_{Z\,peak}$ 90 dB (1800-0700)	Complies with Regulatory criteria at closest sensitive premises. Careful management of airblast at accommodation village outside normal hours required.
Ground Vibration	0.2 mm/s	0-.01 mm/s	5 mm/s – 95% of blasts 10 mm/s – max	Acceptable at accommodation village. Levels at Ringer Soak below background

In regards to the noise to the accommodation village, the noise source ranking, provided in *Table 4-2,* shows that there is no particularly dominant source. As such, noise control options are very limited and control to individual sources is unlikely to have any significant effect on the overall level.

Table 4-2 **Noise Source Ranking**

Noise Source	Source Type	Individual Noise Level dB(A)
Conveyor	Line	31.0
Power Station	Point	31.0
SAG Mill	Point	30.0
Haul Truck	Point	29.7
Water Truck	Point	29.5
Haul Truck	Point	28.5
Haul Truck	Point	28.2
Dust Collector	Point	26.6
Haul Truck	Point	25.7
Primary Crusher	Point	25.2
Haul Truck	Point	23.9
Dozer	Point	23.8

Figure 4-1



Brown's Range Project
Predicted L_{A10} Noise Levels - Assumes All Plant Operating and Wind from All Directions

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5 ASSESSMENT

5.1 Noise

The results of the assessment show that assuming the conservative approach of worst-case meteorological conditions and 100% utilisation of both the fixed and mobile plant, the noise is predicted to comply with the Regulations at the nearest noise sensitive premises, being the Ringer Soak community. While the Regulations do not apply to the accommodation village, being on the same premises as the mine, the aspirational goal is to achieve an internal noise level of L_{A10} 40 dB during the night period. Assuming a 10 dB reduction in noise from outside to inside with windows open, this aspirational goal would be achieved. It should be noted that diesel generators will service the accommodation village and these can result in noise impacts. The generators should therefore incorporate acoustic panels, be located away from sleeping areas, and if practicable, behind earth bunds or non-sensitive buildings.

5.2 Airblast

The airblast level at Ringer Soak is complaint with the Regulations at all times. While the Regulations do not strictly apply to the accommodation village (being on the same premise), blasting out of the hours 0700 to 1800 should be managed to minimise impacts as far as practicable.

5.3 Ground Vibration Levels

Ground-borne vibration levels at Ringer Soak and the accommodation village are predicted to be significantly below the recommended limits contained within *AS 2187.2-2006 Explosives - Storage and use - Use of explosives* [Appendix J Table J4.5(A)] at all times.

6 CONCLUSION AND RECOMMENDATIONS

The results of the assessment show that the noise from the Brown's Range mine, when at maximum capacity, is predicted to comply with assigned levels under the *Environmental Protection (Noise) Regulations 1997,* at the nearest noise sensitive premises during worst-case meteorological conditions. The noise to the accommodation village is below the aspirational goal set by the EPA.

Airblast levels are predicted to comply with the *Environmental Protection (Noise) Regulations 1997*, at all times.

Ground vibration levels resulting from blasting are predicted to be significantly below the recommended levels contained within *AS 2187.2-2006 Explosives - Storage and use - Use of explosives* at all sensitive premises.

Appendix A

Terminology

The following is an explanation of the terminology used throughout this report.

Decibel (dB)

The decibel is the unit that describes the sound pressure and sound power levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

A-Weighting

An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A dB.

Sound Power Level (L_w)

Under normal conditions, a given sound source will radiate the same amount of energy, irrespective of its surroundings, being the sound power level. This is similar to a 1kW electric heater always radiating 1kW of heat. The sound power level of a noise source cannot be directly measured using a sound level meter but is calculated based on measured sound pressure levels at known distances. Noise modelling incorporates source sound power levels as part of the input data.

Sound Pressure Level (L_p)

The sound pressure level of a noise source is dependent upon its surroundings, being influenced by distance, ground absorption, topography, meteorological conditions etc and is what the human ear actually hears. Using the electric heater analogy above, the heat will vary depending upon where the heater is located, just as the sound pressure level will vary depending on the surroundings. Noise modelling predicts the sound pressure level from the sound power levels taking into account ground absorption, barrier effects, distance etc.

L_{ASlow}

This is the noise level in decibels, obtained using the A frequency weighting and the S time weighting as specified in AS1259.1-1990. Unless assessing modulation, all measurements use the slow time weighting characteristic.

L_{AFast}

This is the noise level in decibels, obtained using the A frequency weighting and the F time weighting as specified in AS1259.1-1990. This is used when assessing the presence of modulation only.

L_{Amax}

An L_{Amax} level is the maximum A-weighted noise level during a particular measurement.

L_{A1}

An L_{A1} level is the A-weighted noise level which is exceeded for one percent of the measurement period and is considered to represent the average of the maximum noise levels measured.

L_{A10}

An L_{A10} level is the A-weighted noise level which is exceeded for 10 percent of the measurement period and is considered to represent the "*intrusive*" noise level.

L_{Aeq}

The equivalent steady state A-weighted sound level ("equal energy") in decibels which, in a specified time period, contains the same acoustic energy as the time-varying level during the same period. It is considered to represent the "average" noise level.

L_{A90}

An L_{A90} level is the A-weighted noise level which is exceeded for 90 percent of the measurement period and is considered to represent the "*background*" noise level.

One-Third-Octave Band

Means a band of frequencies spanning one-third of an octave and having a centre frequency between 25 Hz and 20 000 Hz inclusive.

L_{Amax} assigned level

Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded at any time.

L_{A1} assigned level

Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded for more than 1% of the representative assessment period.

L_{A10} assigned level

Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded for more than 10% of the representative assessment period.

Tonal Noise

A tonal noise source can be described as a source that has a distinctive noise emission in one or more frequencies. An example would be whining or droning. The quantitative definition of tonality is:

the presence in the noise emission of tonal characteristics where the difference between -

(a) the A-weighted sound pressure level in any one-third octave band; and

(b) the arithmetic average of the A-weighted sound pressure levels in the 2 adjacent one-third octave bands,

is greater than 3 dB when the sound pressure levels are determined as $L_{Aeq,T}$ levels where the time period T is greater than 10% of the representative assessment period, or greater than 8 dB at any time when the sound pressure levels are determined as $L_{A\ Slow}$ levels.

This is relatively common in most noise sources.

Modulating Noise

A modulating source is regular, cyclic and audible and is present for at least 10% of the measurement period. The quantitative definition of tonality is:

a variation in the emission of noise that —

(a) is more than 3 dB $L_{A\ Fast}$ or is more than 3 dB $L_{A\ Fast}$ in any one-third octave band;

(b) is present for at least 10% of the representative.

Impulsive Noise

An impulsive noise source has a short-term banging, clunking or explosive sound. The quantitative definition of tonality is:

a variation in the emission of a noise where the difference between $L_{A\ peak}$ and $L_{A\ Max\ slow}$ is more than 15 dB when determined for a single representative event;

Major Road

Is a road with an estimated average daily traffic count of more than 15,000 vehicles.

Secondary / Minor Road

Is a road with an estimated average daily traffic count of between 6,000 and 15,000 vehicles.

Influencing factor

$$= \frac{1}{10}\left(\%\ \text{Type A}_{100} + \%\ \text{Type A}_{450}\right) + \frac{1}{20}\left(\%\ \text{Type B}_{100} + \%\ \text{Type B}_{450}\right)$$

where:

$\%\ \text{Type A}_{100}$ = the percentage of industrial land within a100m radius of the premises receiving the noise

$\%\ \text{TypeA}_{450}$ = the percentage of industrial land within a 450m radius of the premises receiving the noise

$\%\ \text{Type B}_{100}$ = the percentage of commercial land within a100m radius of the premises receiving the noise

$\%\ \text{TypeB}_{450}$ = the percentage of commercial land within a 450m radius of the premises receiving the noise

+ Traffic Factor (maximum of 6 dB)

= 2 for each secondary road within 100m

= 2 for each major road within 450m

= 6 for each major road within 100m

Representative Assessment Period

Means a period of time not less than 15 minutes, and not exceeding four hours, determined by an inspector or authorised person to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission.

Background Noise

Background noise or residual noise is the noise level from sources other than the source of concern. When measuring environmental noise, residual sound is often a problem. One reason is that regulations often require that the noise from different types of sources be dealt with separately. This separation, e.g. of traffic noise from industrial noise, is often difficult to accomplish in practice. Another reason is that the measurements are normally carried out outdoors. Wind-induced noise, directly on the microphone and indirectly on trees, buildings, etc., may also affect the result. The character of these noise sources can make it difficult or even impossible to carry out any corrections.

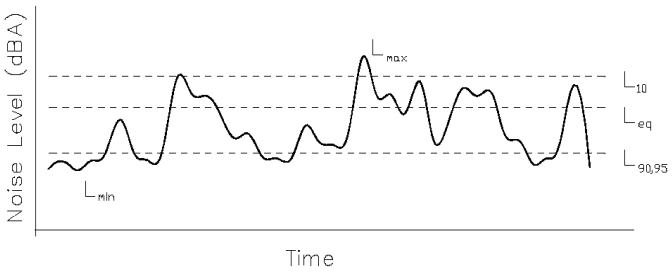
Ambient Noise

Means the level of noise from all sources, including background noise from near and far and the source of interest.

Specific Noise

Relates to the component of the ambient noise that is of interest. This can be referred to as the noise of concern or the noise of interest.

Chart of Noise Level Descriptors



Typical Noise Levels