

17. Noise and Vibration

This chapter addresses the noise and vibration aspects of the Project. It describes the existing sources and levels of noise, and local climatic conditions. Potential impacts from noise and vibration at the construction and operational phases are assessed against available criteria, and measures for the mitigation of any impacts are proposed.

A detailed noise and vibration assessment is provided in Appendix U. The potential impacts and associated mitigation measures identified in this chapter form the basis of the noise and vibration component of the project risk assessment undertaken in Chapter 5. The project risk assessment includes consequence, likelihood and residual risk ratings for noise and vibration impact after management measures are implemented.

17.1 Existing Noise Environment

The Project is located within a predominantly rural area. Noise sources in the area include:

- ▶ traffic noise from the Stuart Highway and Edith Falls Road;
- ▶ rail noise from the Adelaide to Darwin rail line; and
- ▶ natural noise from wind, insects and other animals.

The community of Werenbun is the closest human sensitive receptor, located approximately 7km from the mine facilities. The community consists of about 10 houses, 30 people and an open undercover area used as a community school by the Northern Territory School of the Air.

The mine site and surrounding area is known to support two terrestrial vertebrate species, and potentially a third, protected under the EPBC Act (Gouldian finch, crested-shrike tit and partridge pigeon). These species have the potential to be affected by noise and vibration from the Project.

17.2 Methodology

The detailed methodology is provided in Appendix U.

Attended and unattended noise monitoring was conducted in the area surrounding the proposed mine. The purpose of noise monitoring was to determine the existing noise levels in the area and to assist in setting operational noise goals for the Project.

All sampling activities were undertaken with consideration to the specifications outlined in Australian Standard AS1055 *Description and Measurement of Environmental Noise* and the New South Wales Industrial Noise Policy (INP) (EPA 2000).

Long-term unattended noise monitoring took place between 3 May 2011 and 13 May 2011. Monitoring occurred at the mine site entry near Edith Falls Road (Plate 17-1) and on the western side of the mine site near Batman Creek (Plate 17-2).

Unattended noise loggers were placed at the southern and western side of the mine site. The unattended sites were considered to be representative of the local area, including the community of Werenbun. Attended monitoring was undertaken at the both sites, in addition to the community of Werenbun and east of the mine tailings dam. The attended monitoring provided an understanding of the noise sources contributing to overall noise levels.



Plate 17-1 Noise Logger 1 – Southern Side of Mine Site



Plate 17-2 Noise Logger 2 – Western Side of Mine Site

17.3 Results

17.3.1 Unattended Noise Monitoring Results

Two RION NL-21 sound level loggers were used for unattended noise monitoring. The loggers are capable of measuring continuous sound pressure levels and able to record L_{A90} , L_{A10} , L_{Aeq} and L_{Amax} noise descriptors. The instruments were programmed to accumulate environmental noise data continuously over sampling periods of 15 minutes for the entire monitoring period. Noise descriptors reported in this Chapter, in Decibel A-weighted for human ear response (dB(A)), include L_{Aeq} and L_{A90} which are representative of ambient noise levels¹ and background noise levels² for the period of measurement respectively.

¹ Ambient Noise: The all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far (NSW EPA, 2000).

Data collected by the loggers was downloaded and analysed, and any invalid data removed. Invalid data generally refers to periods of time where average wind speeds were greater than 5m/s, when rainfall occurred, or for when anomalous noise levels occurred.

The results of the ambient noise monitoring is summarised in Table 17-1 and Table 17-2.

Table 17-1 Summary of Noise Monitoring Results – Logger 1

Logger	Background L _{A90} dB(A)			Ambient L _{Aeq} dB(A)		
	Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)	Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
Tuesday 3 May 2011	24	24	24	42	41	40
Wednesday 4 May 2011	-	27	22	-	41	41
Thursday 5 May 2011	26	26	21	43	43	39
Friday 6 May 2011	24	26	22	43	45	41
Saturday 7 May 2011	22	27	22	40	44	42
Sunday 8 May 2011	22	26	22	40	39	37
Monday 9 May 2011	24	24	25	42	38	37
Tuesday 10 May 2011	-	23	23	-	38	39
Wednesday 11 May 2011	-	24	26	-	34	38
Thursday 12 May 2011	-	23	20	-	38	37
RBL and L_{eq} overall	24	25	22	42	41	39

² Background Noise: The underlying level of noise present in the ambient noise, excluding the noise source under investigation, when extraneous noise is removed (NSW EPA, 2000).

Table 17-2 Summary of Noise Monitoring Results – Logger 2

Logger	Background L _{A90} dB(A)			Ambient L _{Aeq} dB(A)		
	Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)	Day (7am to 6pm)	Evening (6pm to 10pm)	Night (10pm to 7am)
Tuesday 3 May 2011	25	23	24	40	48	44
Wednesday 4 May 2011	24	24	20	-	43	34
Thursday 5 May 2011	21	21	19	41	40	28
Friday 6 May 2011	21	20	20	35	47	42
Saturday 7 May 2011	20	27	20	34	46	34
Sunday 8 May 2011	21	22	24	33	46	42
Monday 9 May 2011	-	21	27	-	42	42
Tuesday 10 May 2011	-	25	20	-	42	37
Wednesday 11 May 2011	20	22	19	40	34	41
Thursday 12 May 2011	22	18	17	41	36	32
RBL and Leq overall	21	22	20	38	45	40

17.3.2 Attended Noise Monitoring Results

Attended noise monitoring was conducted over 15 minute periods at each of the long term monitoring locations and at additional locations at Werenbun and east of the tailings dam. Attended measurements were undertaken using a Bruel and Kjaer 2250 sound level meter. This sound level meter is capable of measuring continuous sound pressure levels and is able to record L_{Amin}, L_{A90}, L_{A10}, L_{Amax} and L_{Aeq} noise descriptors. Details of the existing noise environment including noise sources and ambient / background noise levels were recorded during these monitoring periods. The results of attended noise monitoring are shown in Table 17-3.

Table 17-3 Attended Noise Measurements

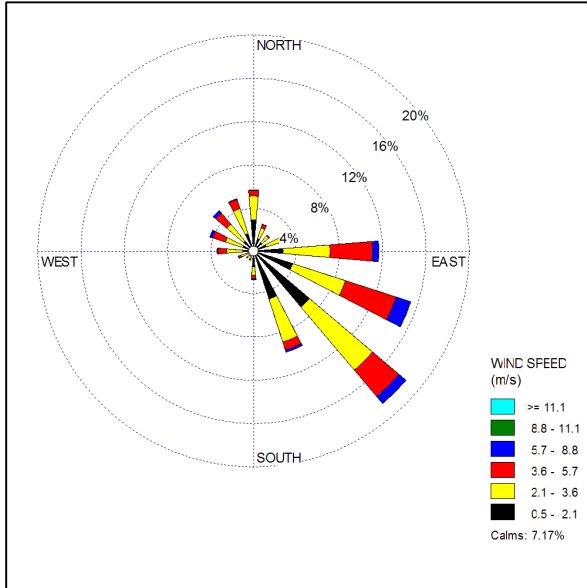
Site Location	Time	L _{A90}	L _{Aeq}	L _{A10}	Comments
Mine Site 2 – Batman Creek	3/05/2011 11:44	23.3	32.1	35.7	Low background noise, some noise from birds and gusts of wind. Wind gusts up to 35 dB(A), lulls in wind around 25 dB(A). Drilling or any site activities not audible
East of Tailings Dam	3/05/2011 12:19	33.9	47.3	47.7	Strong gusty winds up to 50 dB(A). Wind blowing from the south, birds.
Werenbun Community	3/05/2011 14:20	40.5	49.2	48.8	Strong wind the entire monitoring period, and bird noise. No other noise sources identified.
Werenbun community entry	3/05/2011 22:07	21.7	26.3	27.3	Located at the entry to the Werenbun community, approximately 1 km from housing. Very low noise levels. Small peaks from insects at 5 kHz.
Mine Site 2 – Batman Creek	3/05/2011 22:49	42.6	44.3	45.5	No wind, insects in 5 – 6.3 kHz range dominant the entire measurement ~ 40 – 45 dB(A). Drilling noise just audible (other site investigations), however below background.
Mine Site 1 – Site Entry	3/05/2011 23:28	30.0	35.8	40.6	No wind, insect noise dominant during measurement (6.3KHz).
Werenbun community entry	4/05/2011 8:45	34.2	44.5	44.4	Wind related noise, wind gusty at times. Birds calling, no traffic. In calmer periods noise level approximately 30 dB(A).
Mine Site 2 – Batman Creek	4/05/2011 9:27	34.5	38.8	41.8	High winds the entire monitoring period, some birds. Drilling noise not audible.
Mine Site 1 – Site Entry	4/05/2011 11:16	38.7	46.6	49.0	High wind noise, up to 50 dB(A). In calmer periods, noise levels approximately 35 dB(A).

17.3.3 Meteorology

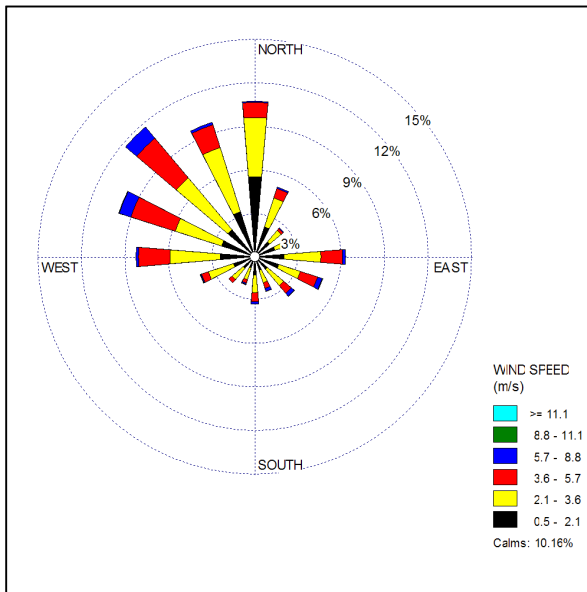
Weather data was obtained from the Bureau of Meteorology automated weather station at RAAF Base Tindal (AWS site 014932), situated approximately 55km southeast of the mine site. This data was considered adequate for the purpose of filtering high wind events and rainfall from the noise data set.

The prevailing wind is from the southeast, comprising 18% of annual winds, followed by the east-southeast, comprising 15.5% (Figure 17-1). This pattern is characteristic of the easterly trade winds experienced at mid-latitudes. The annual average wind speed is 2.8m/s.

Annual



Wet Season



Dry Season

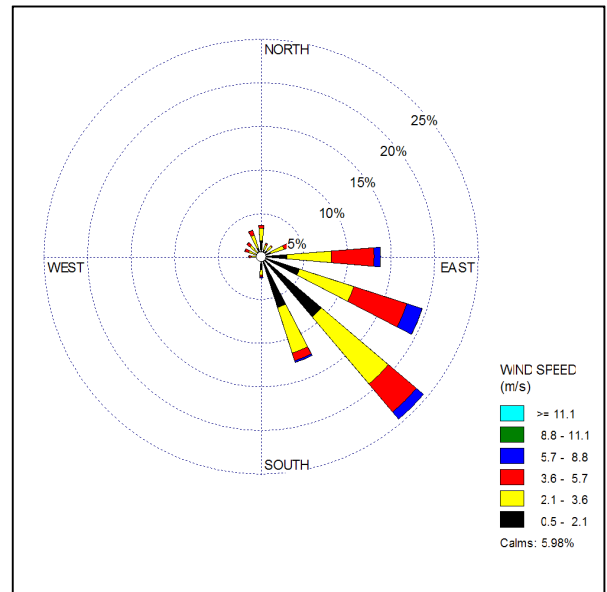


Figure 17-1 Wind Roses for RAAF Base Tindal

There is a clear distinction in incident wind direction between the wet and Dry Season Figure 17-2. The wet season is defined as the beginning of December to the end of March. During the Wet Season the Australian Monsoon dominates synoptic flows with the prevailing wind from the northwest with an average wind speed of 2.7m/s. Synoptic flows during the Dry Season are characterised by the easterly Trade Winds with a greater incidence from the southeast and an average wind speed of 2.9m/s.

The INP states that wind effects need to be assessed where wind is a feature of the area. Based on analysis of meteorological data for the mine, wind is considered to be a feature where source-to-receiver

wind speeds of 3m/s or below occur for 30% of the time or more in any assessment period (day, evening, night) in any season. Therefore, the assessment of the level by which noise from the mine is increased as a result of wind effects has been included in the prediction modelling.

Atmospheric Stability

Atmospheric stability can influence noise propagation. The Pasquill / Gifford scale of atmospheric stability has six stability classes. Class A, B and C represent strongly, moderately and slightly unstable atmospheres respectively. Class D represents a neutral atmosphere while Class E and F represent slightly and moderately stable atmospheres respectively.

Stable conditions generally develop at night, under clear skies and weak gradient winds. Such conditions are often coupled with ground based, radiation forced temperature inversions, sometimes with fog, mist or frost. Temperature inversions will cause sound waves to be reflected back towards the ground, thereby increasing noise levels. It is commonly such stable conditions that result in off-site noise impacts at maximum range.

The annual stability rose for the data set is depicted in Figure 17-2. The following features are shown:

- ▶ Class D is most frequently experienced, present 38% of the time;
- ▶ Class E and F are present 34% of the time; and
- ▶ the highest incidence of Class E and F conditions are seen from the southeast.

When seasonality is taken into account, the highest incidence of stable conditions corresponds to the change in prevailing wind.

As per the INP, assessment of impacts is confined to the night noise assessment period (10pm to 7am), as this is the time likely to have the greatest impact - that is, when temperature inversions usually occur and disturbance to sleep is possible. The INP states that an occurrence of temperature inversions during 30% of the total night-time during winter (June, July and August) represents a significant noise impact warranting further assessment. The night-time period for determining inversion frequency is from one hour before sunset to one hour after sunrise (taken to be 6pm to 7am), which is the time period during which inversions are most likely.

Based on analysis of meteorological data for the mine, F class atmospheric conditions occur for more than 30% of the total winter night-time. Therefore, the assessment of the level by which noise from the mine is increased as a result of inversion effects has been included in the prediction modelling.

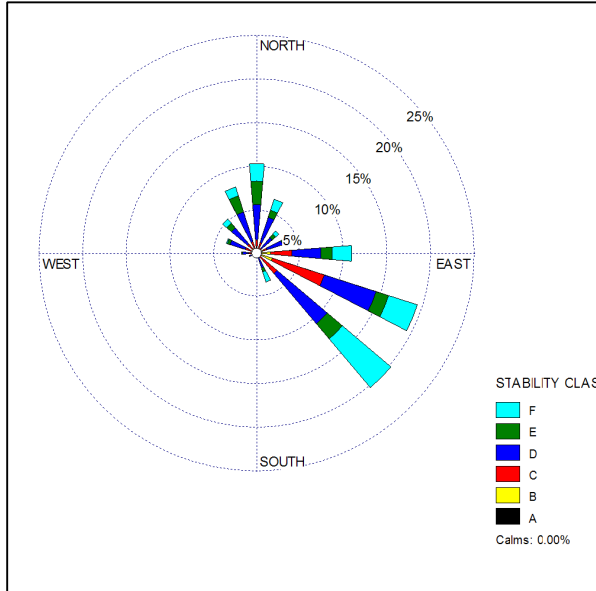
17.4 Noise and Vibration Criteria

17.4.1 Construction Noise Assessment Criteria

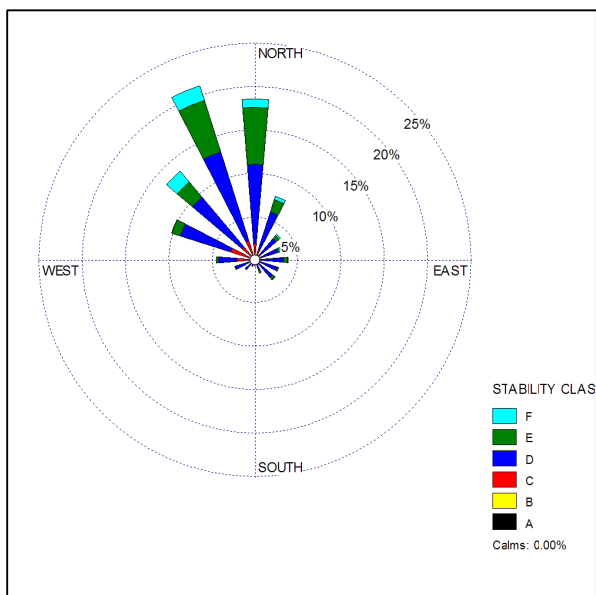
Construction noise emitted from the Project is assessed with consideration to the NT EPA *Noise guidelines for development sites in the Northern Territory* (NT EPA 2013). The NT EPA recommends standard hours for construction activity (Table 17-4).

It is unlikely that blasting will be required during construction. This will be confirmed on finalisation of the relevant geotechnical studies.

Annual



Wet Season



Dry Season

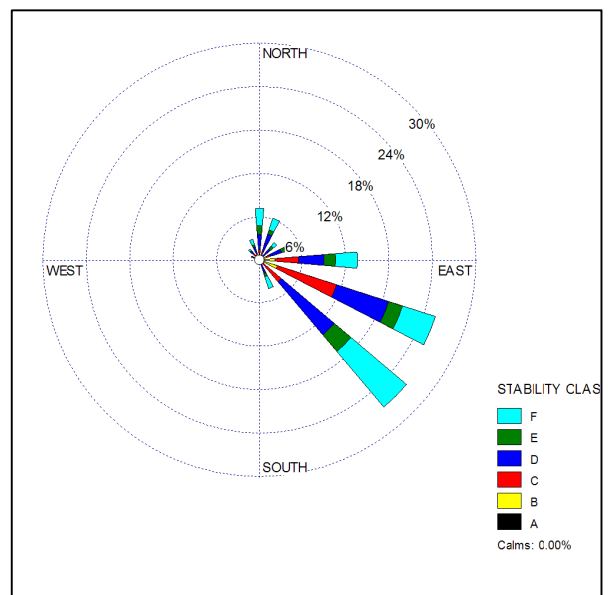


Figure 17-2 Stability Roses – Mine Site

Table 17-4 Standard Hours for Construction

Work type	Standard Hours for Construction
Normal construction	Monday to Saturday: 7am to 7pm. Sunday or Public Holiday: 9am to 6pm.

Work outside of the standard hours of construction will be required on some week nights and potentially weekends, particularly for concrete pours during the hotter months, construction material delivery, or to catch up on schedule delays. Given the location of the mine site and the large distance between sources and receptors, extended working hours are not expected to present a noise issue. The need for extended working hours will be determined during detailed design and during the construction period.

The NT EPA provides a noise limit for construction noise levels at residential receptors / residential area uses during standard hours for construction (Table 17-5). These noise limits are calculated based on the adopted rating background level (RBL) at nearby residential locations.

Table 17-5 Noise Criteria during Standard Hours for Construction

Designation Area	Construction Noise Limit $L_{Aeq}(15 \text{ min})$
Residential uses areas	Background noise + 5dB(A)

The limits apply within 15 metres of a noise sensitive receptor or on the boundary of the noise sensitive receptor (adjusted for tonality, impulsiveness and modulation) during standard hours for construction. Where the noise limit is exceeded, all feasible and reasonable work practices to minimise noise should be applied and all potentially impacted residents should be informed of the nature of the works, expected noise levels, duration of works and a method of contact. This would include the preparation Noise Management Plan provided to NT EPA.

The project construction noise goal for standard working hours was calculated to be 29dB(A) L_{Aeq} , derived from the RBL at Logger 1 (Table 17-1).

17.4.2 Operational Noise Assessment Criteria

The *Waste Management and Pollution Control Act 1998* arose as the initial action in the development of a Strategy for Waste Management and Pollution Control in the Northern Territory that began in 1995.

There are no Northern Territory guidelines and criteria for noise or vibration, therefore operational noise criteria were determined with consideration to the New South Wales INP (NSW EPA 2000). The policy is typically used as a guide for setting statutory limits in licences for large and complex industrial sources.

The INP includes intrusive and amenity criteria designed to protect receptors from noise significantly louder than the background level and to limit the total noise level from all sources near a sensitive receptor.

Intrusive criteria set by the INP control the relative audibility of operational noise compared to the background level. The amenity criteria limit the total level of extraneous noise. Both sets of criteria are calculated and the more stringent of the two in each time period applies.

The amenity criteria are determined based on the overall acoustic characteristics of the receptor area, and the existing level of noise excluding other noises that are uncharacteristic of the usual noise environment. Residential receptor areas are characterised into 'urban', 'suburban', 'rural' or other categories based on land uses, the existing level of noise from industry, commerce and road traffic. The nearest residential receptors to this development were classified as rural.

Attended observations noted that existing levels of industrial noise in the area are not a significant contributor to the existing ambient noise level in the vicinity of the development, therefore the amenity noise criteria do not require adjustment.

The INP states that where the rating background level (RBL) is found to be less than 30dB(A) then it is set to 30dB(A). As the RBL at both noise loggers was less than 30dB(A), an RBL of 30dB(A) was adopted for the development of criteria. The project specific noise criteria at noise sensitive receptors in Werenbun are provided in Table 17-6.

Table 17-6 Project Specific Noise Levels – Werenbun

Criterion	Nearest Residential Receptors		
	Day 7am to 6pm	Evening 6pm to 10pm	Night 10pm to 7am
A: Rating background level	24 $L_{A90,day}$	25 $L_{A90,evening}$	22 $L_{A90,night}$
B: Intrusiveness criteria ($A^1 + 5dB$)	35 $L_{Aeq,15min}$	35 $L_{Aeq,15min}$	35 $L_{Aeq,15min}$
C: Rural amenity criteria (Table 2.1 INP)	50 $L_{Aeq,day}$	45 $L_{Aeq,evening}$	40 $L_{Aeq,night}$
D: Amenity criteria ² : (INP Table 2.2 Adjusted)	-	-	-
Project specific noise level (Page 21 INP)	35 $L_{Aeq,15min}$	35 $L_{Aeq,15min}$	35 $L_{Aeq,15min}$

1 The New South Wales INP states where the rating background level is found to be less than 30dB(A), then it is set to 30dB(A).

2 (-) denotes not applicable since there is no existing industrial noise at the monitoring locations.

Low Frequency Noise

Where a noise source contains certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same noise level.

The INP also addresses noise sources with inherent dominant infrasound characteristics, i.e. very low frequency noise. The planned power station has the potential to generate low frequency noise components below 200Hz.

Table 4.1 in the INP sets out the corrections to be applied for noise sources containing these characteristics. The corrections specified are added to the measured or predicted noise levels at the receiver before comparison with the criteria. A correction of 5dB is applied if the difference between the measurements of C-weighted and A-weighted levels over the same period is 15dB or more.

17.4.3 Sleep Disturbance Criteria

The New South Wales Office of Environment and Heritage Noise Guide for Local Government provides guidelines for assessing sleep disturbance from short-term noise events. To assess potential disturbance during the night noise assessment period (10pm to 7am), Section 2.4.5 of the Noise Guide for Local Government recommends that $L_{A1,1min}$ levels outside a bedroom window should not exceed the background level by more than 15dB. Based on the measured RBL of 22 dB(A) (Table 17-1), the sleep disturbance noise goal for the night noise assessment period is 37dB(A) $L_{A1(1min)}$ for all the surrounding residential noise sensitive receptors.

17.4.4 Vibration Assessment Criteria

In the absence of any Northern Territory or Australian guidelines relating to human comfort criteria for vibration, criteria have been adopted with consideration to the British Standard 6472-1 – 2008, *Guide to*

evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting, which is recognised as the preferred standard for assessing human comfort criteria for residential building types.

Typically, mine activities generate ground vibration of an intermittent nature. Under BS 6472-1:2008, intermittent vibration is assessed using the vibration dose value. Table 17-7 includes acceptable Vibration dose value for residential receptors during daytime and night-time periods.

Table 17-7 Vibration Dose Value Ranges and Probabilities for Adverse Comment to Intermittent Vibration (m/s^{1.75})

Location	Low Probability of Adverse Comment ¹	Adverse Comment Possible	Adverse Comment Probable ²
Residential buildings 16 hour day (7am to 11pm)	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hour night (11pm to 7am)	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

Note: ¹ Below these ranges adverse comment is not expected.

² Above these ranges adverse comment is very likely.

Whilst the assessment of response to vibration in BS 6472-1:2008 is based on vibration dose value and weighted acceleration, for construction related vibration, it is considered more appropriate to provide guidance in terms of peak particle velocity, since this parameter is likely to be more routinely measured based on the more usual concern over potential building damage.

Humans are capable of detecting vibration at levels that are well below those causing risk of damage to a building. The degrees of perception for humans are suggested by the vibration level categories given in British Standard BS 5228-2:2009 *Code of practice for noise and vibration on construction and open sites – Part 2: Vibration* as shown in Table 17-8.

Table 17-8 Guidance on the Effects of Vibration Levels

Approximate Vibration Level	Degree of Perception
0.14mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.
0.30mm/s	Vibration might be just perceptible in residential environments.
1.00mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.
10.00mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.

17.4.5 Structural Damage Vibration Criteria

There is no Australian Standard that sets the criteria for the assessment of building damage caused by vibration. Guidance limiting vibration is attained by reference to German Standard *DIN 4150-3: 1999 Structural Vibration – Part 3: Effects of vibration on structures* (DIN 4150-3).

Table 8 of DIN 4150-3 presents guideline values for the maximum absolute value of the velocity "...at the foundation of various types of building. Experience has shown that if these values are complied with, damage that reduces the serviceability of the building will not occur. If damage nevertheless occurs, it is to be assumed that other causes are responsible."

Measured values exceeding those listed in Table 17-9 "...does not necessarily lead to damage; should they be significantly exceeded, however, further investigations are necessary."

Table 17-9 Guideline Values for Short Term Vibration on Structures

Line	Type of Structure	Guideline Values for Velocity (mm/s)		
		1Hz - 10Hz	10Hz - 50Hz	50Hz - 100Hz ¹
1	Buildings used for commercial purposes, industrial buildings, and buildings of similar design.	20	20 to 40	40 to 50
2	Dwellings and buildings of similar design and/or occupancy	5	5 to 15	15 to 20
3	Structures that, because of their particular sensitivity to vibration, cannot be classified under lines 1 and 2 and are of great intrinsic value (e.g. listed buildings under preservation order)	3	3 to 8	8 to 10

Note: ¹ Where frequencies are above 100 hertz (Hz) the values given in this column may be used as minimum values.

The vibration criteria presented in Table 17-9 exceeds the human comfort criteria presented in Table 17-10. Therefore, as indicated above, the human comfort criteria should be the over-riding criteria for the assessment of any vibration.

17.4.6 Blasting Assessment Criteria

The Australian and New Zealand Environment and Conservation Council (ANZECC) *Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration* (ANZECC 1990) provides guidance when dealing with potential blasting noise and vibration. This guideline recommends the noise and vibration limits shown in Table 17-10.

Table 17-10 Recommended ANZECC Blasting Limits

Airblast Overpressure	Ground Vibration
115dB(lin) peak	5mm/s peak particle velocity
The level of 115dB may be exceeded on up to 5% of the total number of blasts over a period of 12 months, but never over 120dB(lin) peak.	The level of 5mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months, but never over 10mm/s.

As required in the ANZECC guideline, Blasting should only occur between 9am to 5pm (Monday to Friday) and 9am to 1pm (Saturday). The frequency of blasting should be no more than once per day. This requirement does not apply to minor blasts.

17.4.7 Road Traffic Noise Criteria

The former Northern Territory Department of Planning and Infrastructure Road Traffic Noise on Northern Territory Government Controlled Roads Policy (DPI 2006) provides guidance on controlling the adverse effects of road traffic noise on adjacent land uses. The requirements for proposed developments are summarised in Table 17-11.

Table 17-11 Road Traffic Noise Criteria

Road Category	Type of Project / Land Use
Road Traffic Noise on Northern Territory Government Controlled Roads Policy (2006)	<p>Existing Road – Unplanned Significant Development</p> <p><i>Existing Residential</i></p> <p>Where there is both a predicted increase in noise level of >5 dB(A) and the predicted noise target level is >L_{A10 18hour} 68 dB(A), target L_{A10 18hour} 68 dB(A).</p> <p><i>Existing Noise Sensitive¹</i></p> <p>Where there is both a predicted increase in noise level >5 dB(A) and the predicted noise level is > L_{A10 18hour} 63 dB(A), target L_{A10 18hour} 63 dB(A).</p> <p><i>Future Residential and Noise – Sensitive</i></p> <p>Responsibility for noise management of developments undertaken adjacent to an existing or planned future road rests with the proponent (private or government agency).</p>

¹ Includes aged care, nursing homes and may include schools, libraries and hospitals. Commercial accommodation facilities relying on passing trade are not considered as noise sensitive developments under this policy.

17.5 Potential Impacts

17.5.1 Construction Noise Assessment

Typical noise levels produced by construction plant anticipated to be used on site were sourced from Australian Standard AS 2436:2010 *Guide to Noise Control on Construction, Maintenance and Demolition Sites* and from GHD's internal database.

Propagation calculations took into account topography, atmospheric absorption, soft soil ground absorption and temperature inversions. Directivity was not considered, and instead the hemispherical spread of noise emissions from construction equipment was modelled. All construction equipment was assumed to be operating simultaneously and at full capacity. Further, noise predictions did not consider noise barriers or other forms of acoustic shielding.

Given the intermittent, mobile and short-term nature of construction noise, noise predictions are considered conservative. Essentially, they represent the maximum possible distances over which an acoustic impact may be observable during quiet ambient conditions. If such impacts were to occur, they would likely be intermittent and infrequent.

The predicted construction noise level at noise sensitive receptors in Werenbun was 24 dB(A) _{L_{Aeq}}, which is below the 29 dB(A) _{L_{Aeq}} construction noise goal for standard working hours (Section 17.4.1) and the 37dB(A) _{L_{A1 (1min)}} sleep disturbance noise goal for the night noise assessment period (Section 17.4.3).

17.5.2 Construction Vibration Assessment

The Roads and Traffic Authority of New South Wales Environmental Noise Management Manual (RTA 2001) provides typical construction equipment ground vibration levels at 10m, from which ground vibration at various distances can be derived.

Given the distance to the nearest receptor from the mine site is 7km, construction vibration is highly unlikely to exceed the human perception criteria and is not discussed further in this assessment.

17.5.3 Operational Noise Assessment

Acoustic modelling was undertaken using CadnaA V4.3 noise modelling software to predict the effects of industrial noise generated by the proposed mine. CadnaA is a computer program for the calculation, assessment and prognosis of noise propagation. CadnaA calculates environmental noise propagation according to the CONCAWE noise prediction method. Propagation calculations took in account topography, ground absorption, atmospheric absorption and relevant shielding objects.

Sound power levels for all plant and equipment proposed to be used at the site were obtained from noise assessments conducted on similar projects, manufacturer's specifications and available noise source database (Appendix U). Sound power levels were the maximum predicted levels produced when machinery is operating under full load. Assessment was conducted on a "worst case scenario" whereby all equipment was assumed to be operating all the time under full load.

Mine Site

Due to staging, noise impact will vary over the proposed 13 year operational life of the mine depending on where machinery is operating. The areas where these changes will occur are the Batman Pit and waste rock dump. For the noise assessment, a worst case scenario was modelled, which included machinery operating in the southern most area of the waste rock dump.

The processing facilities and power station will operate 24 hours a day, 365 days per year. Prevailing winds during the Dry Season are from the south-east, which are directed away from the nearest noise sensitive receptors at Werenbun. Prevailing winds during the Wet Season are from the northwest, which are directed toward Werenbun.

Noise propagation modelling was undertaken with four scenarios:

- ▶ temperature inversion;
- ▶ 3m/s wind from the south-east (Dry Season);
- ▶ 3m/s wind from the north-west (Wet Season) and
- ▶ neutral conditions (no wind).

Noise impact at the nearest noise sensitive receptor is summarised in Table 17-12. Results are presented in terms of 24-hour operations (i.e. uniform noise generation over day, evening or night-time) and assessed against the project specific noise goals. Noise contours for the temperature inversion scenario during the Dry Season are presented in Figure 17-3. This scenario is presented here instead of the Wet Season due to the predominance of Dry Season wind conditions throughout the year (refer to Figure 17-1). All noise contours for Dry Season, Wet Season and neutral meteorological conditions are presented in Appendix U.

Table 17-12 Summary of Results 1.5m above Ground Level

Receptor	24-Hours Noise Impact [dB(A) SPL re:20µPa]				Project Specific Noise Goals
	Temperature Inversion	Dry Season	Wet Season	Neutral Meteorological Conditions	
Werenbun	29	20	30	23	35

Noise levels assessed under all weather conditions are predicted to be below the operational noise criteria of 35dB(A) (Section 17.4.2).

Noise model results indicate the predicted low frequency for C-weighted and A-weighted noise levels over the same period is less than 15dB. The correction for low frequency noise, as specified in INP, was not required to be added to the predicted noise levels at the receiver.

Traffic Noise Impact

Road access for all traffic will be exclusively via Edith Falls Road and Jatbula Road.

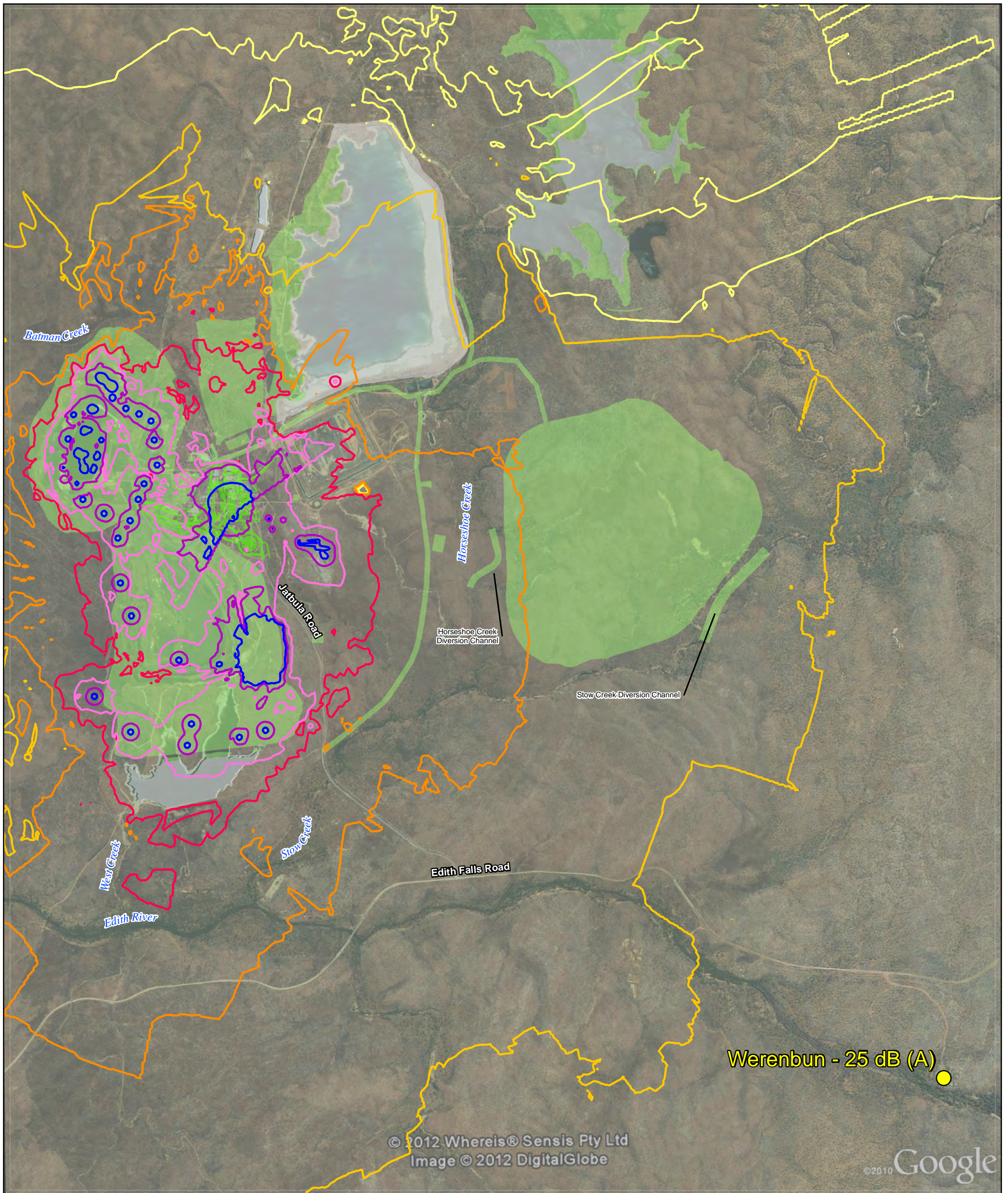
The closest noise sensitive receptor to Edith Falls Road (the Edith Falls Road / Jatbula Road intersection) is Werenbun, approximately 4km away. As such, the estimated increase in traffic noise due to the Project is not expected to be noticeable at Werenbun receptors.

Blasting Impacts

Blasting impacts were estimated with consideration to Australian Standard 2187.2-2006 Explosives – Storage and use Part 2: Use of Explosives (AS2187.2-2006). Blasting vibrations are non-linear in nature and variability in ground type and meteorological conditions makes it difficult to accurately predict ground vibration and airblast overpressure without site specific measurement data.

No details of the blast configuration and design have been supplied at this stage, however it is considered that a maximum instantaneous charge of no greater than 100kg should be required, and a charge of 50kg or less more likely.












It is predicted that a maximum instantaneous charge of greater than 100kg would be required to meet the 5mm/s peak particle velocity vibration criterion (Section 17.4.6). As such, ground vibration from blasting is not predicted to be an issue. It is also predicted that an maximum instantaneous charge of greater than 100 kg would be required to meet the 115dB(L) airblast overpressure criterion (Section 17.4.6). As such, airblast overpressure from blasting is not predicted to be an issue.

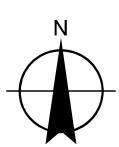
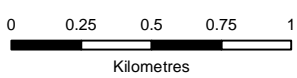


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LEGEND

	Werenbun Noise Level	Sound pressure level dB(A)		50	
	Process Plant		20		60
	Proposed Infrastructure		30		70
	Existing Infrastructure		40		80



Vista Gold Australia Pty Ltd
Mt Todd Gold Project

Job Number | 43-21801
Revision | 1
Date | 24 Jun 2013

Predicted Operational Noise Levels -
Dry Season Temperature Inversions

Figure 17-3

Noise Impacts on Native Fauna and Livestock

There are no government policies or widely accepted guidelines with regard to noise criteria for animals. Information provided in technical literature and has been reviewed for the Project.

Livestock

The noise goals provided in this study are based on human response and annoyance factors and, as such, are not applicable to livestock or other non-human receivers. Sudden noise has the potential to startle or upset domestic livestock and pets.

Heggies Pty Ltd conducted a literature review as part of their assessment of blasting noise impacts on livestock for the proposed Caval Ridge Coal Mine Project (Heggies 2009). Heggies cites results from a study on the response of farm animals to sonic booms, which indicated that reactions of sheep, horses and cattle to sonic booms (125dB to 136dB) were considered slight to mild.

Results of the study showed that the reactions of the sheep and horses to sonic booms were slight and that dairy cattle were little affected by sonic booms. Only 19 of 104 booms produced even a mild reaction, as evidenced by a temporary cessation of eating, rising of heads, or slight startle effects in a few of those being milked. Milk production was not affected during the test period, as evidenced by total and individual milk yield.

Given these conclusions, it is unlikely that the Project would have an adverse effect on livestock.

Native Fauna

The effect of noise on wildlife can be similar to the effects observed in humans. Noise can adversely affect wildlife by interfering with communication, masking the sounds of predators and prey, cause stress or avoidance reactions and (in the extreme) result in temporary or permanent hearing damage. Experiments have shown that exposure to noise impulses throughout the night-time sleep period resulted in poorer daytime task performance by animals (Fletcher and Busnel 1978).

The learning ability of many animal species, in regard to familiarisation, is also discussed by Fletcher and Busnel (1978). The animal's initial reaction to a new noise source is fright and avoidance but if other sensory systems are not stimulated (for instance optical or smell), the animal learns quite quickly to ignore the noise source, particularly when it exists in the presence of human.

Migratory birds have the potential to be influenced by noise from the Project. Studies of birds (Larkin *et al.* 1996) have shown that they will habituate to loud noises that are not biologically meaningful for them. For example if the noise is associated with possible harm such as thunder on a cloudy day, birds will avoid it, but noises such as traffic will not disturb them. Examples are provided of sea-birds that voluntarily co-exist with relatively loud noise environments, such as around airports, and birds roosting on light-posts above busy motorways.

Attempts at using noise to deliberately scare birds away from an area, for example to protect farming crops, have been shown to grow less effective over time as birds habituate to the noise. Larkin suggests that keeping the noise as consistent as possible both in the sound produced and the frequency with which it occurs may also help mitigate its effects on birds. Poole (1982) and Algers *et al.* (1978) shows that birds tend to adapt to steady state noise levels, even of a relatively high level (in the order of 70dB(A)). Given the predicted steady noise levels around the Project are expected to be much less than this level, noise impacts on birds surrounding the Project is considered acceptable.

Summary

Available literature suggests that the impact of noise from the Project is unlikely to result in negative impacts to either livestock or native fauna.

17.6 Overall Assessment of Noise Effects

17.6.1 Construction Noise and Vibration

The results of the construction assessment indicate that construction noise and vibration is expected to comply with nominated criteria at sensitive receptors.

17.6.2 Operational Noise and Vibration

The results of the operational assessment indicate that operational noise and vibration is expected to comply with nominated criteria at sensitive receptors.

Mine site noise was predicted for a worst-case operating scenario under various meteorological conditions, and assumed that all machinery and plant operated continuously. The highest predicted noise level under at the nearest noise sensitive receptor (Werenbun) is 30dB(A).

The estimated increase in traffic noise due to the Project is not expected to be noticeable at Werenbun.

The nature and level of vibration emitted from the site will vary with the activities being undertaken. Due to the distances between the sources and receptors, vibration impacts are unlikely to be an issue.

Airblast overpressure and ground vibration from blasting activities at the mine are predicted to comply with the project specific criteria, however any blast on site should be designed by a qualified contractor and include consideration of the blasting noise and vibration limits outlined in this report.

Literature suggests that noise from the Project is unlikely to result in negative impacts to livestock or native fauna.

17.7 Management Measures

Although noise is not predicted to be an issue for the Project, the following measures will be taken into consideration during construction and operation of the Project.

17.7.1 Construction Noise

A Noise Management Plan will be developed and include the following measures, as a minimum:

- ▶ justification for work that is likely to be undertaken outside of the standard hours for construction;
- ▶ details and the duration of the activities likely to cause noise emissions that may exceed the construction noise levels defined in noise guidelines for development sites in the Northern Territory (NT EPA 2013) during a period specified in Clause 10.1;
- ▶ details clearly demonstrating how site activity will comply with *AS 2436 Guide to Noise and Vibration Control on Construction, Maintenance and Demolition Sites*;
- ▶ documented complaint response procedures and how the procedures will be implemented;

- ▶ documentation demonstrating that all occupants were provided with advice on dates, times and nature of any potentially noisy and disruptive activity including measures proposed to mitigate such activity as well as noise complaint contact details; and
- ▶ name of the onsite person who will be responsible for implementing the Noise Management Plan and the name and phone number of the person to whom a complaint may be made about noise emissions from the site.

In addition, the following construction noise mitigation measures could be implemented:

- ▶ all work should be kept within the standard working hours prescribed by the NT EPA;
- ▶ review the fixed and mobile equipment fleet and prefer more recent and silenced equipment whenever possible. All equipment used on site should be in good condition and good working order;
- ▶ plan to use equipment which is fit for the required tasks in terms of power requirements;
- ▶ all engine covers should be kept closed while equipment is operating;
- ▶ as far as possible, material drop heights into or out of trucks should be minimised;
- ▶ broadband reversing alarms (audible movement alarms) should be used for all site equipment, subject to meeting occupational health and safety requirements;
- ▶ all combustion engine plant, such as generators, compressors and welders should be checked to ensure they produce minimal noise with particular attention to residential grade exhaust silencers;
- ▶ vehicles should be kept properly serviced and fitted with appropriate mufflers. The use of exhaust brakes should be eliminated, where practicable;
- ▶ where practical, machines should be operated at low speed or power and should be switched off when not being used rather than left idling for prolonged periods;
- ▶ machines found to produce excessive noise compared to industry normal standard should be removed from the site or stood down until repairs or modifications can be made; and
- ▶ impact wrenches should be used sparingly with hand tools or quiet hydraulic torque units preferred.

17.7.2 Operational Noise

General Noise Mitigation Measures

- ▶ all mobile equipment will be selected to minimise noise emissions and maintained in good repair. Equipment will be fitted with appropriate silencers and be in good working order. Machines found to produce excessive noise compared to normal industry expectations will be removed from the site or stood down until repairs or modifications can be made;
- ▶ haul roads will be kept smooth and free of potholes and bumps; and
- ▶ broadband reversing alarms (audible movement alarms) will be used for all site equipment.

General Work Practices

All site workers should be aware of the potential for noise impacts and encouraged to take practical and reasonable measures to minimise the impact during the course of their activities, including:

- ▶ avoiding the use of loud radios;
- ▶ avoiding shouting and slamming doors;

- ▶ where practical, machines should be operated at low speed or power and switched off when not being used rather than left idling for prolonged periods;
- ▶ informing truck drivers of designated vehicle routes, parking locations and delivery hours;
- ▶ minimising reversing;
- ▶ avoiding dropping materials from height;
- ▶ avoiding metal to metal contact on material; and
- ▶ closing engine covers while equipment is operating.

Complaint Management

A complaint system will be implemented and will include the following measures as relevant:

- ▶ establish a community liaison phone number and permanent site contact number so that noise related complaints can be received and addressed in a timely manner;
- ▶ determine whether any unusual activities were taking place at the time of the complaint that may have generated higher noise levels than usual;
- ▶ if the complaint is justified and the relevant noise generating activities is continuing, conduct noise monitoring at the location of the complainant within 5 days of receiving the complaint; and
- ▶ if noise levels are excessive, or above environmental authority conditions, implement further management measures.

On receipt of a noise and/or vibration complaint:

- ▶ a written response to a complaint will be provided within seven days, including any monitoring outcomes and management measures; and
- ▶ an email response to an electronic complaint will be provided within two days if the complaint cannot be resolved by an initial response.

Blasting Mitigation Measures

Any blast on site should be designed by a qualified contractor and include consideration of the blasting noise and vibration limits outlined in this report including but not limited to a maximum instantaneous charges of less than 100kg and limit (interim or final walls) blasting.