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Environmental Noise Impact Assessment

Mount Keith Satellite Operations

bhpbilliton

Prepared for BHP Billiton Nickel West

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Signature		

Executive Summary

This report provides an environmental noise assessment for BHP Billiton's Nickel West proposed Mount Keith Satellite Operations (MKSO) project.

The objective of this assessment was to quantify the noise impacts of the mining and road haulage operations on the surrounding sensitive receivers.

Results

Mining Noise

- Table E1 provides a summary of the predicted received noise levels from mining activities at the sensitive receivers.
- It was found that the predicted received noise levels comply with the Regulatory assigned levels at all sensitive receivers.

Table E 1 Night Time Modelling Results – Mining

Sensitive Receiver	L_{A10} Noise Model Prediction	L_{A10} Assigned Noise Level	Exceedance in dB
R1 Wanjarri Shearing Shed	30.1	35	0
R2 Albion Downes Pastoral Station	9.4		0
R3 Ramelius Operation	10.5		0
R4 Yakabindie Pastoral Station	12.4		0
R5 Western Areas (Cosmos) Camp	13.4		0

Blasting

Ground-borne vibration levels are predicted to be below the EPA defined daytime and night time limits if charge sizes are below the levels shown in Table 6-2.

Recommendations

It is recommended that charge sizes are limited according to Table 6-2, which states the following:

- **Night time**. Below 3 tonnes for 9 out of 10 consecutive blasts and 7 tonnes for any one blast.
- **Day time**. Below 55 tonnes for 9 out of 10 consecutive blasts and 130 tonnes for any one blast.

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1 Introduction

Talis have been engaged by BHP Billiton Nickel West (Nickel West) to undertake an environmental noise and ground-borne vibration assessment for Nickel West's Mount Keith Satellite Operations (MKSO) project.

This report will summarise the desktop noise modelling and ground-borne vibration assessment that has been undertaken.

1.1 Aim

The aim of this assessment is to predictively quantify the noise and ground-borne vibration impact of the MKSO pit and haulage operations on sensitive receivers and determine compliance against the Environmental Protection (Noise) Regulations 1997.

1.2 Scope

The scope of this document includes:

- An overview of the MKSO Project (section 2).
- Summary of legislation (section 3), which includes an estimation of the applicable assigned levels for each sensitive receiver.
- Noise Modelling Methodology and Results (section 4and 5), which includes a compliance assessment against the Environmental Protection (Noise) Regulations 1997 at the noise sensitive locations.
- Ground-borne vibration assessment and results from blasting (section 6). Blasting is considered to be the most significant source of ground-borne vibration and as a result other sources of vibration are not considered.

1.3 Applicable Documents

The following are the applicable regulatory requirements.

- Environmental Protection Act;
- Environmental Protection (Noise) Regulations 1997; and
- Draft Guideline on Environmental Noise for Prescribed Premises.
- Australian Standard AS2187.2-2006 "Explosives – Storage and Use, Part 2: Use of Explosives".

2 Project Description

2.1 MKSO Project Overview

Nickel West's MKSO is a proposed new nickel operations which will involve conventional open pit mining methods and hauling. The MKSO mining operations are located approximately 23 kilometres south of Nickel West's existing mining and processing operations. Mining operations will occur in Six Mile Well (Stage 1) & Goliath pits (Stage 1 & 2). The proposed operations are:

- Open cut mining utilising mobile equipment such as drills, diggers, haul trucks and ancillary equipment;
- WRL, ROM pad and haul roads;
- Utilising the existing Nickel West Mount Keith (NMK) processing facility; and
- Ore will be transported in Road Trains via a transport corridor.

Figure 2-1 shows the location of the proposed development.

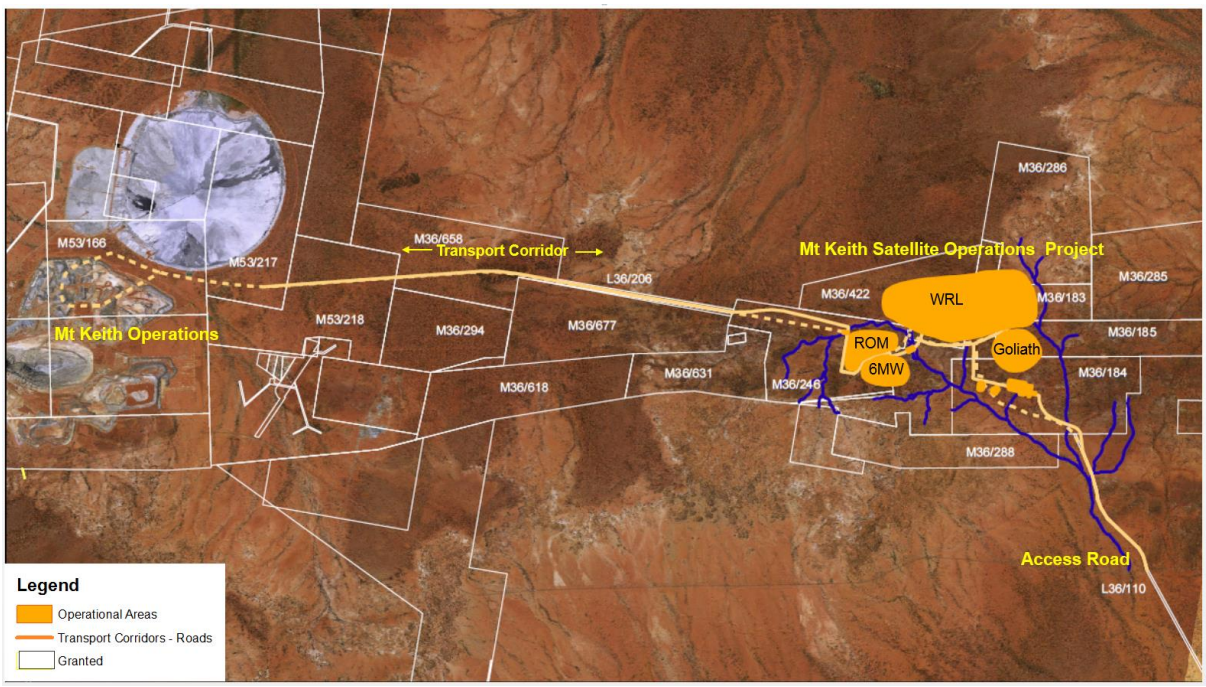

Figure 2-1 : Satellite Image of Proposed Mt Keith Satellite Operations (-90 degrees offset)[1]

[1] A more detailed overview is presented in Appendix C

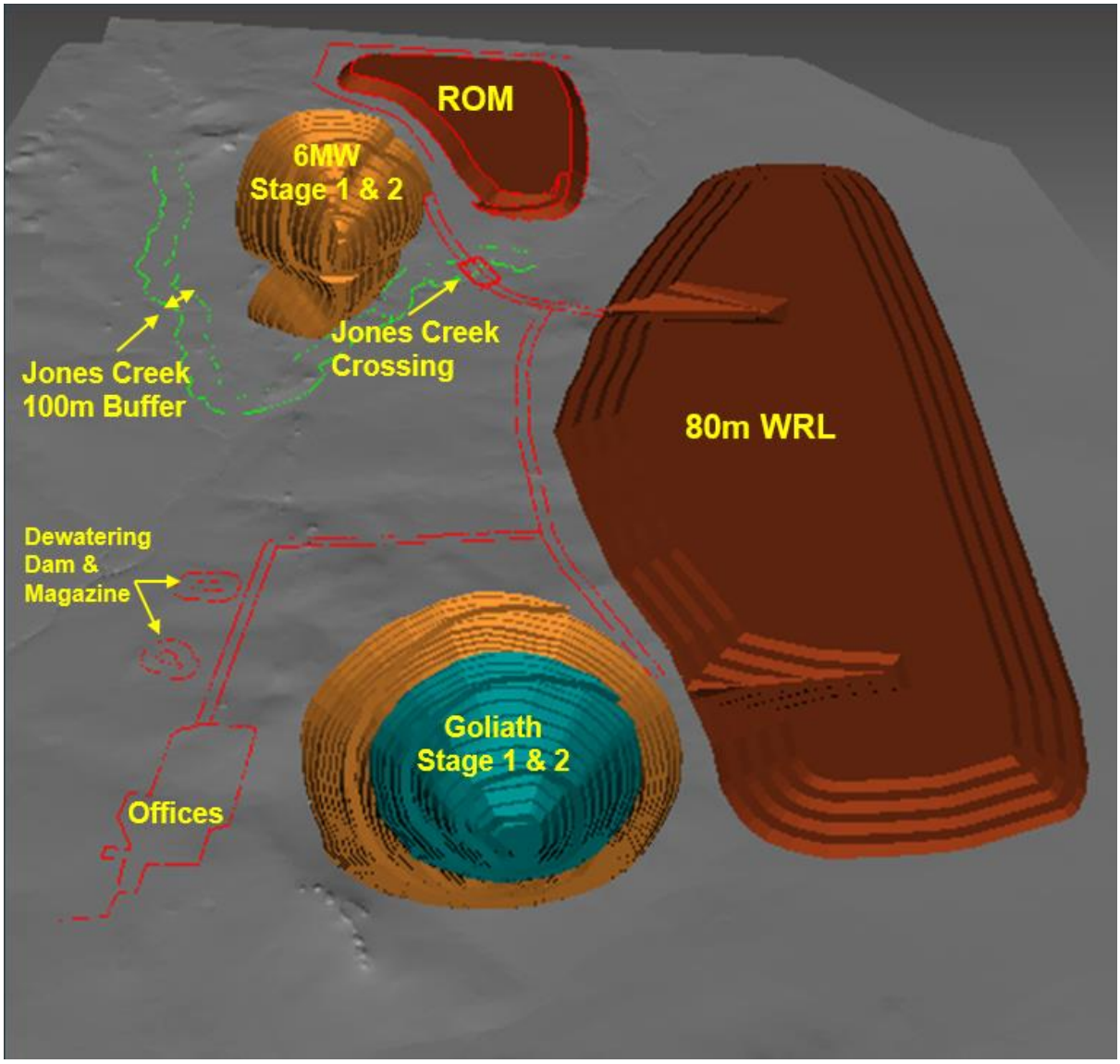

Figure 2-2 : Mount Keith Satellite Pit Details

2.2 Surrounding Noise Sensitive Receptors

The following noise sensitive receivers were identified:

- R1 - Wanjarri Shearing Shed
- R2 - Albion Downes Pastoral Station
- R3 - Ramelius Operation
- R4 - Yakabindie Pastoral Station
- R5 - Western Areas (Cosmos) Camp

The nearest noise sensitive receiver is the Shearing Shed (R1) located within the Wanjarri Nature Reserve, and approximately 7km from the open cut pits and associated mining infrastructure. The shearing shed is an official DEC licensed camping ground and as a result it is classed as a noise sensitive premises as defined in Part 1 of the Environmental Protection (Noise) Regulations 1997 and is subject to the same assigned levels as residential premises. Distances to other receivers are greater than 10km.

3 Summary of Legislation

The legislative document applicable to the MKSO is the Environmental Protection (Noise) Regulations 1997

A brief summary of the assessment criteria is presented below. More detailed information can be found in Appendix A.

3.1 Environmental Protection (Noise) Regulations 1997

Noise management in Western Australia is implemented through the Environmental Protection (Noise) Regulations 1997 which operate under the *Environmental Protection Act 1986*. The Regulations specify maximum noise levels (assigned levels), which are the highest noise levels that can be received at noise-sensitive premises, commercial and industrial premises.

For noise sensitive residences, the time of day also affects the assigned levels. The Regulations define three types of assigned noise levels:

- L_{Amax} assigned noise level means a noise level which is not to be exceeded at any time;
- L_{A1} assigned noise level which is not to be exceeded for more than 1% of the time; and
- L_{A10} assigned noise level which is not to be exceeded for more than 10% of the time.

The L_{A10} noise limit is the most meaningful for this study since it is a limit that is representative of noise from continuous mining operations.

3.1.1 Assigned Noise Levels

Considering the distance of the receivers from the mining activities there are no influencing factors or penalties that are applied to the assigned levels. The applicable assigned noise levels are presented in Table 3-1. As the mining is a continuous operation, the noise modelling results will be assessed against the L_{A10} night-time level of 35 dB(A), which is the most stringent L_{A10}.

Table 3-1 Noise Criteria Applicable at the Sensitive Receivers

Time of Day	L_{A10} Assigned Noise Level in dB(A)
0700 to 1900 hours Monday to Saturday	45
0900 to 1900 hours Sundays and Public Holidays	40
1900 to 2200 hours all days	40
2200 to 0700 hours all days	**35**

3.1.2 Adjustments and Influencing Factors

Noise levels determined at the receiver positions are subject to adjustments if the noise exhibits intrusive or dominant characteristics, i.e. if the noise is impulsive, tonal or modulating.

As the mine is composed of multiple different noise sources and the distance between the mine and the sensitive receivers is greater than 5km, it is expected that the received noise from the mine will not have tonal, modulating or impulsive characteristics. Therefore, no corrections or influencing factors have been applied.

4 Noise Modelling Methodology

4.1 Acoustic Model

An acoustic model was developed using the SoundPlan v7.4 program. This program calculates sound pressure levels at nominated receiver locations or produces noise contours over a defined area of interest around the noise sources. SoundPlan can be used to model different types of noise, such as industrial noise, traffic noise and aircraft noise, and it has been recognised as accepted software by the Department of Environment Regulation (DER). It also provides a range of prediction algorithms that can be selected by the user. The CONCAWE[2,3] prediction algorithms have been selected as most appropriate for this study. The inputs required in SoundPlan are noise source data, ground topographical data, meteorological data and receiver point locations.

The model was used to generate noise contours for the sensitive receiver areas surrounding the proposed mine site and haul route from the proposed Mt Keith Satellite Operations (MKSO) and the existing Mt Keith operations.

The model does not include noise emissions from any source other than the proposed mining operations. Therefore, noise emissions from any other neighbouring industrial sources, road traffic and other extraneous sources are excluded from the modelling.

4.2 Topography

Topographical information for the noise model was obtained from the Nickel West in dxf format. This data consisted of terrain contours in 2m increments and covered all relevant areas with the exception of receivers R4 and R5 which were just outside the areas covered. A flat terrain was assumed to extend to these receivers. This is considered a valid assumption based on satellite imagery.

Also included in the contours are the mine pits and relevant mine year stockpile heights.

4.3 Ground Absorption

The acoustic properties of the ground surface can have a considerable effect on the propagation of noise. Flat non-porous surfaces such as concrete, asphalt, buildings, calm water etc. are highly reflective to noise, and according to ISO 9613-2 have a ground constant of G=0. Soft, porous surfaces such as foliage, loam, soft grass, etc. are highly absorptive to noise, and have a ground constant of G=1.

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[2] CONCAWE (Conservation of Clean Air and Water in Europe) was established in 1963 by a group of oil companies to carry out research on environmental issues relevant to the oil industry.

[3] The propagation of noise from petroleum and petrochemical complexes to neighbouring communities, CONCAWE Report 4/81, 1981

In order to represent the bushland in the greater Leinster area, the ground surface has been modelled using a ground constant of **0.8**.

4.4 Project Noise Emissions

The sound power levels of the noise sources used in the model are based on measurements performed on similar equipment by Talis consultants, and are presented in detailed tables in Appendix B.

4.5 Operating Conditions

With the exception of the haul trucks operating in the pits all mobile and fixed plant is assumed to be operational. For mobile plant noise data is based on 'high idle' or 'high load conditions'.

For the haul trucks operating in the pits half were based on the above conditions and half were based on 'low idle' conditions in order to simulate haul trucks waiting to be loaded.

Overall the above is considered to be a conservative assumption as it assumes all plant is operational. This is rarely the case, particularly at night which represents the critical assessment period.

4.6 Meteorological Conditions

SoundPlan (with the CONCAWE algorithm) calculates noise levels for defined meteorological conditions. In particular, temperature, relative humidity, wind speed and direction data are required as input to the model.

For the noise modelling Talis has used the meteorological conditions (see Table 4-1) suggested by the WA EPA Draft Guidance for assessing noise impact from new developments.

Table 4-1 : Worst-case meteorological conditions for the noise propagation

Time of day	Temperature	Relative Humidity	Wind Speed	Pasquil Stability Category (PSC)
Day (07:00 - 19:00)	20° Celsius	50%	4 m/s	E
Evening (19:00 - 22:00)	20° Celsius	50%	4 m/s	E
Night (22:00 - 07:00)	15° Celsius	50%	3 m/s	F

Since the L_{A10} night time noise limit is the applicable noise limit for this assessment only the night time conditions have been used in the model. Additionally the wind direction has been modelled as worst case, which assumes the wind is always blowing in the direction from source to receiver.

4.7 Modelled Scenario

Modelling was based on Mine Year FY28 since, as shown in Table 2, is expected to have the highest quantity of mobile equipment. Mobile equipment was placed in the model to represent a typical mine operation. Additionally road trains, water carts and graders were also placed in the model along the haul road to simulate these noise sources moving back and forth between the pit and the fixed plant.

Table 2 Equipment Utilisation Based on Proposed 24hr Mining operation

Year	MKS						Mount Keith	
	Excavator R996	Road Train	Dozer D11	Grader 24M	Water Cart 777	Drill Rig Pit Viper	Loader Cat 994	ROM Truck 777/785
FY17	-	-	-	-	-	-	-	
FY18	-	-	-	-	-	-	-	
FY19	-	5	-	-	-	-	-	
FY20	2	11	3	2	2	2	2	2
FY21	4	17	5	3	3	4	2	2
FY22	6	26	7	4	4	6	2	2
FY23	2	14	3	2	2	2	2	2
FY24	3	16	4	3	3	3	2	2
FY25	4	23	5	4	4	4	2	2
FY26	4	23	5	4	4	4	2	2
FY27	5	38	6	6	6	5	2	2
FY28	5	51	6	9	9	5	2	2
FY29	2	19	3	3	3	2	2	2
FY30	1	11	2	2	2	1	2	2
FY31	1	7	2	1	1	1	2	2
FY32	-	2	1	-	-	-	2	2

5 Noise Modelling Results

The following sections present the results of the noise model for the worst case meteorological conditions as defined in section 4.6.

5.1 Mining Noise Model Results

5.1.1 Nominated Receivers Locations

Table 5-1 presents the predicted noise levels for mine year FY28 (the highest activity year) and compliance assessment against the assigned noise levels.

As can be seen from the table, the mining and hauling operation are predicted to comply with the assigned noise levels at all sensitive receivers.

Table 5-1 Predicted Mining Noise Levels

Sensitive Receiver	L_{A10} Noise Model Prediction	L_{A10} Assigned Noise Level	Exceedance in dB
R1 - Wanjarri Shearing Shed	30.1	35	0
R2 - Albion Downes Pastoral Station	9.4		0
R3 - Ramelius Operation	10.5		0
R4 - Yakabindie Pastoral Station	12.4		0
R5 - Western Areas (Cosmos) Camp	13.4		0

A noise contour map for the modelled FY28 scenario is shown in Appendix C.

5.1.2 Wanjarri Nature Reserve

As can be seen in the noise contour map in Appendix C, parts of the western boundary of the Wanjarri Nature Reserve borders up to the haul road. As a result the noise levels along the western boundary range from 30 to 70 dB(A) with the highest levels being where the boundary meets the haul road.

6 Blasting Assessment

Expected ground vibration levels from blasting operations at the Six-mile Well and Goliath pits were predicted using the methodology described in to AS 2187.2-1993 Explosives Storage and Use- Use of Explosives. A summary of the methodology is presented in Appendix D.

Ground-borne vibrations from blasting operations are managed by Australian Standards AS2187.2 Part 2. The standard provides guidance on prediction methods which was used in this study

6.1 Blasting Criteria

It was assumed all blasting takes place in open cut and under average conditions (as defined by AS2187.2). The EPA defines daytime and night time limits for ground vibration levels due to blasting. Since the proposed charge mass per delay was unknown at the time of the assessment, the limits proposed by the EPA were used to estimate the maximum charge mass per delay for vibration levels at the shearing shed not to exceed the EPA limits.

Table 6-1presents the relevant ground-borne vibration levels as defined by the EPA.

Table 6-1 :Recommended Ground Vibration Levels

Description	Time of Day	Ground Vibration Criteria (mm/s)	
		Peak Levels at any Time	Limit for 9 in any 10 Consecutive Blasts
Ground Vibration Peak Particle Velocity	0700 – 1800 (Day Time)	10	5
	1800 – 0700 (Night Time)	1.0	0.5

6.2 Ground Vibration

Figure 6-1 shows the range versus charge mass at which the criteria are not exceeded for ground-borne vibration levels.

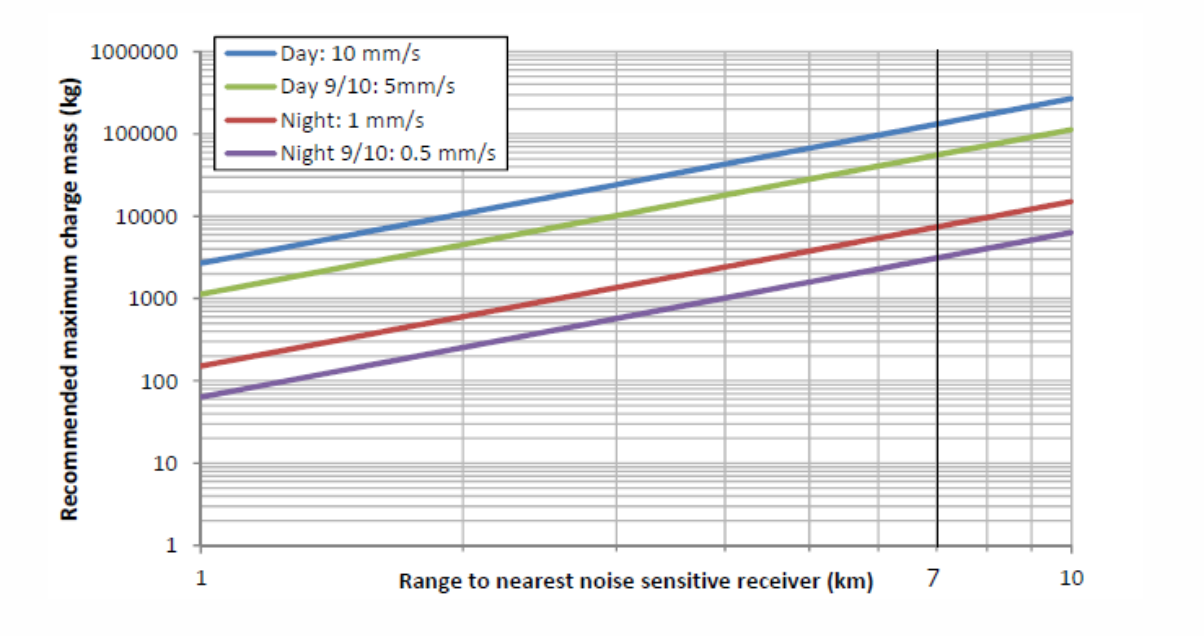


Figure 6-1 : Recommended Maximum Charge Mass (kg) for compliance of Vibration Levels

The results shown in Figure 6-1 were then used to calculate the total maximum charge mass for ground-borne vibration levels to comply at the shearing shed. Should blasting in both pits occur at the same time, the combined charge mass should not exceed the values shown in Table 6-2.

Table 6-2 : maximum Recommended Charge Mass/Delay for Ground Vibration Levels

Time of Day	Maximum Charge Mass per Delay (Tonnes)	
	Peak Levels at any Time	Limit for 9 in 10 Consecutive Blasts
0700 – 1800 (Day Time)	130	55
1800 – 0700 (Night Time)	7	3

Table 6-2 indicates that ground vibration levels at the shearing shed would only be an issue if the proposed blasting operations occur at night and if the proposed charge mas from all three blasting operation exceeds:

- 7 tonnes at any one time;
- 3 tonnes for 9 in 10 consecutive blasts.

7 Conclusion & Recommendations

Talis undertook an environmental noise impact assessment of the proposed satellite operations at Mount Keith which found that the predicted received noise levels from mining operations comply with the Regulatory assigned levels at all sensitive receivers.

Ground-borne vibration levels are predicted to be below the EPA defined daytime and night time limits if charge sizes are below the levels shown in Table 6-2.

It is therefore recommended that the charge sizes are limited according to the table which states the following:

- **Night time**. Below 3 tonnes for 9 out of 10 consecutive blasts and 7 tonnes for any one blast.
- **Day time**. Below 55 tonnes for 9 out of 10 consecutive blasts and 130 tonnes for any one blast.

Appendix A **Applicable Noise Legislation**

Noise management in Western Australia is implemented through the Environmental Protection (Noise) Regulations 1997 which operate under the Environmental Protection Act 1986. The Regulations specify maximum noise levels (assigned levels), which are the highest noise levels that can be received at noise sensitive premises, commercial premises and industrial premises.

Assigned noise levels have been set differently for the different types of premises. For noise sensitive premises, i.e. residences, an 'influencing factor' is incorporated into the assigned noise levels.

The regulations define three types of assigned noise level:

- L_{Amax} assigned noise level is a noise level which is not to be exceeded at any time;
- L_{A1} assigned noise level is not to be exceeded for more than 1% of the time;
- L_{A10} assigned noise level is not to be exceeded for more than 10% of the time.

The L_{A10} noise limit is the most significant for this study since this is representative of continuous noise emissions from the mining operations. Table A1 shows the assigned noise levels for noise sensitive premises. As can be seen from the table the time of day also affects the assigned levels for noise sensitive residences.

Table A1 : Assigned Noise Levels for Noise Sensitive Receivers

Type of premises receiving noise	Time of day	Assigned Levels (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises: highly sensitive area	0700 to 1900 hours Monday to Saturday	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days	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	35 + influencing factor	45 + influencing factor	55 + influencing factor
Noise sensitive premises: any area other than highly sensitive area	All hours	60	75	80
Commercial premises	All hours	60	75	80
Industrial and utility premises other than those in the Kwinana Industrial Area	All hours	65	80	90
Industrial and utility premises in the Kwinana Industrial Area	All hours	75	85	90

Environmental Protection (Noise) Regulations 1997

Received noise levels are subject to penalty corrections if the noise exhibits intrusive or dominant characteristics, i.e. if the noise is impulsive, tonal or modulated. That is, the measured or predicted noise levels are increased by the applicable penalties, and the adjusted noise levels must comply with the assigned noise levels. Regulation 9 sets out objective tests to assess whether the noise is taken to be free of these characteristics. Table A2 lists these penalties.

Table A2 : Assigned penalties for intrusive or dominant noise characteristics

Adjustment where noise emission is not music. These adjustments are cumulative to a maximum of 15 dB		
Where tonality is present	**Where modulation is present**	**Where impulsiveness is present**
+5 dB	+5 dB	+10 dB

Regulation 9 amended in Gazette 5 Dec 2013 p. 5656 7.

A.1: Influencing Factors

The influencing factor depends on land use zonings within 100 metres and 450 metres radius from the noise receiver. The value is dependent on:

- the proportion of industrial land use zonings;
- the proportion of commercial zonings; and
- the presence of major roads within the radius circles.

No influencing factor has been applied to receivers in this study.

Appendix B **Tabulated Noise Source Data**

Table B 1 Modelled equipment, Sound Power Levels (SWLs)

Equipment Item	Overall SWL in dB(A)	Octave Band Levels, Hz in dB(A)								
		31.5	63	125	250	500	1k	2k	4k	8k
Fixed Plant										
Mt Keith	105.0	71	84	92	97	100	102	98	91	83
MKSO	98.1	56	71	84	87	91	93	93	85	81
Mining										
Shovel (R996 or Equivalent)	126.0	86	110	118	118	118	121	119	112	101
Haul Trucks (Trucks (CAT 793))	118.7	79	95	107	112	115	110	108	101	90
Dozer (CAT D11)	112.0	70	77	94	98	104	105	104	109	89
Grader (24M)	108.0	56	75	95	100	102	104	101	95	86
Water Cart (CAT 777)	120.0	76	90	105	108	116	116	113	107	97
Drills (Pit Viper)	123.0	71	88	107	114	117	119	115	108	99
Loader (994K)	108.3	111	107	111	108	106	103	101	93	94
ROM Trucks (CAT 777/785)	120.0	76	90	105	108	116	116	113	107	97
Ore Transport										
Loader (994K)	108.3	111	107	111	108	106	103	101	93	94
Road Trains	118.0	68	82	112	106	109	110	113	107	98

Appendix C **Maps & Noise Contours**

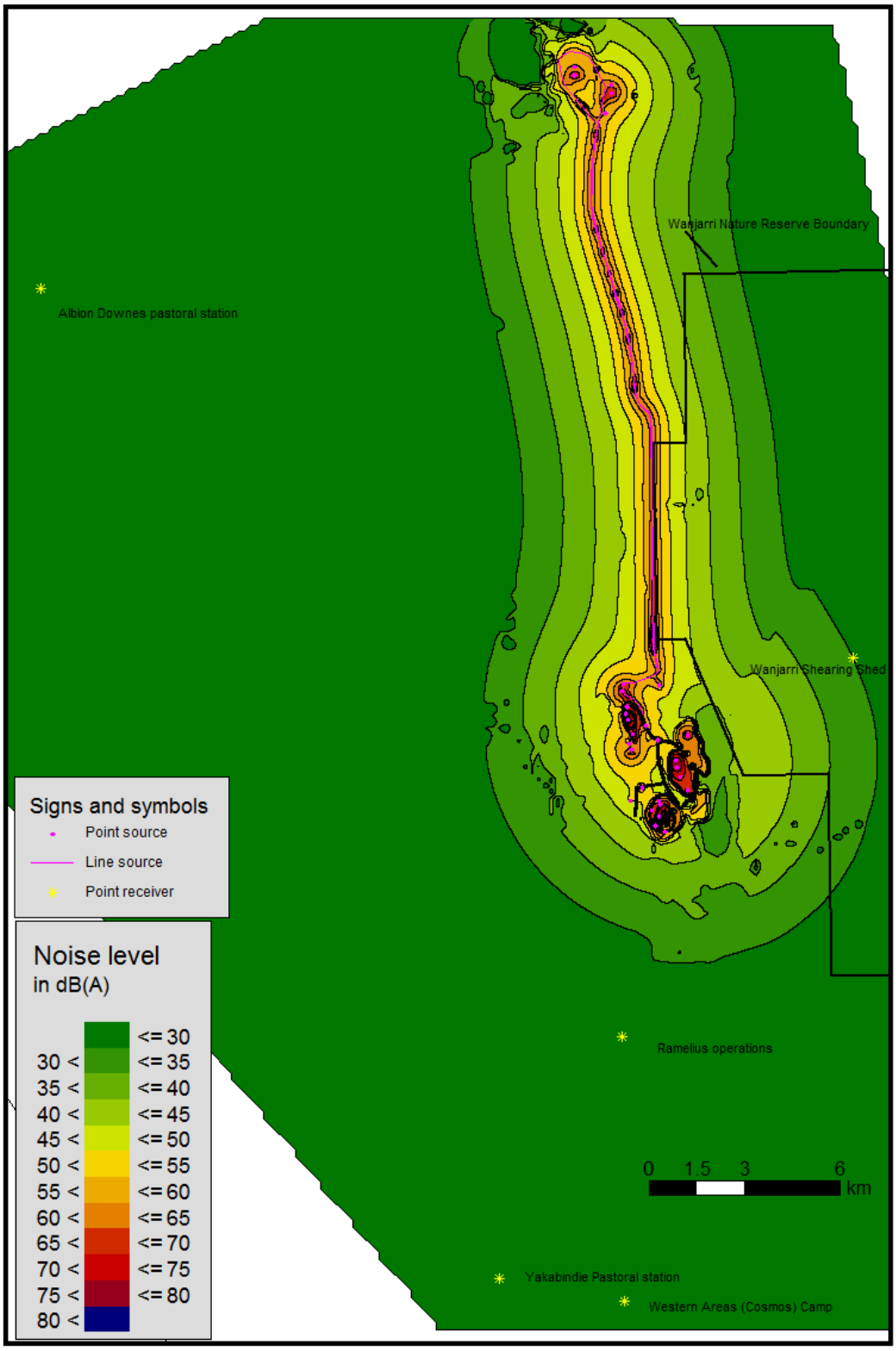
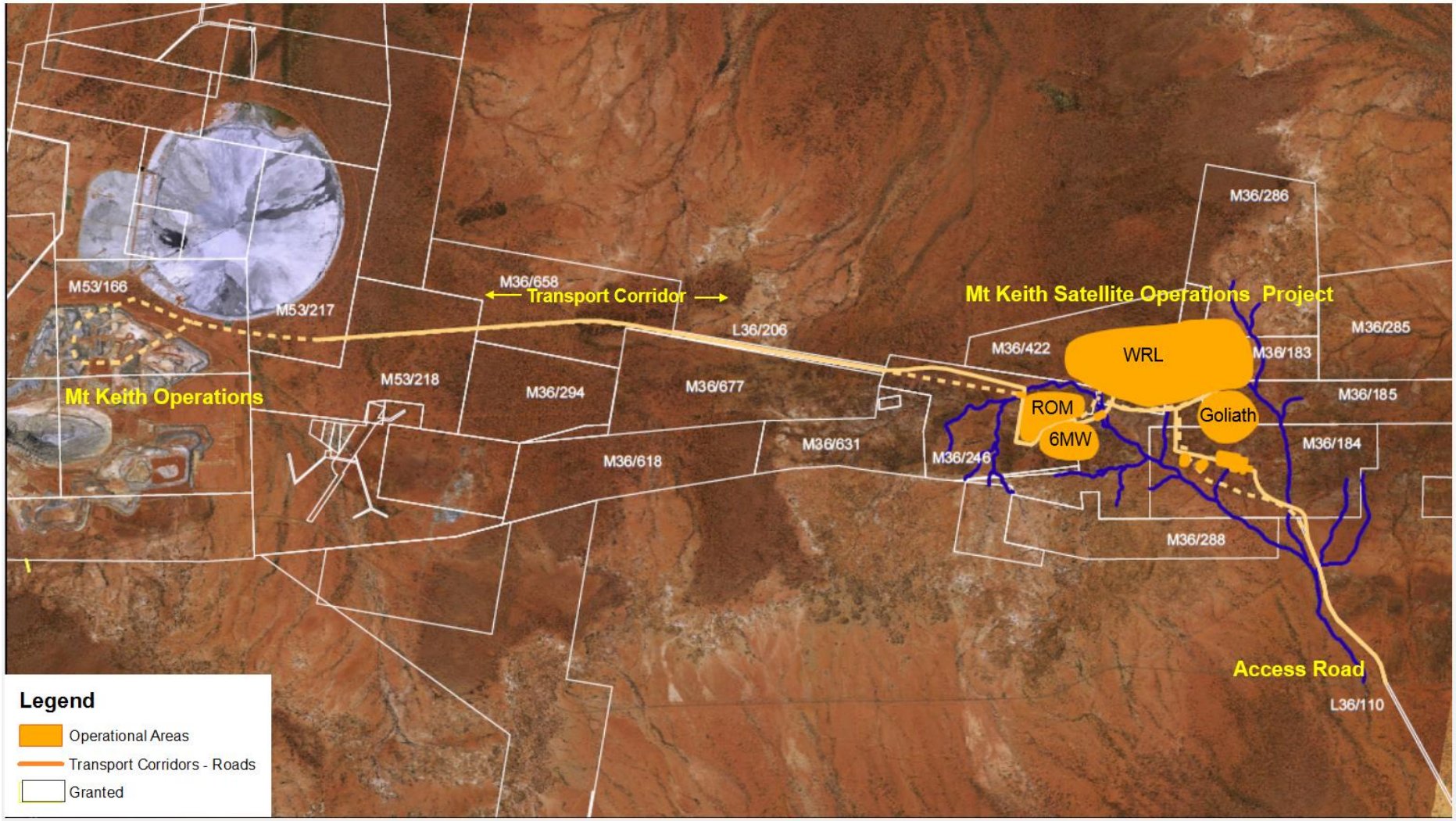


Figure A- 1 Predicted Noise Levels FY28 averaged mobile plant locations along haul road


M53/166
M53/217
M36/658
Transport Corridor
L36/206
Mt Keith Satellite Operations Project
M36/286
M36/285
M36/422
WRL
M36/183
M53/218
M36/294
M36/677
Mt Keith Operations
ROM
Goliath
M36/185
6MW
M36/631
M36/246
M36/184
M36/618
M36/288
Access Road
L36/110
Legend
Operational Areas
Transport Corridors - Roads
Granted

Appendix D **Estimated Ground Vibration Levels from Blasting**

Predicting vibration impacts from blasting is difficult and site specific, as many localised factors affect the transmission of vibration through the ground. The most accurate predictions can be made with all the site relevant data available. In the absence of site data, ground borne vibration levels have been estimated according to the formula[4];

$$V = K(\frac{R}{Q^{0.5}})^{-B}$$

Where:

V is the ground vibration peak particle velocity in mm/s.
R is the distance between the charge and the receiver.
Q is the maximum instantaneous charge in kg.
K and B are empirical constants related to site and rock properties. Where 'K' refers to the site confinement conditions (i.e. free face, quarry, heavily confined blasting) and 'B' refers to expected rock types.

[4] Square Root scaling of charge per delay. Nichols et al 1971 (Nichols, H.R., Johnson, C.F., and Dewall, 1971 "Blasting Vibrations and their effects on structures, Bureau of Mines bulletin 656").

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