Appendix 24

Noise and Vibration Assessment

Noise Mapping Australia

Scalable Consulting Solutions

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Executive Summary

This report provides an assessment of the noise and vibration impact from the proposed Byerwen Coal Project. The Byerwen Coal Project comprises eight pits, two infrastructure areas and a projected 46 year operational life. The assessment addresses construction, operations and decommissioning of the mine. Vibration and blast over pressure were also addressed along with low frequency noise, railway noise and road traffic noise.

The study included measurement of ambient levels at several locations and included one location within the lease and three locations close to the lease boundary. All the measurements confirmed that the noise levels are low throughout the study area. One location, Byerwen Station Homestead was adopted as being representative of all sensitive receptors (other than Cerito Station Homestead) within the study area. This is an extremely conservative assumption since the noise levels measured at Byerwen Station Homestead were the lowest measured.

The Environmental Protection Policy (Noise) was reviewed for applicability and the acoustic quality objectives were considered relevant. These objectives are designed to preserve the health and wellbeing of the occupants of the homesteads. It was found that the EPP (Noise) noise goals for background creep (background noise levels that slowly increase with each successive development introduced into an area) were more stringent than the acoustic quality objectives. Noise level goals to prevent background creep were developed for two locations. The background creep goal for Byerwen Station Homestead was generalised for all remaining sensitive receptors and the resulting limits are the most stringent possible in Queensland. The background creep goal for Cerito Station Homestead is also the most stringent possible in Queensland during the night.

The mining staging is quite complex and three modelling cases were developed. The modelling cases included all eight pits shortly after the commencement of the pit. This places the main noise sources at or close to the natural surface. Noise sources close to the ground surface tend to result in higher noise levels environmentally than for a fully developed pit when many of the noise sources are well below the natural ground surface. In this instance three modelling cases were addressed representing Year 5, Year 17 and Year 36 since these represent the early phases of most of the pits when the activity in the pit is close to the ground surface and the out-of-pit landforms are being developed. These operations are expected to lead to higher environmental noise levels.

The noise models developed for the site includes terrain and meteorology. In fact a comprehensive analysis of noise emissions was carried out to establish the noise levels for all possible weather/meteorological conditions. The model also addressed and included mining machinery close to the surface or at elevated locations on the top of overburden dumps or travelling on roads on the natural surface. Even with these conservative assumptions regarding operating parameters and considering all possible meteorology it was found the noise levels from construction, operation and decommissioning complied with all noise level goals at all noise sensitive receptors.

There were similar finding with respect to blasting over pressure, blasting noise, road traffic noise and railway noise. It was noted that blasting may encroach on the North Queensland gas pipeline, SunWater pipeline and identified historical cultural heritage sites. In these instances it was proposed that vibration compliance goals are set, that blasting programs be designed to consider these goals and to undertake a vibration monitoring program to ensure compliance.

1. Introduction

Byerwen Coal (the proponent), a joint venture between QCoal Pty. Ltd. and JFE Steel, has engaged Noise Mapping Australia ('NMA') to prepare a noise and vibration assessment for the proposed Byerwen Coal Project (the project), west of Glenden.

The objective of this assessment is to provide the proponent with information to assist with obtaining the necessary approvals for the project.

This report addresses the following issues:

- description of existing noise conditions;
- likely change in noise environment following commencement of mining;
- assessment of noise at sensitive receptors to appropriate standards; and
- recommendations for relevant impact mitigation measures and monitoring program.

1.1 ***Project Description***

The project is a proposed open-cut coal mine located in the Bowen Basin approximately 20 kilometres (km) west of Glenden in Central Queensland.

The project consists of six mining leases, MLA 10355, MLA 10356, MLA 10357, MLA 70434, MLA 70435 and MLA 70436. Byerwen Coal holds the two underlying exploration tenements in the project area, EPC 614 and EPC 739. The project area covers a portion of the two underlying EPCs.

Byerwen Coal is seeking 50 year mining leases (two years for construction, 46 years of operation and 2 years for decommissioning and final rehabilitation) for the extraction of the coal resource at a rate of approximately 15 Mtpa ROM coal. From commencement, the project will ramp up production over 5 years to achieve a project average of 15 Mtpa ROM coal. The mine is anticipated to have a life of 45 years. The open cut operation will involve clearing of vegetation, salvage of topsoil, stripping of overburden, extraction of coal, emplacement of waste rock and coal rejects, placement of topsoil or growth media and progressive rehabilitation. Open-cut coal mining would be performed using both truck and shovel and dragline.

1.2 *Locality Description*

The project is situated in a well established grazing and mining region. The region is relatively flat, generally comprising open broad acre grazing and native scrublands.

There are several existing coal mines near the project, with the closest being the Newlands Coal Mine and Newlands Coal Mine extension, within 15 km of the site, refer to Figure 1.

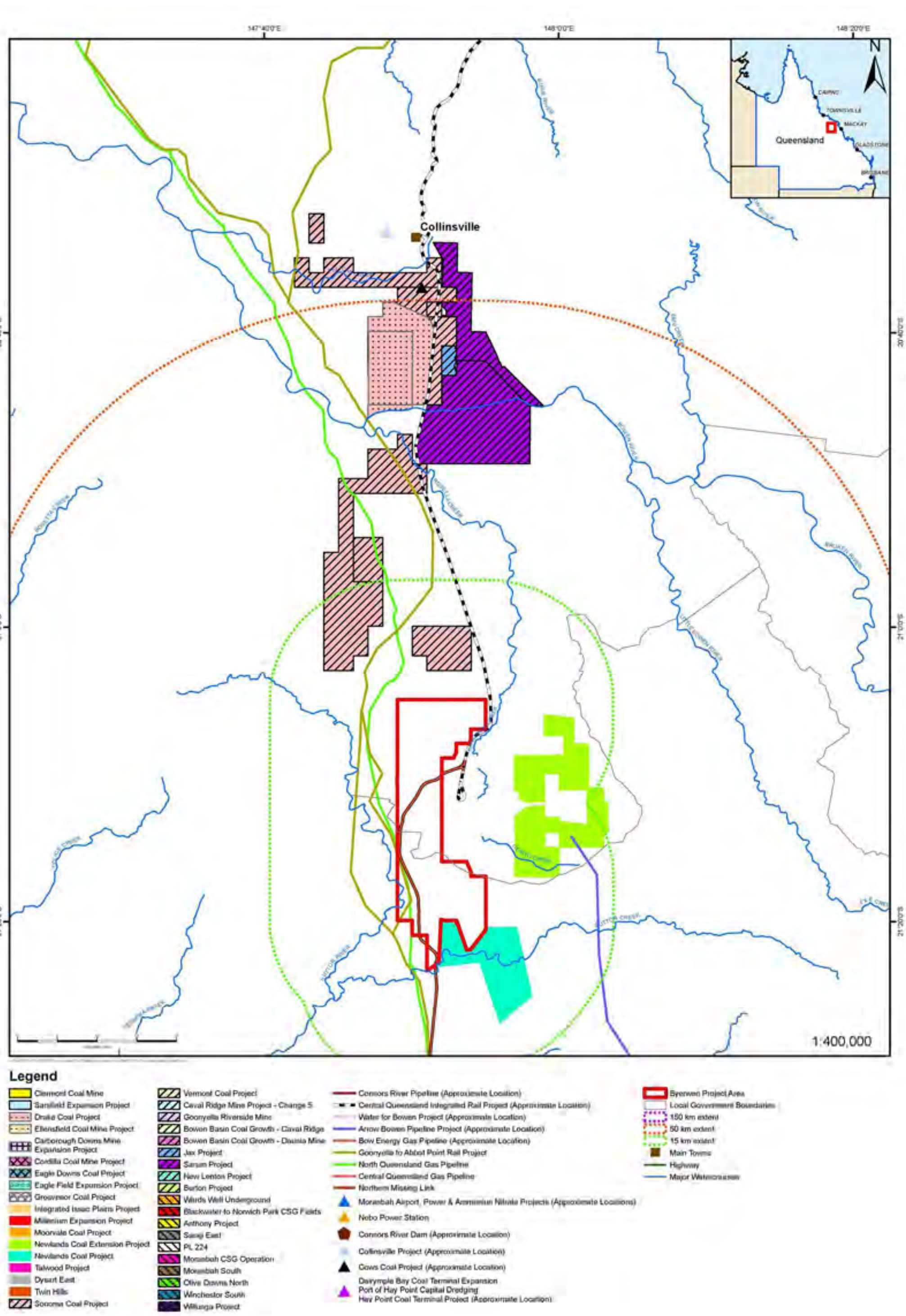

Figure 1: Regional View Showing Subject Site and Nearby Coal Mines (including planned mines)

The potentially sensitive locations in the vicinity of the project comprise the homesteads of grazing properties and Glenden township. The closest potentially sensitive locations are shown on Figure 2 along with the mine site. The locations and separation distances are contained in Table 1. Several sensitive receptors are either not occupied for the duration of the project or are occupied on a part-time basis. These sites have been identified for completeness but will not be considered in the assessment stages of this report.

Table 1: Sensitive Receptors Adjacent to MLA Tenement and Railway Corridor

Sensitive Receptor	***Permanently Occupied For Duration of Project***	***Separation Distance [km] and Direction To Sensitive Receptor to***		
		Project area	Project footprint	TLFs
Glenden Township	Yes	19.4km E	20.0km E	25.7km NE
R1 Suttor North Station Homestead (not occupied for duration of project)	No	(on lease)	-	-
R2 Suttor Creek Station Homestead	Yes	6.8km E	7.3km NW	14.2km NW
R3 Lancewood Station Homestead	Yes	9.7km SE	13.3km NW	19.5km NW
R4 Wollombi Station Homestead (not occupied for duration of project)	No	0.5 km E	0.6 km E	1.4 km E
R5 Cerito Station Homestead (occasional occupancy)	No	5.8km W	7.0km SE	12.7km SE
R6 Byerwen Station Homestead	Yes	1.5km E	7.9km SW	5.5km SW
R7 Weetlaba Station Homestead	Yes	4.9km NE	12.4km SW	10.7km SW
R8 Glenden Station Homestead	Yes	18.2km E	18.5km E	24.0km NE
R9 Two Sheds Quarters (occasional occupation)	No	3.7km N	8.3km N	14.6km N
R10 Fig Tree Station Homestead	Yes	13.2km SE	17.2km SE	20.8km SE

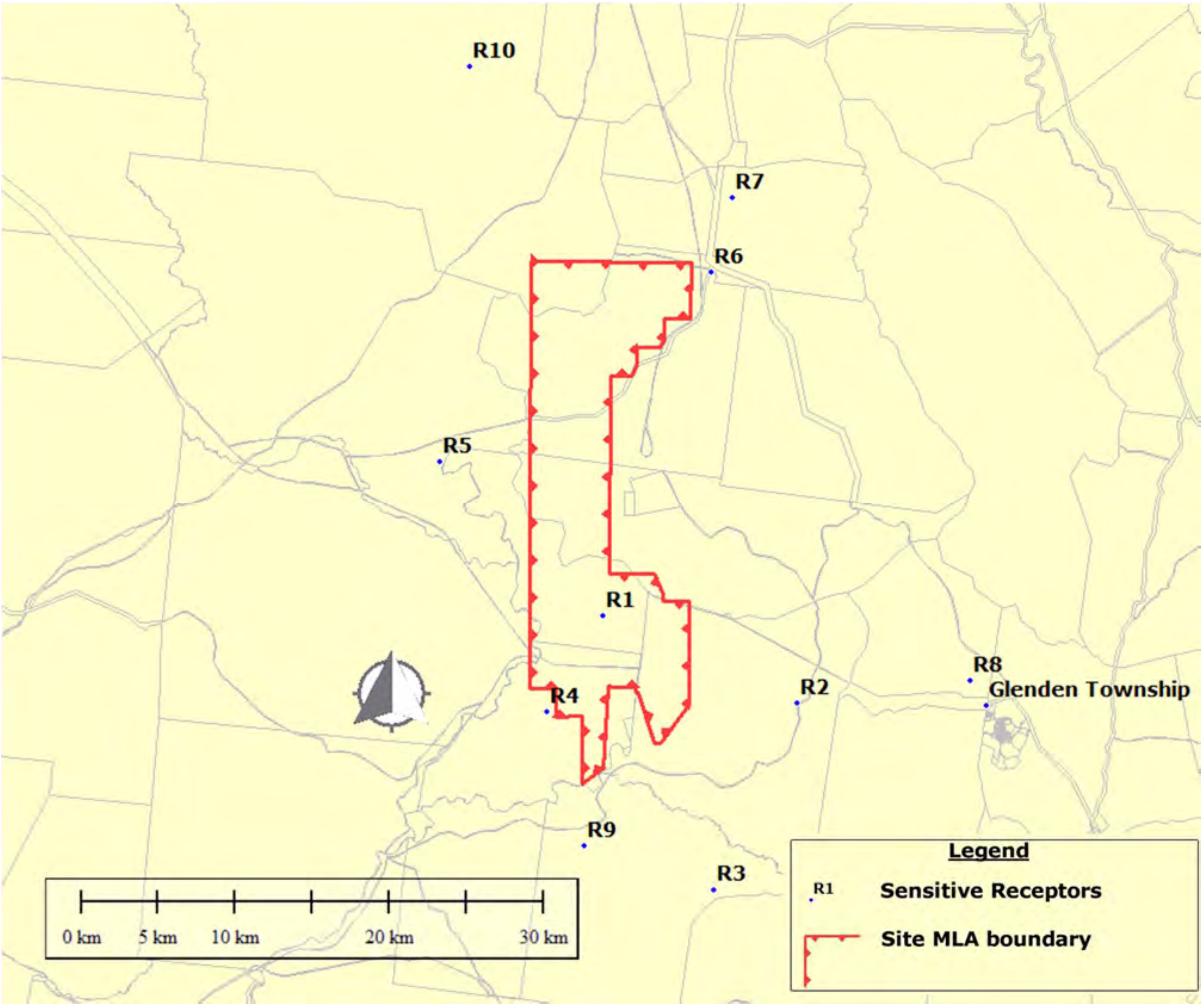

Figure 2: Regional View Showing Subject Site and Nearby Sensitive Receptors

1.3 Climate

The project is situated between Moranbah and Collinsville. Both of these locations maintain a Bureau of Meteorology (BOM) weather monitoring station. Refer to Appendix 1 for a summary of the main statistics collected at these sites. Moranbah (Latitude 21.99, Longitude 148.03) and Collinsville (Latitude 20.55, Longitude 147.85) are manual stations with the weather records recorded twice daily.

The region has a warm climate with two distinct seasons, a dry winter season and a wet summer season. Dry season temperatures average are approximately 9°C to 30°C, while wet season temperatures range from 20°C to 33°C. The rainfall is seasonal and highly variable and ranges from around 200 mm to above 1,200 mm each year, falling mostly between November and April.

The warm wet season encourages crickets, cicadas and other wildlife proliferation. This usually causes higher ambient noise levels. During the dry winter season the ambient noise levels are lower since the cooler conditions and lack of water reduces insect activity. The greatest noise impact from mining usually occurs during the cool dry season since these cooler conditions are more favourable to the propagation of noise at large distances (particularly at night) and the cooler conditions also result in lower ambient noise levels. Daytime conditions throughout the year are always warm to hot since the area is subject to high solar loads. The environmental noise levels from mines are often lower during the day than at night since daytime has less favourable propagation characteristics than night.

2. Existing Noise Environment

Potential sources of noise from the surrounding environment primarily comprise:

- farming and grazing activities;
- residential activity noise;
- existing mining;
- existing commercial activities;
- railway; and
- road-based traffic.

A survey of the existing noise levels was undertaken at four locations surrounding the project, comprising:

- R4 Wollombi Station homestead;
- R5 Cerito Station Homestead;
- R6 Byerwen Station homestead; and,
- Subject site (near R1).

Existing noise levels were obtained at the four locations with calibrated noise logger recording the noise level statistics in ten minute intervals. Site selection was based on the following rationale:

- Wollombi is the closest off lease dwelling, situated to the west of the workings in the south of the project area. However it is not considered a sensitive receptor as the dwelling will not be occupied for the duration of the project. As such this location is included for comparative purposes as part of this assessment;
- Cerito Station Homestead was selected as the closest sensitive receptor situated to the east of the lease between the northern and southern works. It is mostly unoccupied and experiences low background noise levels;
- Byerwen Station homestead was selected due to proximity to the northern operations and it is also situated to the east of the site.
- Subject site (near R1) was selected to determine the lowest noise levels in the surrounding area, essentially free of household, traffic and mining noise. It is a noise level representative of rural areas.

The monitoring was carried out in compliance with Queensland Government Noise Measurement Manual 2000 and AS 1055 Acoustics—Description and measurement of environmental noise.

The noise levels are presented in terms of the $L_{A10(10\ minute)}$, $L_{A90(10\ minute)}$ and $L_{Aeq\ (10\ minute)}$, refer to Table 2, Table 3 and Table 4 for the locations R4 Wollombi, R5 Cerito Station Homestead and R6 Byerwen respectively and refer to Table 5 for the subject site.

The $L_{A90(10\ minute)}$ reported in the tables for the day, evening and night comprises the Assessment Background Level (ABL). For both the $L_{A10(10\ minute)}$ and $L_{Aeq(10\ minute)}$ the table refers to the average result. The rating background level (RBL) is the median of the ABL for the period in question.

The $L_{A90\ (10\ minute)}$ noise levels at some monitoring locations are at or close to the noise floor of the sound level instrument (15 dB(A) to 17 dB(A)). The reported levels (below 20 dB(A)) are likely to have been significantly affected by the inherent electrical noise of the sound level meter (Rion NL22). Hence noise levels below 20 dB(A) can potentially be lower than the reported noise level.

Existing noise levels at the sensitive receptors are considered to be due to noise associated with residential activity, farming, birds, wind (e.g. rustling of leaves) and/or traffic. Mining-related or industrial noise was not a notable feature of the measurements at any monitoring locations.

The procedure used to develop the RBL is expected to provide a representative background noise level free from increased noise levels due to seasonal effects (insects) and commercial noise. At many of the noise monitoring locations there is bird noise at dawn and dusk and insect noise at night. This noise has a repeating diurnal cycle which was evident in the background noise levels recorded at most of the noise monitoring sites. The RBL, obtained during dry period of the year, is considered to be representative of the quieter periods of the year. The noise levels measured at the Byerwen station homestead was extremely low and demonstrate an absence of significant noise producing activities.

Charts of the measurements are contained in Figure 3 to Figure 6 for R4 Wollombi, R5 Cerito Station Homestead, R6 Byerwen and the Subject Site respectively. It should be noted that Wollombi Station Homestead (situated at longitude -21.345849, latitude 147.828759) is located very close to the site boundary and the pits in the southern section of the site. However this homestead will not be occupied for the duration of the project and as such is not considered a sensitive receptor.

Table 2: Measured Existing Noise Levels [in dB(A)] at Wollombi Station Homestead

Date	$L_{A90(10\ minute)}$ Background Noise Level [dB(A)]			$L_{Aeq\ (10\ minute)}$ Noise Level [dB(A)]				$L_{A10(10\ minute)}$ Noise Level [dB(A)]		
	Day	Evening	Night	24 hour	Day	Evening	Night	Day	Evening	Night
29/07/2011	27.8	32.5	24.8	39.6	42.0	37.3	29.0	41.3	38.6	31.1
30/07/2011	26.2	28.5	23.9	39.5	41.9	37.0	28.8	42.9	39.0	30.6
31/07/2011	27.7	29.3	23.5	41.8	43.6	41.6	36.2	45.2	44.6	39.8
1/08/2011	30.4	28.5	28.1	40.5	42.2	38.0	37.6	43.4	40.9	40.6
2/08/2011	31.2	26.7	28.1	42.2	44.6	33.1	37.3	46.2	35.4	40.3
3/08/2011	29.7	28.6	24.0	41.3	43.5	38.1	35.6	44.9	39.4	38.2
4/08/2011	32.7	32.2	25.5	40.5	42.9	37.8	32.6	44.5	38.8	34.5
5/08/2011	28.6	31.1	28.2	42.0	44.3	38.0	36.5	45.8	39.1	38.7
6/08/2011	28.5	31.8	26.3	38.6	40.7	36.5	32.3	41.4	37.6	34.6
7/08/2011	23.3	29.5	26.0	36.6	37.5	38.3	32.6	37.9	40.1	35.0
8/08/2011	25.4	20.3	20.6	37.0	39.6	30.5	29.1	40.6	31.5	30.7
9/08/2011	23.5	19.7	20.0	34.8	37.2	29.6	28.2	38.5	29.7	30.0
10/08/2011	23.6	21.2	22.2	37.3	40.1	26.8	28.5	39.6	28.6	30.3
11/08/2011	25.1		22.5		40.7		26.1	41.8		27.1
RBL / Median	27.8	28.6	24.4	39.6	42.0	37.3	32.5	42.3	38.8	34.5

Table 3: Measured Existing Noise Levels [in dB(A)] at R5 Cerito Station Homestead

Date	$L_{A90(10\ minute)}$ Background Noise Level [dB(A)]			$L_{Aeq\ (10\ minute)}$ [dB(A)]				$L_{A10(10\ minute)}$ [dB(A)]		
	Day	Evening	Night	24 hour	Day	Evening	Night	Day	Evening	Night
29/07/2011	31.0	21.4	19.8	43.9	46.7	37.7	24.9	48.9	35.8	23.4
30/07/2011	30.2	24.1	18.7	43.1	45.5	41.9	26.8	48.0	42.3	25.5
31/07/2011	30.0	19.0	18.4	43.0	45.8	31.6	28.9	48.4	29.9	27.9
1/08/2011	30.9	19.1	18.3	47.1	49.9	42.9	25.7	52.9	42.0	23.4
2/08/2011	31.5	21.5	18.9	46.1	49.1	33.2	25.0	51.8	32.9	23.8
3/08/2011	31.2	20.7	19.3	44.9	47.8	33.7	23.8	50.4	31.1	23.2
4/08/2011	32.2	28.2	18.1	46.6	49.5	38.2	24.1	52.2	38.8	24.0
5/08/2011	29.1	25.5	20.4	44.2	47.1	35.6	27.0	48.8	36.3	25.6
6/08/2011	30.9		19.2		47.8		24.0	48.9		22.4
RBL/ Median	**30.9**	**21.5**	**18.9**	**44.5**	**47.8**	**36.6**	**25.0**	**48.9**	**36.1**	**23.8**

The reported L_{A10} are less than the L_{Aeq} for R5 Cerito Station Homestead. In many situations the L_{A10} is greater than the L_{Aeq} however it is not always the case. In situations where there are a few short-duration loud noises then the L_{Aeq} will exceed the L_{A10}. For this to happen the short-duration loud noises occur for less than 10% of the time.

Table 4: Measured Existing Noise Levels [in dB(A)] at R6 Byerwen Station Homestead

Date	$L_{A90(10\ minute)}$ Background Noise Level [dB(A)]			$L_{Aeq\ (10\ minute)}$ Noise Level [dB(A)]				$L_{A10(10\ minute)}$ Noise Level [dB(A)]		
	Day	Evening	Night	24 hour	Day	Evening	Night	Day	Evening	Night
29/07/2011	18.0	17.5	16.7	30.7	32.0	33.4	18.4	33.4	35.7	19.3
30/07/2011	17.5	17.7	16.7	29.6	31.5	29.5	22.2	32.1	31.1	22.9
31/07/2011	18.5	17.0	16.7	32.7	35.4	26.1	20.5	37.3	27.5	21.0
1/08/2011	18.9	16.7	16.7	32.3	35.0	27.3	21.5	36.4	29.0	22.4
2/08/2011	19.0	17.1	16.4	33.3	35.2	33.9	22.4	37.3	36.1	23.2
3/08/2011	17.4	17.1	16.5	31.8	33.3	33.6	21.6	34.7	36.0	22.0
4/08/2011	19.0	18.0	16.3	36.7	38.9	36.3	23.0	41.4	38.3	24.0
5/08/2011	17.6	17.2	16.5	33.2	34.2	36.5	22.7	35.8	38.2	27.5
6/08/2011	17.9	18.3	16.5	31.4	32.1	34.7	24.4	33.1	37.0	25.6
7/08/2011	17.4	18.4	16.9	30.6	30.5	34.9	22.5	30.6	37.2	25.6
8/08/2011	18.3	18.8	17.8	30.6	32.9	27.8	22.5	34.1	29.7	22.5
9/08/2011	18.0	17.3	17.2	30.0	32.7	22.8	21.0	34.2	23.1	21.5
10/08/2011	17.7	18.4	16.9	30.1	32.8	24.1	19.5	33.0	25.2	19.9
11/08/2011	18.4	18.4	17.2	31.9	34.6	24.1	21.7	36.1	25.2	21.7
RBL / Median	**18.0**	**17.6**	**16.7**	**31.6**	**33.1**	**31.5**	**21.9**	**34.4**	**33.4**	**22.5**

Table 5: Measured Existing Noise Levels [in dB(A)] at Subject Site

Date	$L_{A90(10\ minute)}$ Background Noise Level [dB(A)]			$L_{Aeq\ (10\ minute)}$ Noise Level [dB(A)]				$L_{A10(10\ minute)}$ Noise Level [dB(A)]		
	Day	**Evening**	**Night**	**24 hour**	**Day**	**Evening**	**Night**	**Day**	**Evening**	**Night**
29/07/2011	25.1	26.2	27.0	30.4	31.2	29.3	29.5	31.8	31.2	31.3
30/07/2011	24.8	26.0	26.8	30.5	30.6	31.3	29.8	31.9	30.4	31.3
31/07/2011	25.7	25.5	26.7	31.6	33.4	27.2	29.1	34.7	27.3	30.3
1/08/2011	26.2	25.6	27.3	35.9	38.5	28.4	29.4	39.0	28.5	30.5
2/08/2011	26.0	25.9	26.7	34.9	37.2	27.5	30.0	39.2	28.5	31.3
3/08/2011	25.7	26.0	27.0	35.0	37.4	28.9	29.3	38.4	30.4	30.5
4/08/2011	27.0	26.8	26.7	36.0	38.3	30.9	29.9	40.4	32.6	31.5
5/08/2011	26.0	26.9	26.5	34.5	36.6	30.7	30.3	38.0	32.5	32.1
6/08/2011	25.5	26.6	26.6	32.1	33.7	29.6	29.4	33.8	30.9	31.0
7/08/2011	25.2	25.7	25.7	29.3	30.3	28.0	28.1	30.0	28.8	29.2
8/08/2011	25.5	26.0	26.8	32.0	33.9	27.6	29.1	34.0	28.3	30.4
9/08/2011	25.4	25.8	27.2	31.2	32.5	27.7	29.8	34.3	28.5	30.6
10/08/2011	22.9	21.8	23.0	30.9	32.7	24.4	28.8	33.9	25.3	30.0
11/08/2011	23.4		23.7		33.2		28.7	34.6		30.8
RBL / Median	**25.5**	**26.0**	**26.7**	**32.0**	**33.6**	**28.4**	**29.4**	**34.4**	**28.8**	**30.7**

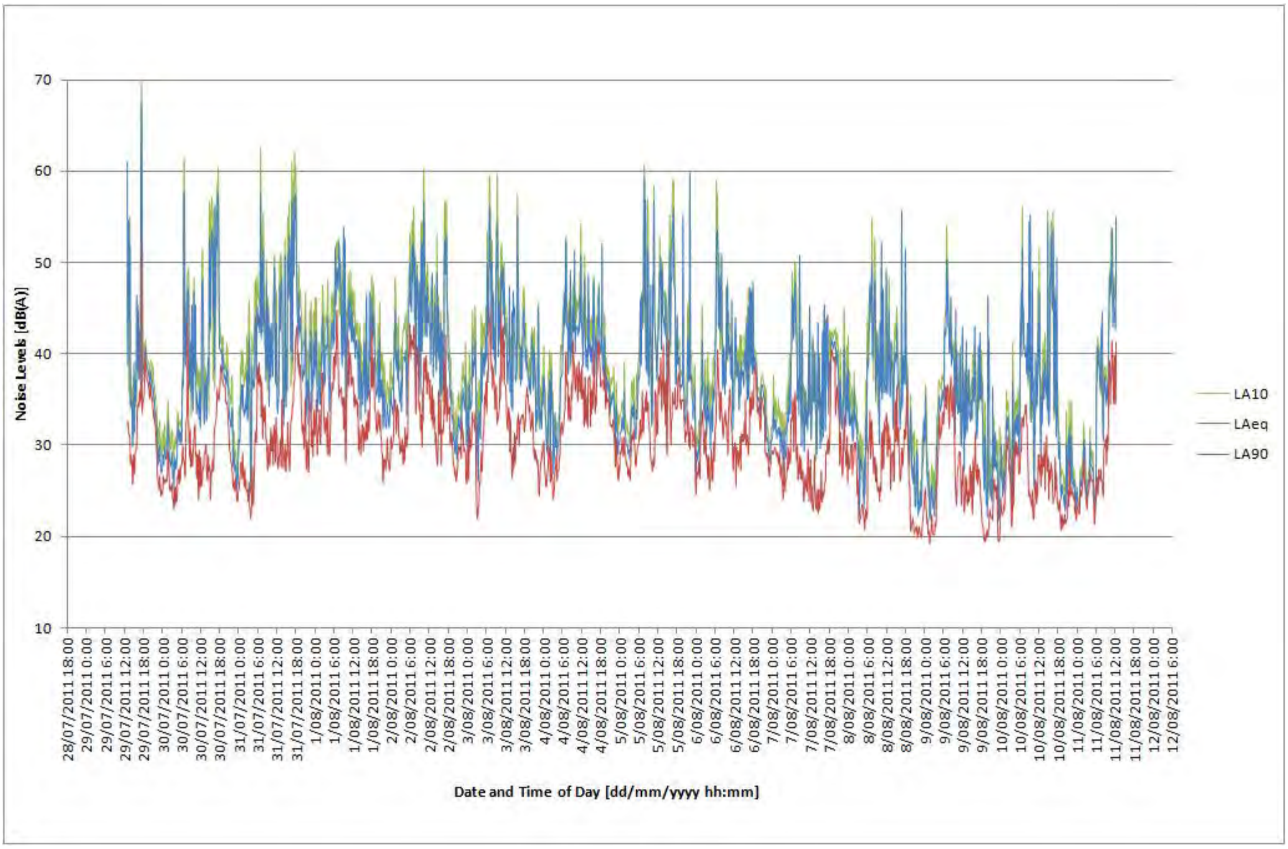

Figure 3: Measured Noise Levels at R4 Wollombi Station Homestead

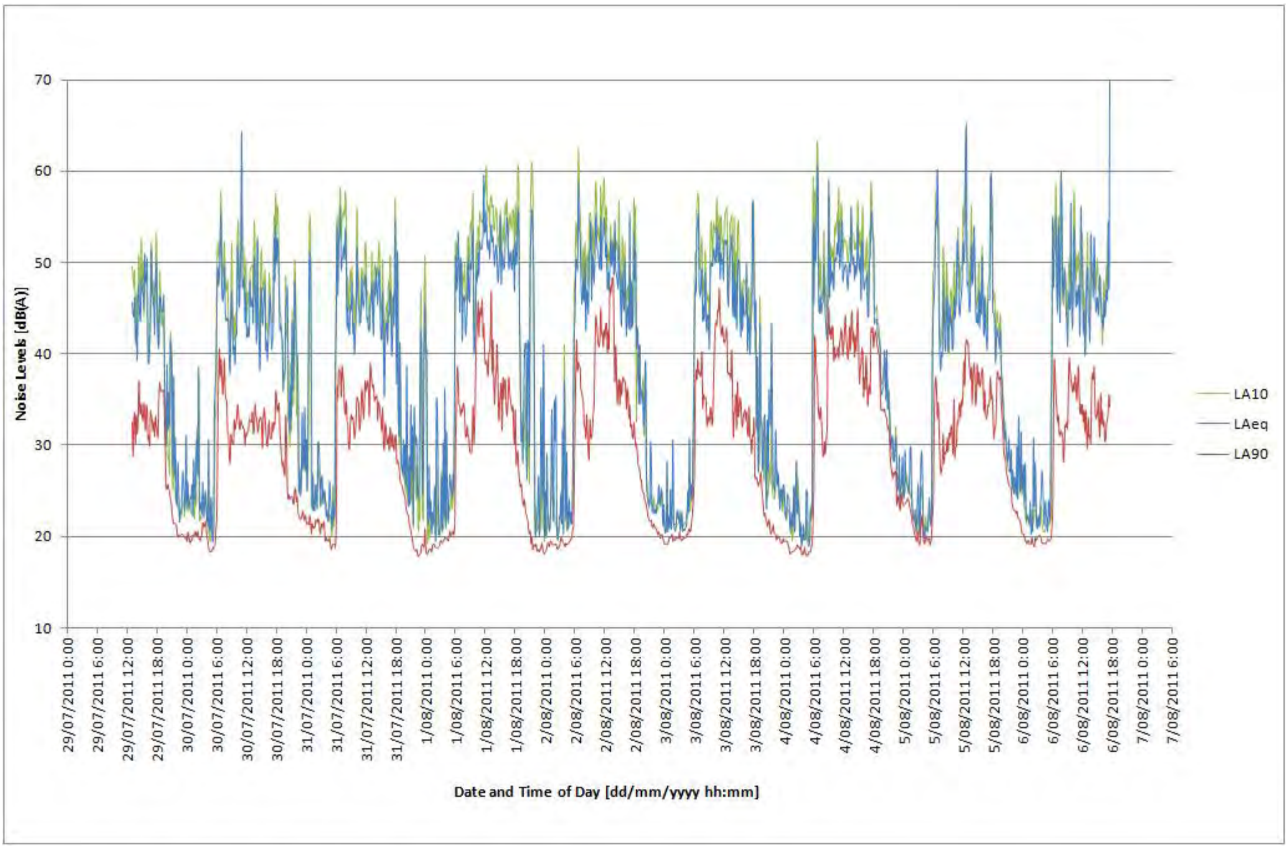

Figure 4: Measured Noise Levels at R5 Cerito Station Homestead

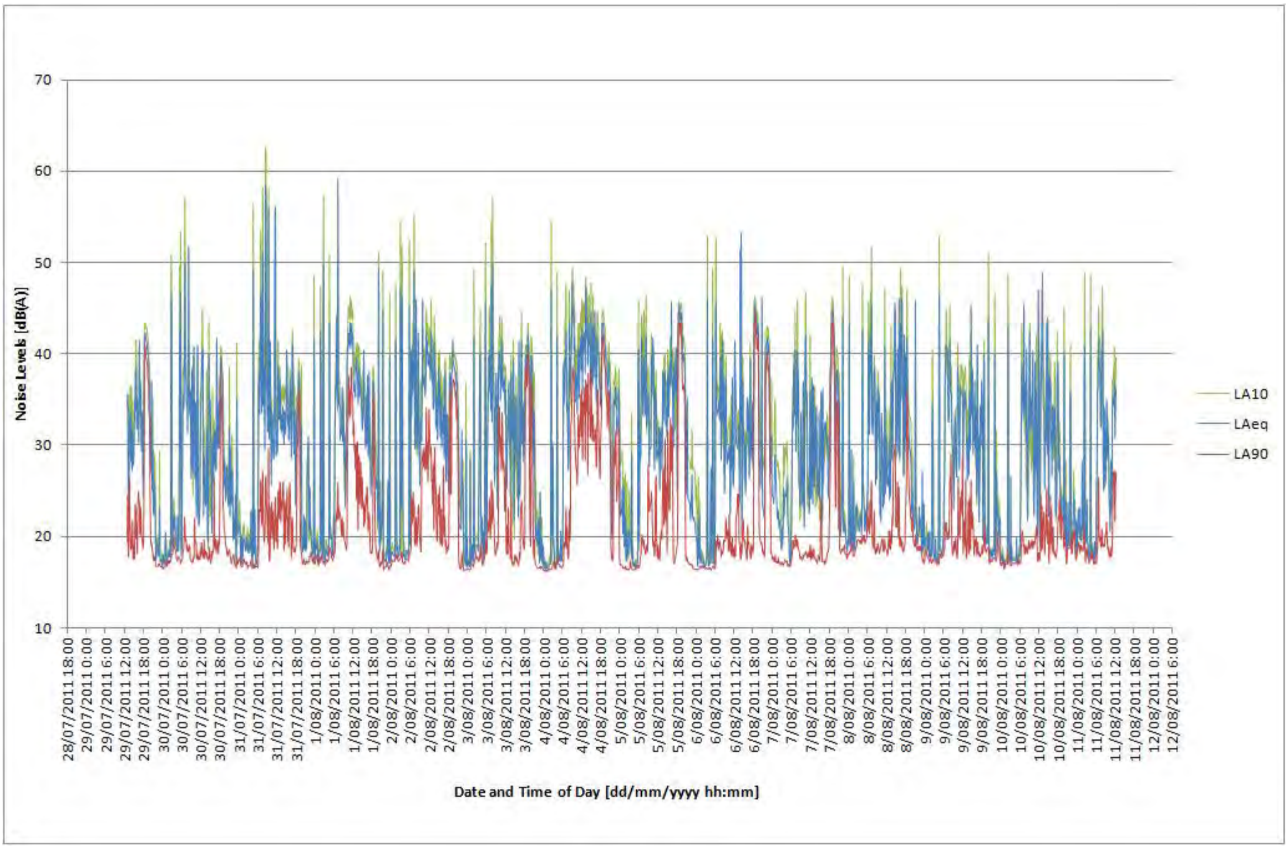

Figure 5: Measured Noise Levels at R6 Byerwen Station Homestead

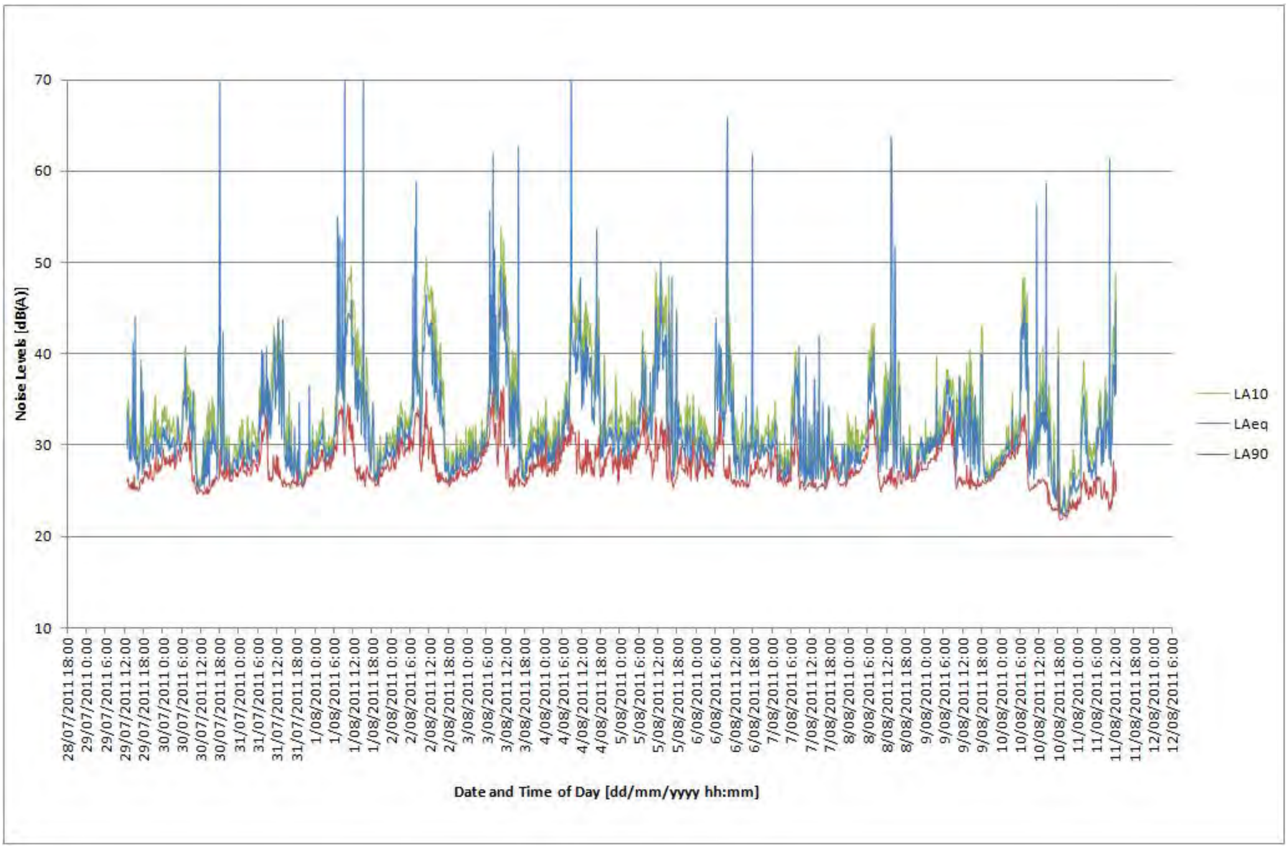

Figure 6: Measured Noise Levels at Subject Site

A series of attended measurements were obtained during the day, evening and night at all four noise monitoring sites. The measurements were obtained close to the monitoring site to obtain a representative measurement, but far enough away not to disturb the domesticated animals near the homestead. The measurements were obtained over the period 14 Sept 2011 to 16 September 2011, refer to Table 6. The noise level measurements are similar (though slightly noisier) and generally confirm the long-term measurements obtained during the previous month. Apart from an occasional truck bypass near Wollombi Station Gate, the measured noise levels were free from mining or industrial noises. It is noted that the L_{AMax}, L_{A10} and L_{Aeq} were influenced by truck bypasses and were higher than recorded at Wollombi Station Homestead, but the L_{A90} was less influenced and is similar to that measured at the homestead.

Table 6: Attended Noise Level Measurements at Sensitive Receptors

Location	Index	Measured (Attended) Noise Level in Time Period					
		12:00am to 3:00am	6:00am to 9:00am	9:00am to 12:00pm	12:00pm to 3:00pm	3:00pm to 6:00pm	9:00pm to 12:00am
R4 Wollombi Station Homestead	L_{Amax}	86	66	75	58	55	89
	L_{Aeq}	64	50	57	41	43	68
	L_{A10}	59	44	51	46	47	60
	L_{A90}	26	31	29	24	29	27
R5 Cerito Station Homestead	L_{Amax}	43	56	62	50	59	52
	L_{Aeq}	23	38	38	33	38	27
	L_{A10}	22	41	40	36	32	28
	L_{A90}	18	23	27	25	21	20
R6 Byerwen Station Homestead	L_{Amax}	38	47	56	51	45	57
	L_{Aeq}	24	31	36	33	33	38
	L_{A10}	28	36	37	36	36	43
	L_{A90}	17	21	22	25	29	32
Subject Site	L_{Amax}	55	49	55	47	44	40
	L_{Aeq}	35	34	37	33	32	33
	L_{A10}	38	36	39	36	34	36
	L_{A90}	28	31	33	26	28	30

3. Noise and Vibration Criteria

The noise and vibration criteria developed in this section apply equally to construction, decommissioning as well as the operational phase of the mine. The study has focussed on operational phase rather than construction or decommissioning phases, since the operational phase has the potential to be significantly noisier than either the construction or decommissioning phases.

3.1 Environmental Protection Act 1994

The objective of the *Environmental Protection Act 1994* (EP Act) is to protect Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends.

The EP Act states a person must not carry out any activity that causes, or is likely to cause, environmental harm unless the person takes all reasonable and practicable measures to prevent or minimise the harm. This is termed the 'general environmental duty'.

Environmental harm is defined as any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance.

The noise level goals for operations may be determined from the *Environmental Protection (Noise) Policy 2008* (EPP (Noise) 2008).

The EPP (Noise) 2008 came into effect on 1 January 2009. There are two main considerations namely:

1. Acoustic quality objective (noise levels that are conducive to human health and well being, ensuring a suitable acoustic environment for individuals to sleep, study or learn, be involved in recreation, including relaxation and conversation; and preserve the qualities of the acoustic environment that are conducive to protecting the amenity of the community); and
2. Controlling background creep.

3.1.1 Acoustic Quality Objectives

The 'acoustic quality objectives' seek to protect the amenity of an acoustic environment. The indoor night-time goals effectively address sleep disturbance and sleep awakenings, while during the day it protects conversation.

The acoustic quality objectives are expressed as indoor noise level goals for dwellings at Night (10pm to 7am) and outdoor noise level goals during the Day (7 am to 6 pm) and Evening (6 pm to 10 pm). Furthermore the EPP (Noise) also includes acoustic quality objectives for critical habitats (as defined in a conservation plan under the *Nature Conservation Act 1992*) and marine parks under the *Marine Parks Act 2004*. These objectives are all contained in Table 7.

The indoor noise quality objective for dwellings conservatively assumes that the windows of the residences are wide open. The equivalent external noise levels measured at least 4 m from the residence would be 5 dB higher (to allow for the reduction of noise through the building envelope). However, it is not uncommon for bedrooms in hot, arid or tropical areas to be air-conditioned. For air conditioners to work efficiently the windows of dwellings are kept closed. For these air conditioned dwellings (where windows are closed) the assumed noise reduction from outside to inside is 20 dB (i.e. the equivalent external noise levels measured at least 4 m from the residence would be 20 dB higher than the acoustic quality objective noted in Table 7). It is noted that often air conditioners create noise, making the inside of rooms noisier. This methodology conservatively assumes the air conditioners do not have any noise emissions, i.e. the air conditioners do not increase the internal noise levels thereby masking the potentially intrusive external noise level.

Table 7: Acoustic Quality Objectives for Dwellings During the Day (7 am to 6 pm), Evening (6 pm to 10 pm) and Night (10 pm to 6 am)

Location	**Time of Day**	**Acoustic Quality Objectives (Measured at the receptors) dB(A)**			**Environmental Value**
		$L_{Aeq, adj, 1 hr}$	$L_{A10, adj, 1 hr}$	$L_{A1, adj, 1 hr}$	
Dwelling outdoors	Daytime & evening	50	55	65	Health and wellbeing
Dwelling indoors	Daytime & evening	35	40	45	Health and wellbeing
Dwelling indoors	Night-time	30	35	40	Health wellbeing in relation to the ability to sleep
Protected area, or an area identified under a conservation plan under the *Nature Conservation Act 1992* as a critical habitat or an area of major interest	Anytime	The level of noise that preserves the amenity of the existing area or place			Health and biodiversity of ecosystems

Source: EPP (Noise) 2008

3.1.2 Controlling Background Creep

The controlling background creep objectives are twofold, firstly it seeks to avoid intrusiveness and secondly, when setting limits, it is not intended that the acoustic environment be permitted to deteriorate. To the extent that it is reasonable to do so, noise from an activity must not be:

1. 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
2. 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 $L_{A90,T}$.

These are measured noise level goals. Hence when developing a limit for the purposes of assessing a "modelled" noise level the cumulative effect of the background noise level needs to be addressed. For a noise that varies over time the limit is an $L_{Aeq,adj,T,} = L_{A90,T} + 3dB(A)$.

The DERM (now DEHP) Ecoaccess Guideline "Planning for Noise Control" provides methods and procedures that are applicable for setting conditions relating to noise emitted from industrial premises, commercial premises and mining operations, and are intended for planning purposes. The Guideline is applicable to sounds from all sources, individually and in combination, which contribute to the total noise from a site.

The guideline takes into account three factors:

- firstly, the control and prevention of background noise creep in the case of a steady noise level from equipment such as that caused by ventilation fans and other continuously operating machinery;
- secondly, the containment of variable noise levels and short-term noise events, such as those caused by forklift trucks and isolated hand tools, to an ‘acceptable’ level above the background noise level; and
- thirdly, the setting of noise levels that should not be exceeded to avoid sleep disturbance.

To prevent background noise levels from progressively creeping higher and higher over time with the establishment of new developments in an area, the EcoAccess guideline indicates that the $minL_{A90,1hour}$ outdoor background noise planning levels given in Table 8 not be exceeded.

Table 8: Recommended Outdoor Background Noise Planning Levels (in terms of $minL_{A90,1hour}$)

Receiver Land Use	**Receiver Area Dominant Land Use**	**Background noise Level $minL_{A90,1hour}$ [dB(A)] During Time Period**		
		Day	**Evening**	**Night**
Purely residential	Very Rural	35	30	25
	Rural residential	40	35	30
	Shop or commercial office	45	40	35
	Light industry	50	45	40

For sites that are above or below the recommended outdoor background level, the planning background noise levels are corrected by reference to Table 9. Essentially for very quiet locations, the guideline provides a lower limiting background level for planning purposes. The guideline states "It may not be possible to maintain background levels in very rural areas below 25 dB(A) as developments occur. In such cases a threshold background level of 25 dB(A) is to be used." At all locations where the measured background was below 25 dB(A), the threshold background noise level of 25 dB(A) has been substituted as required by the Guideline.

Table 9: Recommended Noise Emission Planning Levels ($L_{A90,1hour}$) for Developments

Existing background noise level at the most sensitive point in an affected residential area	Recommended $L_{A90,1hour}$ maximum noise level contribution, for planning approval purposes, at that point as a result of a proposed new noise source
A. Background noise level is above relevant recommended level (Table 8)	Preferably, set maximum planning level 10 dB(A) or more below relevant recommended level (Table 8). At least, set maximum planning level 10 dB(A) below existing background level
B. Background noise level is at recommended level	Set maximum planning level 10dB(A) below relevant recommended level (Table 8)
C. Background noise level is below recommended level by: 1dB(A) 2dB(A) 3dB(A) 4dB(A) 5dB(A) 6dB(A) or more	Set maximum planning level: 9dB(A) below recommended level 5dB(A) below recommended level 3dB(A) below recommended level 2dB(A) below recommended level 2dB(A) below recommended level 5dB(A) above background level

The noise level goal for each location is contained in Table 10, this based on the assumption that the homesteads are in the noise reference zone "very rural area".

Table 10: Planning Background Noise Levels From Method Contained in "Planning For Noise Control"

Location	**Rating Background Noise Level**			**Maximum Planning Level L_{A90}**		
	Day	**Evening**	**Night**	**Day**	**Evening**	**Night**
R4	28	29	24	33	25[#1]	25[#1]
R5	31	22	19	33	27	25[#1]
R6	18	18	17	25[#1]	25[#1]	25[#1]
Subject site	25	26	26	30	28	25[#1]

Note #1: As described above the background L_{A90} noise level of 25 dB(A) has been adopted for locations with noise levels below 25 dB(A).

The noise level goal to avoid background creep is an L_{Aeq} equal to the Maximum Planning Level plus 3 dB(A). It is proposed to adopt the noise goals for R6, Byerwen Station Homestead for all sensitive receptors considered in the assessment. Adoption of these goals provides the lowest noise level goals possible under the approach described in the EcoAccess guideline.

Sleep Disturbance

As a rule in planning for short-term or transient noise events, for good sleep over eight hours, the indoor sound pressure level measured as a maximum instantaneous value should not exceed approximately 45 dB(A) L_{Amax} more than 10-15 times per night. The corresponding external noise level, assuming wide open windows, is 50 dB(A) L_{Amax}, measured in the free field.

3.2 DERM Ecoaccess Guideline - Low Frequency Noise

The DERM Ecoaccess Guideline "Assessment of Low Frequency Noise" identifies a number of industrial sources and processes having high noise levels and frequency content less than 200 Hz.

Industrial sources may exhibit a spectrum that characteristically shows a general increase in sound pressure level with decrease in frequency. Annoyance due to low frequency noise can be high, even though the dB(A) level measured is relatively low. Typically, annoyance is experienced in the otherwise quiet environs of residences, offices and factories adjacent to, or near, low frequency noise sources. Generally, low level/low frequency noises become annoying when the masking effect of higher frequencies is absent. This loss of high frequency components may occur as a result of transmission through the fabric of a building, or in propagation over long distances.

Where a noise emission occurs exhibiting an unbalanced frequency spectra, the overall sound pressure level inside residences should not exceed 50 dB(Linear) to avoid complaints of low frequency noise annoyance.

3.3 Blasting Criteria

Open-cut coal mining procedures often include drilling and blasting of overburden material above the coal to make removal of that material easier.

Most commonly specified "safe" structural vibration levels are designed to minimise the risk of threshold or cosmetic surface cracks, and are set well below the levels that have the potential to cause damage to the main structure. Examples of threshold or cosmetic cracking include minor non-structural effects such as superficial cracking in cement render or plaster. I

Reinforced and heavy framed commercial structures and less likely to be the subject of cosmetic damage from vibration and as a consequence have higher vibration limits than unreinforced or light frames buildings. Thus the goals presented in this section are for the light-frames dwellings typical of central Queensland.

3.3.1 Environmental Protection Act 1994

The relevant section of the Queensland Environmental Act states:

"A person must not conduct blasting if-

(b) the ground vibration is-

i. for vibration of more than 35 Hz - not more than 25 millimetres per second ground vibration, peak particle velocity; or

ii. for vibration of not more than 35 Hz - not more than 10 millimetres per second ground vibration, peak particle velocity."

3.3.2 Ecoaccess

The Ecoaccess Guideline specifically address limits associated with human comfort, rather than cosmetic building damage.

According to the Ecoaccess Guideline "Noise and Vibration From Blasting", blasting should generally be limited to the hours of 9 am to 3 pm, Monday to Friday, and from 9 am to 1 pm on Saturdays unless there is no likelihood of persons in a noise-sensitive place being affected because of the remote location of the blast site.

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 should apply); or

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

Blasting activities must be carried out in such a manner that if blasting noise should propagate to a noise-sensitive place, then:

a) the airblast overpressure must be not more than 115 dB(linear) peak for 9 out of any 10 consecutive blasts initiated, regardless of the interval between blasts; and
b) the airblast overpressure must not exceed 120 dB(linear) peak for any blast.

Blasting operations must be carried out in such a manner that if ground vibration should propagate to a vibration-sensitive place:

a) the ground-borne vibration must not exceed a peak particle velocity of 5mm per second for nine out of any 10 consecutive blasts initiated, regardless of the interval between blasts; and
b) the ground-borne vibration must not exceed a peak particle velocity of 10mm per second for any blast.

3.3.3 ***BS 7385:Part 2-1993 Vibration in Buildings***

British Standard 7385:Part 2-1993 Evaluation and Measurement for Vibration in Buildings provide limits to avoid the likelihood of cosmetic building damage from ground vibration. Sources of vibration addressed by the standard blasting (carried out during mineral extraction or construction excavation).

BS 7385 sets guide values for building vibration based on the lowest vibration levels above which cosmetic damage has been credibly demonstrated. These levels are judged to give a minimal risk of vibration-induced cosmetic damage, where ‘minimal risk’ for a named effect is usually taken as a 95% probability of no effect. In this standard, the guide values for transient vibration judged to give minimal risk of cosmetic damage to residential buildings are 3.7 mm/s at 1 Hz, rising to 15 mm/s at a frequency of 4 Hz, increasing to 20 mm/s at a frequency of 15 Hz, then to 50 mm/s at a frequency of 40 Hz and above, refer to Figure 7.

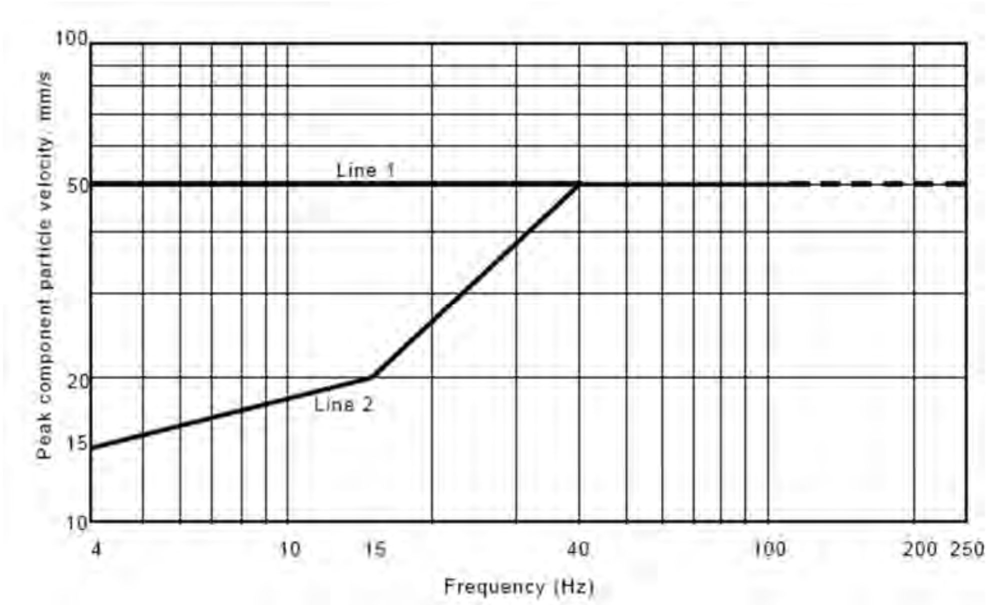

Figure 7: Transient Vibration Guide Values for Cosmetic Damage to Lightweight Structures (Line 2) (BS 7385-2)

Typically the dominant frequencies associated with blasting is in between 5 Hz and 30 Hz. Thus the vibration limits are effectively between about 15mm/s and almost 40mm/s PPV.

3.3.4 DIN 4150.3 - Buried Pipework and Telecommunication Cables

The German Standard DIN 4150.3-1999 Structural Vibration – Part 3: Effects of vibration on structures provides guideline values to avoid damage to underground pipe work. The limits for buried pipe work is contained in Table 11.

Table 11: Vibration Limits for Buried Pipework from DIN 4150.3-1999

Pipe material	**Peak Wall Vibration Velocity (mm/s)**	
	Short Term	**Long Term**
Steel (including welded pipes)	100	50
Clay, concrete, reinforced concrete, pre-stressed concrete, metal with or without flange (other than steel)	80	40
Masonry, Plastic	50	25

3.4 Railway Noise Goals

Queensland Railways (QR) is responsible for setting noise level limits from railway in Queensland. The planning levels for a railway, assessed 1 m in front of the most exposed part of an affected noise sensitive place are:

a) 65 dB(A), assessed as the 24 hour average equivalent continuous A-weighted sound pressure level; and
b) 87 dB(A), assessed as a single event maximum sound pressure level.

Typically the planning goals for coal train operations are met close to the railway (i.e. at distances up to approximately 50 m).

It is beyond the scope of this study to assess the noise from the entire rail line. The study will focus on the northern and southern balloon loops and railway spurs.

3.5 *Road Traffic Noise Goals*

Queensland Department of Main Roads (QDMR) is responsible for setting noise level limits from road traffic on public roads in Queensland. Typically the planning goals for roads are met close to the road, i.e. distances up to about 30m or thereabouts. There are no noise sensitive receptors close to any of the local roads. Furthermore the planning levels do not apply for minor roads surrounding the project and it is beyond the scope of this study to assess the overall noise levels from the road network. There are no criteria in Queensland to assess the impact of noise from a road traffic-generating development. However an increase of 3dB(A) over a short period of time is considered to be a significant increase in traffic noise and an increase which justifies consideration of noise control. It is recommended that the assessment of road noise be limited to a 3 dB(A) increase over the existing noise levels.

3.6 *WHO Night Noise Guidelines for Europe*

The Night Noise Guidelines For Europe (2009) by the World Health Organisation has been developed as an extension of the WHO Guidelines for community noise (1999). Unlike Australia many European Member states do not have legislation directed at controlling night noise exposure and WHO developed guidelines to provide a consistent scientifically based approach. The documents determined that the L_{Amax} and the L_{Aeq} are indicators that best address short term effects and the yearly average of night noise level outside at the facade ($L_{night\ outside}$) best address long-term effects. The adoption of $L_{night\ outside}$ in Europe assumes a that the reduction in noise from outside to inside is with windows slightly open and for this a noise reduction of 21 dB has been assumed. Furthermore the WHO considers that 21 dB reduction from outside to inside to be a relatively low level. The $L_{night,outside}$ is the long-term average sound level between 23:00 and 7:00 over an entire year. WHO adopt reduction from outside to inside of 15 dB(A) for assessing short-term noise impacts.

WHO advise that below the level of 30 dB(A) $L_{night,outside}$, no effects on sleep are observed except for a slight increase in the frequency of body movements during sleep due to night noise. There is no sufficient evidence that the biological effects observed at the level below 40 dB(A) $L_{night,outside}$ are harmful to health. However, adverse health effects are observed at the level above 40 dB(A) $L_{night,outside}$, such as self-reported sleep disturbance, environmental insomnia, and increased use of somnifacient drugs and sedatives.

Therefore, 40 dB(A) $L_{night,outside}$ is equivalent to the lowest observed adverse effect level (LOAEL) for night noise. Above 55 dB the cardiovascular effects become the major public health concern, which are likely to be less dependent on the nature of the noise. Closer examination of the precise impact will be necessary in the range between 30 dB and 55 dB as much will depend on the detailed circumstances of each case.

WHO have adopted the interim target of 55 dB(A) $L_{night,outside}$ and night noise guideline 40 dB(A) $L_{night,outside}$. However, the guidelines are designed to comply with the WHO "Guidelines for Community Noise" (1999) of 30 dB(A) for continuous noise measured in the bedroom. For this guideline that a window slightly open should provide a reduction from outside to inside of 15 dB.

3.7 *Summary of Noise and Vibration Goals*

Application of Acoustic Quality Objectives

The noise level goals are based on the acoustic quality objectives and are expressed as outdoor noise level goals, at 4 m from residences. It is conservatively assumed that the residences have their windows open and the reduction through the building facade is 5 dB.

Application of Background Creep Goals

The noise from most plant and equipment working in a coal mine varies over a short time period. Furthermore the noise propagation characteristics over large distances always results in fluctuating noise levels. Since all the noise sensitive locations are located at large distances from the mine, it is reasonable to apply the limits "for noise that varies over time". The noise level goals have been calculated and are equal to $L_{Aeq,adj,T} = L_{A90,T}$ + 3 dB(A). The $L_{A90,T}$ is the Maximum Planning background noise level calculated in Table 10. The noise levels measured at Cerito Station Homestead are considered acceptable for that site. The noise levels measured at R6 Byerwen Station Homestead are considered to be representative of the quietest noise levels likely in the study area. Thus the noise level goals developed for Byerwen Station Homestead apply at all remaining sensitive receptors.

Application of Low Frequency Noise Goals

It is possible that, due to the propagation of noise over the large separation distances between the source of noise and the receiver, a loss of high frequency components may occur. Thus the low frequency noise goal of 50 dB(Linear) applies at noise sensitive receptors.

Application of Blasting Limits

The blasting goals apply and it is proposed to carry out the assessment with typical blasting charge weights.

A summary of the noise and vibration goals for this project is contained in Table 12 and Table 13.

Application of Railway Goals

It is proposed to adopt both the $L_{Aeq\ 24\ hour}$ noise level and the single event maximum sound pressure level of 87 dB(A) as the goals for railway noise level. This is generally met within 100 m of the railway and the closest receptor is located approximately 2 km from the railway.

Application of Road Traffic Goals

It is proposed to adopt a 3 decibel or more increase in the $L_{Aeq\ 24\ hour}$ noise levels as a measure of a significant change in the road traffic noise levels.

Application of the WHO European Night Noise Level Goals

The WHO European Night Noise Level Goals is an annual average night L_{Aeq} of 40 dB(A) and called the $L_{night,outside}$. The limit developed for the standard does not readily translate to Queensland conditions since the assumed reduction of noise though the building envelope is based on European buildings and climate, rather than that experienced in Queensland. However, to account for the differences in building type in Queensland a goal of 30 dB(A) to 35 dB(A) $L_{night,outside}$ would be appropriate.

Discussion

The acoustic quality objectives (Table 12) are based on Section 3.1.1, Table 7, specifically, the indoor noise quality objectives. To convert from an indoor objective to an outdoor objective the noise levels have been increased by 5 dB(A), representative of a dwelling with wide open windows. If windows are kept closed (the dwelling is air conditioned) the noise reduction through the building facade would increase to 20 dB(A). It should be noted that these are not strictly design limits but objectives that are considered to provide acceptable health and wellbeing for the community. The blasting and low frequency goal, described in this section are summarised in Table 12.

The noise level goals to avoid background creep (refer to Table 13) are based on Section 3.1.2 for time varying noise and based on the RBL determined in Section 2. All noise associated with the operation of a mine is time-varying. AS1055.1 provides the definition for time varying noise. Steady sound comprises continuous noise level where typically variations are less than or equal to ±3dB(A). Non-steady (time varying) noise comprises fluctuating, impulsive or noise with greater than a ±3dB(A) variation.

It is noted that the noise level goals to avoid background creep (Table 13) are lower than the acoustic quality objectives (Table 12) during all time periods. This indicates the existing noise levels are relatively low and generally unaffected by industrial or traffic noise. Since noise level measurements were obtained at both Cerito Station Homestead and Byerwen Station homestead nose level goals to avoid background creep have been developed for both locations. However, since the Byerwen station better represents typical homestead use (and is permanently occupied) it proposed to adopt this goal for all other sensitive receptors.

The existing homesteads are not significantly exposed to road traffic noise or other industrial or mining noises. The township of Glenden to the east is potentially noisier due to road traffic and human habitation. However, since it located a large distance from the project and mostly upwind of the project for much of the time, Glenden is likely to have a very low exposure to noise from the project.

Table 12: Summary of Noise and Vibration Goals

Location	**Time Period**	**Acoustic Quality Objectives (Measured at the receptors and to protect health and wellbeing) [dB(A)]**			**Low Frequency Noise Limit [dB]**	**Blasting to Avoid Annoyance at Sensitive Receptors**	
		$L_{Aeq, adj, 1 hr}$	**$L_{A10, adj, 1 hr}$**	**$L_{A1, adj, 1 hr}$**		**Noise [dBLin Peak]**	**Vibration PPV [mm/s]**
All Residential Receptors	Day	40	45	50	50	115	5
	Evening	40	45	50	50	115	5
	Night	35	40	45	50	115	5

Table 13: Summary of Noise Level Goals to Avoid Background Creep based on $L_{Aeq,adj,T} = L_{A90,T}$ + 3 dB(A).

Location	**Modelled Noise Goals to Avoid Background Creep $L_{Aeq, adj, 1 hr}$ [dB(A)]**		
	Daytime	**Evening**	**Night**
Cerito Station Homestead	36	30	28
Byerwen Station Homestead and all other sensitive receptors	28	28	28

4. Noise Modelling

4.1 Modelling Methodology

A digital terrain noise model of the site and surroundings has been developed using PEN3D software. The PEN3D General Prediction Model (GPM) is based on the method contained in a book by Bies and Hansen (1988, pages 117, 127). The implementation is a more complex variation of the approach to sound propagation described in Concawe (1981). Concawe is one of the most commonly used methodologies to predict outdoor noise propagation from industrial sites. PEN also draws on aspects from ISO 9613-2. The PEN3D software was originally developed in 1993 and has been in constant development and review. The basic equation adopted by the GPM is:

$$L_p = L_w - 20\log10(r) - 10\log10(4\pi) + AE$$

Where

Lp is the sound pressure level at an observer

Lw is the sound power level of the source, in octave bands from 63 Hz to 8kHz

20 log10(r) + 10log10(4π) is the distance attenuation (spherical)

AE is the excess attenuation factors

The excess attenuation factors AE comprise:

$$AE = Aa + Ag + Am + Ab + Af$$

Where:

Aa = Excess attenuation due to air absorption from Sutherland *et. al*. (1974)

Ag = Excess attenuation due to ground reflection

Am = Excess attenuation due to meteorological effects

Ab = Excess attenuation due to barriers

Af = Excess attenuation due to forests.

PEN is a sophisticated environmental noise model incorporating a 3D terrain model that permits accurate representation of the ground, ground cover, tree zones, mounds, barriers and weather conditions. PEN calculates a curved noise path based on surface friction, vertical temperature gradients and wind speed. All the noise calculations are based on this curved path. A finite differences approximation method is used to calculate the curved path. The curvature of the path determines the meteorology corrections. The meteorology corrections are frequency and distance dependent and are limited to +12 dB (downwind at night) and –7 dB (upwind and during the day) similar to the Concawe Category 1 and Category 6 meteorological corrections.

The excess attenuation due to ground reflection is obtained by combining the direct wave and the reflected wave incoherently, that is the energy from the ground wave is added to the direct wave. The ground reflection attenuation (or ground effects) will be between 0 and –3dB (a negative value is an increase in noise levels) for all cases. This contrasts with the coherent reflection approach. The coherent approach is considered to be an “exact” method. For those situations where the source and receiver are located close to the same very hard reflecting plane and the path difference between the direct path and the reflected path is small, then the addition of the reflected wave and the direct wave will result in 6 dB increase rather than a 3 dB increase. However, at large distances the sound pressure level reduces at 12 dB per doubling with the coherent model (not 6 dB as per the incoherent model). This approach, while "exact", is dubious as DTM models are neither of sufficient accuracy nor can noise models truly account for the effects of atmospheric turbulence. Other methods such as the Nordic method or ISO 9613-2 divide the region between the source and receiver into three zones, and those zones closest to the source and to the receiver can potentially have higher absorption values. Consequently, if a noise source was measured say at a distance of 30 m and the sound power level is calculated by the commonly adopted formula PWL = SPL + 10log10(2 π r^2) then the calculations using the PEN3D methodology would remain conservatively high for all distances.

The ground reflection (or ground effects) is a complex calculation using the flow resistivity for the surface likely to provide the ground reflection and the likely angle of incidence of the reflected wave to the ground. In those instances where the ground is highly absorptive the excess correction will approach zero. For those surfaces which are highly reflective the correction will be - 3dB, i.e. will lead to an increase in noise levels of 3 dB(A) (simulates hemispherical propagation).

While there are numerous methods to calculate ground effect (some of which providing significant attenuation (reduction of noise levels)), the PEN implementation is one of the more conservative estimates of ground effect in the far field. Bies & Hansen (1988) indicate "as the distance from the source or frequency increases, the incoherent model will become more appropriate".

The theoretical approach to meteorology implies that PEN is likely to provide more significant corrections than other models. Thus, at night or during downwind predictions, the PEN calculations are likely to result in conservatively high results, i.e. the modelled noise levels are likely to be higher than the measured levels.

The likely barrier attenuations are calculated for four possible curved paths, namely:

- source, to the top of barrier then to the receiver;
- source, reflection from ground (source side), top of barrier, receiver;
- source, top of barrier, reflection from ground (receiver side), receiver; and
- source, reflection from ground (source side), top of barrier, reflection from ground (receiver side), receiver.

These are combined to obtain effective barrier attenuation. In the situation where the source and receiver are well above the ground and the barrier just intercepts line-of-sight then the barrier effect will be 5 dB(A). However, if the source and receiver are close to the ground and the noise barrier just intercepts line of sight (a pebble) the barrier effect will tend to zero.

Once the most likely curved path has been calculated, the method determines if it intercepts any tree zones within the digital terrain model. If the curved noise path travels in the lower 75% of the tree zone then the full excess attenuation is applied for the distance travelled in the tree zone. If the curved noise path travels in the upper 25% of the tree zone then:

a) the average propagation height is determined;
b) the length in the zone is determined; and
c) the forest excess attenuation is taken to be linearly interpolated between zero at the top of the tree zone and full excess attenuation at 75% height.

Potentially tree zones can provide extremely high attenuations if the coverage of tree zones are large. However, in practice, the curved path adopted in the PEN methodology usually results in the noise rays passing above the tree zones (at night or during downwind conditions) and only intercepting tree zones if they exist on the tops of hills or whenever the noise ray approaches the ground. Tree zones can potentially provide higher than expected attenuations during calm neutral conditions.

4.2 Meteorology

The meteorology for the project was modelled as part of the Air Quality Assessment. A single year, 2004, was extracted from that meteorological database. The modelling has been carried out for each relevant sensitive receptor for every hour of the day and every day of the year, resulting in a total of almost 9,000 meteorological cases being modelled for every noise sensitive receptor.

A chart of the hourly wind speed and wind direction is contained in Figure 8. The most common wind direction is from the east and the most common wind speed is approximately 2.9 m/s. However, this chart shows wind blowing from all directions at wind speeds up to almost 7 m/s. The meteorological data file also varies the temperature and the stability on an hourly basis and both of these parameters are also used by the noise model.

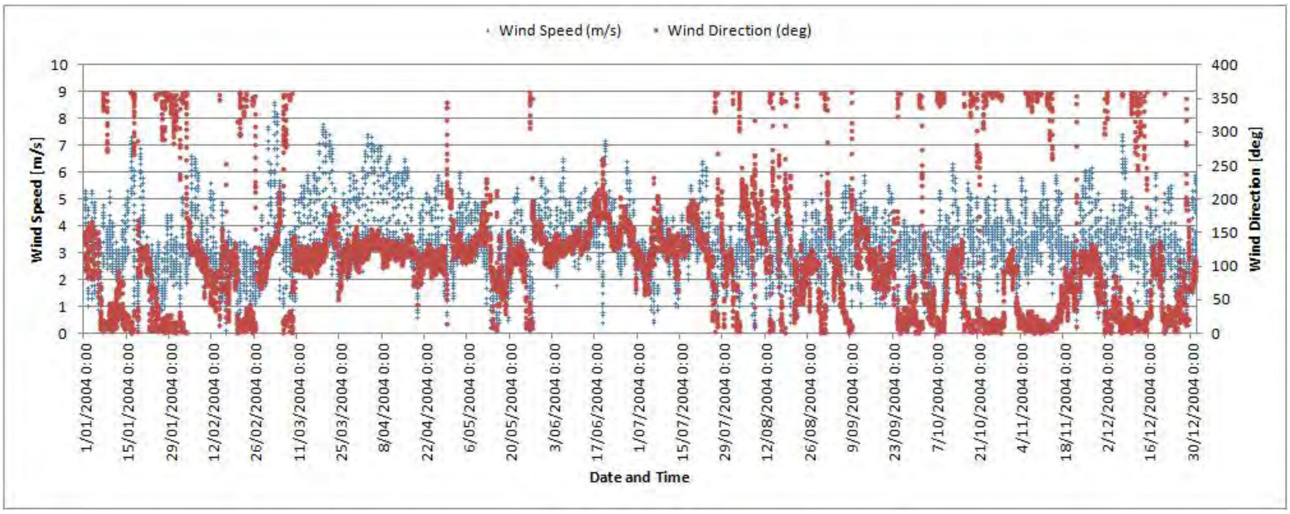

Figure 8: Wind Speed and Wind Direction Cases Modelled (Almost 9000 Cases)

The analysis has been based on the hourly calculations and two night-time cases were developed. The first case modelled winds from the east, the most common night time meteorology and the second case modelled winds from the west, likely to lead to the highest noise levels in at homesteads to the west of the site (Table 14).

Table 14: Modelling Cases

Modelling Case Name	Wind Speed [m/s]	Wind Direction [deg]	Vertical temperature gradient [C/100m]	Temperature [C]	Humidity [%]
Night (Common)	3	90	-2	9	50
Night (Less frequent)	2	270	-3	9	50

Night cases were conservatively selected as they are representative of the meteorological cases likely to lead to the highest environmental noise levels.

Table 15 also provides details of the vertical temperature gradient ranges adopted in the PEN model for stability classes. The hour-by-hour calculations are carried out at both the minimum and maximum extent of the likely vertical temperature gradient for each stability class, effectively doubling the number of calculations per site. A description of the likely conditions that may prevail for a given stability class is shown in Table 16.

Table 15: Typical Pasquill Stability Categories Based on Vertical Temperature Gradient

Stability Category	Range of vertical temperature gradient (°C/100m)	
	Minimum	Maximum
A	-3.0	-1.4
B	-1.4	-1.2
C	-1.2	-1.0
D	-1.0	0
E	0	2.0
F	2.0	4.5
G	<4.5	-

Table 16: Stability Categories

Wind Speed [m/s]	**Pasquill stability categories**							
	Day Time Incoming Solar Radiation mW/cm2				**1 hour before Sunset or after Sunrise**	**Night Time Cloud cover 6pm – 7am (octas)**		
	Strong >60	**Medium 30 to 60**	**Weak <30**	**Overcast**		**0 - 3**	**4-7**	**8**
≤ 1.5	A	A - B	B	C	D	F, G	F	G
2.0 – 2.5	A-B	B	C	C	D	F	E	E
3.0 – 4.5	B	B - C	C	D	D	E	D	D
5.0 - 6.0	C	C - D	D	D	D	D	D	D
> 6.0	D	D	D	D	D	D	D	D

Note1: Wind speed is measured to the nearest 0.5 m/s.

Note 2: Category G is restricted to night-time with less than 1 octa of cloud and a wind speed less than 0.5m/s.

4.3 *Noise Model Parameters*

The main components of the project construction phase include construction of the following:

- Early works
- Site clearance and preparation
- Civil works
- Structure and plant erection and installation
- Construction of mine infrastructure
- Commissioning and testing
- Materials, plant and equipment sourcing and transportation
- Accommodation and transport of construction personnel
- Construction of coal haul roads
- Construction of the train loading facility
- Construction of ancillary infrastructure such as power and water reticulation systems

The construction operations will comprise vegetation clearance, some earthworks and construction of structures. The proposed plant and equipment comprise similar but typically smaller equipment than that which will be used during the operations phase. These units are not only quieter but typically used at lower activity levels. The noise levels associated with the construction phase are significantly lower than operational noise levels. Consequently, the assessment of the operational phase also applies to construction phase.

Similarly, decommission involves removal of the infrastructure, structures, and the final stages of revegetation of the site. As with the construction phase, the noise levels associated with the decommissioning phase are significantly lower than operational noise levels. Consequently, the assessment of the operational phase also applies to construction phase.

It is not proposed to separately model the construction or decommissioning phases, however, if pertinent, differences in the expected noise levels will be highlighted in the assessment.

The Digital Terrain Model (DTM) for the project has been provided by the client. The surrounding has been based on NASA Shuttle Radar telemetry. The noise model has an adopted ground cover of 'grain field' as a representation of the combination of the roughness provided by pasture and the taller vegetation that exists throughout the region. The model dose not incorporate excess attenuation factors associated with tree zones.

The operational noise sources comprise:

- dragline;
- shovel operation in the pit;
- dozers;
- rock drill;
- blasting;
- dump trucks (in-pit);
- CHPP; and
- various surface earth working machines.

The likely equipment noise levels are contained in Table 17. The noise levels are expressed as a sound power level and a sound pressure level at 100 m from a working machine. The octave band sound power levels are "linear" while the overall sound pressure levels are "A" weighted. The "A" weighting emulates the way the human ear responds to sound. These noise levels are mostly based on measurements obtained at mines in Queensland since August 2005 and published data. The sources include NMA reports associated with the EIS' for Kestrel Coal Mine Expansion, Isaac Plains Expansion, monitoring at Millennium Coal Mine and published data sources such as Parsons Brinkerhoff (2004).

All the noise sources have been placed in exposed positions in the noise model. For instance, the overburden trucks have been placed on top of the waste rock emplacement. This is an elevated position and completely unscreened. In practice, an operational mine may choose to operate trucks at night in positions that are screened by stockpiles, and consequently significant noise reductions are likely. The purpose of this model is to highlight the likely worst-case noise levels.

To calculate the L_{Aeq} from the maximum sound power levels in Table 17 it is necessary to make corrections to account for load and operational cycles. For instance, it should be noted that mobile sources such as the haul and dump trucks operate in a complex cycle comprising low-load and high-load conditions at various positions along the route. The corrections of the L_{Amax} to the L_{Aeq} for each source are contained in Table 19.

Table 17: Summary of Maximum Noise Levels From Mining Equipment

Item	Maximum Sound Power Levels (dB) in Octave Band Centre Frequency [Hz]								Overall dB(A)	Overall Sound Pressure Level at 100 m dB(A)
	63[#1]	125	250	500	1000	2000	4000	8000[#2]		
Dragline (Engine)	91	108	104	107	106	108	101	95	114	64
Dragline (Sheaves)	114	115	119	125	127	128	125	114	133	85
500T Excavation (EX5500)	115	107	115	110	108	105	103	94	120	66
350T Excavator (EX3600)	96	104	109	109	113	114	105	99	118	70
240T Haul Truck (CAT 789)	112	119	115	116	114	112	106	102	123	71
180T Haul Truck (Cat 777D)	109	108	112	119	113	117	105	101	123	73
Caterpillar D10T Tracked Dozer	86	101	98	99	116	103	99	92	117	68
Caterpillar D11T Tracked Dozer	89	104	101	102	121	106	102	95	121	73
Caterpillar 994 wheeled dozer	110	109	98	99	104	98	92	87	114	58
Caterpillar 16M Grader	106	108	110	102	104	101	99	93	114	61
100T off highway water truck	124	122	118	115	112	110	103	99	127	70
Rock Drill	113	117	112	116	115	114	116	115	124	74
CHPP	128	122	121	120	117	114	110	107	130	74
Rail load out	110	105	104	103	104	104	104	101	114	63
Product Coal Stacker	110	106	101	101	97	93	86	84	102	54

Note 1: All energy in the frequencies below 63 Hz is added to the 63 Hz octave band

Note 2: All energy in the frequencies above 8000 Hz is added to the 8000 Hz octave band

In the noise model, the noise sources are positioned as follows:

- stacker at 8 m above local terrain;
- dump truck and other mobile sources at 4.5 m above local terrain;
- dragline engine noise at 8m and sheaves at 15m above local terrain;
- CHPP at 8 m above local terrain; and
- several sources are contained in the pit including dump trucks, loaders, excavators, drill rigs, dozers and draglines.

It is assumed that the rail loader is a fully enclosed structure and noise associated with loading trains is relatively minor compared with other nearby noise sources. There are a number of minor mining plant not included in the Table 17. Minor noise sources are comparatively quiet or operated infrequently. The exclusion of this plant from the noise model will not make a noticeable difference in the calculated noise levels at sensitive receptors.

Three modelling cases are addressed representing Year 5, Year 17 and Year 36 since these represent the early phases of most of the pits when the activity in the pit is close to the surface and the out-of-pit landforms are being developed. These operations are expected to lead to higher environmental noise levels.

The first case (Year 5) is at the end of the ramp-up phase of the mine, when the projected waste rock is 142.2 million bank cubic meters (Mbcm). The ROM coal for this year is approximately 15 Mtpa. The second case (Year 17) includes the open North Pit and the projected waste rock reaches is 125.8 Mbcm. The ROM coal for this year is approximately 15 Mtpa. The final case includes the opening of the eastern pits. The projected waste rock is 166.1 Mbcm. The ROM coal for this year is approximately 15 Mtpa

All cases relate to the maximum rate of handling of waste rock for the respective mining phases. During the first 16 years of the mine life there is only one case where the total waste rock exceeds 142.2 Mbcm, with the typical mining rate being less than 120 Mbcm.

During the later phase of the mine, the peak waste rock is in the 27th year of the mine operation. In this year total waste production is 185 Mbcm, slightly higher than the year 35 case of 166.1 Mbcm. However, unlike the cases considered, much of the waste movement occurs at depth in the pit.

The equipment lists for the mining phases are contained in Table 18. Table 19 provides the correction L_{Amax} to L_{Aeq} that represents the difference between the absolute maximum noise level and the average noise levels of a single operating machine having various loads and operating conditions and (for mobile plant) moving around a site changing direction and orientation. The dump trucks in elevated and exposed locations are key noise source in all noise models.

Table 18: Equipment Utilisation By Pit for Modelling Cases Year 5, Year 17 and Year 36

Mine Activity	**Equipment**	**Equipment Utilisation By Pit Designation**								
		WP1	**WP2**	**WP3**	**SP1**	**SP2**	**EP1**	**EP2**	**NP1**	**TOTAL**
YEAR 5										
Excavate, Load and Haul	Dragline	0			1					1
	500T Class Excavator	4			4					8
	350T Class Excavator	2			2					4
	240T Haul Truck	16			16					32
	180T Haul Truck	10			8					18
	Caterpillar D10T Tracked Dozer	2			2					4
Stockpiling (Waste)	Caterpillar D11T Tracked Dozer	3			3					6
	Caterpillar 994 wheeled dozer	1			1					2
Road Maintenance	Caterpillar 16M Grader	2			3					5
	100T off highway water truck	2			2					4
Ancillary Equipment	40T Excavator	1			1					2
	Service Trucks	1.5			1.5					3
YEAR 17										
Excavate, Load and Haul	Dragline		0		1	0			0	1
	500T Class Excavator		1.5		3.5	1.5			1.5	8
	350 Class Excavator		1		1	1			1	4
	240T Haul Truck		7		18	7			8	40
	180T Haul Truck		3		11	3			3	20
	Caterpillar D10T Tracked Dozer		1		2	2			2	7
Stockpiling (Waste)	Caterpillar D11T Tracked Dozer		2		3	1.5			1.5	8
	Caterpillar 994 wheeled dozer		0.5		1.5	0.5			0.5	3
Road Maintenance	Caterpillar 16M Grader		1		2	1			1	5
	100T off highway water truck		1		1.5	1.5			1	5
Ancillary Equipment	40T Excavator		0.5		0.5	0.5			0.5	2
	Service Trucks		1		2	1			1	5
YEAR 36										
Excavate, Load and Haul	Dragline			0	1		0	0		1
	500T Class Excavator			1	3		3	1		8
	350 Class Excavator			1	1		1	1		4
	240T Haul Truck			5	14		8	5		32

Mine Activity	Equipment	Equipment Utilisation By Pit Designation								
		WP1	WP2	WP3	SP1	SP2	EP1	EP2	NP1	TOTAL
	180T Haul Truck			3	8		6	3		20
	Caterpillar D10T Tracked Dozer			1	2		1	1		5
Stockpiling (Waste)	Caterpillar D11T Tracked Dozer			1.5	3.5		1.5	1.5		8
	Caterpillar 994 wheeled dozer			0.5	1.5		0.5	0.5		3
Road Maintenance	Caterpillar 16M Grader			1	2		1	1		5
	100T off highway water truck			1	1		1	1		5
Ancillary Equipment	40T Excavator			0.5	0.5		0.5	0.5		2
	Service Trucks			1	2		1	1		5

Table 19: L_{Amax} to L_{Aeq} correction

Equipment	L_{Amax} to L_{Aeq} Correction [dB]
Dragline	-5
Shovel (RH200)	-5
Loader 998	-5
Dump truck (190t)	-8
Dump truck (250t)	-8
Conveyor	0
Conveyor drive	0
D11 Dozer	-10
Drill rig	-5
Grader	-3
Stacker (Product Coal)	-3
CHPP	0

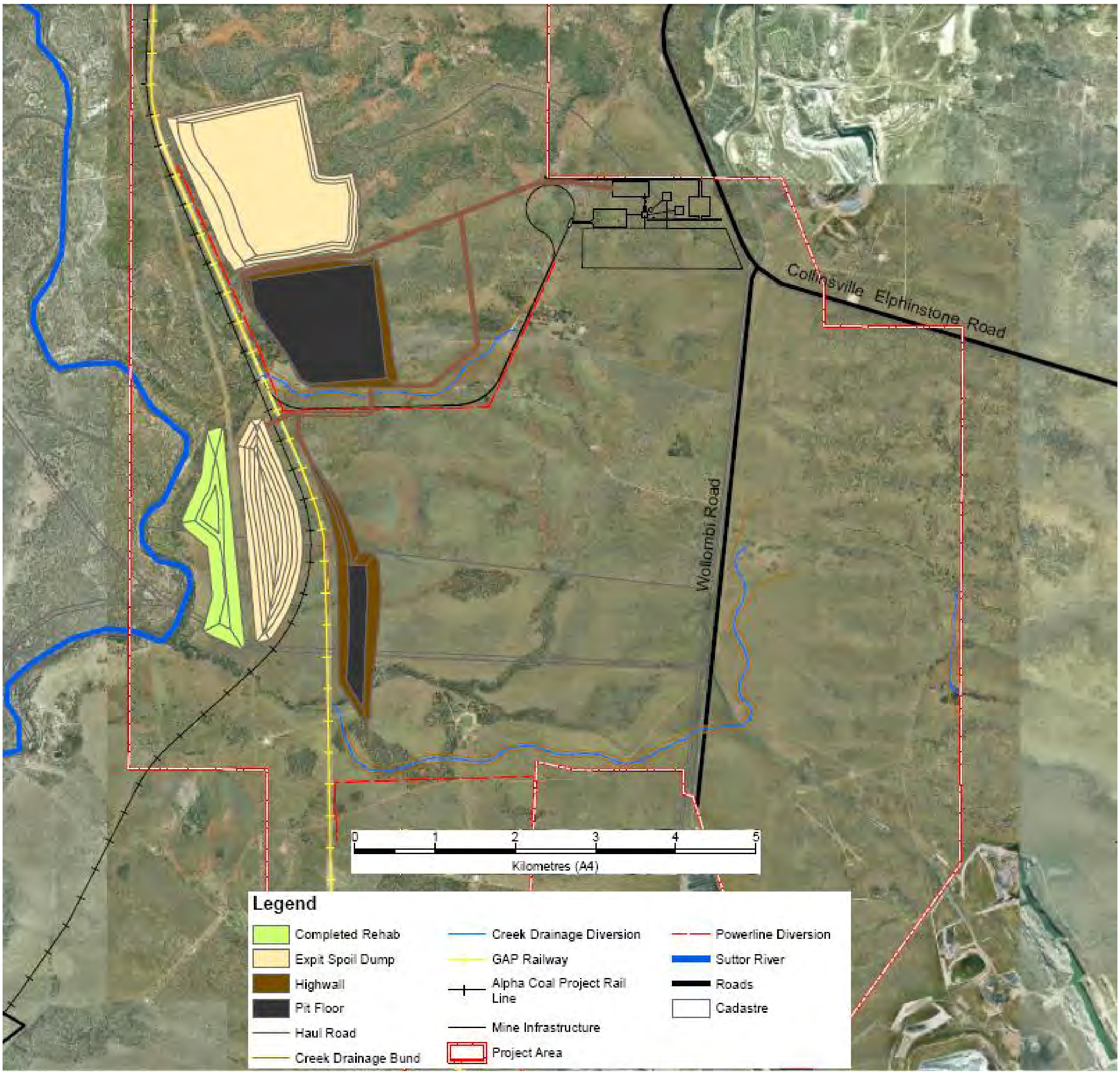

Figure 9: Mine Plan For Year 5 Showing Pits WP1 and SP1, Railway and Plant

Blasting

PEN3D contains a blasting module that includes the effects of meteorology. The basic equation for blast overpressure is:

dBL = 20*log(3557/0.00005) – 20*1.26*log(Distance) + 20 * 1.268 3* log(MIC) + 3

For a charge weight of 500 kg, the blast overpressure at 1000 m is 115 dB Lin peak. For vibration, the peak particle velocity is V = 2000*(Distance/(MIC)^0.5)^-1.6. For a charge weight of 500 kg, the peak vibration velocity at 1000 m is 4.6 mm/s. This assessment is based on a charge weight of 500 kg.

4.4 *Noise Modelling Results*

The noise models have been developed for the three mining stages for the fully operational project.

L_{A01} Noise Model

For the purpose of this assessment the L_{A01} is taken to be represented by the L_{Amax}. This model assumes that both the mining operations and the atmospheric propagation conditions remain constant throughout the modelling hour. This is a very conservative assumption, as in reality equipment operates through a complex cycle and the likelihood of all equipment emitting maximum noise levels at the same time is unlikely.

It is assumed that all mine plant and equipment operate as described in Section 4.3 throughout the day and night and for the entire year.

L_{Aeq} Noise Model

As mentioned previously, each item of equipment goes through a repeating short duration cycle representative of operations. The L_{Aeq} noise model incorporates the fluctuating noise levels to obtain the L_{Aeq} at the receiver. This is a mathematically correct analysis as it is independent of the time the noise is generated. However, it is also a conservative methodology as it requires the meteorology to remain constant for the entire hour (i.e. it ignores the small variations in a turbulent atmosphere that lead to variations of actual noise level below the calculated noise level).

L_{A10} Noise Model

The L_{A10} is taken to be 3 dB(A) above the L_{Aeq}, but no higher than the L_{A01}. It is has been observed the L_{A10} is greater than the L_{Aeq} and typically by about 3 dB(A) for most continuous and pseudo-continuous noise. This relationship is acknowledged in Australian Standards for traffic noise.

Appendix 2 contains charts of the hour by hour noise levels for selected (nearby) noise sensitive receptors and the calculation methodology. Calculations were carried out for almost 9000 meteorological cases representing the hourly meteorology over one year. The Appendix contains the calculated L_{Aeq} and L_{A01} for all meteorology cases and both mining cases. The hour-by-hour calculations were processed to obtain the highest L_{A01}(annual maximum), L_{A10}(annual maximum) and L_{Aeq}(annual maximum) in each time period (day, evening and night) for each sensitive receptor and presented in Table 20 for mining Case 1. Refer to Table 21 for mining Case 2 and Table 22 for Mining case 3. Also shown of these tables are the L_{Aeq}(Annual Average). This represents the highest L_{Aeq} (annual average) calculation during each modelling period.

Although the charts in Appendix 2 provide an hour-by-hour L_{A01} and L_{Aeq} noise levels over one year it is not to be assumed that that this will be the noise levels for the year. It must be recognised that this is a modelling scenario only. It is designed to test 'worst-case' noise levels with all equipment operating at maximum noise levels simultaneously in locations likely to lead to highest ambient noise levels. These 'worst-case' noise levels are then compared to the objectives and the likely impacts assessed.

Table 20: Calculated Noise Levels [dB(A)] for Each Sensitive Receptor Surrounding the Project - Mining Year 5

Location	**$L_{A01\ (1\ hour)}$ (Annual Maximum)**			**$L_{A10\ (1\ hour)}$ (Annual Maximum)**			**$L_{Aeq\ (1\ hour)}$ (Annual Maximum)**			**$L_{Aeq\ (1\ hour)}$ (Annual Average)**		
	Day	Eve.	Night	Day	Eve.	Night	Day	Eve.	Night	Day	Eve	Night[#1]
Objectives: Acoustic Quality	*50*	*50*	*45*	*45*	*45*	*40*	*40*	*40*	*35*	*40*	*40*	*35*
Background Creep												
Cerito Station Homestead	-	-	-	-	-	-	*36*	*30*	*28*	*36*	*30*	*28*
Byerwen and all other sensitive receptors	-	-	-	-	-	-	*28*	*28*	*28*	*28*	*28*	*28*
Glenden Township	18	13	15	18	13	15	16	15	13	0	0	0
R2 Suttor Creek Station Homestead	26	23	25	26	23	25	24	24	22	16	16	16
R3 Lancewood Station Homestead	21	19	20	21	19	20	18	17	17	12	13	13
R5 Cerito Station Homestead	30	29	29	30	29	29	28	27	27	21	23	23
R6 Byerwen Station Homestead	21	19	20	21	19	20	19	18	17	0	5	5
R7 Weetlaba Station Homestead	16	15	16	16	15	16	14	14	13	0	3	3
R8 Glenden Station Homestead	18	14	16	18	14	16	17	15	13	0	0	0
R10 Fig Tree Station Homestead	16	14	15	16	14	15	14	14	13	0	4	4

Note #1 The $L_{Aeq(Annual\ Average)}$ at night is equivalent to the WHO $L_{night,outside}$ with a goal of 30 to 35 dB(A).

Table 21: Calculated Noise Levels for Each Sensitive Receptor Surrounding the Project - Mining Year 17

Location	**$L_{A01\ (1\ hour)}$ (Annual Maximum)**			**$L_{A10\ (1\ hour)}$ (Annual Maximum)**			**$L_{Aeq\ (1\ hour)}$ (Annual Maximum)**			**$L_{Aeq\ (1\ hour)}$ (Annual Average)**		
	Day	Eve.	Night	Day	Eve.	Night	Day	Eve.	Night	Day	Eve	Night[#1]
Objectives: Acoustic Quality	*50*	*50*	*45*	*45*	*45*	*40*	*40*	*40*	*35*	*40*	*40*	*35*
Background Creep												
Cerito Station Homestead	-	-	-	-	-	-	*36*	*30*	*28*	*36*	*30*	*28*
Byerwen and all other sensitive receptors	-	-	-	-	-	-	*28*	*28*	*28*	*28*	*28*	*28*
Glenden Township	17	12	14	17	12	14	15	14	12	1	1	0
R2 Suttor Creek Station Homestead	25	22	24	25	22	24	23	24	22	15	16	16
R3 Lancewood Station Homestead	20	19	19	20	19	19	17	17	17	12	14	13
R5 Cerito Station Homestead	29	28	29	29	28	29	26	26	26	21	24	23
R6 Byerwen Station Homestead	22	21	22	22	21	22	19	20	19	0	6	6
R7 Weetlaba Station Homestead	17	16	17	17	16	17	14	15	14	0	5	4
R8 Glenden Station Homestead	17	13	15	17	13	15	16	15	13	2	1	1
R10 Fig Tree Station Homestead	17	16	17	17	16	17	14	15	14	0	6	5

Note #1 The $L_{Aeq(Annual\ Average)}$ at night is equivalent to the WHO $L_{night,outside}$ with a goal of 30 to 35 dB(A).

Table 22: Calculated Noise Levels for Each Sensitive Receptor Surrounding the Project - Mining Year 36

Location	$L_{A01\ (1\ hour)}$ **(Annual Maximum)**			$L_{A10\ (1\ hour)}$ **(Annual Maximum)**			$L_{Aeq\ (1\ hour)}$ **(Annual Maximum)**			$L_{Aeq\ (1\ hour)}$ **(Annual Average)**		
	Day	Eve.	Night	Day	Eve.	Night	Day	Eve.	Night	Day	Eve	Night#1
Objectives: Acoustic Quality	*50*	*50*	*45*	*45*	*45*	*40*	*40*	*40*	*35*	*40*	*40*	*35*
Background Creep												
Cerito Station Homestead	-	-	-	-	-	-	*36*	*30*	*28*	*36*	*30*	*28*
Byerwen and all other sensitive receptors	-	-	-	-	-	-	*28*	*28*	*28*	*28*	*28*	*28*
Glenden Township	19	15	18	19	15	18	18	18	15	5	4	3
R2 Suttor Creek Station Homestead	28	26	29	28	26	29	26	27	26	13	14	14
R3 Lancewood Station Homestead	21	19	21	21	19	21	18	18	18	13	14	14
R5 Cerito Station Homestead	29	28	29	29	28	29	27	27	26	20	23	23
R6 Byerwen Station Homestead	19	18	19	19	18	19	18	18	17	5	9	8
R7 Weetlaba Station Homestead	15	14	15	15	14	15	13	14	13	1	6	5
R8 Glenden Station Homestead	20	16	19	20	16	19	19	18	16	6	5	4
R10 Fig Tree Station Homestead	15	13	14	15	13	14	14	13	12	0	4	4

Note #1 The $L_{Aeq(Annual\ Average)}$ at night is equivalent to the WHO $L_{night,outside}$ with a goal of 30 to 35 dB(A).

Typical adverse noise levels are contained in Figure 10 to Figure 13 and are based on the adverse night modelling cases contained in Table 14.

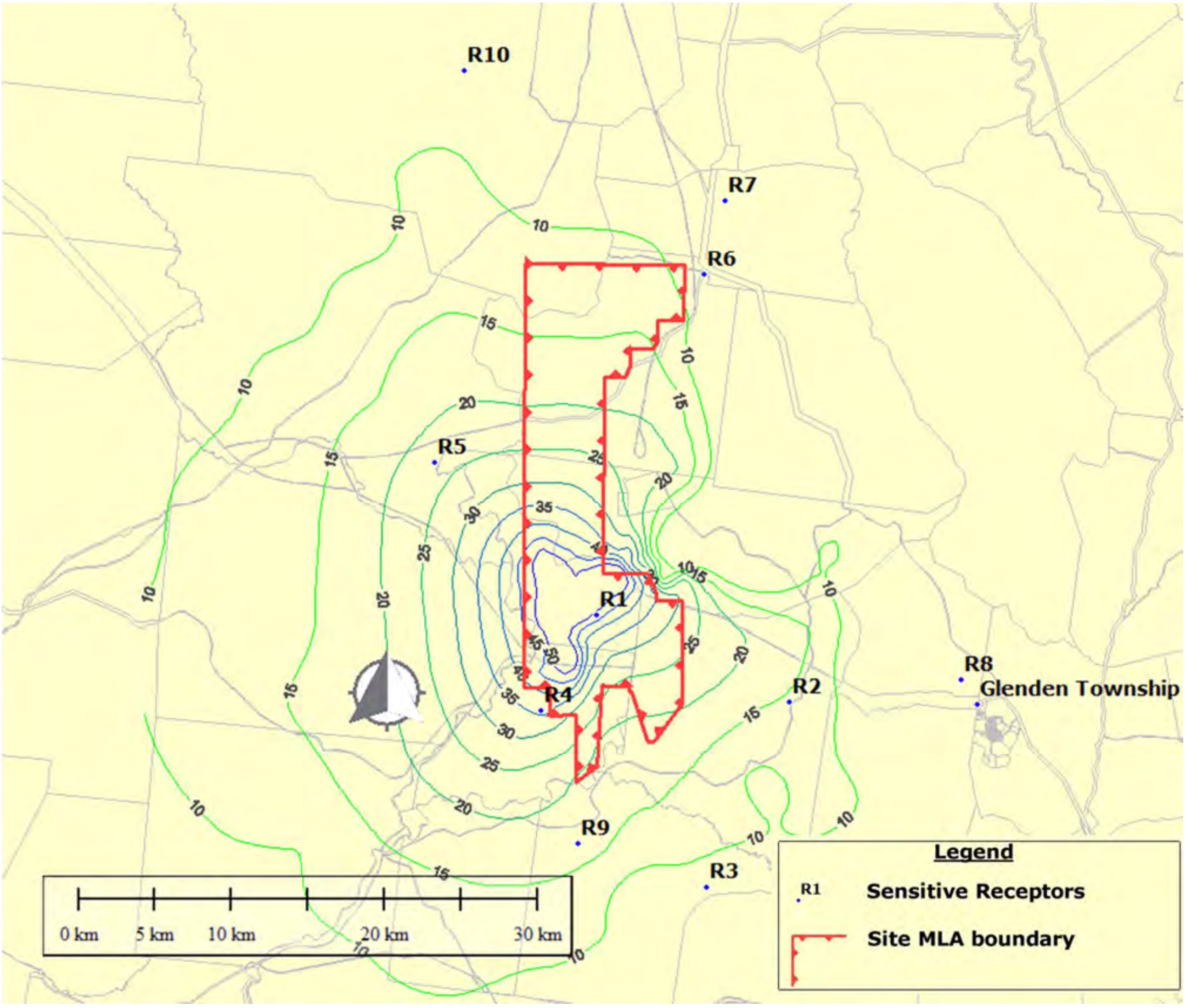

Figure 10: L_{Aeq} Noise Level For Night With East Wind - Mining Year 05

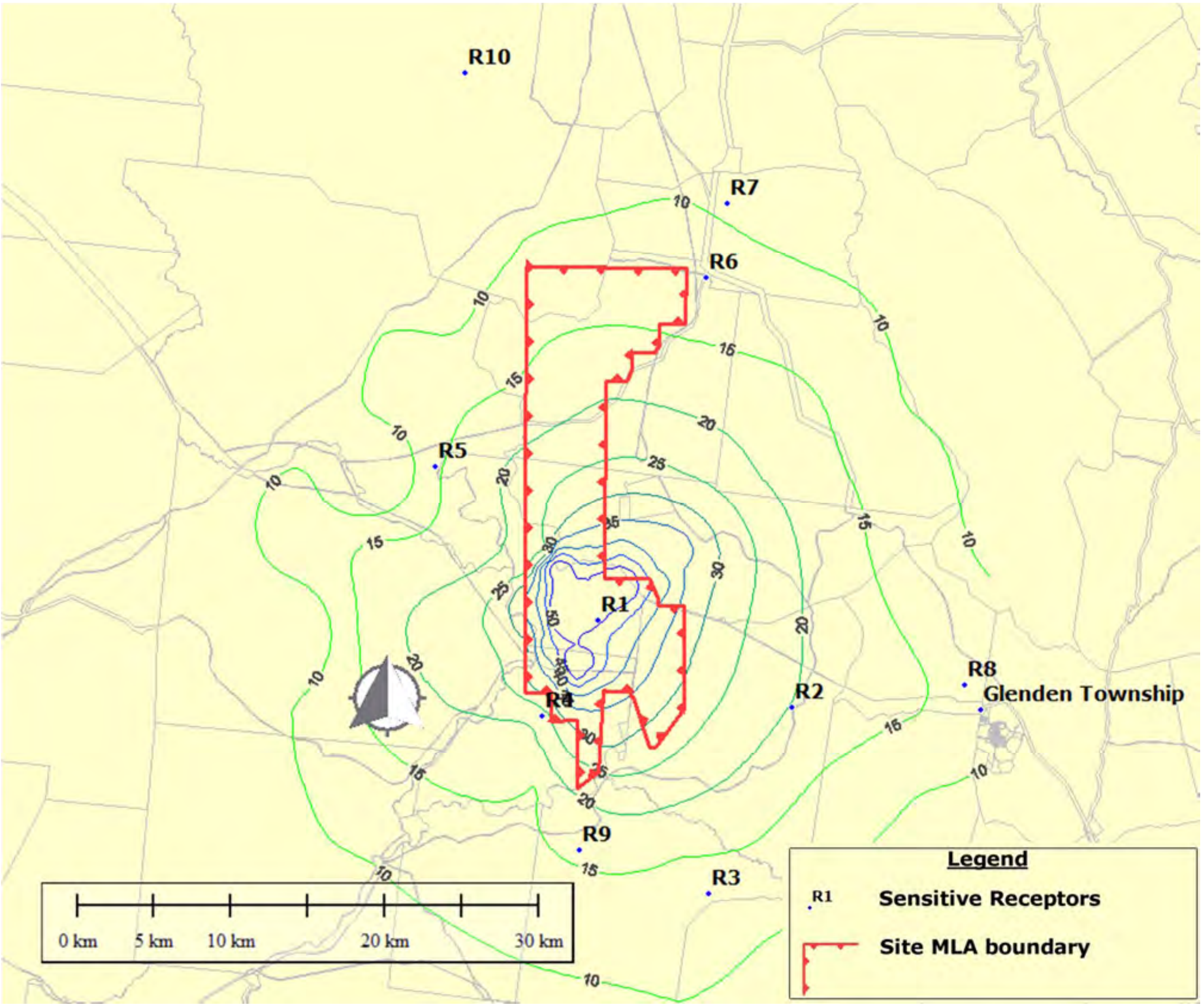

Figure 11: L_{Aeq} Noise Level For Night With West Wind - Mining Year 05

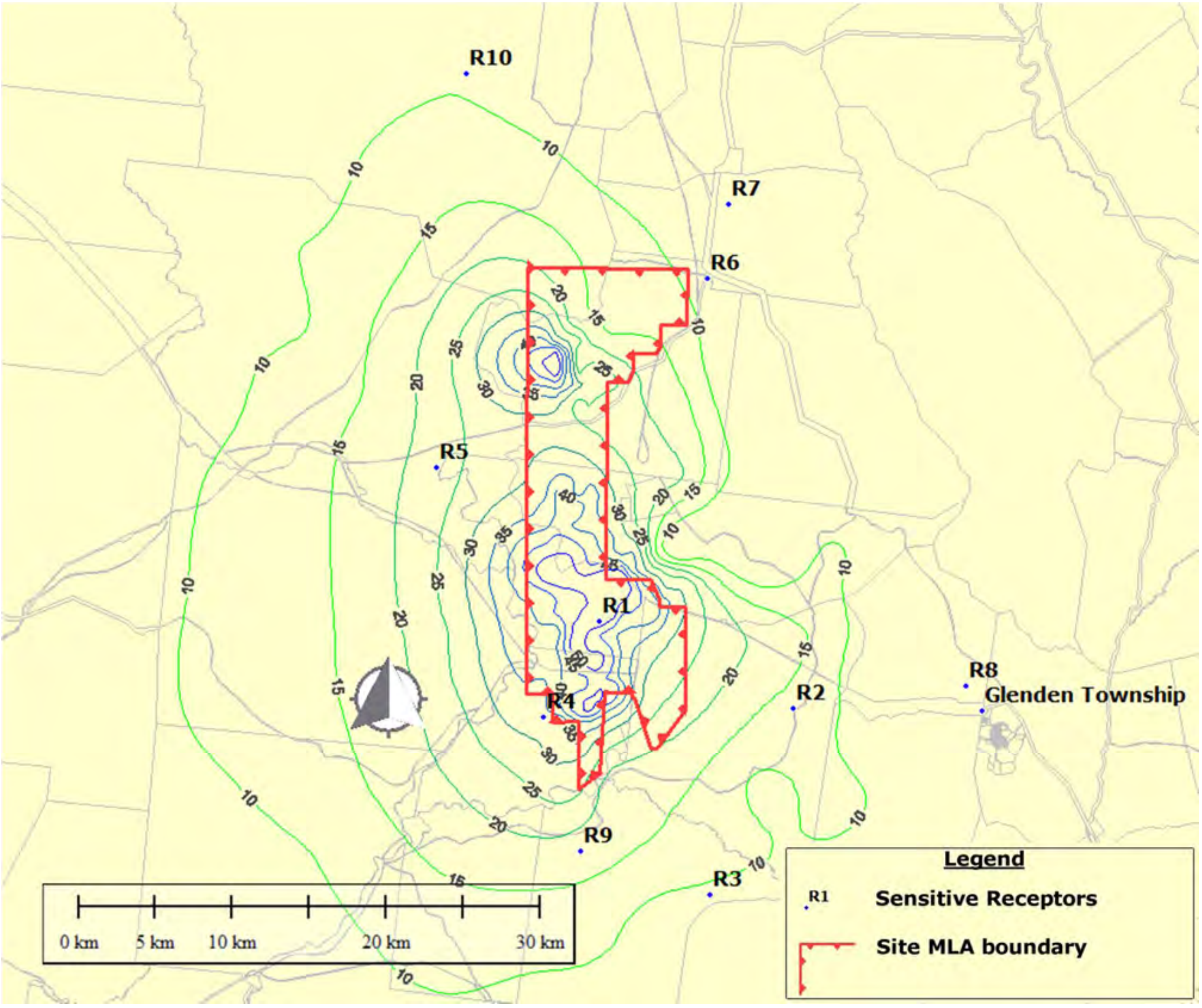

Figure 12: L_{Aeq} Noise Level For Night With East Wind - Mining Year 17

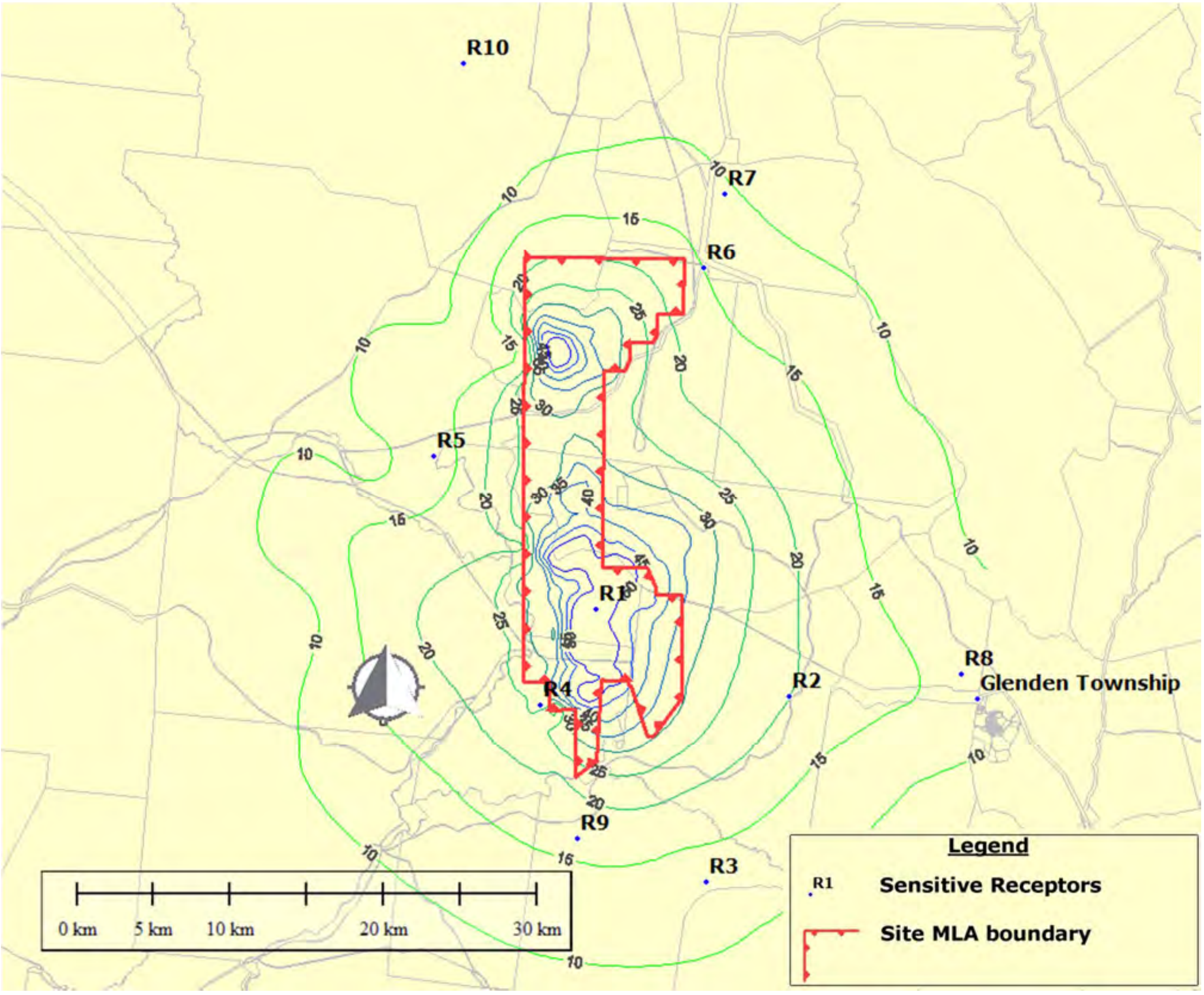

Figure 13: L_{Aeq} Noise Level For Night With West Wind - Mining Year 17

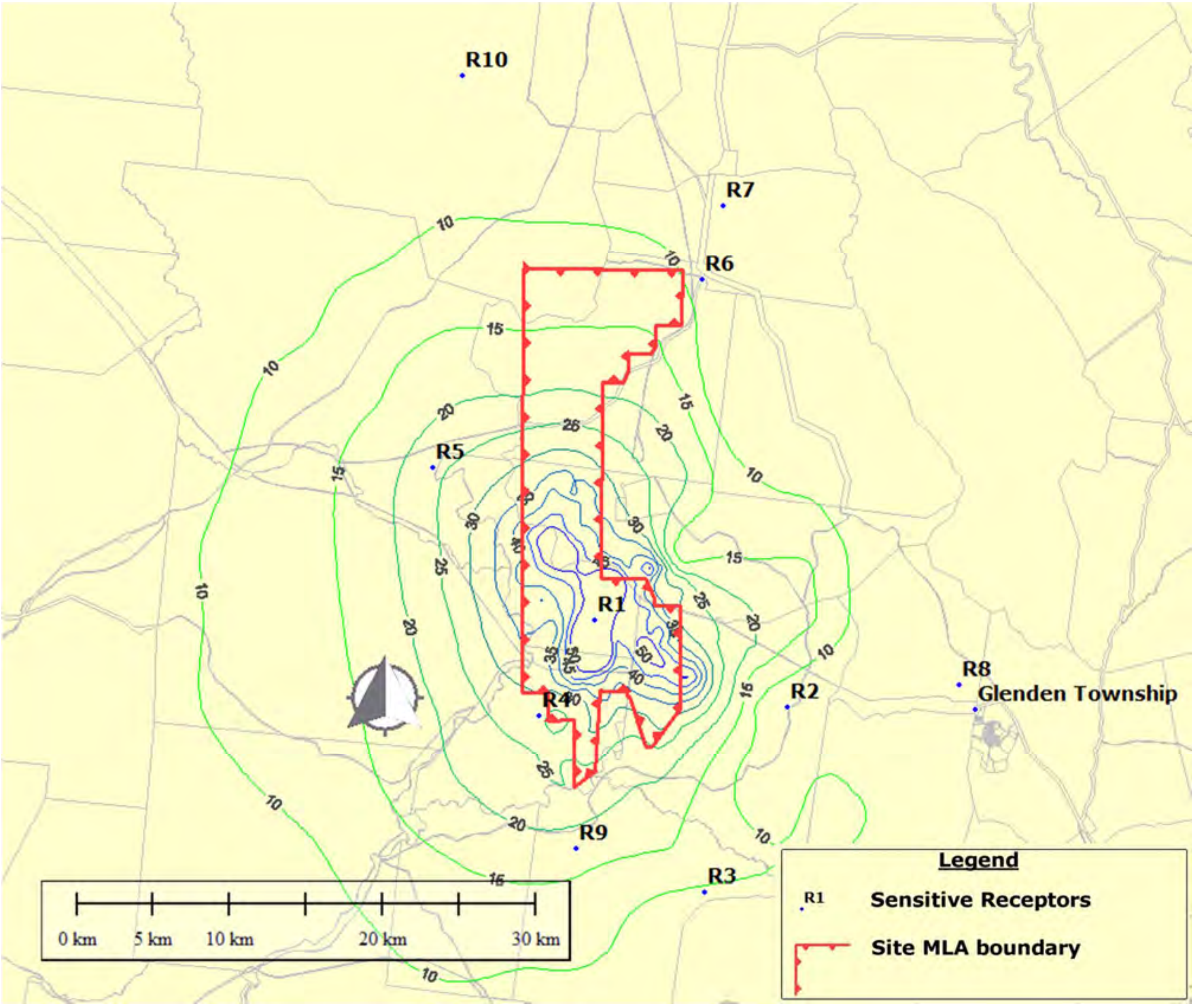

Figure 14: L_{Aeq} Noise Level For Night With East Wind - Mining Year 36

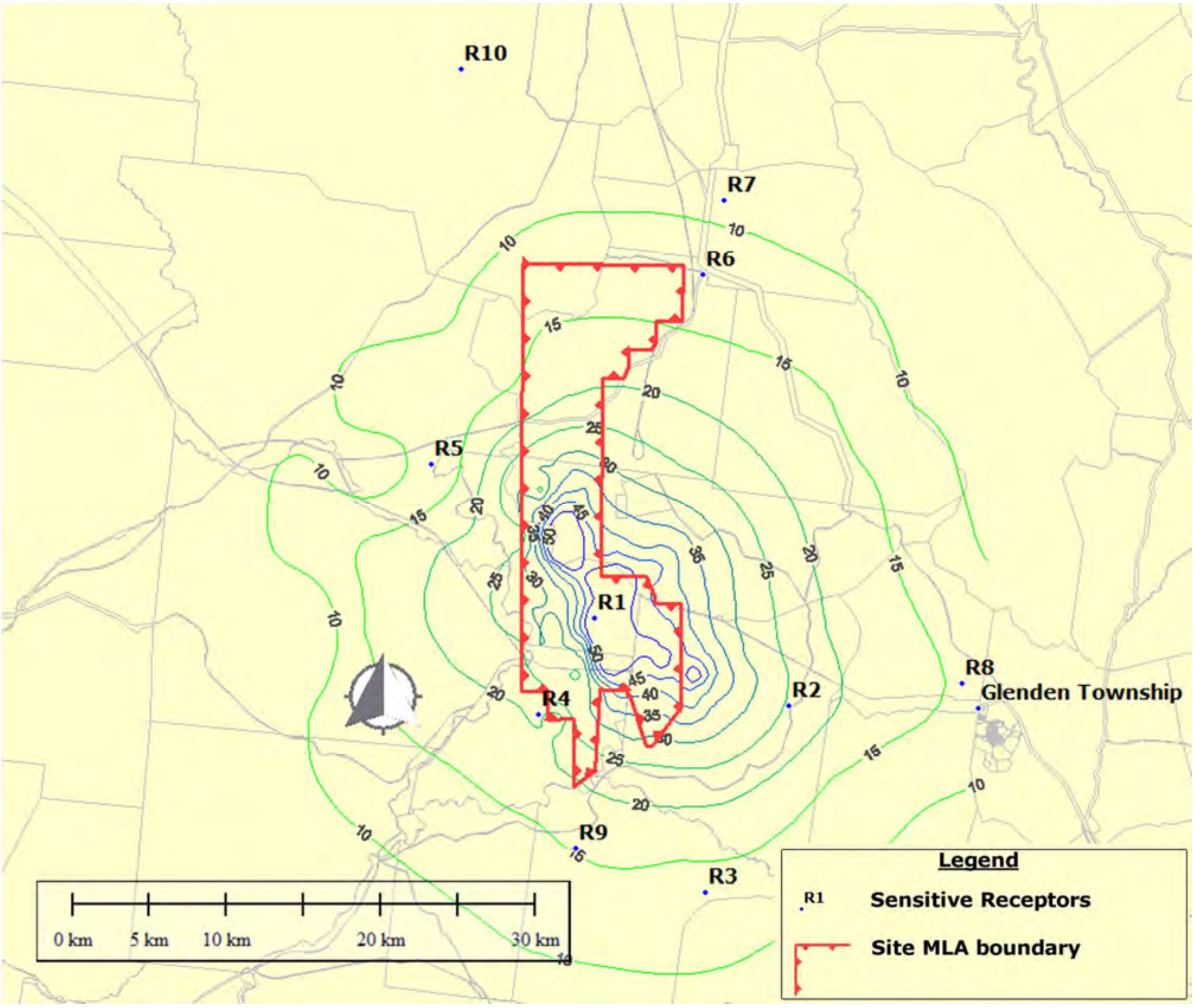

Figure 15: L_{Aeq} Noise Level For Night With West Wind - Mining Year 36

Table 23: Low Frequency Noise Levels at Night [dB(Lin)] for Mining Years 5, 17 and 36.

Location	Low Frequency Noise Level $L_{Aeq(1\ hour)}$ [dB(Lin)]		
	Year 5	**Year 17**	**Year 36**
Objective	**50**	**50**	**50**
Glenden Township	32.0	32.7	33.6
R2 Suttor Creek Station Homestead	38.5	39.2	39.9
R3 Lancewood Station Homestead	34.8	35.4	35.5
R5 Cerito Station Homestead	39.9	40.5	40.7
R6 Byerwen Station Homestead	33.8	35.0	34.9
R7 Weetlaba Station Homestead	31.5	32.6	32.4
R8 Glenden Station Homestead	32.5	32.9	33.8
R10 Fig Tree Station Homestead	28.5	29.6	29.2

Blast Overpressure and Vibration

The blast overpressure and vibrations at all sensitive receptors is contained in Table 24. For a MIC of 500 kg, the blast overpressure and vibration level goals are readily met at all sensitive receptors, including the accommodation village. Contours of the blast vibration and blast over pressure are contained in:

- Figure 16: Vibration Velocity (Peak Particle Velocity) in mm/s for Mining Year 5 with 500 kg MIC;
- Figure 17: Peak Sound Pressure Levels in dBLin for Mining Year 5 with 500 kg MIC;
- Figure 18: Vibration Velocity (Peak Particle Velocity) in mm/s for Mining Year 17 with 500 kg MIC;
- Figure 19: Peak Sound Pressure Levels in dBLin for Mining Year 17 with 500 kg MIC
- Figure 20: Vibration Velocity (Peak Particle Velocity) in mm/s for Mining Year 36 with 500 kg MIC; and,
- Figure 21: Peak Sound Pressure Levels in dBLin for Mining Year 36 with 500 kg MIC.

Table 24: Predicted Noise and Vibration Levels from Blasting at the project (for 500 kg MIC)

Location	Mining Year 5 Vibration and Blast Overpressure		Mining Year 17 Vibration and Blast Overpressure		Mining Year 36 Vibration and Blast Overpressure	
	Blast Overpressure [dBLin]	**Vibrations [mm/s]**	**Blast Overpressure [dBLin]**	**Vibrations [mm/s]**	**Blast Overpressure [dBLin]**	**Vibrations [mm/s]**
Objective	**115**	**5**	**115**	**5**	**115**	**5**
Glenden Township	<80	<0.5	<80	<0.5	<80	<0.5
R2 Suttor Creek Station Homestead	90	<0.5	92	<0.5	90	<0.5
R3 Lancewood Station Homestead	88	<0.5	98	<0.5	98	<0.5
R5 Cerito Station Homestead	92	<0.5	106	<0.5	108	<0.5
R6 Byerwen Station Homestead	80	<0.5	96	<0.5	96	<0.5
R7 Weetlaba Station Homestead	<70	<0.5	96	<0.5	94	<0.5
R8 Glenden Station Homestead	<80	<0.5	<80	<0.5	<80	<0.5
R10 Fig Tree Station Homestead	70	<0.5	98	<0.5	95	<0.5

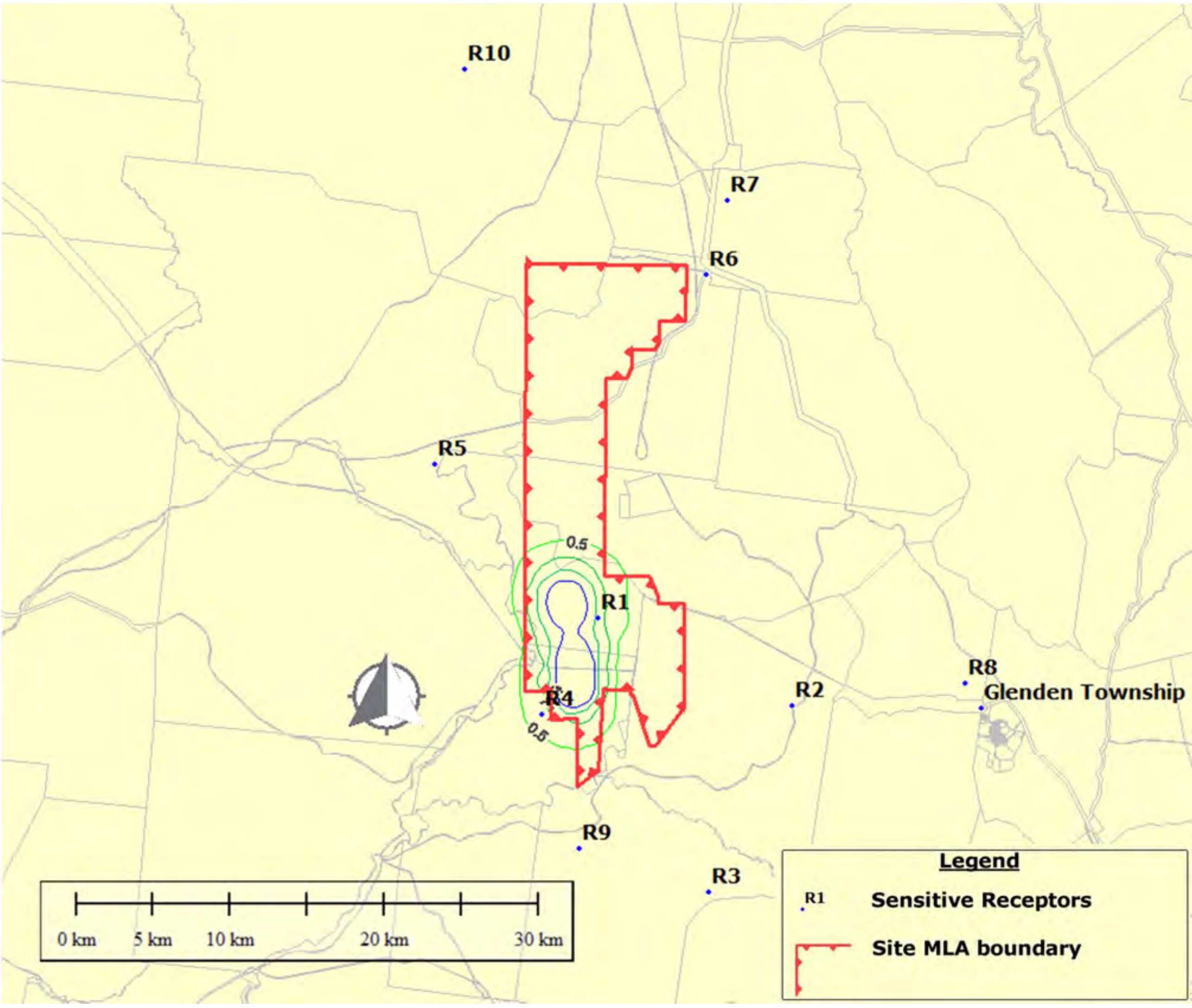

Figure 16: Vibration Velocity (Peak Particle Velocity) in mm/s for Mining Year 5 with 500 kg MIC

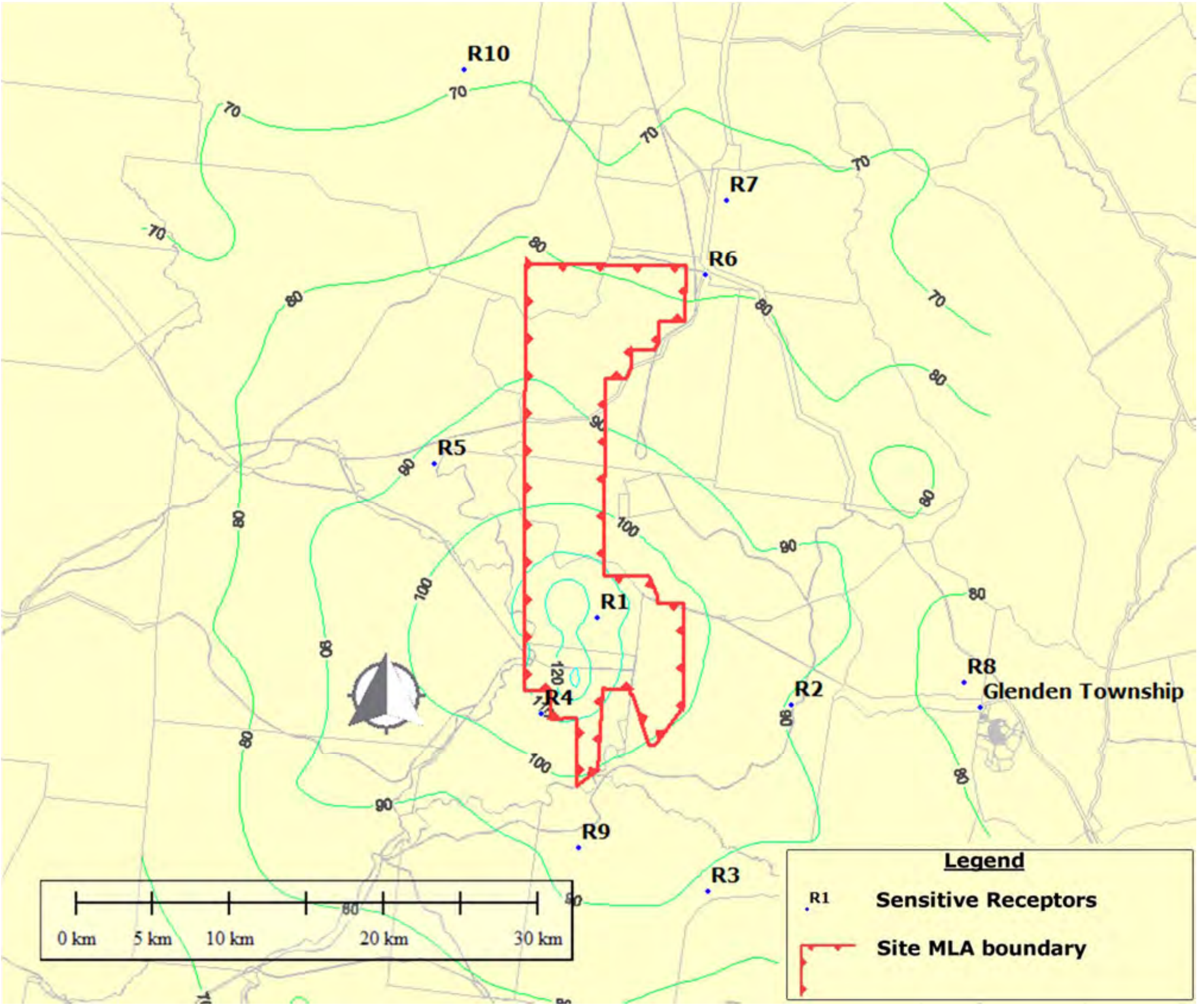

Figure 17: Peak Sound Pressure Levels in dBLin for Mining Year 5 with 500 kg MIC

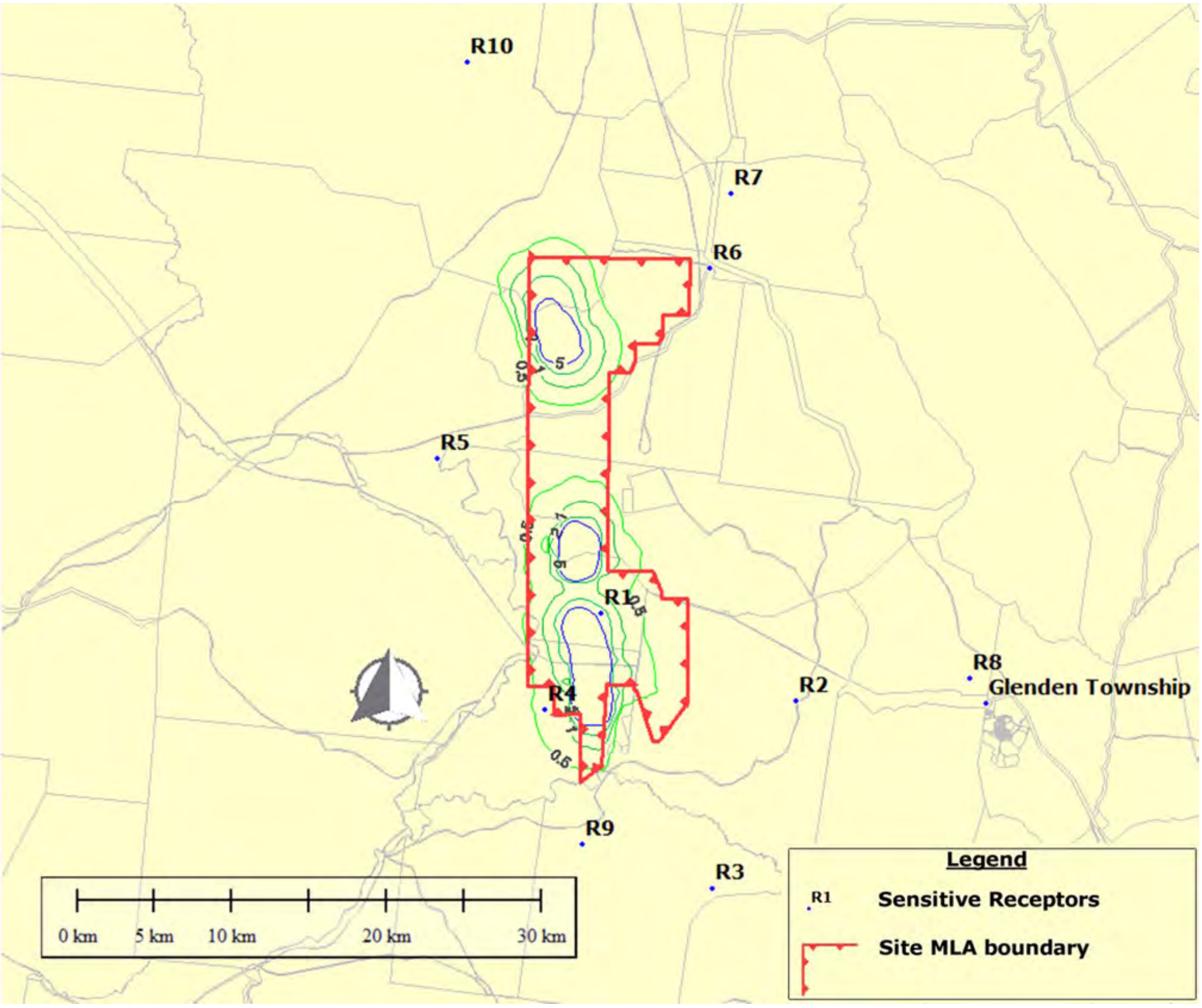

Figure 18: Vibration Velocity (Peak Particle Velocity) in mm/s for Mining Year 17 with 500 kg MIC

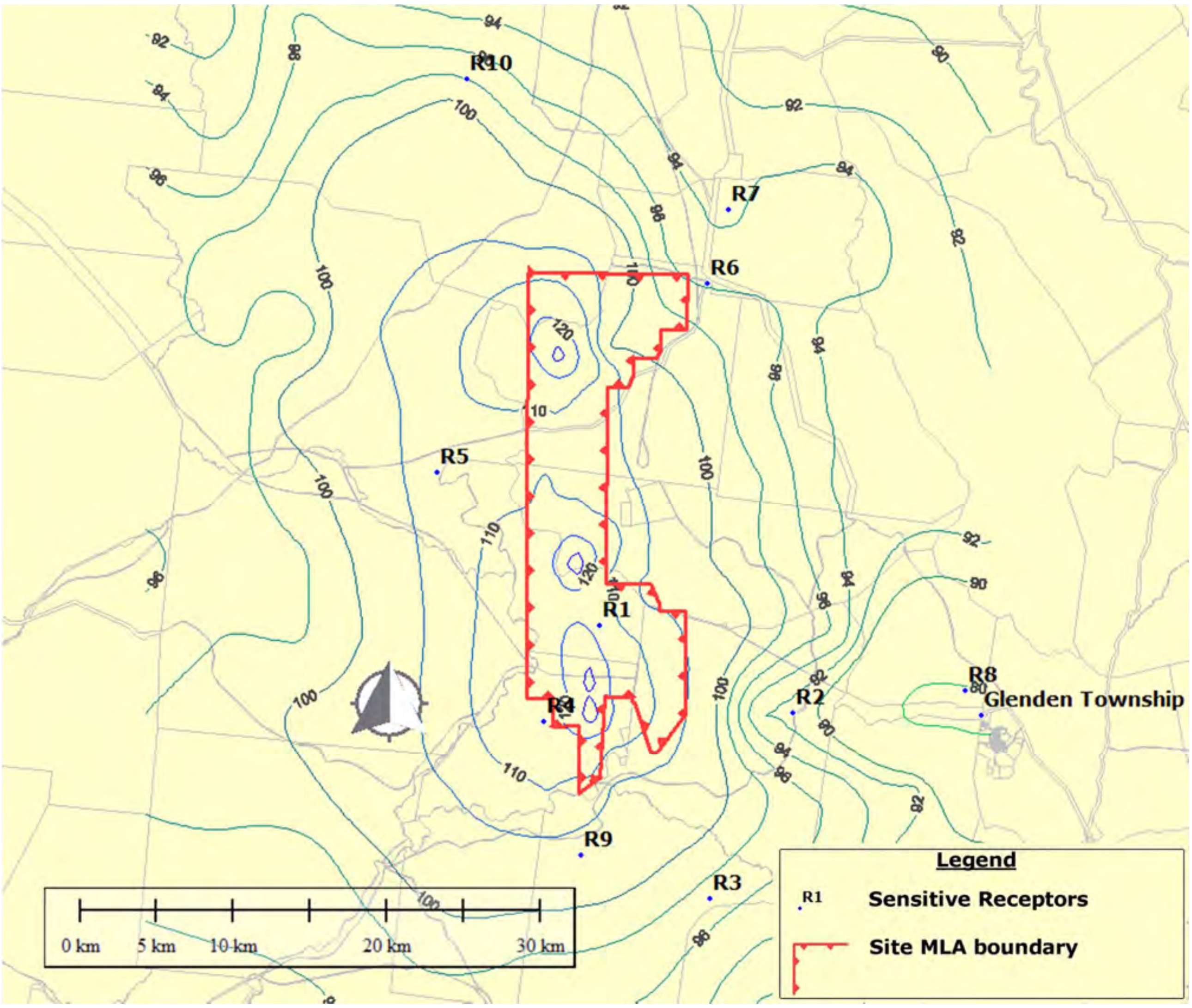

Figure 19: Peak Sound Pressure Levels in dBLin for Mining Year 17 with 500 kg MIC

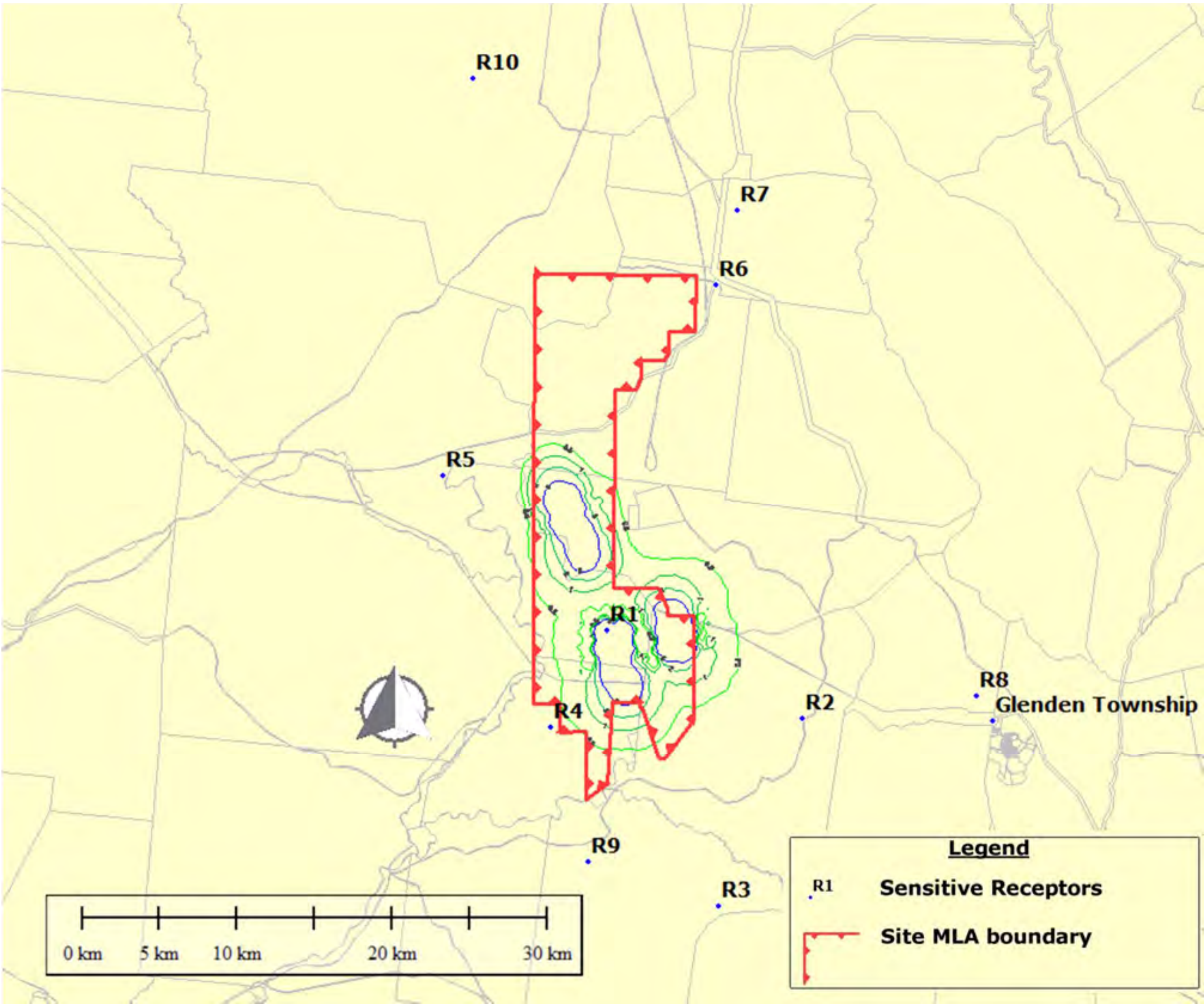

Figure 20: Vibration Velocity (Peak Particle Velocity) in mm/s for Mining Year 36 with 500 kg MIC

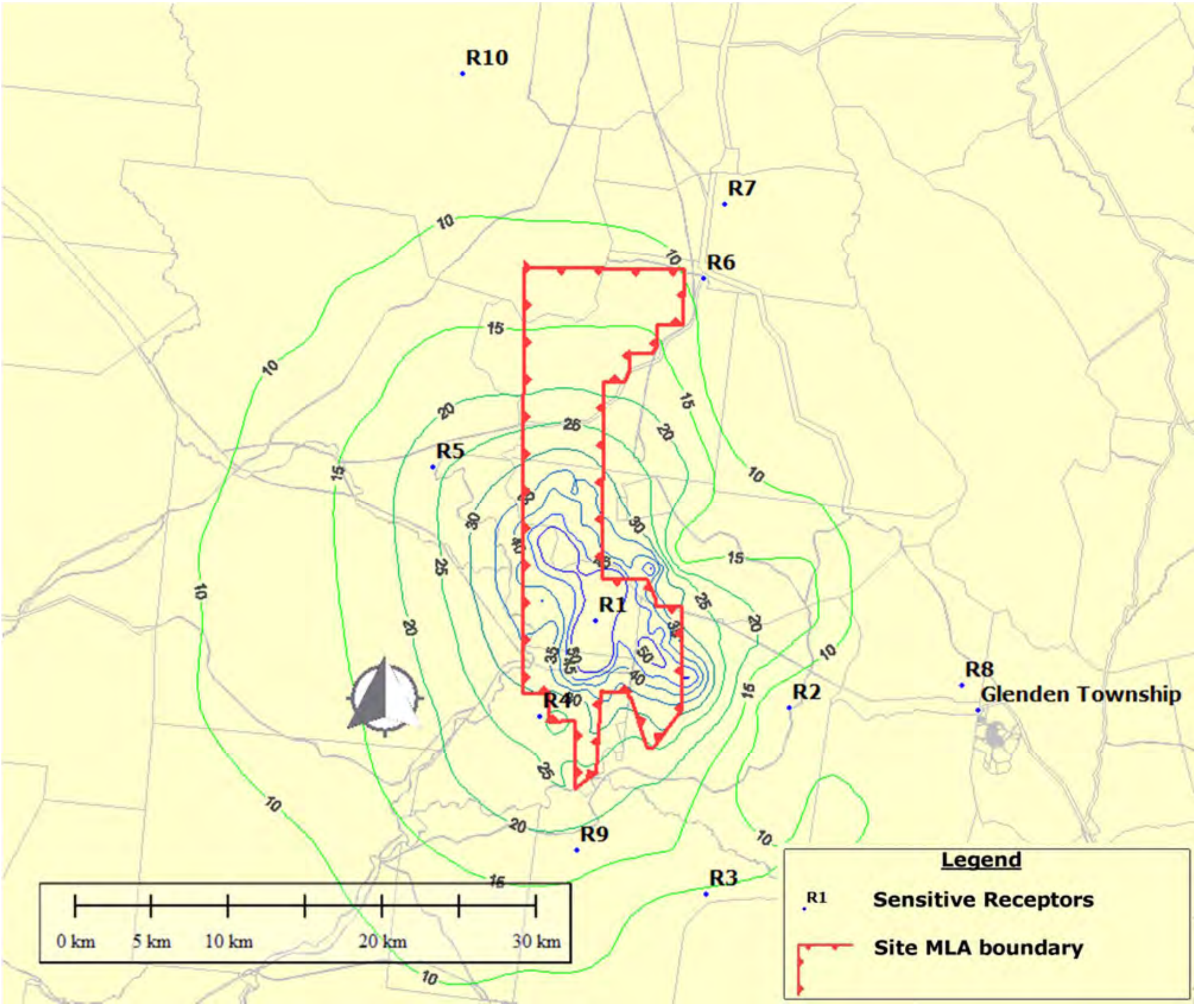

Figure 21: Peak Sound Pressure Levels in dBLin for Mining Year 36 with 500 kg MIC

4.5 ***Railway Noise***

Two proposed rain loading facilities (including rail spur and balloon loop) will be constructed off the Goonyella to Abbott Point (GAP) rail line which intersects the project.

It is beyond the scope of this assessment to address the noise emissions for the entire rail line route. Only noise from the rail spur and balloon loop is assessed in this report.

The noise levels from diesel electric trains in the Savery & Associates (2011) assessment has been based on a survey of existing diesel electric coal trains. The noise levels comprise:

- L_{Amax} of 117 dB(A) (sound power level);
- L_{Aeq} of 72 dB(A) per lineal metre for 15 Mtpa.

The likely noise levels from trains is shown in Figure 22 and Figure 23 for the maximum noise level and the $L_{Aeq(24\ hour)}$ respectively. Tight-radius curves are likely to generate wheel squeal. Wheel squeal is a high-pitched noise caused by a slip-stick movement of the wheels in tight-corners having radius of less than about 100 times the bogie wheelbase (FTA 2006). It is understood that most bogies on QR wagons are shorter than approximately 1.8m. Thus wheel-squeal is unlikely to occur on the curves having a radius of at least 180m. It is understood all the curves associated with the balloon track have a radius of more than 180m.

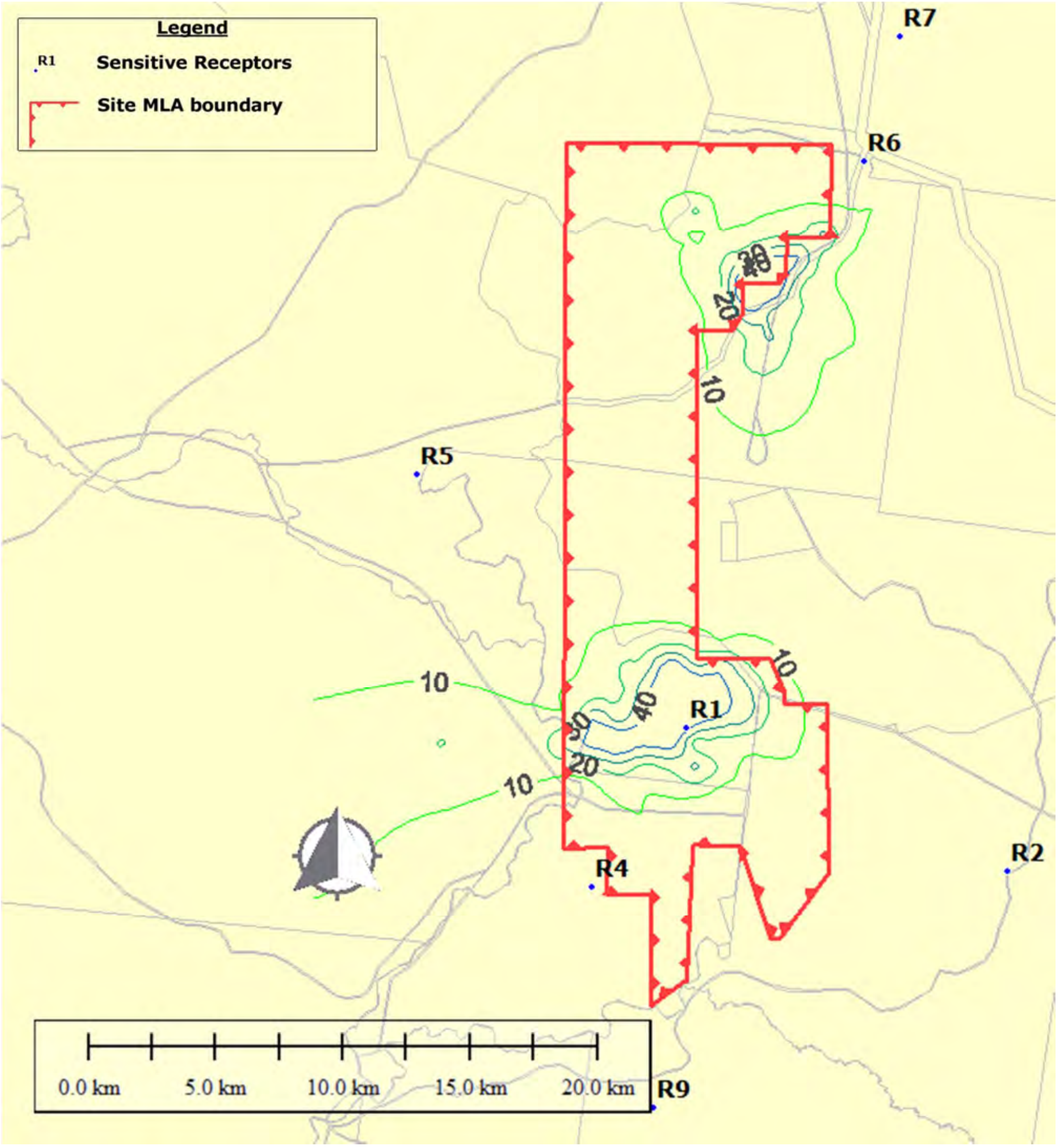

Figure 22: Calculated Maximum Noise Levels from Operation of the TLFs [dB(A)]

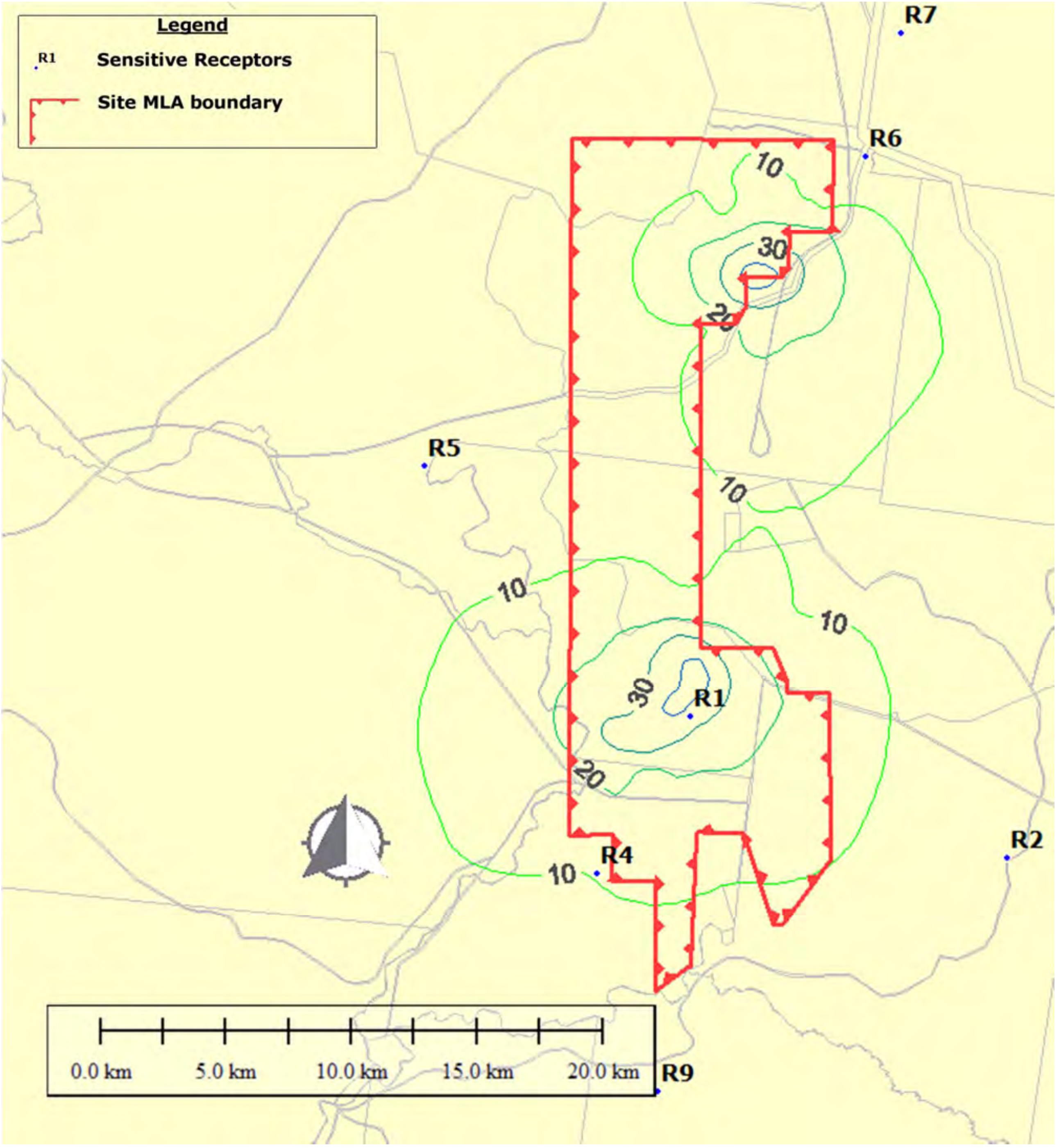

Figure 23: Calculated $L_{Aeq(24\ hour)}$ from Operation of the TLFs [dB(A)]

4.6 ***Road Traffic Noise***

The road access to the mine will occur through Collinsville-Elphinstone Road via two new proposed at grade intersections, one located to access the northern end of the site and the second to access the southern end of the site. The traffic generated by the development will vary through the stages of the mine operation and construction. The proponent anticipates that the workforce will reside in Glenden.

The traffic report prepared by Lambert & Rehbein "Byerwen Coal Project - Transport Impact Assessment Report" For Byerwen Coal Pty Ltd has assessed all roads likely to be affected by increased traffic. Their analysis has shown that the maximum increase in traffic is 10.5% for the route between site and Glenden, known as Collinsville-Elphinstone road (south of development). A 10.5% increase in traffic will lead to a 0.6 dB(A) increase in traffic noise along the route.

5. Noise Assessment

EPP (Noise) Acoustic Quality Objectives

The modelling methodology adopted for this assessment has been designed to model the L_{A01}, L_{A10} and L_{Aeq} as required by the EPP (Noise). The EPP (Noise) sets acoustic quality objectives to protect human health and wellbeing and are mostly indoor nose levels. The modelled noise levels generated by the project comply with the acoustic quality objectives during the day, evening and night at all sensitive receptors.

EPP (Noise) Sleep Disturbance

The EPP (Noise) contains goals to protect the qualities that are conducive to sleep. The noise modelling shows that at all times the indoor noise level goals to protect sleep disturbance are met at all locations.

EPP (Noise) Background Creep

The EPP (Noise) (in conjunction with the Ecoaccess Guideline "Planning For Noise Control") contains a methodology to avoid background creep and the goal is related to the background noise level. It is noted that some of the rural areas surrounding the project are very quiet. In these circumstances the methodology permits a minimum background noise level of 25 dB(A).

The modelling shows that the calculated noise levels in Glenden and all off-site Homesteads comply with the goals to avoid background creep for all time periods.

The enHealth Council (2004) document provides a review of the health effects, other than hearing loss, of environmental noise and reviews measures aimed at the management of environmental noise. The document addresses annoyance and quality of life, sleep disturbance, performance and learning with school children, cardio vascular disease, mental health and neuro-physiological stress. The goals adopted in this report comply with all aspects of this document as do the predicted noise levels from the project.

DERM Low Frequency Noise

The low-frequency noise level goals are expected to be met at all off-site sensitive receptors.

DERM Blasting Noise and Vibration

The recommended vibration goal of 5mm/s PPV, from the Queensland Ecoaccess guideline, is met at all sensitive receptors. This goal is designed to avoid the adverse impacts for occupiers at sensitive receptors.

The vibration limits from the Environmental Protection Act (1994) is also met at all sensitive receptors.

The vibration limits designed to avoid cosmetic damage to lightweight structures is also met at all structures.

Finally the vibration limits to avoid damage to underground pipelines is significantly higher and met within a few hundred meters of the blasting area. However, to protect these structures from excessive vibration, it is recommended that if blasting encroaches within 1km of the North Queensland gas pipeline or the SunWater pipeline that the blast vibrations be monitored to demonstrate compliance.

Railway Noise

Due to the large separation distances between the railway and sensitive receptors, all sensitive receptors readily comply with the QR noise level goals for railways.

Road Traffic Noise

The generation of road traffic by the site is minor leading to a maximum increase of less than 1 dB(A) at the most adversely affected road. This is considered a minor increase in traffic noise and complies with the project noise level goals for road traffic noise.

WHO European Night Time Goal

The annual average night noise levels are presented in Table 20, Table 21 and Table 22 for the three modelling cases respectively. The highest predicted $L_{night,\ outside}$ is 23 for Cerito Station Homestead. With a goal between 30 to 35 dB(A) all locations comply with the WHO European night time goal.

Critical Habitat

The EPP (Noise) has acoustic quality objectives (measured at the receptor) for areas identified as a critical habitat or an area of major interest under a conservation plan under the Nature Conservation Act. There are no assessable areas close to the proposed mine and or infrastructure.

However, the Acoustic Quality Objectives are a level of noise that preserves the amenity of the existing area or place. The existing amenity is not just defined by the background noise level but by the fluctuating noise that occurs naturally. Referring to Figure 6, a chart of the noise level on the subject site reveals that the existing noise levels vary between about 25 dB(A) and up to 70 dB(A). These measurements were obtained at the quieter times of the year. During the warmer months, when insect noise dominates, the distribution of noise is completely different and much louder.

The modelling methodology adopted for this project has focussed on identifying the highest noise levels likely from the operation of mine using a set of assumptions that should result in a conservatively high noise level. However, the noise levels from the mine will fluctuate with load and movement of the mobile plant. In addition as the pit depths increase the noise levels in the area immediately surrounding the pit or behind overburden dumps will be significantly quieter than that modelled.

Therefore assuming these conservative assumptions adopting a maximum noise level of 50 dB(A) from individual items of plant to comprise the commencement of a zone of adverse influence, i.e. 20 decibels below the maximum noise level as measured on site. Based on the maximum noise levels from mobile plant, Table 17, a noise level of 50 dB(A) would be met at 300m to 500m from the mobile plant.

Potential impact on wildlife due to changes in noise is addressed in the ecological studies undertaken as part of this EIS (Terrestrial Ecology Impact Assessment AMEC 2012).

5.1 Cumulative Impacts

This assessment has adopted the "Background Creep" goal as one of the primary noise targets. One of the background creep objectives is that the acoustic environment not be permitted to deteriorate. This implies that, should a mine or other development undertake a noise assessment at any of the sensitive receptors identified in this report then the noise level goal developed for that study would be the same or very similar to that developed for this report.

This study has demonstrated that the operational noise levels readily comply with the background creep noise level goal at all sensitive receptors. Hence future developments are not adversely affected from a noise perspective.

6. Conclusion

Existing noise levels were measured at several homesteads surrounding the project. The noise levels at all the homesteads are low and industrial or commercial noise is not currently a feature of the existing noise levels at the homesteads.

The EPP (Noise) was reviewed for applicability and the acoustic quality objectives were considered relevant. These objectives are designed to preserve the health and wellbeing of the occupants of the homesteads. It was found that the EPP (Noise) noise goals for background creep were more stringent than the acoustic quality objectives and these goals, particularly at the homesteads, are the most stringent noise level goals possible in Queensland.

This report has provided a methodology to predict the L_{01}, L_{A10} and L_{Aeq} for every hour over a full one year modelling simulation (almost 9000 meteorological cases were modelled). The methodology assumes worst case operations to calculate these parameters. Whilst each sensitive receptor has been assessed based on a full year of calculations, two meteorological cases were selected for presentation of contours. These cases represent the more adverse meteorology at night, one featuring an easterly wind (the most common case) and the other featuring the less common westerly wind.

EPP (Noise) Acoustic Quality Objectives

The EPP (Noise) acoustic quality objectives to protect human health and wellbeing are met at all locations with wide open windows.

EPP (Noise) Sleep Disturbance

The EPP (Noise) sleep disturbance goals are met at all locations with wide open windows.

EPP (Noise) Background Creep

The calculated noise levels at all off-site sensitive receptors comply with the noise level goals to avoid background creep for all time periods.

DERM Low Frequency Noise

The low-frequency noise level goals are expected to be met at all off-site sensitive receptors.

DERM Blasting Noise and Vibration

The blasting contours vibration levels are expected to be met at all off-site sensitive receptors for a MIC of 500 kg. It is recommended that if blasting encroaches within 1km of the North Queensland gas pipeline or the SunWater pipeline that the blast vibrations be monitored to demonstrate compliance.

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Railway Noise

Due to the large separation distances between the railway and sensitive receptors, all sensitive receptors readily comply with the QR noise level goals for railways.

Road Traffic Noise

The generation of road traffic by the site is minor leading to a maximum increase of less than 1 dB(A) at the most adversely affected road. This is considered a minor increase in traffic noise and complies with the project noise level goals for road traffic noise.

WHO European Night Time Goal

the WHO European night time goal are calculated to be met at all off-site sensitive receptors.

Glossary of Acoustical Terms

$L_{A10,t}$	The L_{A10} is the "A"-weighted statistical noise level exceeded 10% of the time. Commonly accepted time periods (t) include 10 minutes, 15 minutes, 30 minutes, 60 minutes and 24 hours. It is sometimes referred to as the average maximum noise level.
$L_{A90,t}$	The L_{A90} is the "A"-weighted statistical noise level exceeded 90% of the time. Commonly accepted time periods (t) include 10 minutes, 15 minutes, 30 minutes, 60 minutes and 24 hours. It is commonly referred to as the background noise level.
$L_{Aeq,t}$	The L_{Aeq} is the "A"-weighted energy average noise level over the time in question. It is the constant noise level containing the same energy as the actual fluctuating noise level. Commonly accepted time periods (t) include 10 minutes, 15 minutes, 30 minutes, 60 minutes and 24 hours.
Day	Refers to the period between 6 am and 6 pm.
Evening	Refers to the period between 6 pm and 10 pm.
Night	Refers to the period between after 10 pm and before 6 pm.
Ambient noise	The all-encompassing noise associated within a given environment. It is the composite of sounds from many sources, both near and far.
Assessment background level (ABL)	The single-figure background level representing each assessment period–day, evening and night (i.e. three ABLs are determined for each 24 hour period of the monitoring period). ABL is a measure of background noise level in the absence of noise from the source. Determination of the ABL is by the tenth percentile method, i.e. sort the recorded hourly LA90's into ascending order and select the are the lowest ten percentile level.
Rating background level (RBL)	The overall single-figure background level representing each assessment period (day/evening/night) over the whole monitoring period (as opposed to over each 24 hour period used for the ABL). It is the median value of the ABL's.
Free field	A position where there are no reflecting surfaces, other than the ground, close enough to influence the sound pressure level. Taken as a minimum of 1.2 metres above ground level and 4m from the closest building façade.
Noise floor	The noise floor, inherent or 'self-noise' of sound level measuring equipment is the combination of the preamplifier's electrical noise and thermal noise from the microphone.
dB (linear) peak	the maximum reading in decibels (dB) obtained using the "P" time – weighting characteristic as specified in AS 1259.1 – 1990 with all frequency-weighted networks inoperative.
Maximum instantaneous charge (MIC)	the maximum amount of explosive in kg on any one specific delay detonator in any one blast hole.
Peak particle velocity (ppv)	is a measure of ground vibration magnitude and is the maximum instantaneous particle velocity at a point during a given time interval in mms-1. (Peak particle velocity can be taken as the vector sum of the three component particle velocities in mutually perpendicular directions).
octas	Is a rating system describing cloud cover. A clear sky is zero octas while full cloud cover is 8 octas.

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Appendix 1 Climate Data for Moranbah and Collinsville

Climate Data for Moranbah

Statistic Element	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Mean maximum temperature (Degrees C) for years 1986 to 2012	33.8	33.1	32.1	29.5	26.5	23.7	23.7	25.5	29.2	32.3	33.1	34	29.7
Highest temperature (Degrees C) for years 1986 to 2012	45	41.1	40.4	36	33.9	31.9	31	36.4	38	40.5	42.7	42.5	45
Lowest maximum temperature (Degrees C) for years 1986 to 2012	23.3	22	21.8	17.8	14.2	10.6	13.9	11	18.9	17.5	20.8	20	10.6
Decile 1 maximum temperature (Degrees C) for years 1986 to 2012	30.2	28.8	28.8	26.4	23.3	19.9	20.2	21.8	25.4	28.5	28.8	29.5	
Decile 9 maximum temperature (Degrees C) for years 1986 to 2012	37.4	36.9	35.2	32.8	29.5	27.4	27.1	29.4	33.3	36.2	37.2	37.8	
Mean number of days >= 30 Degrees C for years 1986 to 2012	26.8	23.6	24.4	12.5	2	0.2	0.2	2.4	11.4	24	24.5	25.8	177.8
Mean number of days >= 35 Degrees C for years 1986 to 2012	10.3	7.7	3.9	0.6	0	0	0	0.1	0.7	5.4	8.1	12.1	48.9
Mean number of days >= 40 Degrees C for years 1986 to 2012	0.6	0.1	0	0	0	0	0	0	0	0.1	0.4	0.6	1.8
Mean minimum temperature (Degrees C) for years 1986 to 2012	21.9	21.8	20.2	17.6	14.2	11.2	9.9	11.1	14.1	17.6	19.4	21.1	16.7
Lowest temperature (Degrees C) for years 1986 to 2012	14.9	15.5	14.3	6	5	1.1	0.2	3	5.4	10.8	11.9	15	0.2
Highest minimum temperature (Degrees C) for years 1986 to 2012	28.5	26.5	27	25.2	21.6	21.9	18	20.2	23.6	23.6	25.6	27.9	28.5
Decile 1 minimum temperature (Degrees C) for years 1986 to 2012	19.8	19.5	18	15	9.5	6.1	4.7	6.5	10.4	14.6	16.7	18.4	

Decile 9 minimum temperature (Degrees C) for years 1986 to 2012	24.1	23.9	22.7	20.5	18	15.4	14.6	15.4	17.9	21	22.1	23.6	
Mean number of days <= 2 Degrees C for years 1986 to 2012	0	0	0	0	0	0.1	0.2	0	0	0	0	0	0.3
Mean number of days <= 0 Degrees C for years 1986 to 2012	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean rainfall (mm) for years 1972 to 2012	105.3	100.7	55.4	36.4	34.5	22.1	18	25	9.1	35.7	69.3	103.9	614.5
Highest rainfall (mm) for years 1972 to 2012	315	347.4	268	271	196.6	170.3	103.6	247.3	60.7	146.6	220.3	350	1109.2
Date of Highest rainfall for years 1972 to 2012	1975	2008	1988	1989	1983	2007	1978	1998	2010	1995	1998	2010	2010
Lowest rainfall (mm) for years 1972 to 2012	9.4	0.3	0.2	0	0	0	0	0	0	0	0	0.2	280.7
Date of Lowest rainfall for years 1972 to 2012	1988	1996	2005	1993	2010	2006	2009	2008	2009	2006	1980	2009	1982
Decile 1 monthly rainfall (mm) for years 1972 to 2012	21	9	1.4	0.6	0	0	0	0	0	0	4.5	20.8	375
Decile 5 (median) monthly rainfall (mm) for years 1972 to 2012	89.2	91.6	37.2	24.9	22.7	10.4	6	11.3	4.2	15.8	55	82.6	606.8
Decile 9 monthly rainfall (mm) for years 1972 to 2012	220.7	219	185.8	85.4	76.3	48	63.1	72.2	22.2	104.5	159.7	201.3	882.7
Highest daily rainfall (mm) for years 1972 to 2012	120.4	150.8	164.8	143.8	58	43.4	60	150.8	27.6	73.8	86	116	164.8
Mean number of days of rain for years 1800 to 3000	8.5	8.2	5.5	4.3	3.8	3.2	2.6	2.2	2.2	4	6.2	7.3	58
Mean number of days of rain >= 1 mm for years 1972 to 2012	6.4	6.4	3.9	3.1	2.6	2.1	1.8	1.7	1.4	3.1	4.9	5.9	43.3
Mean number of days of rain >= 10 mm for years 1972 to 2012	3	2.7	1.4	1.1	0.9	0.6	0.6	0.7	0.3	1.2	2.1	2.6	17.2

Mean number of days of rain >= 25 mm for years 1972 to 2012	1.4	1.1	0.6	0.4	0.4	0.3	0.2	0.3	0	0.4	1	1.4	7.5
Mean daily solar exposure (MJ/(m*m)) for years 1990 to 2012	24.1	22.1	21.9	18.9	16.1	14.5	15.9	18.7	22.3	24.6	25.4	25.3	20.8
Mean number of clear days for years 1986 to 2010	5.1	3.8	7.4	9.9	10.9	13.4	16.4	16.8	16.7	14.2	10.2	7.3	132.1
Mean number of cloudy days for years 1986 to 2010	10.4	11	8.6	7.2	7.7	6.6	4.8	4.1	2.8	4.7	6.6	8.3	82.8
Mean daily evaporation (mm) for years 1986 to 2012	8	7.4	6.8	5.7	4.3	3.5	3.7	4.9	6.6	8	8.5	8.5	6.3
Mean 9am temperature (Degrees C) for years 1986 to 2010	26.4	25.8	24.7	22.1	18.9	15.4	14.7	16.6	20.6	24	25.3	26.4	21.7
Mean 9am wet bulb temperature (Degrees C) for years 1986 to 2010	22.3	22.3	20.9	18.9	16	12.8	11.8	13.1	15.8	18.6	20	21.4	17.8
Mean 9am dew point temperature (Degrees C) for years 1986 to 2010	20.1	20.5	18.7	16.7	13.5	10.2	8.6	9.6	11.6	14.8	16.5	18.5	14.9
Mean 9am relative humidity (%) for years 1986 to 2010	69	74	70	72	73	73	69	66	60	58	60	64	67
Mean 9am cloud cover (oktas) for years 1986 to 2010	4.4	4.6	3.8	3.3	3.3	2.8	2.4	2.1	1.8	2.3	3.1	3.7	3.1
Mean 9am wind speed (km/h) for years 1986 to 2010	7.5	7.7	8.1	7.6	6.2	5.5	5.3	6.6	7.7	8.4	8.4	8.4	7.3
Mean 3pm temperature (Degrees C) for years 1986 to 2010	32.7	31.9	31.2	28.6	25.8	22.9	22.9	24.6	28.3	31.4	32.2	33	28.8
Mean 3pm wet bulb temperature (Degrees C) for years 1986 to 2010	22.9	23.1	21.6	19.9	17.7	15.6	14.9	15.5	17.4	19.6	20.8	22.1	19.3
Mean 3pm dew point temperature (Degrees C) for years 1986 to 2010	17.3	18.2	15.7	13.8	11.2	8.8	7	6.7	7.6	10.5	12.7	15.4	12.1

Mean 3pm relative humidity (%) for years 1986 to 2010	43	48	41	43	43	44	39	35	30	31	34	38	39
Mean 3pm cloud cover (oktas) for years 1986 to 2010	5	5.2	4.5	4.3	4	3.2	2.7	2.6	2.4	3.3	3.8	4.4	3.8
Mean 3pm wind speed (km/h) for years 1986 to 2010	8.8	9.6	9.4	8.7	6.9	6.6	7	7.7	8.3	8.4	8.9	8.8	8.3

Climate Data for Collinsville

Statistic Element	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual
Mean maximum temperature (Degrees C) for years 1955 to 2012	33.4	32.7	31.9	30.3	27.5	25.1	25	26.9	29.6	32.2	33.4	34	30.2
Highest temperature (Degrees C) for years 1957 to 2012	44	43.3	40.7	36.8	33.2	32.8	31.7	34.2	36.6	39.9	41.6	42.2	44
Lowest maximum temperature (Degrees C) for years 1957 to 2012	24	23.2	22	20	16.4	11	13.4	15.2	20.8	21.7	22.7	23	11
Decile 1 maximum temperature (Degrees C) for years 1957 to 2012	29.8	29.4	29.3	27.8	24.8	21.8	22	23.8	26.8	29	30.1	30.5	
Decile 9 maximum temperature (Degrees C) for years 1957 to 2012	36.7	35.7	34.6	33	30.1	28	27.9	30	32.8	35.4	36.5	37.2	
Mean number of days >= 30 Degrees C for years 1957 to 2012	24.2	21.9	23	15.5	3.5	0.5	0.4	2.9	12.8	22.8	24.4	24.6	176.5
Mean number of days >= 35 Degrees C for years 1957 to 2012	7.6	5	2	0.3	0	0	0	0	0.2	3.6	7.3	10.5	36.5
Mean number of days >= 40 Degrees C for years 1957 to 2012	0.4	0.1	0	0	0	0	0	0	0	0	0.2	0.2	0.9
Mean minimum temperature (Degrees C) for years 1955 to 2012	21.9	21.9	20	17	13.7	10.4	9	10.6	13.6	17.3	20	21.3	16.4

Lowest temperature (Degrees C) for years 1957 to 2012	15	15.6	10.2	6.7	1.7	-1.1	-1	-1.1	2.2	8.3	12.8	14.3	-1.1
Highest minimum temperature (Degrees C) for years 1957 to 2012	28.3	27.2	26.9	25.4	22.5	21.8	20	21.5	24.5	26.1	25.5	27.4	28.3
Decile 1 minimum temperature (Degrees C) for years 1957 to 2012	19	19.3	17	13.5	8.7	5	3.3	5.2	9.4	13.3	16.7	18.3	
Decile 9 minimum temperature (Degrees C) for years 1957 to 2012	24.4	24.1	23	20.6	18.5	16	14.8	16	18.5	21.4	23	24.1	
Mean number of days <= 2 Degrees C for years 1957 to 2012	0	0	0	0	0.1	0.5	1.2	0.3	0	0	0	0	2.1
Mean number of days <= 0 Degrees C for years 1957 to 2012	0	0	0	0	0	0.1	0.1	0	0	0	0	0	0.2
Mean rainfall (mm) for years 1939 to 2012	134.8	162.3	97.8	42.3	32.4	27.2	20.3	17.8	11.4	21.6	51.8	96.8	716.6
Highest rainfall (mm) for years 1939 to 2012	505.8	524.6	341.8	448.6	246.6	207.6	207.4	200	56.2	158.3	216.2	410.4	1583.6
Date of Highest rainfall for years 1939 to 2012	1974	1991	1946	1940	1955	2007	1950	1998	2010	1985	1950	1956	1956
Lowest rainfall (mm) for years 1939 to 2012	15.4	4	2.6	0	0	0	0	0	0	0	0	4.2	282.8
Date of Lowest rainfall for years 1939 to 2012	1988	1983	2005	1967	1949	2004	2009	2009	2011	2006	2003	2009	1969
Decile 1 monthly rainfall (mm) for years 1939 to 2012	39.3	32.4	11.8	1.2	2	1.8	0	0	0	0	3.5	32.9	425.3
Decile 5 (median) monthly rainfall (mm) for years 1939 to 2012	105.4	132	72.6	21.9	14.2	14.8	6.4	4	4.3	12.8	33.5	77.8	687.8
Decile 9 monthly rainfall (mm) for years 1939 to 2012	271	349.5	218.6	81.9	67.5	55.4	60.9	45.6	32	47	125.2	215.3	1133.7
Highest daily rainfall (mm) for years 1939 to 2012	146.2	266.2	235.7	348.7	102.9	84.8	92.2	114	44	57	143	182.4	348.7

Mean number of days of rain for years 1800 to 3000	10.6	11.5	8.5	4.9	4.2	3.6	2.5	2.1	1.8	3	5	7.5	65.2
Mean number of days of rain >= 1 mm for years 1939 to 2012	8.9	10	7	3.8	3	2.7	1.7	1.6	1.4	2.3	4.1	6.6	53.1
Mean number of days of rain >= 10 mm for years 1939 to 2012	3.9	4.4	2.8	1	0.8	0.7	0.7	0.5	0.4	0.7	1.5	2.9	20.3
Mean number of days of rain >= 25 mm for years 1939 to 2012	1.6	2	1.2	0.4	0.3	0.3	0.2	0.2	0.1	0.2	0.7	1.3	8.5
Mean daily solar exposure (MJ/(m*m)) for years 1990 to 2012	22.5	21.1	21.2	18.6	16.1	14.8	16.1	18.6	22.3	24.5	25	24.1	20.4
Mean number of clear days for years 1957 to 2010	4.2	2.9	5.6	7.4	9.6	12.7	15.5	15.6	14.3	11.9	8.9	6	114.6
Mean number of cloudy days for years 1957 to 2010	10.6	10.7	8	5.8	6.6	4.9	4.1	3.2	3.1	3.7	5.6	7.3	73.6
Mean daily evaporation (mm) for years 1967 to 2012	6.1	5.6	5.2	4.4	3.4	2.9	3.1	4.1	5.3	6.4	6.9	6.8	5
Mean 9am temperature (Degrees C) for years 1955 to 2010	27.4	26.8	25.6	23.5	20.2	16.9	16.1	18.5	22.1	25.4	27	27.9	23.1
Mean 9am wet bulb temperature (Degrees C) for years 1955 to 2010	23	23.1	21.9	19.9	17.2	14.2	13.3	14.9	17.2	19.6	21.2	22.6	19
Mean 9am dew point temperature (Degrees C) for years 1957 to 2010	20.7	21.2	19.8	17.7	14.9	11.7	10.5	11.5	13.4	15.7	17.9	19.7	16.2
Mean 9am relative humidity (%) for years 1955 to 2010	68	72	71	71	73	73	71	65	60	56	58	62	67
Mean 9am cloud cover (oktas) for years 1955 to 2010	4.4	4.4	3.6	2.9	2.8	2.3	1.9	1.7	1.9	2.5	3.2	3.7	2.9
Mean 9am wind speed (km/h) for years 1957 to 2010	5.3	4.9	5.2	5.8	5	4.4	4.7	5.3	6.6	7.4	7.4	6.2	5.7

Mean 3pm temperature (Degrees C) for years 1955 to 2010	31.7	31.2	30.7	29	26.4	24.2	24.1	25.9	28.6	31	32.1	32.6	29
Mean 3pm wet bulb temperature (Degrees C) for years 1955 to 2010	23.7	23.8	22.9	21	19	16.9	16.1	16.9	18.4	20.3	21.9	23.1	20.3
Mean 3pm dew point temperature (Degrees C) for years 1957 to 2010	19.3	19.8	18.5	16.1	13.4	10.5	8.8	8.9	10.1	12.7	15.8	17.7	14.3
Mean 3pm relative humidity (%) for years 1955 to 2010	51	53	50	48	47	44	40	37	34	35	40	44	44
Mean 3pm cloud cover (oktas) for years 1955 to 2010	5.3	5.6	5	4.7	4.3	3.4	2.9	2.7	2.7	3.1	3.9	4.5	4
Mean 3pm wind speed (km/h) for years 1957 to 2010	7.1	7	7.6	8.4	7.4	7	8	7.7	8.5	8.9	9.2	8	7.9

Appendix 2 Charts of Calculated Noise Levels at Selected Sensitive Receptors

Assumptions regarding chart generation are contained within the following paragraphs.

L_{A01} Noise Model

For the purpose of this assessment the L_{A01} is taken to be represented by the L_{Amax}. The model assumes that both the mining operations and the atmospheric propagation conditions remain constant throughout the modelling hour. This is a very conservative assumption. In reality equipment operate through a complex cycle and the likelihood of all equipment emitting maximum noise levels at the same time is unlikely.

It is assumed that all mine plant and equipment operate as described in Section 4.3 throughout the day and night and for the entire year.

L_{Aeq} Noise Model

Each item of equipment goes through a repeating short duration cycle representative of operations. The L_{Aeq} noise model incorporates the fluctuating noise levels to obtain the L_{Aeq} at the receiver. This is a mathematically correct analysis as it is independent of the time the noise is generated. However, it is also a conservative methodology as it requires the meteorology to remain constant for the entire hour, i.e. it ignores the small variations in a turbulent atmosphere that lead to variations of actual noise level below the calculated noise level. It also requires all the equipment operate during that hour in the exposed positions selected for the purpose of modelling.

Charts Description

For each location a series of four charts are presented. The first chart is the predicted L_{A01} and L_{Aeq} noise level for every hour of the year, almost 9000 individual calculations for mining case 1. The second chart shows the diurnal variability in the predicted noise levels by grouping the L_{A01} and L_{Aeq} by hour of the day for Case 1 mining. For every hour of the day there are 365 calculations (one for every day of the year) and the maximum L_{A01} (L_{A01}(annual maximum)) and maximum L_{A10} (L_{A10}(annual maximum)) is plotted along with the L_{Aeq} (annual average) for each hour of the day. The third chart is a repeat of the first chart but for mining case 2 and the fourth chart is a repeat of second chart also for case 2.

Locations Presented

The locations presented in this Appendix are for sensitive receptors closest to the project and Glendon township. These are also locations with the highest noise exposure.

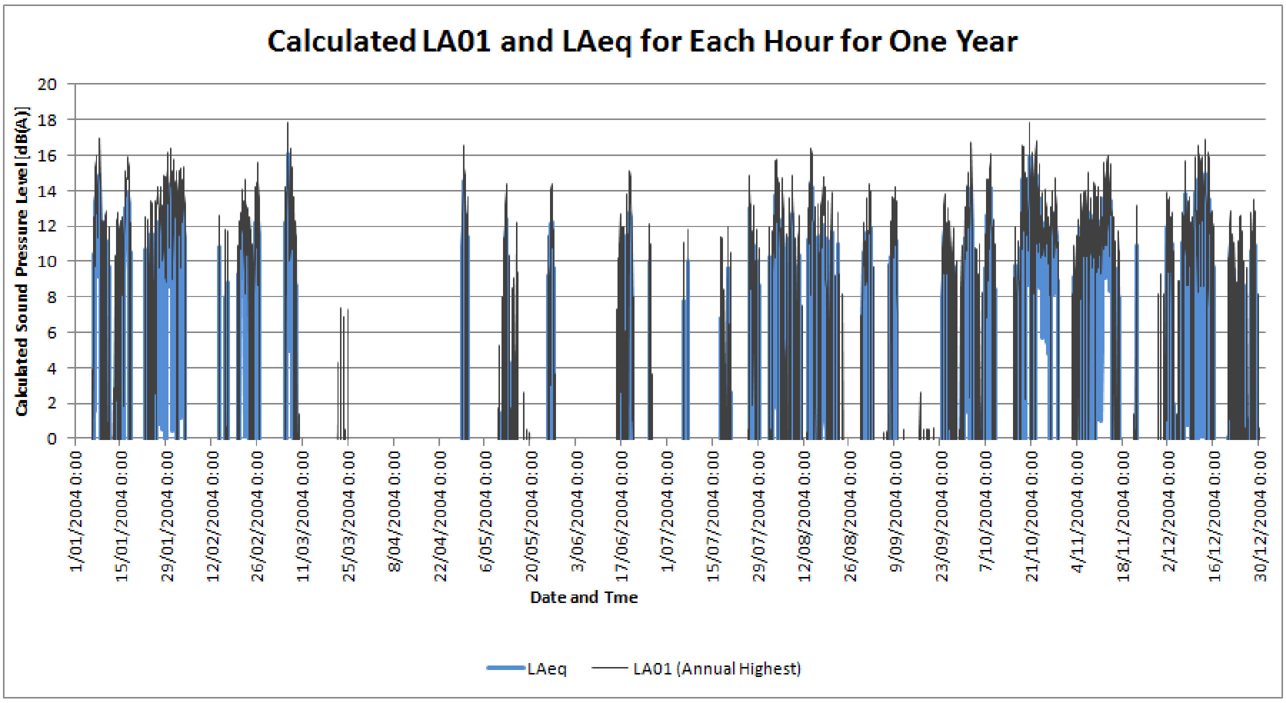

Figure 24: Calculated Noise Levels For Glenden Over 1 Year For Mining Year 05

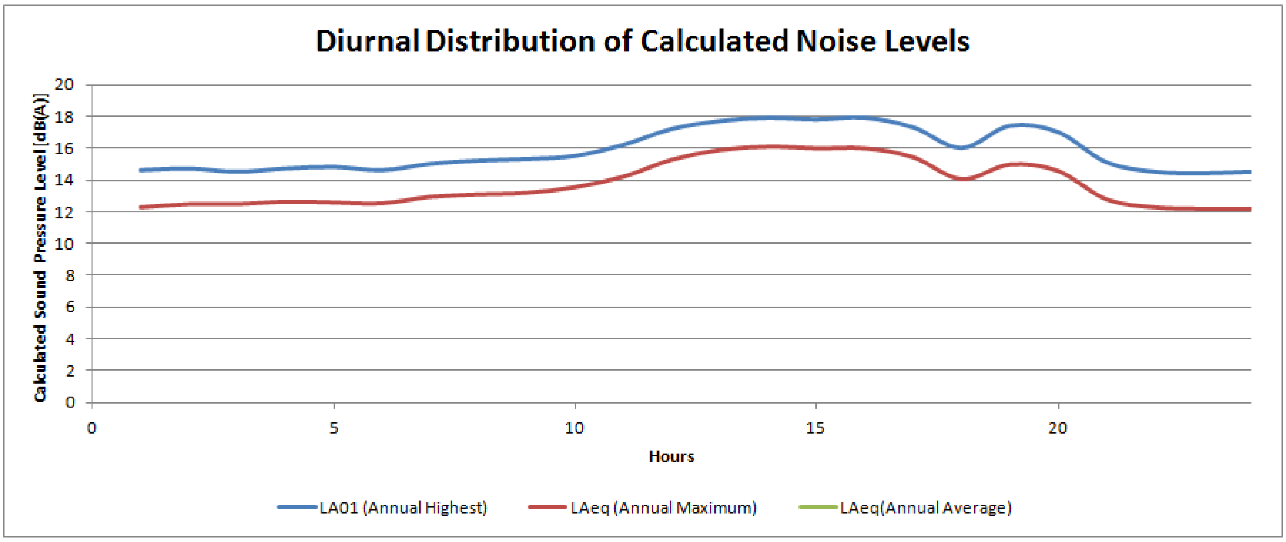

Figure 25: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Glenden Over One Year - Mining Year 05

The modelled noise levels for Glenden Mining year 5 show that the lowest noise levels are likely during the night and the highest noise levels are during the evening. The L_{Aeq} (annual average) noise levels are below the threshold of human hearing.

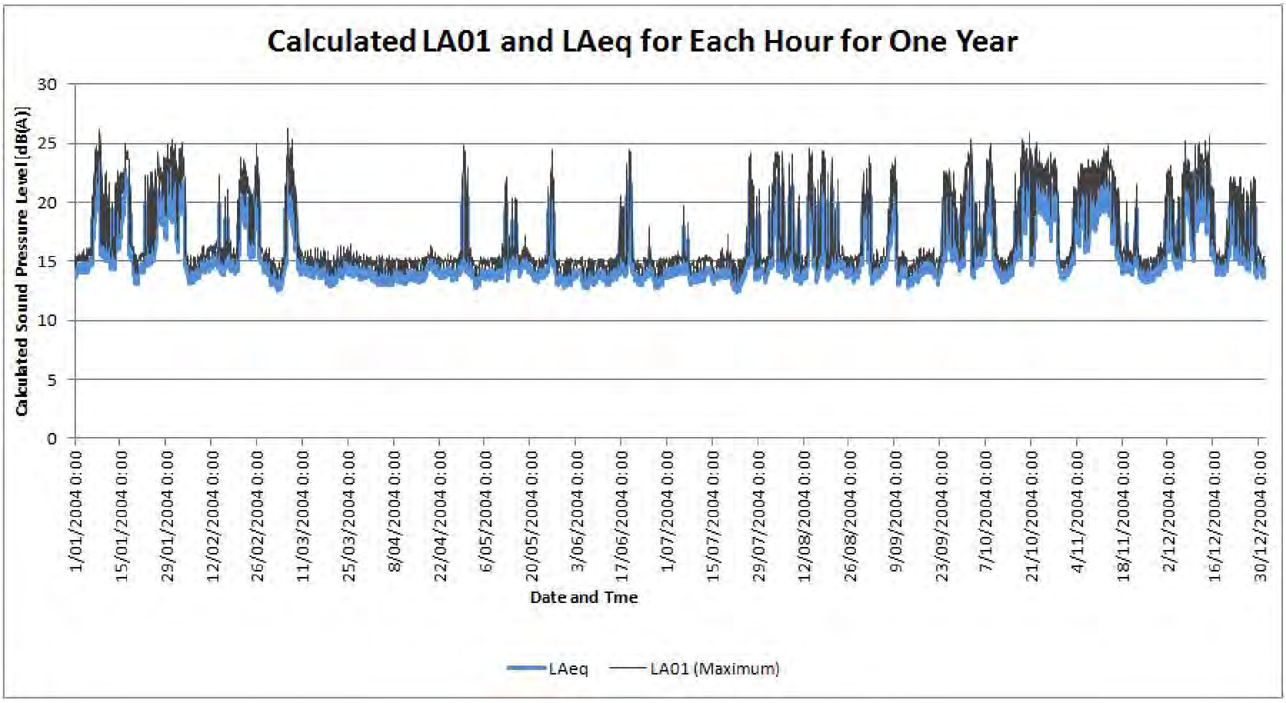

Figure 26: Calculated Noise Levels For Suttor Creek Station Homestead Over One Year For Mining Year 05

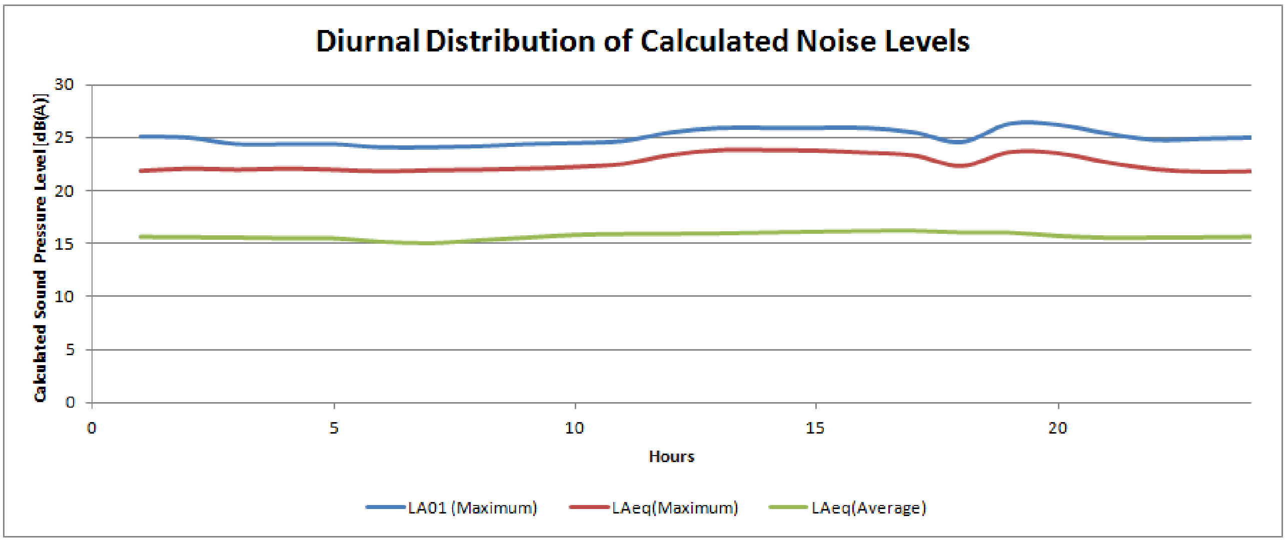

Figure 27: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Suttor Creek Station Homestead Over One Year - Mining Year 05

Suttor Creek Station homestead is situated to the east of the project. Most of the time the noise levels are very low, below 20 dB(A). However, there are period during the year when the L_{Aeq} noise levels increase to almost 25 dB(A) when the prevailing winds are from the west.

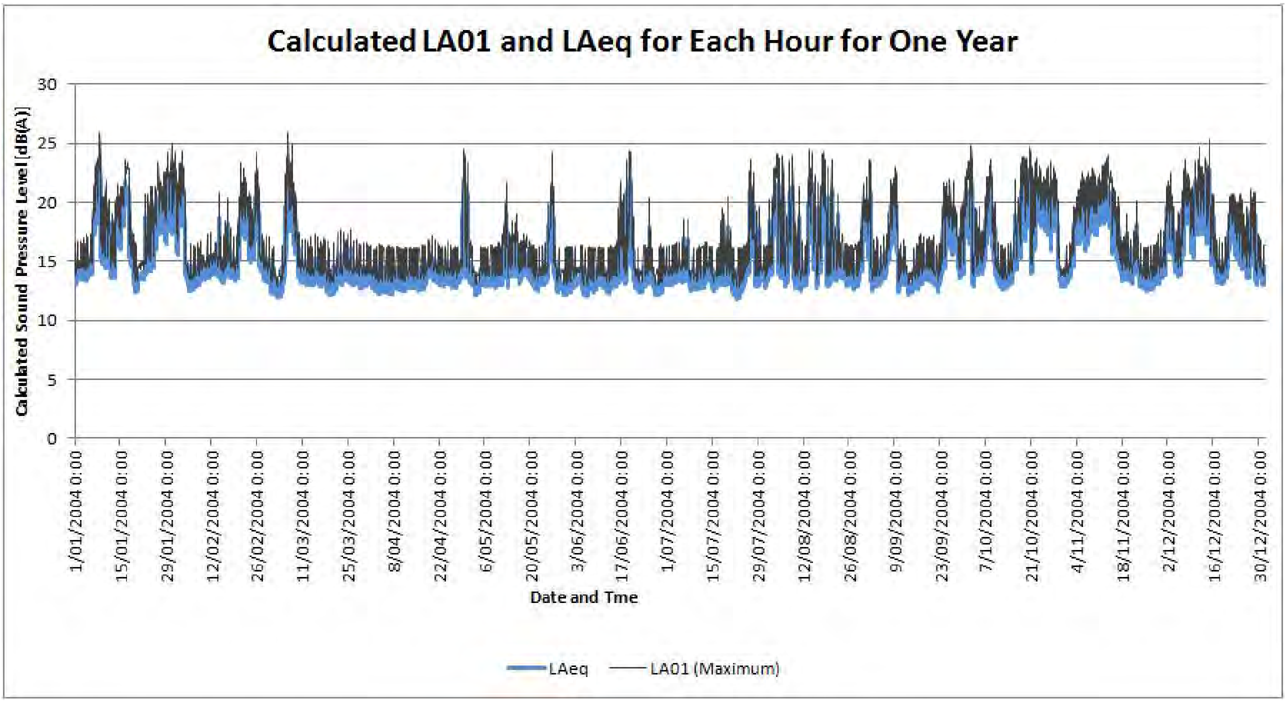

Figure 28: Calculated Noise Levels For Suttor Creek Station Homestead Over One Year For Mining Year 17

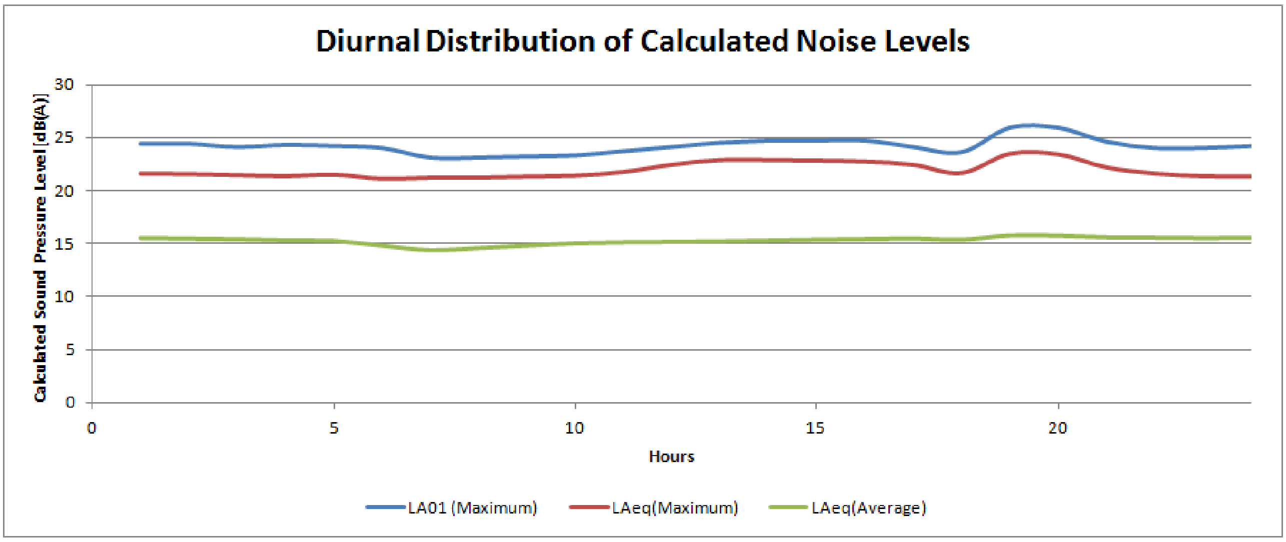

Figure 29: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Suttor Creek Station Homestead Over One Year - Mining Year 17

The modelled noise levels for Suttor Creek (Year 17) show that the (Annual Maximum) noise levels are similar to Year 05. However, the L_{Aeq} (annual average) noise levels are likely to be slightly quieter than Year 05. The lack of significant variation between mining year 5 and 17 suggests that there are dominant noise sources that has not moved between cases, such as the CHPP, conveyors etc.

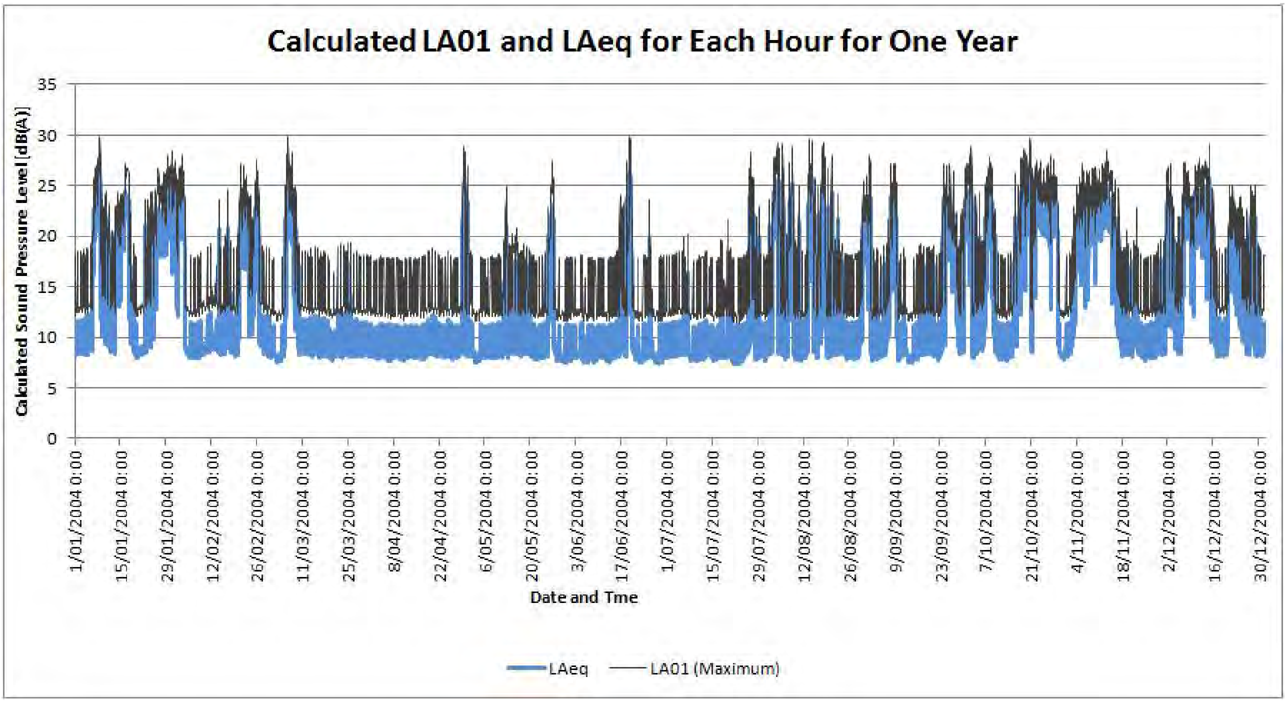

Figure 30: Calculated Noise Levels For Suttor Creek Station Homestead Over One Year For Mining Year 17

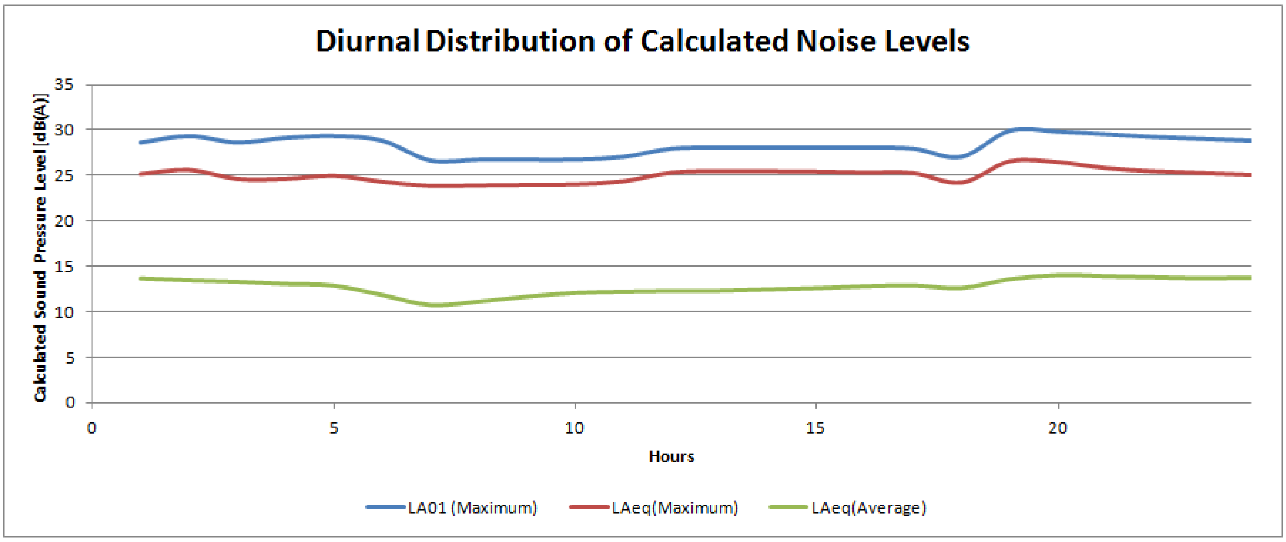

Figure 31: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Suttor Creek Station Homestead Over One Year - Mining Year 17

The modelled noise levels for Suttor Creek Homestead (Year 36) show that the (Annual Maximum) noise levels have increased compared to previous years. However, the L_{Aeq} (annual average) noise levels are likely to be slightly quieter than Case 1. In this instance the landform has changed leading to screening of distant 'dominant' noise sources, however, the opening of closer pits has resulted in an increase in the maximum noise levels.