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11.1 INTRODUCTION

This chapter identifies sensitive receptors and assesses baseline ambient noise levels within the area of the proposed mine and quantifies the potential change in noise and vibration environments as a result of the construction and operation of the mine site and its associated infrastructure. A detailed technical assessment of the potential impacts associated with noise and vibration emissions has been conducted and is presented at Volume 5, Appendix 20.

The assessment for the mine site has included potential impacts associated with the construction and operation of the mine and associated infrastructure, including the proposed new access road and airport. The assessment has not included the decommissioning of the mine or the potential upgrading of the existing airport at Alpha. It is envisaged that the decommissioning of the mine site would produce similar noise and vibration emissions as would be associated with the construction of the mine.

The potential upgrading of the existing Alpha airport has not been considered as part of this assessment as it is assumed that the upgrade will be undertaken by other parties.

11.2 LEGISLATIVE FRAMEWORK

11.2.1 ENVIRONMENT PROTECTION (NOISE) POLICY

The EP Act provides the framework for the management of the noise environment in Queensland. T*he Queensland Environmental Protection (Noise) Policy 2008* (EPP Noise) is subordinate legislation to the EP Act and it specifically identifies the acoustic environmental values to be enhanced or protected within the state of Queensland. These values are:

- the protection of the health and biodiversity of ecosystems;
- the protection of human health and wellbeing by ensuring a suitable acoustic environment for individuals to:
  - sleep;
  - study or learn;
  - be involved in recreation, including relaxation and conversation; and
- the protection of the amenity of the community.

11.2.2 ECOACCESS GUIDELINE PLANNING FOR NOISE CONTROL

For simple and common sources of noise disturbance in the community (e.g. noise from regulated devices, domestic or commercial air-conditioning systems) the acoustic values are protected by prescribed noise offences defined within EP Act. For new major industries or facilities the methodology for setting noise emission limits to protect the acoustic environmental values is determined in accordance with the Ecoaccess Guideline Planning for Noise Control (the Guideline).

The Guideline is intended to manage three aspects of the acoustic environment that may be affected by new development. These aspects are:

- the control and prevention of 'background noise creep' (the gradual cumulative increase in minimum noise levels generated by continuously operating noise sources);
- the containment of variable noise levels and short term noise events to an 'acceptable level' above the background noise levels (e.g. noise associated with a short term but periodic noise such as the clanging of a tailgate), and
- the setting of noise limits for transient noise events in the night period to avoid 'sleep disturbance'.

11.2.3 QUANTITATIVE NOISE POLICY

The EPP (Noise) defines "Acoustic quality objectives" for the environment that are conducive to human health and wellbeing, including the ability for individuals to sleep, study, relax or converse. The acoustic quality objectives relevant to residential locations are reproduced below in Table 1 for reference. The Explanatory Notes to the EPP (Noise) advises; however, that these objectives relate to the all-encompassing noise environment, and should not be used to set emission limits for individual industries or noise sources.

Part 4, Section 10 of the EPP (Noise) defines the "management intent for an activity involving noise" as follows:

To the extent that it is reasonable to do so, noise from an activity must not be –

(a) for noise that is continuous noise measured by $L_{A90,T}$ – more than nil dB(A) greater than the existing acoustic environment measured by $L_{A90,T}$; or

(b) for noise that varies over time measured by $L_{Aeq,adj,T}$ – more than 5 dB(A) greater than the existing acoustic environment measured by $L_{A90,T}$.

Relevant criteria for various elements of noise and vibration management are outlined within legislation, the Guideline and various national and international documents and standards. The following section provides an outline of the relevant noise and vibration criteria that have been adopted for the assessment of potential impacts associated with this project and which are considered best practice.

11.2.4 RELEVANT NOISE AND VIBRATION CRITERIA

11.2.4.1 Noise Criteria

11.2.4.1.1 Construction

Construction noise and vibration is generally managed by local government under the EP Act. The EP Act controls construction noise by specifying building work that creates audible noise at a receptor location may only occur between 6.30 am and 6.30 pm on any day except Sundays and public holidays. There are no noise limits within or outside of these hours for building or other similar construction works. If construction work is required outside of normal daytime hours (6.30 am to 6.30 pm) then a construction noise EMP will be prepared which outlines the method by which audible noise at a receptor location will be controlled during the out-of-hours work.

The mine site construction will be regulated by an environmental authority (EA) issued for the mining activities. The EA will be supported by an EMP which will contain suitable construction noise and vibration management policies and procedures.

11.2.4.1.2 Operations

For new major developments, the methodology for setting noise emission limits to protect acoustic environmental values is determined in accordance with the Guideline.

The Guideline recommends a Planning Noise Level (PNL) for a new facility expressed as an unadjusted equivalent continuous measurement. The PNLs is based on the ambient noise monitoring data at the monitoring locations, the town planning designation of the area and the observed proximity to significant road transport corridors. The Guideline recommends a PNL for a new facility expressed as an unadjusted equivalent continuous A-weighted sound pressure level ($L_{Aeq\ 1\ hour}$), with adjustment for assumed tonal and/or impulsive characteristics of a future noise source (or sources). The design PNLs are expressed as adjusted levels ($L_{Aeq\ 1\ hour,\ adj}$). For this the project the design PNLs are summarised in Table 2.

When using the PNLs to assess the received noise at a receptor from a specific source, the received level should be adjusted for tonal and / or impulsive characteristics as per the adjustments detailed in Table 3.

Table 1. EPP (Noise) acoustic quality objectives for residential dwellings

SENSITIVE RECEPTOR	TIME OF DAY	ACOUSTIC QUALITY OBJECTIVES (MEASURED AT THE RECEPTOR) DB(A)			ENVIRONMENTAL VALUE
		$L_{AEQ,ADJ,1HR}$	$L_{A10,ADJ,1HR}$	$L_{A1,ADJ,1HR}$	
Dwelling (for outdoors)	daytime and evening	50	55	65	health and wellbeing
Dwelling (for indoors)	daytime and evening	35	40	45	health and wellbeing
	night-time	30	35	40	health and wellbeing in relation to the ability to sleep

Table 2. Design PNLs at residential receivers (outdoors)

RECEIVERS	DESIGN PLANNING NOISE LEVEL ($L_{AEQ,1HOUR,ADJ}$ – DBA)		
	DAY (7AM-6PM)	EVENING (6PM-10PM)	NIGHT (10PM-7AM)
Mine areas	39	28	28

Table 3. Guideline adjustments to design PNLs for audible characteristics

AUDIBLE CHARACTERISTIC	CRITERION	CORRECTION
Tonality	Subjectively just detectable	K1 = 2 – 3 dB
	Subjectively prominent (clearly audible) and objectively measurable by one-third octave band analysis as per AS1055.1 Clause 6.6.3	K1 = 5 – 6 dB
Impulsivity	Subjectively detectable and objectively measureable as per AS1055.1 Clause .6.4	K2 = 2 dB

11.2.4.2 EPP (Noise) Review of Design Planning Levels

An evaluation of the derived Design PNLs has been conducted as recommended in the Explanatory Notes to the EPP (Noise). The Explanatory Notes require that the PNLs be compared with the Rating Background Level (RBL) which is the overall single-figure background noise level representing each assessment period (day/evening/night) over the whole monitoring period. The RBL represents the background noise level that is present for ninety per cent of the standard day, evening or night periods and is the level used for assessment purposes. Background noise monitoring to determine the RBLs has been undertaken for the project and the results are outlined in Section 11.6.

Comparison of design planning levels in Table 2 with the general Acoustic Quality Objectives for the Queensland acoustic environment outlined in Table 1 indicates that the design PNLs for the areas near the mine site comply with the general Acoustic Quality Objectives for the Queensland acoustic environment. (To enable direct comparison of data for evening and night periods it is necessary to take into consideration a nominal 5-10 dB indoor/outdoor transmission loss for a naturally ventilated dwelling). Table 4 presents a comparison of the measured RBL for the representative area around the mine and the Design PNLs from Table 2.

The PNLs derived for the evening and night periods may permit background noise levels to exceed the "background creep" management intent as per Part 4, Section 10(2) of the EPP Noise (i.e. The PNL may be greater than the background noise level plus zero or 5 dB). It is noted; however, that this possibility is inherent to the procedures of the Guideline and the EPP Noise and does not relate to the merits or acoustic impact of the project.

It does; however, highlight the possibility that received noise emission levels that just comply with PNLs may be audible at some receptor locations when background noise levels are very low.

Sleep Disturbance

The relationship between the level of a noise event external to a dwelling and sleep awakenings is probabilistic, depending on individual sensitivity. The Guideline advises an approximate relationship between the maximum external noise event level ($maxL_{pA}$), the degree of dwelling envelope sound insulation and the resulting likelihood of sleep awakening, as shown in Table 5.

The Guideline suggests achieving no higher than 10 % probability of sleep awakenings. For the low background noise environments encountered in the study area, a 5 % probability of sleep awakenings has been adopted for this project as a nominal goal.

It is possible that naturally ventilated receptor dwellings may be occupied with windows fully open at times. The sleep disturbance external noise limit for transient events on the project site to prevent sleep awakenings at such a receptor is 42 dBA ($maxL_{pA}$).

For an air-conditioned receptor dwelling the indicative external noise limit for transient events would be 57 dBA. The sleep disturbance limits provide an upper noise limit relevant to very infrequent short duration

Table 4. Comparison of RBLs with design PNLs

RECEIVER AREAS	DESIGN PLANNING NOISE LEVEL ($L_{AEQ,1HOUR,ADJ}$ – DBA)		
	DAY (7AM-6PM)	EVENING (6PM-10PM)	NIGHT (10PM-7AM)
Mine area	37 (29 RBL)	28 (22 RBL)	28 (<15 RBL)

Table 5. Probability of sleep awakening (from the Guideline)

TYPICAL FACADE NOISE REDUCTION	FACADE DESCRIPTION	EXTERNAL MAXIMUM INSTANTANEOUS NOISE LEVEL ($MAXL_{PA}$, DBA) CORRESPONDING TO AWAKENING PROBABILITY (%)			
		0%	5%	10%	20%
5	Windows wide open	37	42	47	52
10	Windows partially closed	42	47	52	57
20	Single glazed, closed	52	57	62	67
25	Double glazed, closed	57	62	67	72

Table 6. Applicable noise limits for haul trucks on the mine site for the day, evening and night periods

TIME OF DAY	CRITERION
Day (0700-1800)	65 dBA L_{Amax}
Evening (1800-2200)	<60 dBA $L_{Amax, adj}$
Night (2200-0700)	42 dBA L_{Amax} naturally ventilated 57 dBA L_{Amax} air-conditioned

noise events which do not form part of typical normal operations.

As the sleep disturbance limit is much higher than the night time PNLs, sleep disturbance will be unlikely at receptor locations for normal operations.

Noise produced by passing trucks on haul routes consists of short duration transient events. There are two key requirements for persons potentially affected by noise from haul route traffic:

- noise emissions should not cause interference with sleep, and
- noise emissions should be reasonable.

Transient events are generally described in terms of the maximum noise level (L_{Amax} or $maxL_{pA}$).

To determine appropriate noise criteria for the noise emissions of haul trucks travelling along the proposed haul routes, reference is made to the defined 100 m separation buffer for designated haul roads in SP2/07[1]. The noise level at 100 m for a truck complying with the ADR 28/01[2] noise limit of 87 dBA at 7.5 m, is estimated to be a max L_{pA} level of 65 dBA. This limit is considered reasonable for daytime only use of the haul route. It is expected that the evening noise limit would be reduced below the daytime limit by a minimum of 5 dB.

The sleep disturbance criteria, as described in Section 5.4.3, would be applicable to the night period. This results in a noise limit for the 10pm to 7am period of 42dBA (max L_{pA}) at the nearest receptors.

Table 6 provides an outline of the applicable noise criteria for haul trucks within the mine site for various times of the day.

The criterion used to assess vehicle noise on access roads to the mine site is a free field noise level of 60 dBA $L_{A10\ (18Hour)}$, in accordance with the Road Traffic Noise Management: Code of Practice, Queensland Department of Main Roads.

11.2.4.3 Vibration Criteria

Vibration criteria are divided into four groups for assessment:

- criteria to prevent building cosmetic damage, which is applicable to general construction vibration;
- criteria to prevent damage to buried pipework and telecommunication cables during construction;
- regulated vibration criteria in the EP Act relating to blasting during construction; and
- criteria to maintain human vibration comfort, applicable to the more long-term vibration occurrences from operations, such as vibration potentially resulting from coal train pass-bys.

[1] SP2/07 - *Queensland Government State Planning Policy 2/07, Protection of Extractive Resources.*, specifically Annex 1 of the Policy (p10), the transport separation area is defined as "100 metres on either side of the road or rail reserve boundary or, if no reserve the centreline of the indicated route"

[2] ADR 28/01 - *Vehicle Standard (Australian Design Rule 28/01 — External Noise of Motor Vehicles) 2006*

11.2.4.3.1 General Construction Vibration

The maximum peak particle velocities recommended to prevent cosmetic damage to buildings are provided in Table 7 and are as recommended in AS 2187.2 2006 *Explosives - Storage and use - Use of explosives.*

Vibration due to construction and blasting activities has the potential to effect services such as buried pipework, electrical and telecommunication cables. Short-term vibration limits for buried pipes are summarised in Table 8 and are the limits recommended by German Standard DIN 4150.3-1999 *Structural Vibration – Part 3: Effects of vibration on structures.*

Recommended vibration limits for electrical cables and telecommunication services such as fibre optic cables are between 50mm/s and 100mm/s.

11.2.4.3.2 Human Vibration Comfort Level

AS2670.2 1990 Evaluation of Human Exposure to Whole-body Vibration – Continuous and Shock-induced Vibration in Buildings (1 to 80 Hz) recommends vibration levels to maintain human comfort. Vibration levels (in one-third octave bands) are considered to be acceptable to protect human comfort if they are less than the following:

- 0.48 mm/s at 1Hz, reducing to;
- 0.18 mm/s at 2Hz, reducing to; and
- 0.1 mm/s at 8Hz and above to 80Hz.

11.2.5 BLASTING CRITERIA

Blasting causes airblast overpressure (noise) and ground vibration. The criteria for blast noise and vibration are contained in the EP Act and the Guideline. The Act contains regulated vibration criteria, with the Guideline containing more stringent (in parts) advisory vibration criteria.

The following regulated criteria are specified in the EP Act:

> "61 Noise from blasting is not unlawful environmental nuisance for an affected building if:
>
> - the airblast overpressure is no more than 115 dBA Z Peak for 4 out of 5 consecutive blasts; or
> - the airblast overpressure is more than 120 dBA Z Peak for any blast; or
>
> the ground vibration is:
>
> - for vibrations of more than 35 Hz – no more than 25 mm/s ground vibration, peak particle velocity; or
> - for vibrations of no more than 35 Hz – no more than 10 mm/s ground vibration, peak particle velocity."

Table 7. Transient maximum peak particle velocity to prevent cosmetic damage of buildings

TYPE OF BUILDING	PEAK COMPONENT PARTICLE VELOCITY IN FREQUENCY RANGE OF PREDOMINANT PULSE	
	4 HZ TO 15 HZ	15 HZ AND ABOVE
Reinforced or framed structures. Industrial and heavy commercial buildings	50mm/s at 4Hz and above	
Unreinforced or light framed structure. Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

Table 8. DIN 4150 Part 3 – Damage to Buried Pipes – Guidelines for Short-term Vibration

PIPE MATERIAL	PEAK WALL VIBRATION VELOCITY (MM/S)
Steel (including welded pipes)	100
Clay, concrete, reinforced concrete, prestressed concrete, metal with or without flange (other than steel)	80
Masonry, Plastic	50

The *Ecoaccess Guideline: Noise and Vibration* (2006) from Blasting advises that blasting activities should be carried out in such a manner that if blasting may affect a noise-sensitive place, then:

- the airblast overpressure must be not more than 115 dB(linear) peak for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts,
- the airblast overpressure must not exceed 120 dB(linear) peak for any blast;
- the ground-borne vibration must not exceed a peak particle velocity of 5 mm per second for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts,
- the ground-borne vibration must not exceed a peak particle velocity of 10 mm per second for any blast; and
- blasting should generally only be permitted during the hours of 9 am to 3 pm, Monday to Friday, and from 9 am to 1 pm on Saturdays. Blasting should not generally take place on Sundays or public holidays.

Blasting outside these recommended times should be approved only where:

a) blasting during the preferred times is clearly impracticable (in such situations blasts should be limited in number and stricter airblast overpressure and ground vibration limits may be applied), or

b) there is no likelihood of persons in a noise-sensitive place being affected because of the remote location of the blast site.

11.2.6 AIRCRAFT NOISE CRITERIA

The criteria for aircraft noise are provided by AS2021-2000 *Acoustics – Aircraft noise intrusion – Building siting and construction*. According to Table D1 of this Standard, for 20 or less flights per day, an 80 dBA noise limit is recommended for acceptability. As normal aircraft movements are anticipated during daytime hours only, consideration of sleep disturbance noise criteria are not required.

11.3 ASSESSMENT METHODS

The following section describes the methodology utilised to survey the baseline noise environment and undertake the predictive modelling of additional noise and vibration sources into the environment.

11.3.1 NOISE MODELLING

Noise monitoring was conducted in accordance with the *Australian Standard AS1055.1-1997 Acoustics – Description and measurement of environmental noise,* Part 1: General procedures, and the *Queensland Noise Measurement Manual* (3rd Edition, 1 March 2000).

Properties for monitoring were selected to represent potentially affected residences nearest to the proposed site of the mine. Baseline noise levels were monitored for a minimum period of seven days at four sites that are relevant to the mine site.

Instrumentation was field-calibrated before and after measurements with all post-calibration results within 0.3 dBA of the pre-calibration level of 94 dBA. Simultaneous monitoring of wind speed, direction, and temperature, pressure and humidity conditions was conducted in the vicinity of baseline noise monitoring locations. Noise data that was affected by excessive wind speed or precipitation has been excluded from the aggregate noise level statistics.

The Noise Control Manual also indicates that the influence of insect noise on baseline noise levels should be carefully considered. Some insect noise was evident on dusk and as a persistent feature throughout the night-time at a number of monitoring sites. The contribution of insects to the background noise levels was removed to ensure that the levels represented worst case seasonal levels..

A noise model of the mine site, rail line and surrounding area, including the noise sensitive receptor locations, was constructed using SoundPLAN software. The model predicts A-weighted sound pressure levels under meteorological conditions favourable to propagation (mild temperature inversion with slight downwind) from sources of known sound emission. The overall model accuracy is estimated as ±3 dBA.

The graphical noise contours generated by the model represent the envelope of results for noise propagation in all directions (i.e. summary of typical worst-case noise propagation in all directions relative to the noise source).

Noise contours were interpolated from predicted grid noise levels that were calculated at a height of 1.6 m above local ground level. Point source receptors were also located at a height of 1.6 m above ground level, representing mid-window height. The model ground terrain was based on elevation data sourced from the Department of Natural Resources and was assigned to be 100% absorptive in the model which is consistent with predominant forested grass-land.

The source noise data used to model noise emissions during the typical operation of the mine and train movements were based on measured noise levels and library data files from relevant EIS documentation and manufacture specifications. Noise spectra were included in addition to the overall levels.

The operations during the evening period are the same as the night-time period. As the night-time period has the most stringent noise limits due to the low background noise levels, it can be concluded that if the noise emissions from the project site comply with the night-time noise limits, then the limits of the evening period will also be achieved.

11.3.2 BLASTING AT MINE SITE

The proposed method of material extraction involves drilling and blasting. It is anticipated that there will be 8 blasts per fortnight of 700,000 bcm to enable optimum coal extraction from the open cut mines.

The planned blast specifications for the mine are shown in Table 9.

11.3.3 NOISE MODEL SCENARIOS – HAUL TRUCKS

The use of haul trucks, other than for transporting coal from within the open cut mines, is only required in the construction of the mine infrastructure and rail and predominately involves the delivery of heavy equipment via use of the mine access road. The A-weighted sound pressure levels of the haul trucks were determined based upon published noise information from the Department for Environment Food and Rural Affairs (2008) (UK (DEFRA)) database. Calculations of the maximum noise levels at each of the identified receptors were carried out using the computer model to determine the impact of haul truck noise.

11.3.4 NOISE MODEL SCENARIO – MINE ACCESS ROAD

Road traffic noise levels from the mine access road were predicted using the CORTN Method (Calculation of Road Traffic Noise, Department of Transport, Welsh Office, UK 1988). A speed limit of 80 km/hr along the proposed mine access road was used. The traffic volume was estimated to be a maximum of 500 vehicles per day during construction, with 20% heavy vehicles, with volumes significantly decreasing during typical operations of the mine site. The road surface was assumed to be impervious bitumen with a surface depth of 3 mm.

11.4 DESCRIPTION OF EXISTING ENVIRONMENT

11.4.1 EXISTING NOISE LEVELS

Properties for monitoring were selected to represent potentially affected residences nearest to the proposed site of the mine and haul route. The location of the noise monitoring sites is outlined in Figure 1. Baseline sampling was conducted in autumn months between 13 and 21 April 2010, and in winter months between 2 and 9 July 2010. The Rating Background Level (RBL) is predominately composed of a variety of noise sources such as insects, birds and frogs, ongoing low intensity farming, vehicle noise and weather induced noise. Potential anomalies in noise levels as a result or irregular noise emissions, excessive insect noise or meteorological conditions were excluded from the RBLs through the use of the spectral noise logging carried out. The RBLs determined in accordance with the the Guideline are presented in Table 10.

Table 9. Parameter of rock bench blasting

BENCH HEIGHT (M)	DRILLING DIAMETER (MM)	BOTTOM BURDEN (M)	SPACING OF SIDE HOLE	PITCH ROW (M)	ROW SPACING (M)	EXPLOSIVE LOADING PER HOLE (KG)
56	310	7.5	7.5	10	7.5	3430
50	310	7.5	7.5	10	7.5	3071
30	310	7.5	7.5	10	7.5	1843

Table 10. Rating background noise levels

MEASUREMENT LOCATION	RATING BACKGROUND NOISE LEVEL (MINL_{A90} – DBA)		
	DAY	EVENING	NIGHT
Monklands	34	25	<15
Corntop	29	17	<15
Lambton Meadows	29	22	<15
Cavendish	35	34	22

A summary of the minimum $L_{Aeq,1hour}$ data for the day, evening and night periods for each monitoring location is presented in Table 11.

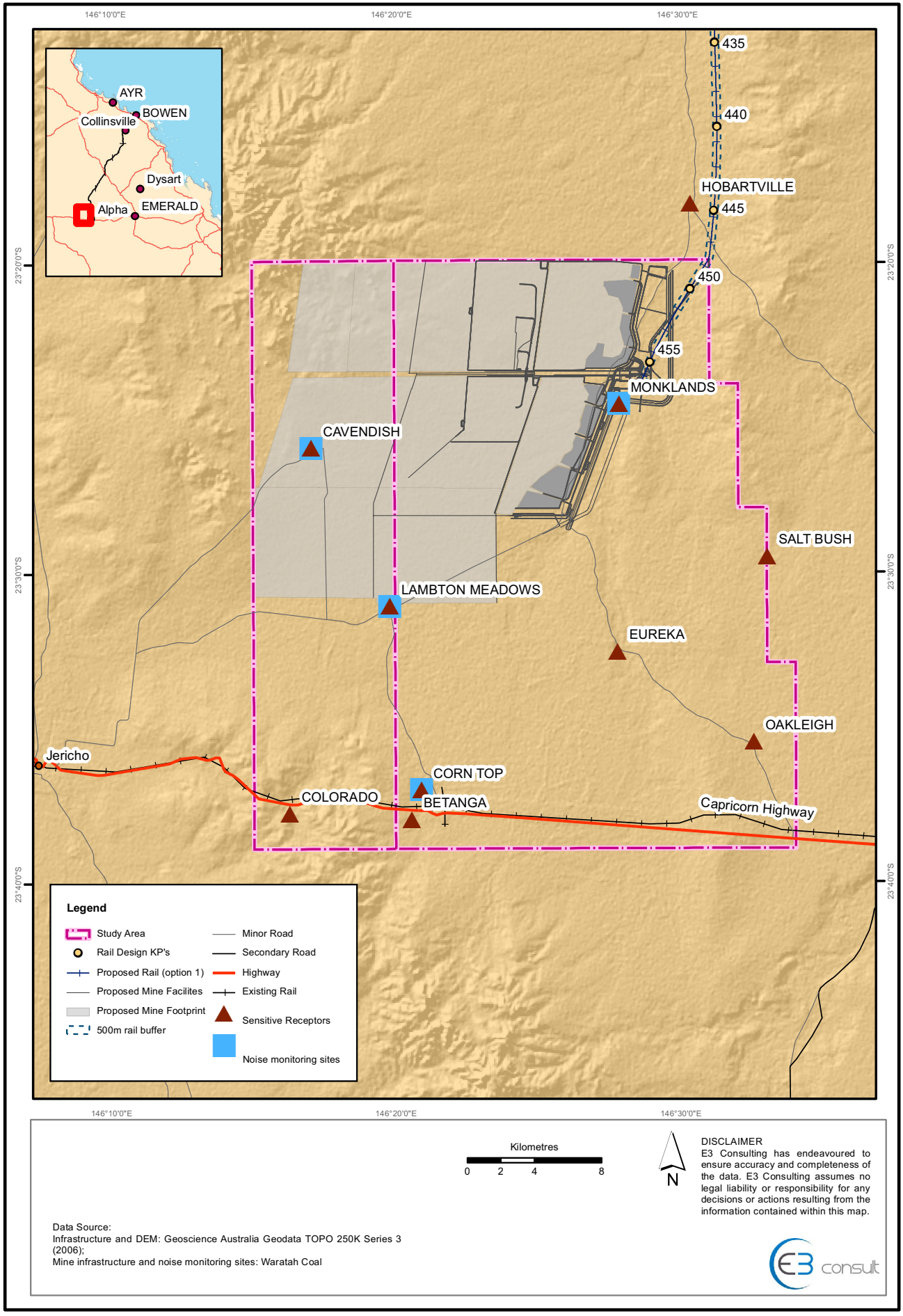
Table 11. Minimum equivalent hourly noise levels

MEASUREMENT LOCATION	MINIMUM EQUIVALENT HOURLY NOISE LEVEL (MIN$L_{AEQ,1HOUR}$ – DBA)		
	DAY	EVENING	NIGHT
Monklands	44	39	32
Corntop	39	35	23
Lambton Meadows	37	31	23
Cavendish	43	47	36

11.4.2 VIBRATION

No baseline ground vibration assessment was undertaken, as there are no recognised sources of background vibration in the vicinity of proposed mine site. It is recognised that some existing activities within the general area of the mine site might generate localised ground vibration emissions.

Figure 1. Location of Sensitive Receptors



11.5 IMPACT ASSESSMENT

11.5.1 PREDICTED NOISE LEVELS

Noise predictions were made on the basis of various mine scenarios.

A summary of the adjusted predicted noise levels, $L_{Aeq, adj, 1hour}$, for day and night periods for the noise model scenarios at Year 1, 5, 10 and 20 of the mine life is given in Table 12.

11.5.2 Assessment of Noise Emissions from Mine Site Operations

Comparison of the predicted adjusted noise levels in Table 13 with the derived design PNLs in Table 2 shows that the predicted adjusted noise levels in remote rural areas exceed the design PNL of $L_{Aeq,adj,1hr}$ 28 dBA by:

- 2 dB for Year 1, then 7 dB for Years 5, 10 and 20 at Eureka Station;
- 3 dB for Years 5, 10 and 20 at Lambton Meadows and Saltbush;
- 4 dB for Years 5, 10 and 20 at Cavendish;
- 26 dB for all scenarios at Monklands; and
- 4 dB for Year 1, then 6 dB for Years 5, 10 and 20 at Hobartville.

It is understood that Hobartville will be vacated should the Hancock Coal project commence and will therefore no longer be a noise sensitive receptor. The town of Alpha will not be significantly affected by noise emissions from the mine site operations.

11.5.2.1 Assessment of Sleep Disturbance – Mine Operations

Transient noise events are anticipated from haul trucks and other mobile equipment on the site and from the daytime activities such as blasting. All other noise sources are reasonably constant, such as the various crushing stations excavators and conveyors distributed throughout the mine area.

The largest transient noise event would be generated by blasting and would occur around four times per week. This activity is limited to the daytime only and is therefore not required to be assessed in terms of sleep disturbance.

The only residential location that receives a significant noise contribution from mobile plant is Monklands.

11.5.2.2 Assessment of Low Frequency Noise – Mine Operations

Sound power frequency spectra (50Hz to 8kHz) for the plant equipment has been reviewed and no significant low frequency noise components were identified. It is noted that the description of the proposed mine does not include any plant items that have previously been linked with low frequency noise problems.

Table 12. Adjusted predicted noise levels $L_{Aeq, 1hour. adj}$ from mine site at receptor locations

RESIDENTIAL RECEPTORS (GROUND LEVEL)	PREDICTED OVERALL NOISE LEVELS, $L_{AEQ, 1HOUR}$ FOR SCENARIO			
	MINE YEAR 1	MINE YEAR 5	MINE YEAR 10	MINE YEAR 20
Jericho	<15	<15	<15	<15
Corntop	21	26	26	26
Eureka	**30**	**35**	**35**	**35**
Alpha	<15	<15	<15	<15
Lambton Meadows	25	**31**	**31**	**31**
Salt Bush	27	**31**	**31**	**31**
Cavendish	27	**32**	**32**	**32**
Monklands	**54**	**54**	**54**	**54**
Hobartville	**32**	**34**	**34**	**34**
Skye	<15	<15	<15	<15

Note: Bold indicates predicted exceedences of night noise limits

11.5.3 BLASTING ASSESSMENT

11.5.3.1 Ground Vibration

Ground vibration due to blasting generally increases with an increase in charge mass and reduces with distance, which is commonly described as the scaled distance site law:

$$PPV = k\left(\frac{D}{\sqrt{m}}\right)^{e}$$

Where:

PPV = peak particle velocity (mm/s)
m = charge mass per hole (kg)
D = distance (m)
e = site exponent or attenuation rate (a negative number)
k = site constant

The site constant and site exponent are usually determined by site calibration. For coal overburden sites, an exponent of 1.6 is usually found to be appropriate.

The likely range of k factors at coal mines is 800 to 1,600. The vibration assessment is therefore carried out using this range allowing for the possibility that the ground has better vibration transmission characteristics.

Using the planned blast specifications for the mine as shown in Table 9, the limiting distance for overburden blasts at the incremental vibration levels of 1.0, 2.0, 5.0 and 10 mm/s are shown in Table 13.

11.5.3.2 Vibration Prediction

The ground vibration assessment was carried out using the pit shell at the 20 year mark to estimate the maximum ground vibration levels which would be experienced from blasting operations up to this time. The predicted peak ground vibration levels at the sensitive receptors are listed in Table 14.

The predicted ground vibration levels at Kiora and Monklands significantly exceed the recommended ground vibration guideline limit of 5 mm/s using the design blast specifications. Kiora is within the bounds of the 20 year open pit and is therefore not anticipated to be a viable residence well before this point. The vibration levels at Hobartville are predicted to comply with the guideline limit, though the vibrations due to blasting would be anticipated to be perceptible. Vibration monitoring will be conducted at Hobartville if this location remains a residential property. This will enable the blast emissions site-laws used in ground vibration and airblast predictions to be progressively updated to optimise future blast designs, based on actual site conditions.

There is not expected to be any impacts to existing underground pipework or telecommunication cables as a result of blast ground-borne vibration during the construction and operation of the mine..

Table 13. Overburden blasts – distances to incremental ground vibration contours

MASS OF OVERBURDEN BLAST (KG)	PEAK PARTICLE VELOCITY, PPV (MM/S)	CORRESPONDING DISTANCE (KM)	
		K = 800	K = 1600
3,440	10.0	0.90	1.40
	5.0	1.40	2.15
	2.0	2.50	3.80
	1.0	3.80	5.90
3,071	10.0	0.85	1.3
	5.0	1.30	2.05
	2.0	2.35	3.60
	1.0	3.60	5.60
1,843	10.0	0.65	1.00
	5.0	1.00	1.60
	2.0	1.80	2.80
	1.0	2.80	4.30

Table 14. Predicted peak ground vibration levels at sensitive receptors

RECEPTOR	CLOSEST DISTANCE TO 20YR PIT (KM)	PEAK GROUND VIBRATION (MM/S)	
		K=800	K=1600
Jericho	31	0.04	0.07
Corntop	17.25	0.09	0.2
Eureka	14	0.1	0.3
Alpha	29.3	0.04	0.08
Lambton Meadows	8.85	0.3	0.5
Salt Bush	12.65	0.2	0.3
Cavendish	10.20	0.2	0.4
Kiora	Inside Pit	N/A	N/A
Monklands	1.10	**7.1**	**14.3**
Hobartville	4.70	0.7	1.4
Skye	18	0.08	0.2

Note: Bold indicates predicted exceedences

11.5.3.3 Airblast

Airblast pressure levels have been determined using the Terrock (2005) model.

This model determines the maximum distance to the 115 dB airblast compliance level contours from the formula:

$$D_{115} = \left(\frac{290\ d}{B}\right)^{2.5} \times \sqrt[5]{m}$$

Where:

D_{115} = distance to the 115 dB re: 20 µPa pressure contour (m)
d = hole diameter (mm)
B = burden (mm)
m = charge mass (kg)

The predicted compliance distances are listed in Table 15.

The airblast compliance distances relate to locations directly in front of the blasting faces. The only residences which fall within the above D_{115} distances are Kiora, Monklands and Hobartville. Kiaora is within the bounds of the 20 year open pit and is therefore not anticipated to be a viable residence well before this point. Monklands is well within the D_{115} contour based on the proposed burden, hole diameter and charge mass. It is unlikely that any of these parameters could be sufficiently modified to achieve the 115 dB criterion at this residence without having significant implications on coal extraction.

If achieving the 115 dB criterion for airblasts at Hobartville was required without shielding, the required stemming height could be increased to 9.1 m for the D_{115} contour to fall to approximately 4.63 km. It is possible that the blast overpressure levels at Hobartville may be reduced to lower than 115 dB with shielding from spoil dumps or stockpiles and / or modification of the design of the firing of the blast charges. Achievement of the airblast criteria will be confirmed during preparation of a detailed blasting management plan.

11.5.4 AIRCRAFT NOISE ASSESSMENT

There are expected to be a maximum of four daily aircraft movements at the airport (two return trips from Brisbane). The predicted maximum noise levels for various aircraft types at the development site whilst on approach for landing or take-off on the new runway may be determined from AS2021 and are summarised in Table 16.

Relevant distances utilised in accordance with AS2021 to determine the maximum noise levels of aircraft over the site during landing approaches to the airport are shown at Table 17.

Modelling for a range of possible aircraft types and capacities indicates that flyover noise levels at residential receptors would be well below the recommended 80 dBA noise limit relevant to a small number of flights per day. The potential aircraft noise impact is considered to be negligible.

Table 15. Predicted airblast compliance distances using design blast specifications

BENCH HEIGHT (M)	CHARGE MASS (KG)	NOMINAL BURDEN	D115 (KM)
30	1,843	7.5	6.1
50	3,071	7.5	7.2
56	3,440	7.5	7.5

Table 16. AS2021 predicted maximum aircraft noise levels

AIRCRAFT TYPE	MAXIMUM NOISE LEVEL DUE TO AIRCRAFT, DB(A)					
	SALT BUSH		MONKLANDS		HOBARTVILLE	
	TAKE-OFF	LANDING	TAKE-OFF	LANDING	TAKE-OFF	LANDING
Boeing 737-300, Boeing 737-400, Airbus 320	63	55	<53	<52	71	70
British Aerospace BAe146	57	51	<47	<48	70	67
Boeing Dash 8	53	51	<44	<42	60	65
Corporate Jets (e.g. Lear 35)	60	46	<48	<50	68	61
Typical Light Aviation Aircraft (e.g. Beech 58 Baron)	56	50	<47	<41	66	63

Table 17. AS2021 predicted maximum aircraft noise levels

NOISE LEVELS	SALT BUSH	MONKLANDS	HOBARTVILLE
Offset distance from centre-line of runway (DS)	1.6 km	4.4 km	0 km
Distance to nearest end of runway (DT)	8.2 km	0 km	11 km

At this stage in the design process, the layout of the workers camp relative to the airstrip is unknown. It is recommended that the workers camp be a minimum of 500 m away from the extended centreline of the airstrip, as well as ensuring that the building envelope is adequately designed to achieve appropriate indoor noise levels.

The potential upgrade of the existing Alpha airport is not part of the project and has not been considered in this assessment.

11.6 MITIGATION AND MANAGEMENT

Noise and vibration will be managed by the incorporation of noise mitigation measures into the project EMP. The following specific mitigation will be considered and, if appropriate, implemented during the project.

11.6.1 NOISE

11.6.1.1 Compliance with Design Planning Noise levels

The design planning noise levels in Year 1 at Eureka could be achieved by attenuation of the crushers associated with OC2 at the source (partial enclosures) or by modification of the proposed earthworks to include a berm between the two locations, or a combination of the two. The planning noise levels in later years could be achieved by attenuation of the crushers associated with the underground mines at the source (partial enclosures) and/or the combination of shielding from spoil dumps or stockpiles.

The design planning noise levels at Lambton Meadows, Salt Bush and Cavendish could be achieved by attenuation of the crushers associated with OC1, OC2 and the underground mines at the source (partial enclosures) and / or the combination of shielding from spoil dumps or stockpiles.

It is understood that Hobartville may be acquired by another mining company in the process of developing a mining lease to the north of the site. If the mining project to the north does not occur, consultation with the land owner will occur to address potential noise impacts. There is no practical means of attenuation to reduce the noise levels at Monklands to below the design planning noise levels. Waratah Coal will consult with the property owner at Monklands with a view to potentially using the dwelling for a purpose other than residential, relocating the dwelling or the possibility of acquiring the property.

11.6.1.2 Assessment of Sleep Disturbance – Mine Operations

Transient noise events are anticipated from haul trucks and other mobile equipment on the site and from the daytime activities such as blasting. All other noise sources are reasonably constant, such as the various crushing stations excavators and conveyors distributed throughout the mine area.

The largest transient noise event would be generated by blasting and would occur around four times per week. This activity is limited to the daytime only and is therefore not required to be assessed in terms of sleep disturbance.

The only residential location that receives a significant noise contribution from mobile plant is Monklands. Waratah Coal will consult with the property owner at Monklands with a view to potentially using the dwelling for a purpose other than residential, relocating the dwelling or the possibility of acquiring the property.

11.6.1.3 Assessment of Low Frequency Noise – Mine Operations

Sound power frequency spectra (50Hz to 8kHz) for the plant equipment has been reviewed and no significant low frequency noise components were identified. It is noted that the description of the proposed mine does not include any plant items that have previously been linked with low frequency noise problems.

11.6.1.4 Aircraft Noise Assessment

Modelling for a range of possible aircraft types and capacities indicates that flyover noise levels at residential receptors would be well below the recommended 80 dBA noise limit relevant to a small number of flights per day. The potential aircraft noise impact is considered to be negligible.

At this stage in the design process, the layout of the workers camp relative to the airstrip is unknown. The workers camp will be a minimum of 500 m away from the extended centreline of the airstrip, and the building envelope will be designed to achieve appropriate indoor noise levels from AS2021.

11.6.2 BLASTING OPERATIONS

11.6.2.1 Ground Vibration

The predicted ground vibration levels at Monklands significantly exceed the recommended ground vibration guideline of 5 mm/s using the design blast specifications. The vibration levels at Hobartville are predicted to comply with the guideline limit, though the vibrations due to blasting would be anticipated to be perceptible. Vibration monitoring will be undertaken at Hobartville should this location remain a residential property. This will enable the blast emissions site-laws used in ground vibration and airblast predictions to be progressively updated to optimise future blast designs, based on actual site conditions.

11.6.2.2 Airblast

The airblast compliance distances relate to locations directly in front of the blasting faces. The only residences that fall within the D115 distances are Monklands and Hobartville. Monklands is well within the D_{115} contour based on the proposed burden, hole diameter and charge mass. It is unlikely that any of the blast design parameters could be sufficiently modified to achieve the 115 dB criterion at this residence without having significant implications on coal extraction. Waratah Coal will consult with the property owner at Monklands with a view to potentially using the dwelling for a purpose other than residential, relocating the dwelling or the possibility of acquiring the property

If achieving the 115 dB criterion for airblasts at Hobartville was required without shielding, the required stemming height could be increased to 9.1 m for the D_{115} contour to fall to approximately 4.63 km. It is possible that the blast overpressure levels at Hobartville may be reduced to lower than 115 dB with shielding from spoil dumps or stockpiles and / or modification of the design of the firing of the blast charges. Achievement of the airblast criteria are achieved will be confirmed during preparation of a detailed blasting management plan.

11.7 CONCLUSIONS

Baseline ambient noise levels were sampled at four locations representing noise sensitive locations around the proposed mine site. From these measurements, design planning levels were determined for noise emissions from the project. Noise and vibration modelling was subsequently carried out for the mine area and associated ancillary infrastructure.

From the modelling conducted, noise and vibration impacts were assessed and where necessary, methods and options for amelioration were recommended. The following conclusions can be drawn from the assessment outcomes:

Mine Operations

With implementation of the recommended amelioration methods, the noise emissions from mine site will comply with the derived noise criteria of the Guideline.

Blasting

With the recommended modifications to the blast design, the predicted noise and vibration from blasting will comply with the relevant criteria.

Aircraft Noise

The potential noise impact of aircraft on the existing residences will be negligible.

The potential noise impact of aircraft on the proposed accommodation camp will also not be significant if it is located. a minimum of 500 m away from the extended centreline of the airstrip and the building envelope is designed to comply with AS2021.

Construction Noise

There is only limited potential for significant construction noise emissions at the nearest receptors due to the nature of the construction activities required for this project, the allowable time for construction per day and the large intervening distance between the sources and the receptors. Using the measures outlined in the EMP, potential noise impacts during construction (including commissioning) will be minimised at noise sensitive locations.

Haul Roads and Mine Access Road

To ensure that the haul road and mine access road has a negligible impact on the nearby residences, it is recommended that the surface of the haulage road should be kept in good order to minimise impulsive noise due to empty trucks on an irregular road surface. The noise of vehicles on the mine access road will have minimal impact on the surrounding residences.

11.8 COMMITMENTS

To manage potential impacts of noise and vibration during construction, Waratah Coal will develop and implement construction noise and vibration management plans that address potential impacts. Specifically, Waratah Coal commitment to undertaking the following:

- investigate techniques to attenuate noise from crushers and modify proposed earthworks where required and where practicable to enable design planning noise levels to be met; and
- in locations where noise attenuation and vibration and air blast modification are impractical, Waratah Coal will consult with the affected property owner with a view to potentially using the dwelling(s) for a purpose other than residential use or the possibility of acquiring the property.

Ongoing monitoring of noise and vibration will occur during the construction of the operation of the mine and associated facilitates to ensure compliance with the EMP.