Lloyd George Acoustics
PO Box 717
Hillarys WA 6923
T: 9300 4188 F: 9300 4199
E: daniel@lgacoustics.com.au W: www.lgacoustics.com.au

Environmental Noise Assessment

Wingellina Nickel Project

Reference: 13012341-01 draft

Prepared for:
Hinkley Range Pty Ltd

Lloyd George Acoustics Pty Ltd

ABN: 79 125 812 544

PO Box 717
Hillarys WA 6923

Offices:	Ocean Reef	Padbury	Scarborough	Heathridge
Phone:	9300 4188	9401 7770	9245 3223	0412 611 330
Fax:	9300 4199	9401 7770	9300 4199	9300 4199
Email:	daniel@lgacoustics.com.au	terry@lgacoustics.com.au	mike@lgacoustics.com.au	matt@lgacoustics.com.au
Mobile:	0439 032 844	0400 414 197	0438 201 071	0412 611 330

Member of the Association of Australian Acoustical Consultants – (AAAC)

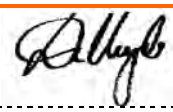
Prepared By:	Daniel Lloyd 
Position:	Project Director
Verified	Terry George 
Date:	19 July 2013

Table of Contents

List of Tables

List of Figures

Appendices

1 INTRODUCTION

Hinckley Range Pty Ltd are currently proposing to develop the Wingellina Nickel Project located, approximately 1,400 km north-east of Perth along the Gunbarrel Highway (Figure 1.1).

The Project will involve open pit mining of nickeliferous limonite ore with on-site processing using a high pressure acid leach (HPAL) process to produce an intermediate mixed nickel-cobalt hydroxide product. The Project will require the development of roads to a rail siding to transport the hydroxide product by rail to the Port of Darwin or the Port of Adelaide for export to international markets. Ore production for the Project will peak at 4.3 million tonnes per annum (Mtpa) within four years of commencement of operations.

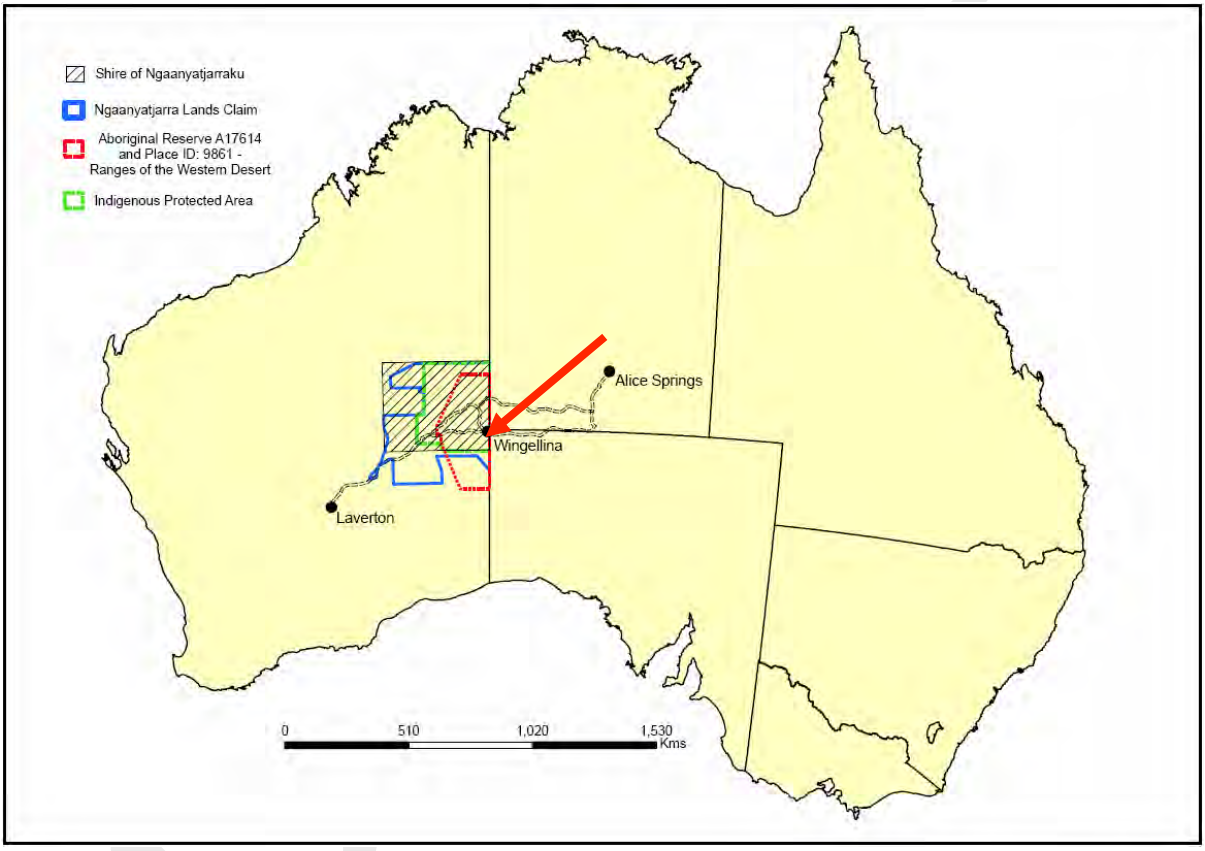


Figure 1-1 Mine Locality

Noise and vibration impacts associated with the project are predicted at sensitive premises. The nearest noise sensitive receptors to the Project are the proposed construction workers camp, permanent accommodation village, Wingellina township and Kalka community. The Wingellina Township is located within 3 km from the ore body and the Kalka communities are 16 km away. The location of the mine in respect to these sensitive receivers is shown in *Figure 2.1*.

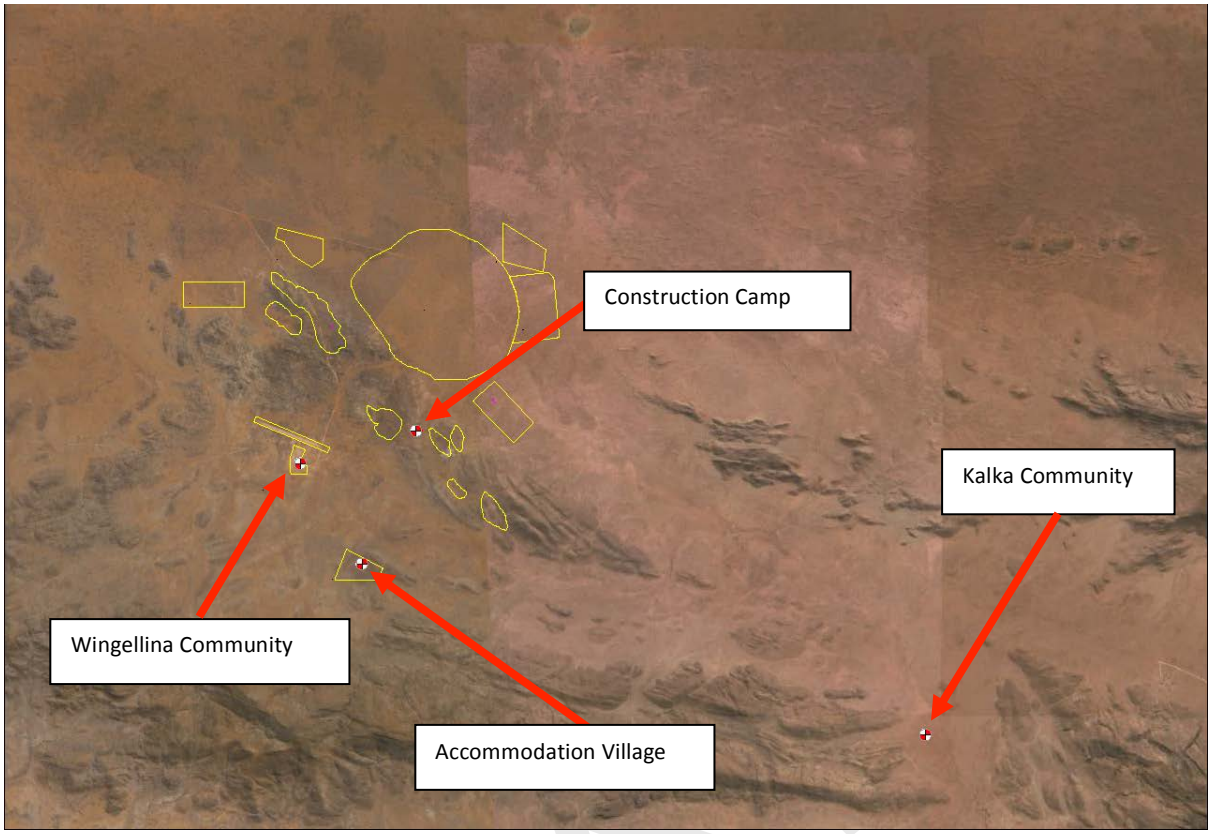


Figure 1-2 Location of Noise Sensitive Receivers

The assessment considers the following operations:

- Noise from mobile plant during the construction phase of the project;
- Noise from mobile plant and processing plant during full operation; and
- Airblast and ground-borne vibration from blasting.

The noise levels associated with the mining, processing and transportation operations are compared against the assigned noise levels prescribed in the Environmental Protection (Noise) Regulations 1997.

The results are presented as either predicted noise or ground-borne vibration levels to specific receiver locations and as noise level contours superimposed onto maps of key project areas.

It should be noted that the haul road used to transport the product to port, has been placed a significant distance from both the Wingellina township and the accommodation village. Therefore noise impacts from this operation are extremely unlikely and have not been considered further.

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

2 ASSESSMENT CRITERIA

2.1 Operational 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 –

(a) 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

(b) Must be free of –

i. Tonality;

ii. Impulsiveness; and

iii. 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
Noise Sensitive[2]	All hours	60	75	80

1. Applies within 15metres of a building associated with a noise sensitive use, as defined in Schedule 1, Part C.
2. Applies at a noise sensitive premises greater than 15 metres from a building with a noise sensitive use.

The Wingellina mine is proposed as a 24-hour operation and therefore the most critical assigned noise levels will be those during the night. In accordance with Noise Regulation Criteria the assigned levels are 35 dB L_{A10}, 45 dB L_{A1} and 55 dB L_{Amax}, with the L_{A10} most likely to dictate the compliance status. As there are no other mines in the area, ambient noise levels are expected to be at least 5 dB below the assigned levels and therefore would not be considered as contributing.

2.2 Construction Noise

Construction noise is addressed through Regulation 13 of the Regulations. Regulation 13 states the following:

Regulation 7 does not apply to … construction work carried out between 0700 hours and 1900 hours on any day which is not a Sunday or public holiday if the occupier of the premises … shows that –

a The construction work was carried out in accordance with control of environmental noise practices set out in section 6 of AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites;

b The equipment used on the premises was the quietest reasonably available; and

c If the occupier was required to prepare a noise management plan … in respect of the construction site –

i. The noise management plan was prepared and given in accordance with the requirement, and approved by the Chief Executive Officer; and

ii. The construction work was carried out in accordance with the management plan.

Regulation 7 does not apply to … construction work carried out other than between the [above] hours if the occupier of the premises … shows that –

a *The construction work was carried out in accordance with control of environmental noise practices set out in section 6 of AS 2436-1981 Guide to Noise Control on Construction, Maintenance and Demolition Sites;*

b *The equipment used on the premises was the quietest reasonably available;*

c *The construction work was carried out in accordance with a noise management plan in respect of the construction site –*

i. *Prepared and given to the Chief Executive Officer not later than 7 days before the construction work commenced; and*

ii. *Approved by the Chief Executive Officer;*

d. *At least 24 hours before the construction work commenced, the occupier of the construction site gave written notice of the proposed construction work to the occupiers of all premises at which noise emissions received were likely to fail to comply with the standard prescribed under regulation 7; and*

e. *It was reasonably necessary for the construction work to be carried out at that time.*

As the construction noise is not affecting other premises, there would be no requirement to seek approval from the Chief Executive Officer.

2.3 Airblast

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

(3) No airblast level resulting from blasting on any premises or public place, when received at any other premises, may exceed –

(a) *125dB $L_{Linear\ peak}$ between 0700 hours and 1800 hours on Monday to Saturday inclusive; or*

(b) *120dB $L_{Linear\ peak}$ between 0700 hours and 1800 hours on a Sunday or public holiday.*

(4) Notwithstanding subregulation (3), airblast levels for 9 in any 10 consecutive blasts (regardless of the interval between each blast), when received at any other premises, must not exceed –

(a) *120dB $L_{Linear\ peak}$ between 0700 hours and 1800 hours on Monday to Saturday inclusive; or*

(b) *115dB $L_{Linear\ peak}$ between 0700 hours and 1800 hours on a Sunday or public holiday.*

2.4 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.

3 METHODOLOGY

3.1 Operational Noise

Computer modeling has been used to predict noise from the proposed mine. It is assumed that for normal production, all plant will be operating simultaneously.

The software used was SoundPLAN 7.2 with the CONCAWE algorithms selected. These algorithms have been selected as they include the influence of wind and atmospheric stability. The input data required in the model were:

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

3.1.1 Meteorological Information

Meteorological information utilised (*Table 3.1)* is based on that specified in the *draft EPA Guidance for the Assessment of Environmental Factors No.8 - Environmental Noise*. These conditions are considered the worst-case for noise propagation. 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.

Table 3-1 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	E

* Note that 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 stipulates 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, the above conditions occur for more than 2% of the time and therefore must be satisfied.

3.1.2 Topographical Data

Topographical data was based on information provided by Hinkley Range. The contours are in 5 metre intervals and cover the noise sensitive receivers of concern.

3.1.3 Ground Absorption

Ground absorption varies from 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). From our experience, a value of 0.8 has been used as an average value to represent the ground cover expected in this area.

3.1.4 Noise Sources

The noise sources considered in the assessment are split between the open pit and the ROM area. A description of the plant and quantity are provided *Table 3.2.*

Within the model, the plant has been located in such a way as to represent a typical scenario. This includes but is not limited to: drill rigs, dump trucks and excavation plant within the pit; dump trucks, graders and water carts on the haul roads; and dump trucks and loaders at the ROM area.

Table 3-2 Noise Sources Considered in the Assessment

Location	Plant Description	Quantity
Open Pits	Excavator	2
	Haul Truck	9
	Dozer	2
	Grader	1
	Water Cart	1
	Drill Rig	1
ROM Area	Jaw Crusher	1
	Mobile Rock Breaker	1
	Screens	6
	Stackers	2
	Front End Loaders	1
Transport to Rail	Road Trains	22

3.1.5 Sound Power Levels

The sound power levels used in the modelling are presented in *Tables 3.2 and 3.3* respectively.

Table 3-3 Sound Power Levels, dB

Description	Octave Band Centre Frequency (Hz)								Overall dB(A)
	31.5	63	125	250	500	1k	2k	4k	
Drill Rig	97	114	103	104	106	110	113	111	118
Komatsu 930E Dump Truck	110	120	123	123	122	118	117	110	124
CAT 785 Dump Truck	110	107	123	113	123	114	110	105	122
Track Dozer	108	109	115	109	110	115	109	107	117
Wheel Dozer	106	106	104	99	99	101	101	98	112
Rock Breaker	108	113	114	118	117	113	109	104	118
Grader	105	112	110	107	109	108	106	101	112
Water Cart	110	107	123	113	123	114	110	105	116
Hitachi EX5600 Excavator	106	110	116	111	110	105	99	94	111
WA1200 Front-End Loader	116	115	116	113	111	108	103	97	113
CAT 980 Front-End Loader	99	101	111	106	111	108	103	99	112
Conveyor	83	81	82	84	85	80	63	63	85/m
Conveyor Drive	96	100	100	102	108	105	93	84	109
Stacker	120	124	114	108	104	104	103	103	111

With regards to *Table 3.3*, please note that the sound power levels have been derived from measurements undertaken by Lloyd George Acoustics on similar equipment.

3.2 Airblast Assessment

Both confined and unconfined blasting has been considered in the assessment of airblast levels to the nearest noise sensitive receivers. For the assessment, the following maximum charge mass have been assumed:

- Confined blasting assumed to be 26 kg per during mine operation.
- Unconfined blasting assumed to be 10 kg.

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).

Unconfined Charge

$$Airblast\ Level\ dB\ L_{Linear\ peak} = 20\log\left(\frac{P_A}{P_0}\right)$$

where:

$$P_A = 185\left(\frac{R}{W^{\frac{1}{3}}}\right)^{-1.2}$$

$$P_0 = 2x10^{-8}$$

R = *distance from blast*

W = *maximum charge mass per delay*

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 generally only used for large rock removal from machinery or access paths after blasting. It is assumed that these blasts will be managed appropriately.

3.3 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 results of the predicted noise, airblast, ground vibration and transportation Noise levels are presented below.

4.1 Operational Noise

The predicted noise levels at noise sensitive receivers during the operational phase of the project are provided in *Table 4.1.* This prediction assumes all plant is operating and the wind is blowing from the mining operations towards the receiver. As the noise from individual items of plant are below 26 dB, we would not expect the noise to exhibit tonal characteristics, and therefore a penalty would not be applied. These results are shown graphically in *Figure 4.1* with the compliance line is shown in blue.

Table 4-1 Predicted Noise Levels During Operational Phase

Sensitive Receiver	Predicted Noise Level L_{A10} dB	Comment
Wingellina Community	34	Compliant with Regulations
Kalka Community	8	Compliant with Regulations
Accommodation Village	30	Compliant with Regulations

4.2 Construction Noise

The predicted noise level at the Construction Camp during the construction phase of the project is L_{A10} 58 dB. This prediction assumes all plant is operating and the wind is blowing towards the receiver. Providing works are carried out in accordance with *Australian Standard 2436-1981*, this would be considered as acceptable.

4.3 Airblast

The predicted confined airblast level at noise sensitive receivers are provided in *Table 4.2*

Table 4-2 Predicted Airblast Levels

Sensitive Receiver	Predicted Airblast Level $L_{Linear\ peak}$ dB	Comment
Wingellina Community	100	Compliant with Regulations
Kalka Community	74	Compliant with Regulations
Accommodation Village	100	Compliant with Regulations

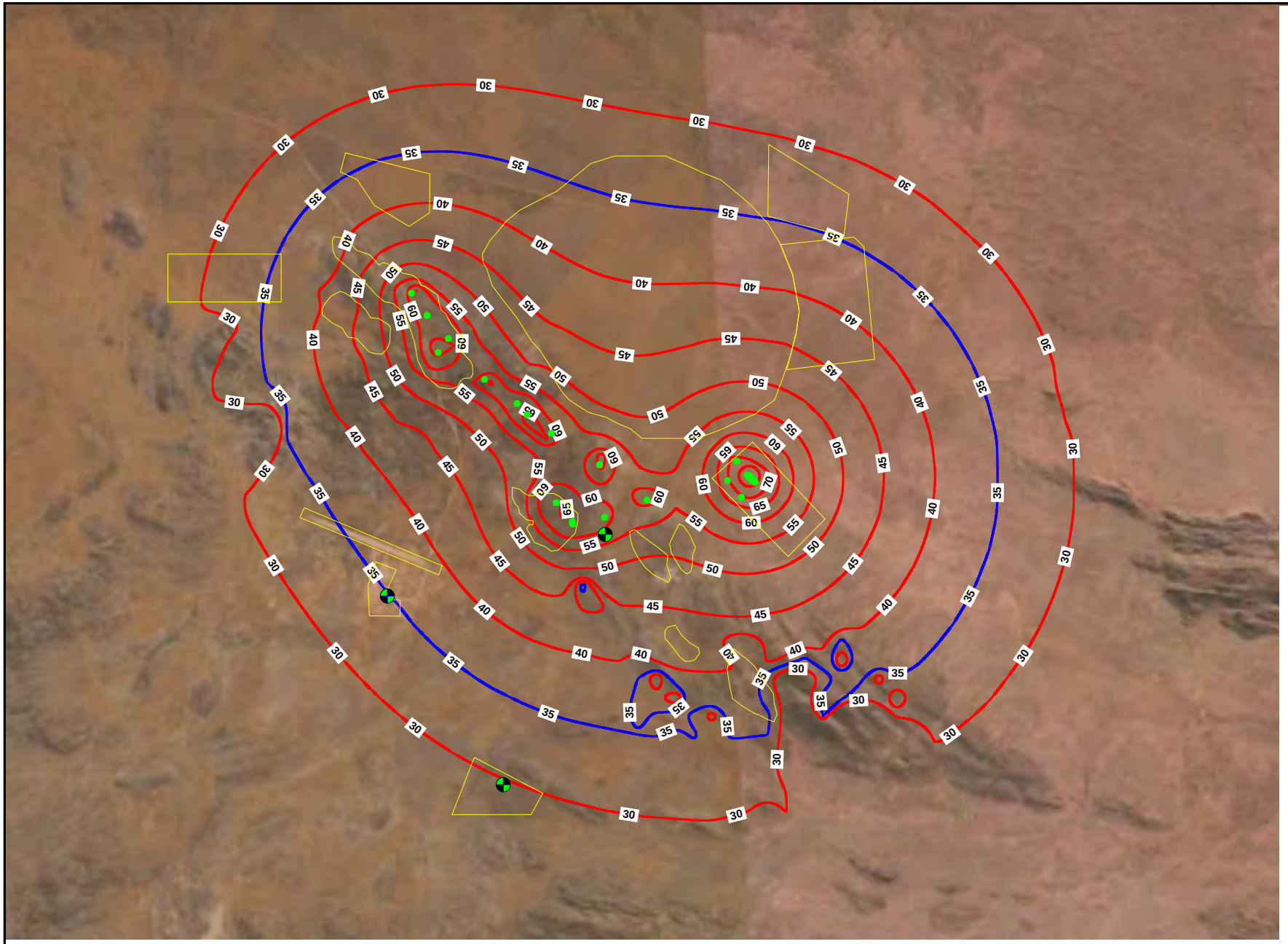
4.4 Ground Vibration

The predicted ground vibration velocity level at sensitive receivers is provided in *Table 4.3*

Table 4-3 Predicted Ground Vibraion Levels

Sensitive Receiver	Predicted Ground Vibration Level mm/s	Comment
Wingellina Community	0.22	Considered Acceptable
Kalka Community	0.00	Considered Acceptable
Accommodation Village	0.08	Considered Acceptable

Figure 4.1



Wingellina Nickel Project
Predicted L_{A10} Noise Levels - Assumes All Plant Operating and Wind from All Directions

Lloyd George Acoustics
by Daniel Lloyd
daniel@lgacoustics.com.au
(08) 9300 4188

5 CONCLUSION AND RECOMMENDATIONS

The results of the assessment show that the noise from the Wingellina Nickel Project, when at maximum capacity, is predicted to comply with the assigned levels under the *Environmental Protection (Noise) Regulations 1997,* at all noise sensitive premises.

However, as the predicted noise levels are close to the criterion at the Wingellina townsite, all plant should be kept well maintained, with particular attention to any increases in noise levels, to ensure continuing compliance.

The noise to the temporary construction camp during the construction phase of the project is considered acceptable providing works are carried out in accordance with *Australian Standard 2436-1981*.

Confined airblast levels at the Wingellina Nickel Project are predicted to comply with the *Environmental Protection (Noise) Regulations 1997*, at all times.

Ground vibration levels resulting from blasting are predicted to be 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_{APeak}

This is the maximum reading in decibels using the A frequency weighting and P time weighting AS1259.1-1990.

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.

Satisfactory Design Sound Level

The level of noise that has been found to be acceptable by most people for the environment in question and also to be not intrusive.

Maximum Design Sound Level

The level of noise above which most people occupying the space start to become dissatisfied with the level of noise.

Reverberation Time

Of an enclosure, for a sound of a given frequency or frequency band, the time that would be required for the reverberantly decaying sound pressure level in the enclosure to decrease by 60 decibels.

RMS

The root mean square level. This is used to represent the average level of a wave form such as vibration.

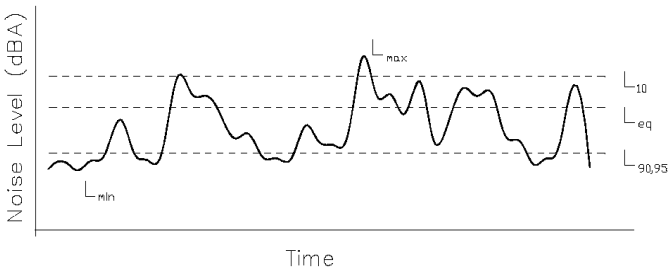
Vibration Velocity Level

The RMS velocity of a vibration source over a specified time period. Units are mm/s.

Peak Velocity

Level of vibration velocity measured as a non root mean square (r.m.s.) quantity in millimetres per second (mm/s).

Chart of Noise Level Descriptors



Typical Noise Levels