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1. Introduction

AMCI (Alpha) Pty Ltd ('AMCI') has engaged Noise Mapping Australia ('NMA') to prepare a noise and vibration assessment for the proposed South Galilee Coal Project (SGCP), west of Alpha.

The objective of this assessment is to provide AMCI with information to assist with obtaining the necessary approvals for the proposed SGCP.

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 SGCP is a proposed open-cut and underground coal mine located approximately 12 kilometres (km) west of Alpha and 170 km west of Emerald in Central Queensland.

The SGCP will be located within Mining Lease Application (MLA) 70453 located within the Barcaldine Regional Council Local Government Area.

The proposed run-of-mine (ROM) extraction rate for surface and underground mining is expected to be up to 19 Mtpa by 2024 to enable an estimated production rate of up to approximately 17 Mtpa. The mine is anticipated to have a life of 35 years. The open cut component of the 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. Underground operations will involve longwall mining.

The SGCP would necessitate up to 1600 personnel during construction and up to 1288 during operations.

1.2 Locality Description

The SGCP is situated west of Alpha in a well established grazing region. The region is relatively flat comprising open farmlands and native scrublands.

Although there are no existing coal mines near the SGCP, there are several mines proposed to the north of the SGCP (e.g. Galilee Coal Project, Alpha Coal Project, Kevin's Corner Coal Project and the Carmichael Coal Mine and Rail). These mines are currently in the processes of obtaining the necessary approvals to permit operation. As part of the development of these mines a railway line will need to be constructed to link the Galilee Basin to the coal export facilities on the coast. A number of rail lines have been proposed by other mining proponents, the closest of which is located approximately 40 km north of the SGCP. All of these rail line proponents have indicated that third party access will be available. The SGCP proposal includes a railway spur to link to one of the proposed common user rail lines.

The sensitive locations in the vicinity of the SGCP comprise the homesteads of grazing properties, the Alpha township and the accommodation village within MLA 70453. The closest sensitive locations are shown on Figure 1 along with the mine site. The locations and separation distances are contained in Table 1.

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

Sensitive Receptor	***Separation Distance [km] From Sensitive Receptor to***		
	MLA 70453	Surface Works	Railway Corridor
Alpha Township	7	14	8
Eureka Station Homestead	12	14	11
Villafield Station Homestead	1	9	6
Bonanza Station Homestead	2	10	9
Creek farm Station Homestead	1	8	8
Chesalon Station Homestead	1	6	15
Betanga Station Homestead	2	12	18
Corntop Station Homestead	3	12	18
Oakleigh Station Homestead	6	8	2
Saltbush Station Homestead	17	19	2
Accommodation Village	Within MLA 70453	3	2

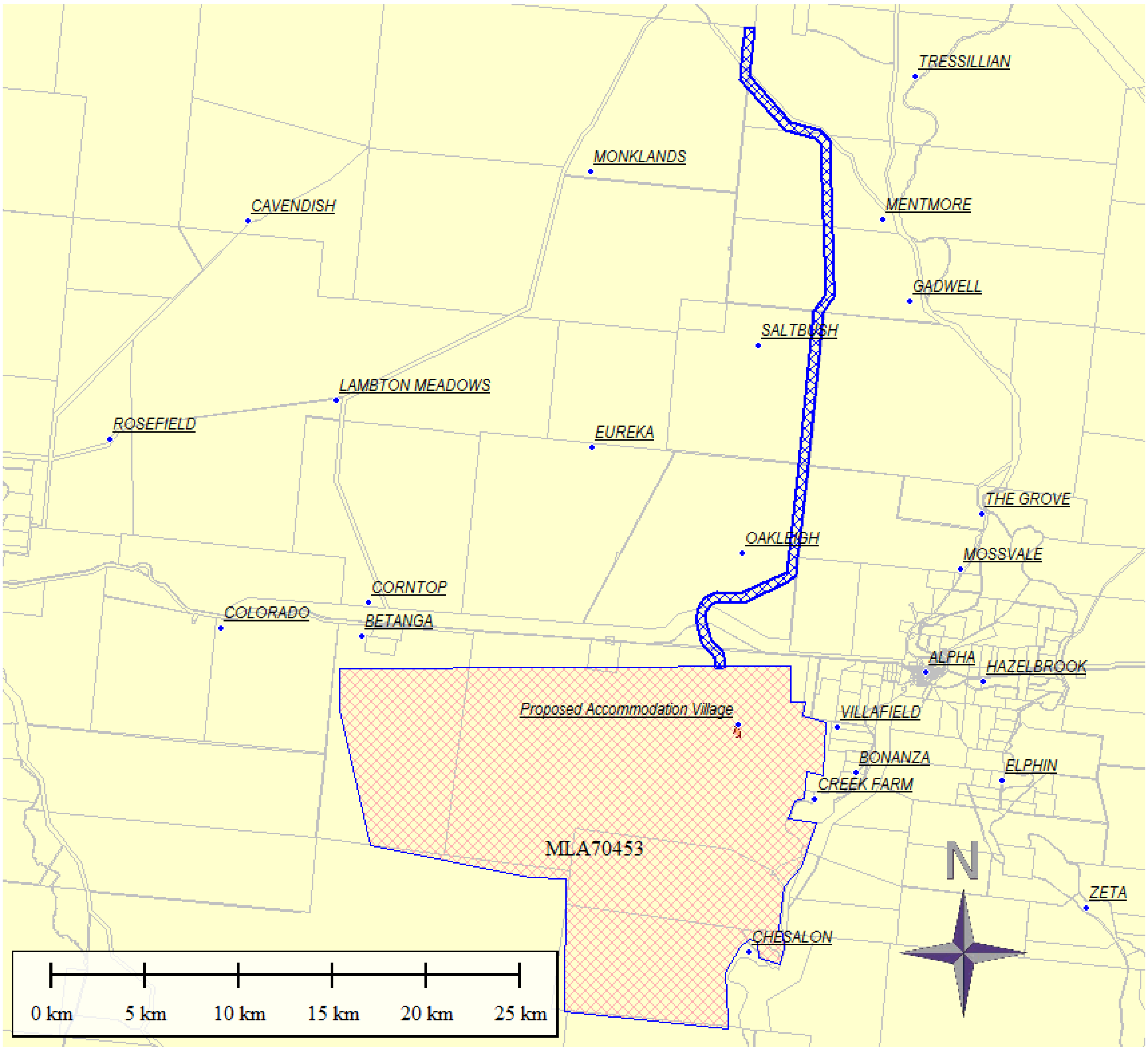

Figure 1: Regional View Showing MLA 70453, the Infrastructure Corridor, Proposed Accommodation Village, Alpha and Homesteads

1.3 Climate

The SGCP is situated between Emerald and Barcaldine. 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. Barcaldine (Latitude 23.55, Longitude 145.29) is a manual station with the weather records recorded twice daily. The closest BOM continuous recording automatic weather station (AWS) is at Emerald (Latitude 23.57, Longitude 148.18).

The region has a warm climate with two distinct seasons, a dry winter season and a wet summer season. Dry season temperatures average from 9ºC to 30ºC, while wet season temperatures range from 18ºC to 35ºC. The region averages approximately 550 mm of rainfall each year, falling mostly between November and March.

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.

2. Existing Noise Environment

Potential sources of noise from the surrounding environment primarily comprise:

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

A survey of the existing noise levels was undertaken at five locations surrounding the SGCP and proposed railway, including:

- Alpha;
- Betanga Station homestead;
- Creek Farm Station homestead;
- Oakleigh Station homestead; and
- Villafield Station homestead.

Since easterly winds are commonplace it was considered appropriate that noise measurements be obtained both upwind and downwind of the proposed SGCP site.

Existing noise levels were obtained at Alpha over a period of nine days from 20 July 2011 to 28 July 2011. The calibrated noise logger recorded the noise level statistics in ten minute intervals. 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 6 for Alpha Township and the homesteads of Betanga, Creek farm, Oakleigh and Villafield Stations respectively. 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) are likely to be lower than the actual reported noise level.

The 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 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 is considered to be representative of the quieter periods of the year.

The noise levels measured at the station homesteads are extremely low and demonstrate an absence of significant noise producing activities. Both Villafield and Oakleigh Stations homesteads were unoccupied during the monitoring period.

Charts of the measurements are contained in Figure 2 to Figure 6 for Alpha Township and the homesteads of Betanga, Creek farm, Oakleigh and Villafield Stations respectively.

Table 2: Measured Existing Noise Levels [in dB(A)] at Alpha Township

Date	$L_{A90(10\ minute)}$ Background Noise Level			$L_{Aeq\ (10\ minute)}$ Noise Level				$L_{A10(10\ minute)}$ Noise Level		
	Day	**Evening**	**Night**	**24 hour**	**Day**	**Evening**	**Night**	**Day**	**Evening**	**Night**
20/07/2011	31.9	31.5	29.7	40.9	43.4	37.0	32.0	44.6	38.4	33.0
21/07/2011	32.9	31.9	26.6	33.7	35.6	32.2	29.2	45.2	36.4	32.1
22/07/2011	32.9	30.3	28.0	42.6	45.2	38.2	32.9	46.5	39.5	34.7
23/07/2011	31.2	27.8	25.6	41.0	43.6	36.8	30.9	45.5	37.4	32.1
24/07/2011	30.2	29.3	26.1	39.8	42.2	37.3	31.2	43.6	39.7	32.8
25/07/2011	30.5	30.6	28.0	41.6	43.8	39.2	34.9	44.9	42.0	36.4
26/07/2011	32.4	31.0	27.5	45.6	48.4	37.9	33.5	51.0	40.7	35.3
27/07/2011	32.9	31.1	26.9	47.7	50.5	40.4	32.4	52.9	42.3	34.1
28/07/2011	36.2		26.6	45.1	47.9		35.4	50.4		38.0
RBL / Median	**32.4**	**30.8**	**26.9**	**41.6**	**43.8**	**37.6**	**32.4**	**45.5**	**39.6**	**34.1**

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

Date	$L_{A90(10\ minute)}$ Background Noise Level			$L_{Aeq\ (10\ minute)}$				$L_{A10(10\ minute)}$		
	Day	**Evening**	**Night**	**24 hour**	**Day**	**Evening**	**Night**	**Day**	**Evening**	**Night**
20/07/2011	26.3	26.3	26.6	37.1	39.6	30.7	29.3	42.2	32.4	30.9
21/07/2011	23.7	24.8	19.1	28.8	30.3	29.1	24.9	38.7	31.7	28.2
22/07/2011	21.0	27.7	17.0	35.3	37.6	33.0	27.8	40.2	34.6	28.7
23/07/2011	16.9	16.2	16.2	28.9	31.0	26.1	23.0	32.8	26.5	23.6
24/07/2011	17.5	15.9	16.0	33.0	35.5	25.9	26.8	37.3	27.2	27.7
25/07/2011	17.6	16.0	16.0	31.2	33.7	23.6	25.4	35.5	26.3	25.3
26/07/2011	17.4	16.1	16.0	29.3	31.3	28.6	22.8	33.6	31.3	22.7
27/07/2011	17.4		16.1		37.9		25.7	40.4		25.3
RBL / Median	**17.6**	**16.2**	**16.2**	**31.2**	**34.6**	**28.6**	**25.5**	**38.0**	**31.3**	**26.5**

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

Date	$L_{A90(10\ minute)}$ Background Noise Level			$L_{Aeq\ (10\ minute)}$ Noise Level				$L_{A10(10\ minute)}$ Noise Level		
	Day	Evening	Night	24 hour	Day	Evening	Night	Day	Evening	Night
20/07/2011	-	5.3	16.9	21.9	-	26.3	23.9	-	24.1	25.3
21/07/2011	21.3	18.8	15.9	23.9	25.3	22.4	21.6	37.8	31.8	32.5
22/07/2011	22.2	19.4	15.7	38.7	41.5	28.1	26.2	42.1	28.6	26.4
23/07/2011	22.6	17.4	15.8	36.4	39.0	27.3	28.6	40.1	25.9	27.1
24/07/2011	19.3	15.9	15.7	38.3	38.7	37.3	38.2	37.9	34.3	37.6
25/07/2011	19.1	16.6	15.8	36.1	38.6	31.1	28.9	37.8	30.1	29.3
26/07/2011	20.2	15.8	15.7	36.2	38.1	33.4	32.6	37.7	33.1	34.2
27/07/2011	19.3	17.4	15.8	37.4	39.2	35.4	33.2	38.3	30.9	33.0
28/07/2011	21.5	-	15.7	37.4	40.2	-	27.6	41.5	-	27.3
RBL / Median	20.8	17.0	15.8	36.4	38.9	29.6	28.6	38.1	30.5	29.3

Table 5: Measured Existing Noise Levels [in dB(A)] at Oakleigh Station Homestead

Date	$L_{A90(10\ minute)}$ Background Noise Level			$L_{Aeq\ (10\ minute)}$ Noise Level				$L_{A10(10\ minute)}$ Noise Level		
	Day	Evening	Night	24 hour	Day	Evening	Night	Day	Evening	Night
21/07/2011	22.2	23.3	18.7	23.9	22.6	28.6	20.3	39.4	31.6	22.2
22/07/2011	19.1	20.2	17.4	35.3	38.2	24.4	21.2	32.5	23.4	19.6
23/07/2011	19.5	20.0	17.1	33.1	35.7	27.9	24.1	29.9	26.9	22.0
24/07/2011	17.9	16.8	16.8	28.7	31.5	19.5	19.8	23.6	17.1	18.4
25/07/2011	17.9	16.8	16.8	26.8	29.5	18.4	19.7	22.6	17.2	18.4
26/07/2011	18.0		17.0		33.5		18.5	22.0		17.8
RBL / Median	18.5	20.0	17.1	28.7	32.5	24.4	20.1	26.7	23.4	19.0

Table 6: Measured Existing Noise Levels [in dB(A)] at Villafield Station Homestead

Date	$L_{A90(10\ minute)}$ Background Noise Level			$L_{Aeq\ (10\ minute)}$ Noise Level				$L_{A10(10\ minute)}$ Noise Level		
	Day	Evening	Night	24 hour	Day	Evening	Night	Day	Evening	Night
21/07/2011	24.6	18.4	17.5	28.4	31.2	19.9	17.6	43.4	21.9	19.3
22/07/2011	20.6	17.6	17.6	40.2	43.2	21.1	20.1	46.0	22.3	21.0
23/07/2011	20.5	17.5	17.5	36.9	39.8	20.1	20.3	42.3	21.0	21.4
24/07/2011	18.9	17.3	17.5	32.7	35.5	21.7	21.9	37.4	22.8	22.6
25/07/2011	19.9	17.5	17.5	31.9	34.6	23.8	21.8	36.1	23.1	22.3
26/07/2011	19.5	17.5	17.5	30.4	33.0	23.4	21.8	34.3	24.3	22.0
27/07/2011	20.6	17.3	17.4	31.5	34.3	20.0	19.3	36.5	21.5	20.5
28/07/2011	20.7	-	17.5	36.3	39.2	-	21.4	41.2	-	22.9
RBL / Median	20.6	17.5	17.5	32.3	35.1	21.1	20.8	39.3	22.3	21.7

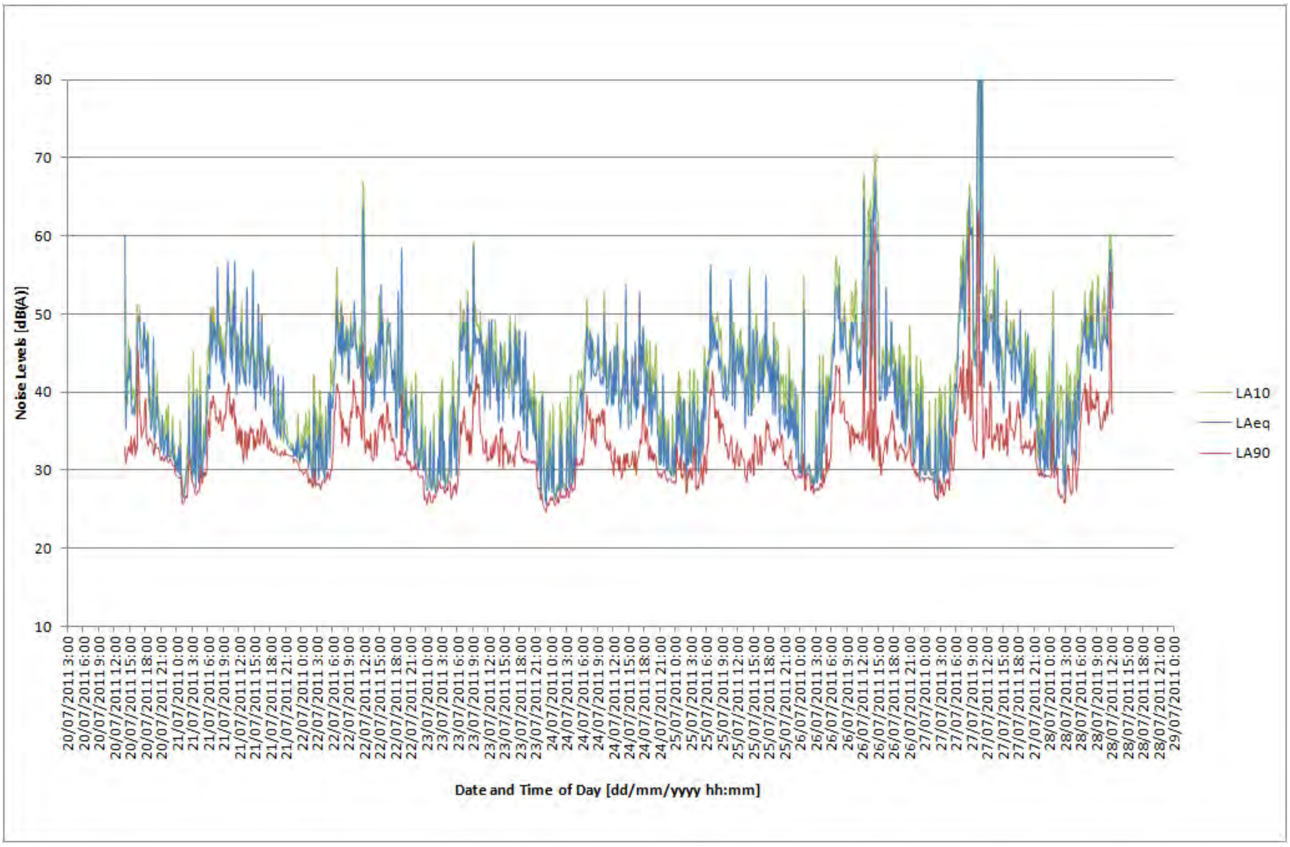

Figure 2: Measured Noise Levels at Alpha

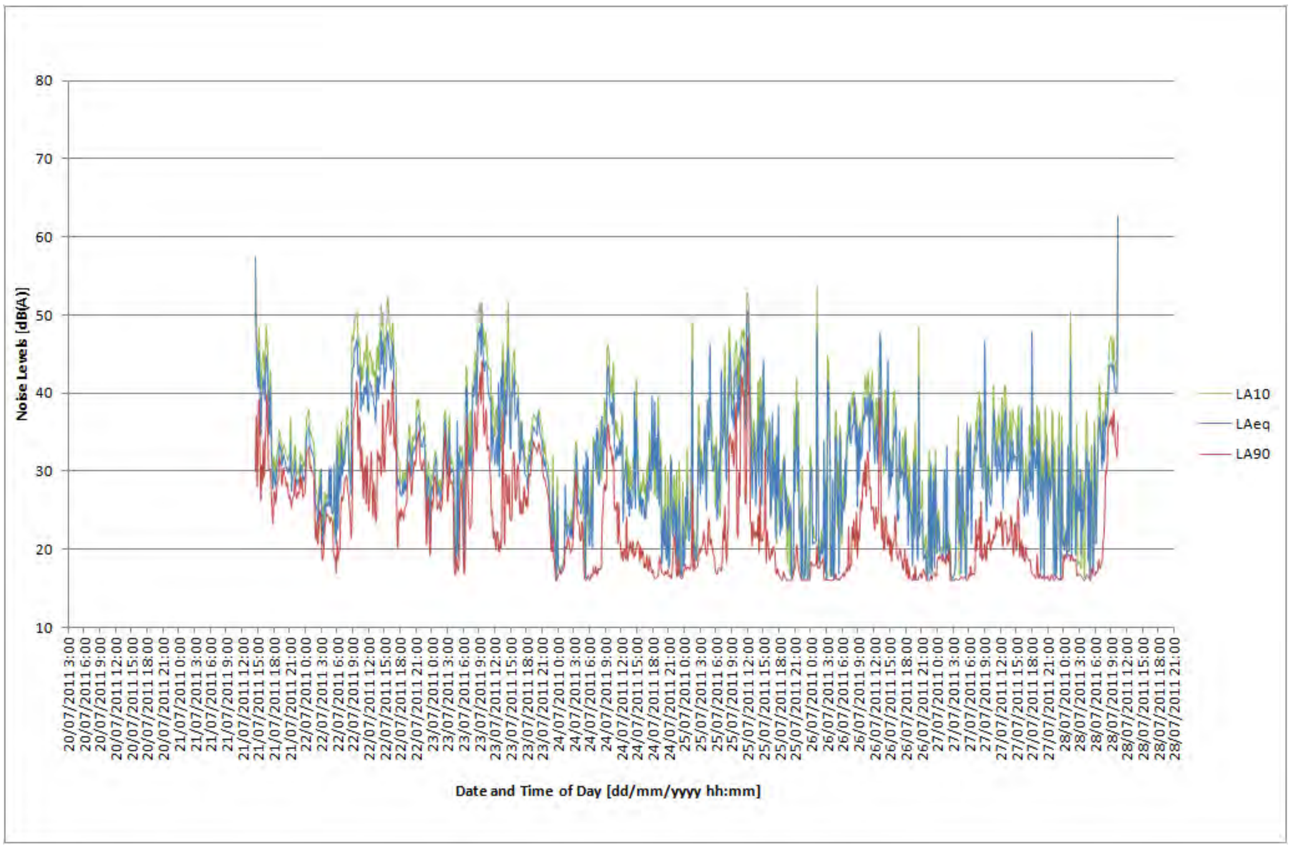

Figure 3: Measured Noise Levels at Betanga Station Homestead

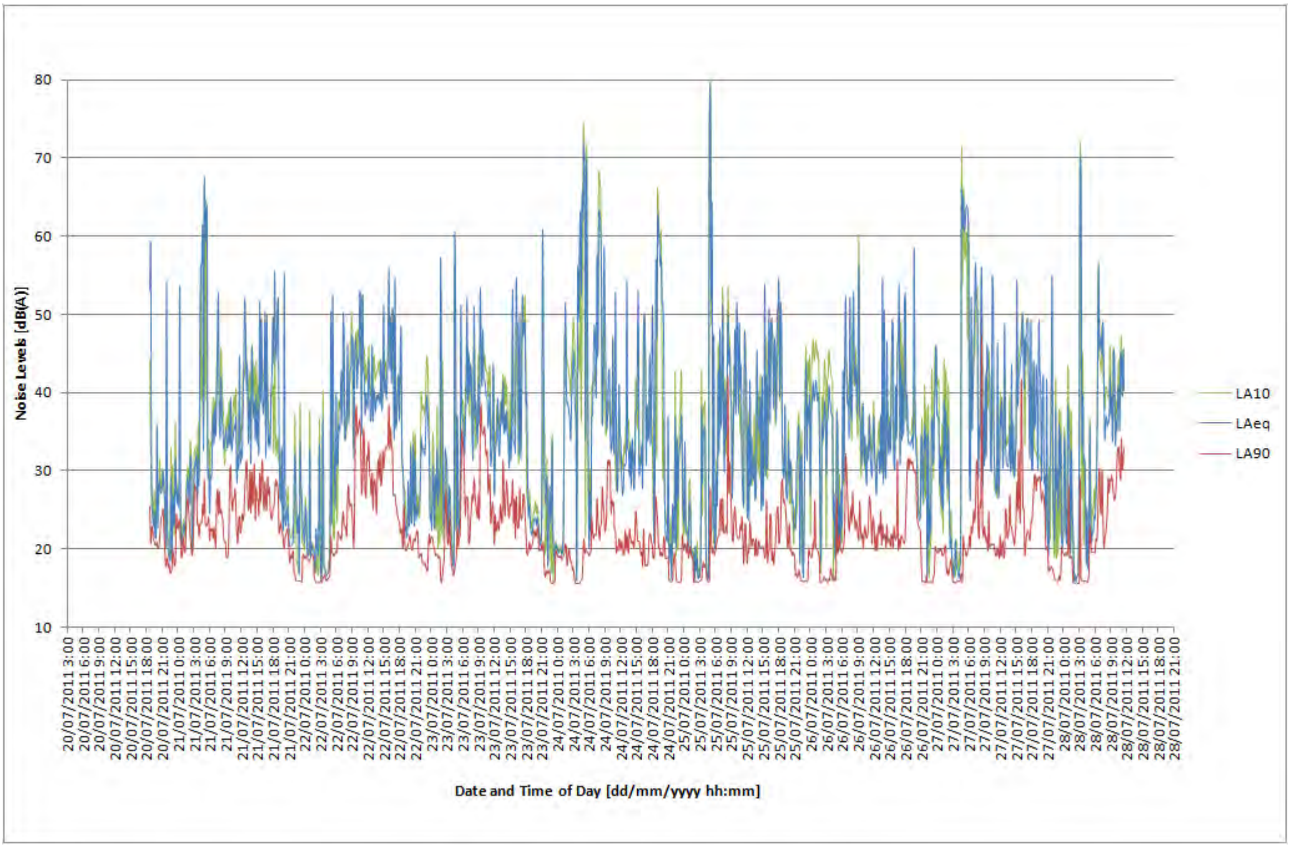

Figure 4: Measured Noise Levels at Creek farm Station Homestead

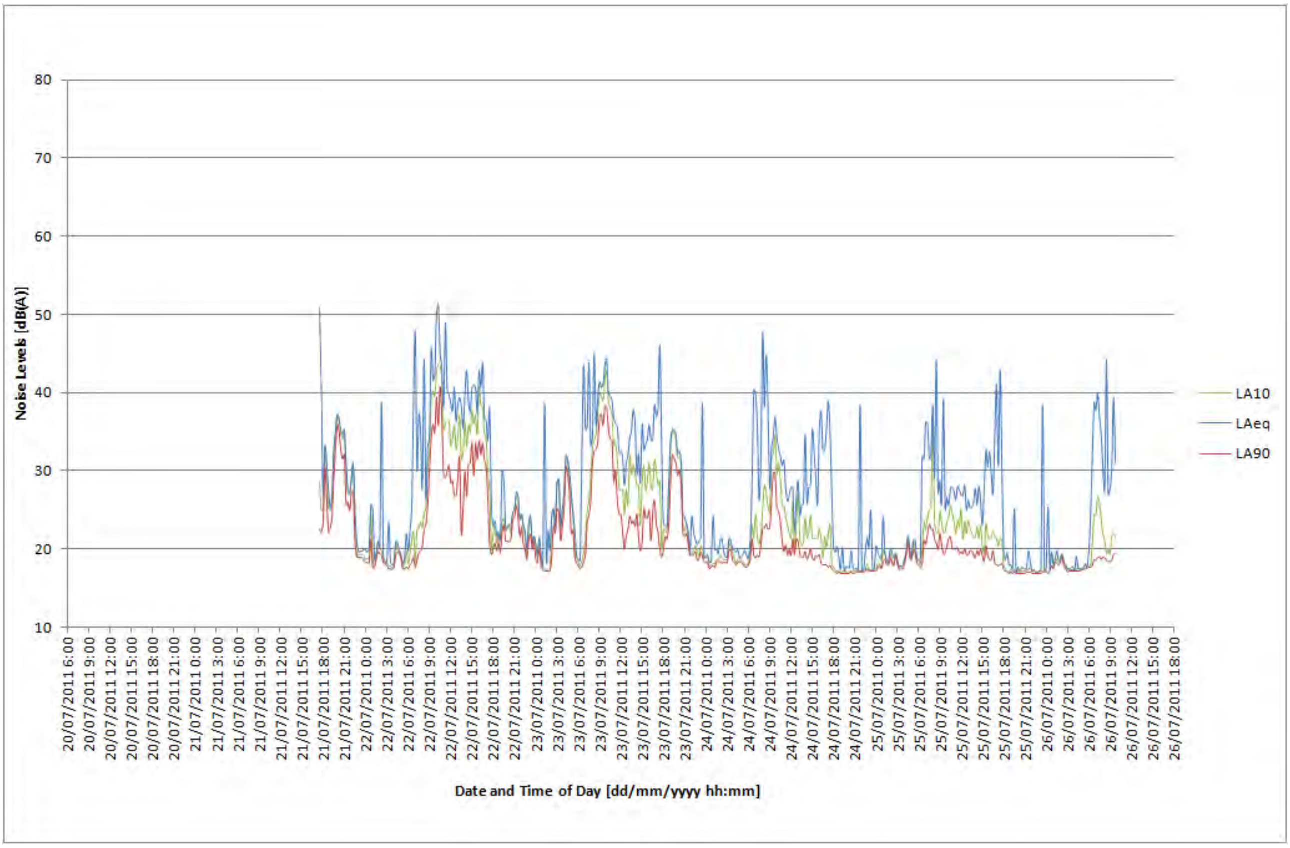

Figure 5: Measured Noise Levels at Oakleigh Station Homestead

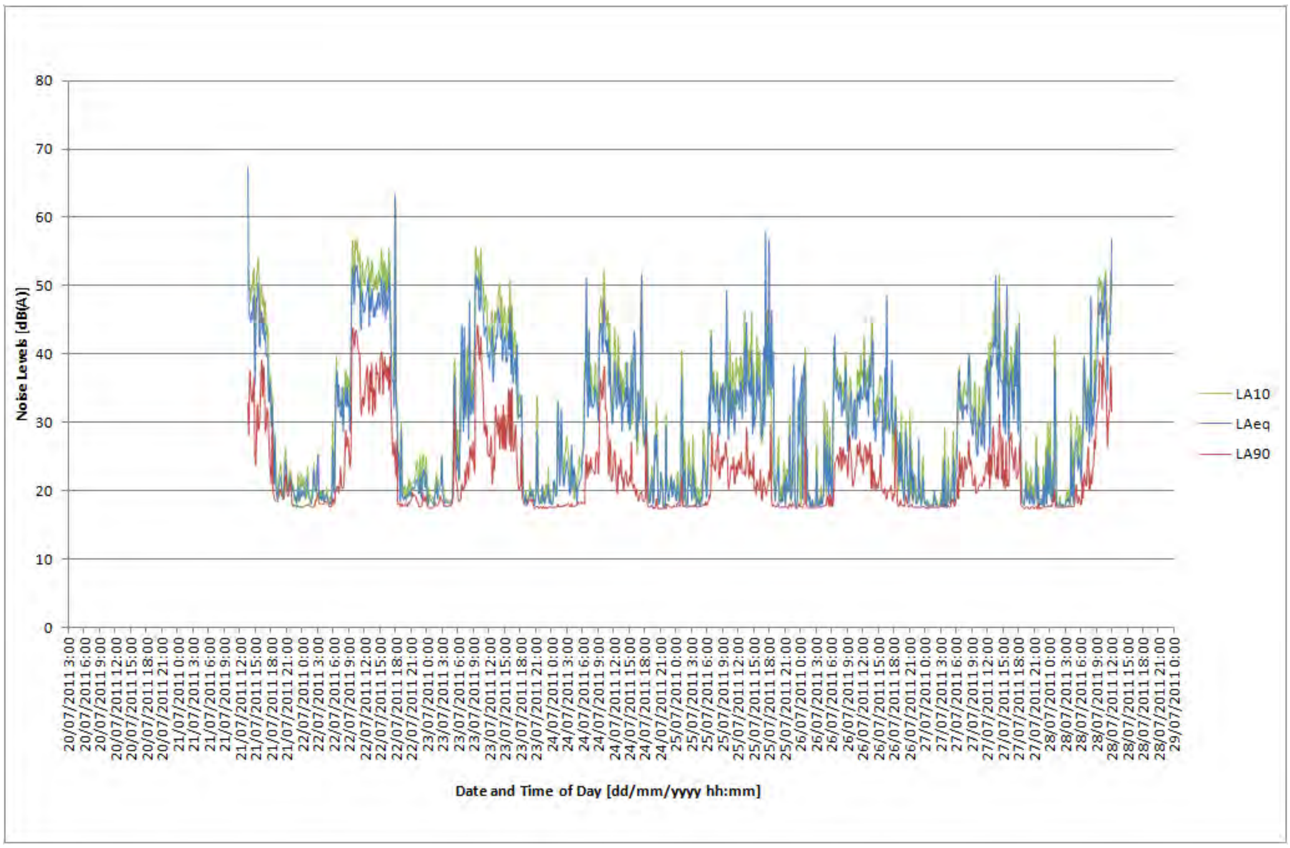

Figure 6: Measured Noise Levels at Villafield Station Homestead

3. Noise Criteria

3.1 Environmental Protection Act

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 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
Marine park under the *Marine Parks Act 2004*	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 objective seeks to avoid intrusiveness. When setting limits it is not intended that the acoustic environment be permitted to deteriorate and this is achieved by controlling background creep. 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 $L_{Aeq,adj,T,} = L_{A90,T} + 3$dB(A).

The DERM 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, it is recommended 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 Guidelines state "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." Given the very quiet background noise levels at the SGCP, at all locations where the measured background was below 25 dB(A), the threshold background noise level of 25 dB(A) has been substituted for the measurements.

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 a very rural area and Alpha is equivalent to a rural residential area.

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

Location	**Planning Background Noise Level**			**Maximum Planning Level L_{A90}**		
	Day	**Evening**	**Night**	**Day**	**Evening**	**Night**
Alpha	32.4	30.8	26.9	37.4	33.0	27.0
Betanga	25.0[#1]	25.0[#1]	25.0[#1]	30.0	28.0	25.0[#1]
Creek farm	25.0[#1]	25.0[#1]	25.0[#1]	30.0	28.0	25.0[#1]
Oakleigh	25.0[#1]	25.0[#1]	25.0[#1]	30.0	28.0	25.0[#1]
Villafield	25.0[#1]	25.0[#1]	25.0[#1]	30.0	28.0	25.0[#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).

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 50dB(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.

According to the DERM's 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. Blasting should not generally take place on Sundays or public holidays.

Blasting outside these recommended times should be approved only where:

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

3.4 Railway Noise Goals

Queensland Railways (QR) is responsible for setting noise level limits from rail traffic. 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 trains operations are met close to the railway (i.e. at distances up to approximately 100 m). The closest noise sensitive receptors to the SGCP rail spur are Oakleigh Station homestead, Saltbush Station homestead and the proposed accommodation village, all of which are located approximately 2 km from the rail line.

However, there may be noise sensitive receptors within nominally 100 m of the common user rail line where the SGCP coal trains make up a small fraction of the total railway traffic. It is beyond the scope of this study to assess the noise from the entire rail line to the Abbot Point Coal Terminal.

3.5 Road Traffic Noise Goals

Queensland Department of Main Roads (QDMR) is responsible for setting noise level limits from road traffic. Typically the planning goals for roads are met close to the road, i.e. distances up to about 100m 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 SGCP and it is beyond the scope of this study to assess the noise from the road network. There are no criteria in Queensland to assess the impact of noise from a road traffic-generating development. It is recommended that the assessment road noise be limited to a 3 dB(A) increase over the existing noise levels, since an increase in 3 dB(A) is not noticeable. Hence, the road traffic noise assessment is limited to assessing the increase in road traffic noise.

3.6 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 background noise level calculated in Table 10.

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 determine the maximum instantaneous charge that is permissible for the proposed SGCP and compare this with typical blasting charge weights.

A summary of the noise and vibration goals for this project is contained in Table 11 and Table 12.

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 less than 3 decibel increase in the $L_{Aeq\ 24\ hour}$ noise levels as a measure of a minor change in the road traffic noise levels.

Discussion

The acoustic quality objectives (Table 11) 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 11.

The noise level goals to avoid background creep (refer to Table 12) 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 12) are lower than the acoustic quality objectives (Table 11) during all time periods. This indicates the existing noise levels are relatively low and generally unaffected by industrial or traffic noise.

As mentioned in Section 2, it is considered that there are two notional noise zones containing noise sensitive receptors surrounding the proposed SGCP. The rural areas are not significantly exposed to road traffic noise or other industrial or mining noises. The township of Alpha to the east and north-east is potentially noisier due to road traffic and human habitation. However, since it located upwind of the SGCP for much of the time, Alpha is likely to have a low exposure to noise from the SGCP.

Table 11: 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	
		$L_{Aeq, adj, 1 hr}$	$L_{A10, adj, 1 hr}$	$L_{A1, adj, 1 hr}$		Noise [dBLin Peak]	Vibration PPV [mm/s]
All Residential Receptors	Day	40	45	50	-	115	5
	Evening	40	45	50	50	-	-
	Night	35	40	45	50	-	-

Table 12: Summary of Noise Level Goals to Avoid Background Creep

Location	Modelled Noise Goals to Avoid Background Creep $L_{Aeq, adj, 1 hr}$ [dB(A)]		
	Daytime	Evening	Night
Alpha	40.3	36	30
All rural homesteads	33	31	28

4. Noise Modelling

4.1 Modelling Methodology

A digital terrain noise model of the site and surroundings has been developed using PEN3D. 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:

$$Lp = Lw - 20\log10(r) - 10\log10(4\pi) + AE$$

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

$20\log10(r) + 10\log10(4\pi)$ 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.

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 SGCP 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 7. 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.

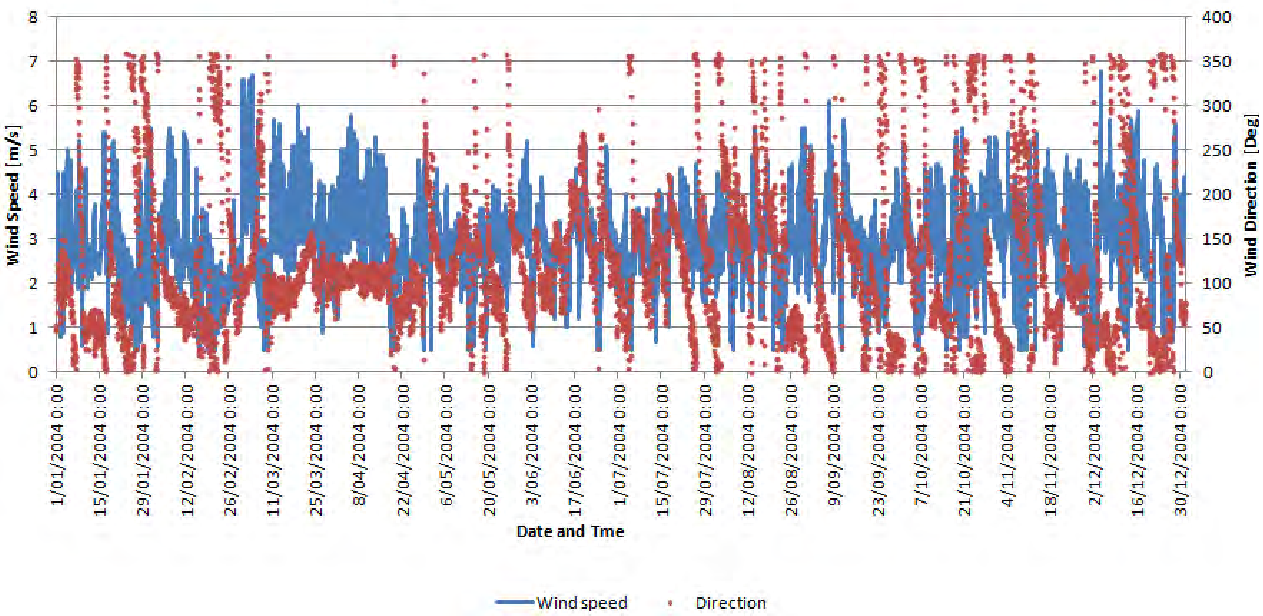

Figure 7: Wind Speed and Wind Direction Cases Modelled (Almost 9000 Cases)

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 Alpha (Table 13).

Table 13: 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	5	50
Night (Less frequent)	2	270	-3	5	50

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

Table 14 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 giver stability class is shown in Table 15.

Table 14: 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 15: 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 SGCP construction phase include construction of the following:

- an internal road network including access from the Capricorn Highway to the accommodation village and mining areas and heavy vehicle haul roads;
- initial development of the open cut pits;
- development of underground operations (including sinking shafts and declines);
- a railway line, rail loop and rail loader;
- CHPP;
- various supporting infrastructure including administration and workshops;
- materials handling infrastructure;
- power supply and reticulation infrastructure;
- water supply and management infrastructure; and
- accommodation village.

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 levels of activity. As a consequence, the noise levels associated with the construction phase are predicted to be 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 noise, however, differences in the expected noise levels will be highlighted in the assessment.

The Digital Terrain Model (DTM) for the SGCP is 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;
- rockdrill;
- blasting;
- sizing stations;
- conveyors between sizing stations, ROM stockpile area, CHPP, product stockpile area and waste rock emplacement;
- dump trucks (in-pit);
- CHPP;
- various surface earth working machines.

The likely equipment noise levels are contained in Table 16. 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 16 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 17.

Table 16: 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	117	117	116	119	116	113	106	94	120	73
998 loader	97	114	110	113	112	114	107	101	118	70
Haul truck	107	115	110	110	108	107	102	97	113	65
Rear dump truck (250t)	118	126	121	121	119	118	113	108	124	76
Rear Dump truck (195t)	115	123	118	118	116	115	110	105	121	73
D11 Dozer	110	112	114	106	108	105	103	97	113	65
Drill Rig	113	117	112	116	115	114	116	115	122	74
Grader	106	108	110	102	104	101	99	93	109	61
Shovel (34m^3)	115	126	122	121	119	114	108	103	123	75
Shovel (25 m^3)	111	122	118	117	115	110	104	99	119	71
Conveyor per km	105	99	101	103	100	97	90	90	101	50
Conveyor Drive	115	111	105	103	99	93	86	79	105	57
Stacker reclaimer	110	106	101	101	97	93	86	84	102	54
CHPP	117	119	114	110	113	103	101	91	115	67
Ventilation Fans	121	108	97	94	95	93	80	85	101	53

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:

- conveyor at 1.5 m above local terrain;
- stacker reclaimer at 8 m above local terrain;
- conveyor drives at 2 m above local terrain;
- ventilation fans at 5 m above local terrain;
- dump truck at 4.5 m 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 16. They are minor since the noise levels are relatively low or they operate infrequently. The exclusion of this plant from the noise model has not made a noticeable difference in the calculated noise levels at sensitive receptors.

Two modelling cases are addressed representing Year 3 (2017) and Year 26 (2040).

The first case (Year 3) is during the ramp-up phase of the mine, when the projected waste rock reaches its maximum at 55.3 million bank cubic meters (Mbcm). The product coal for this year is approximately 9.7 Mtpa. The second case (Year 26) is a fully developed mine with the projected waste rock reaches its local maximum at 37.7 million bank cubic metres. The product coal for this year is approximately 15.1 Mtpa.

Both cases relate to the maximum rate of handling of waste rock for the respective mining phases. During the first 20 years of the mine's life there are only three cases where the total waste rock exceeds 40 Mbcm, with the typical mining rate being 20 to 30 Mbcm. Although total ROM coal increases to approximately 19 Mtpa during this period, the increase is mostly due to the ramp up in underground mining operations.

During the later phase of the mine, the peak waste rock is in 2040, the 26th year of the mine's operation and is considered representative of the worst case emissions after the 20th year of operation. At this time the open cut pits have joined and operations have progressed in a westerly direction for the full north to south extent of the pit.

The equipment lists for the two mining phases are contained in Table 17. The correction L_{Amax} to L_{Aeq} 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 the key noise source in all noise models.

Table 17: Equipment List for Noise Modelling Cases and L_{Amax} to L_{Aeq} correction

Equipment	L_{Amax} to L_{Aeq} Correction [dB]	Modelling Case 1	Modelling Case 2
Dragline	-5	1	2
Shovel (RH200)	-5	1	2
Loader 998	-5	2	2
Dump truck (190t)	-8	10	10
Dump truck (250t)	-8	12	12
Conveyor	0	5.8 km	10.5 km
Conveyor drive	0	1	1
D11 Dozer	-10	1	1
Drill rig	-5	1	1
Grader	-3	1	1
Stacker/reclaimer	-3	1	1
CHPP	0	1	1
Ventilation fan	0	0	2

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 two mining stages for the fully operational SGCP.

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 18 for mining Case 1 and presented in Table 19 for mining Case 2. Also shown of these table is 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 high ambient noise levels. These 'worst-case' noise levels are then compared to the objectives and the likely impacts assessed.

Table 18: Calculated Noise Levels for Each Sensitive Receptor Surrounding SGCP - Mining Case 1

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
Objectives for Alpha: Acoustic Quality Background Creep	*50*	*50*	*45*	*45*	*45*	*40*	*40* *40.4*	*40* *36*	*35* *30*	*40* *40.4*	*40* *36*	*35* *30*
Alpha township	27.9	28.1	29.4	27.9	28.1	29.4	25.0	27.6	27.4	14.1	15.5	14.6
Objectives for stations: Acoustic Quality Background Creep	*50*	*50*	*45*	*45*	*45*	*40*	*40* *33*	*40* *31*	*35* *28*	*40* *33*	*40* *31*	*35* *28*
Betanga Homestead	26.4	26.6	26.8	26.4	26.6	26.8	24.2	25.0	24.6	20.2	22.3	22.3
Bonanza Homestead	30.0	29.8	30.6	30.0	29.8	30.6	28.4	29.0	28.7	7.1	6.8	4.9
Chesalon Homestead	35.3	34.7	35.1	35.3	34.7	35.1	31.3	33.2	33.1	22.4	23.1	22.0
Corntop Homestead	26.3	27.4	27.5	26.3	27.4	27.5	24.1	25.5	25.3	19.8	22.4	22.4
Creek farm Homestead	33.4	35.4	35.9	33.4	35.4	35.9	30.0	31.6	31.4	7.6	7.5	5.3
Eureka Homestead	28.8	28.3	28.7	28.8	28.3	28.7	26.8	26.7	26.6	15.0	18.6	18.5
Oakleigh Homestead	28.5	28.8	29.6	28.5	28.8	29.6	26.7	27.7	27.6	10.8	11.5	13.4
Accommodation Village	39.9	39.9	40.6	39.9	39.9	40.6	37.1	39.0	39.0	26.3	27.9	27.7
Saltbush Homestead	23.3	22.1	23.6	23.3	22.1	23.6	19.7	21.7	21.6	10.5	13.4	13.4
Villafield Homestead	29.6	29.3	30.2	29.6	29.3	30.2	28.0	28.9	28.3	7.2	7.4	6.4

Table 19: Calculated Noise Levels for Each Sensitive Receptor Surrounding SGCP - Mining Case 2

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
Objectives for Alpha: Acoustic Quality Background Creep	*50*	*50*	*45*	*45*	*45*	*40*	*40* *40.4*	*40* *36*	*35* *30*	*40* *40.4*	*40* *36*	*35* *30*
Alpha township	25.3	26.6	27.8	25.3	26.6	27.8	23.8	26.2	25.9	1.7	3.7	3.1
Objectives for stations: Acoustic Quality Background Creep	*50*	*50*	*45*	*45*	*45*	*40*	*40* *33*	*40* *31*	*35* *28*	*40* *33*	*40* *31*	*35* *28*
Betanga Homestead	27.2	27.2	27.4	27.2	27.2	27.4	25.0	25.8	25.4	20.8	23.1	23.1
Bonanza Homestead	29.8	29.9	30.9	29.8	29.9	30.9	28.3	29.2	29.1	6.3	5.7	4.1
Chesalon Homestead	31.4	31.7	32.7	31.4	31.7	32.7	30.1	31.3	31.1	16.6	15.8	14.0
Corntop Homestead	27.9	28.1	28.1	27.9	28.1	28.1	25.3	26.5	26.1	21.0	23.7	23.8
Creek farm Homestead	32.7	34.1	34.7	32.7	34.1	34.7	30.8	32.7	32.6	7.9	8.0	6.3
Eureka Homestead	28.9	27.6	28.6	28.9	27.6	28.6	26.8	26.8	26.6	14.6	18.6	18.5
Oakleigh Homestead	28.5	29.7	30.5	28.5	29.7	30.5	26.9	28.8	28.6	10.6	11.5	13.1

Accommodation Village	39.2	39.5	40.5	39.2	39.5	**40.5**	36.7	39.0	**39.0**	16.1	17.5	17.8
Saltbush Homestead	22.6	21.9	23.6	22.6	21.9	23.6	19.4	21.8	21.7	0.7	7.3	7.4
Villafield Homestead	28.8	28.9	29.9	28.8	28.9	29.9	27.4	28.4	28.2	7.3	6.9	6.0

Bolded values denote exceedances of the acoustic quality objectives.

Typical adverse noise levels are contained in Figure 8 to Figure 11 and are based on the adverse night modelling cases contained in Table 13.

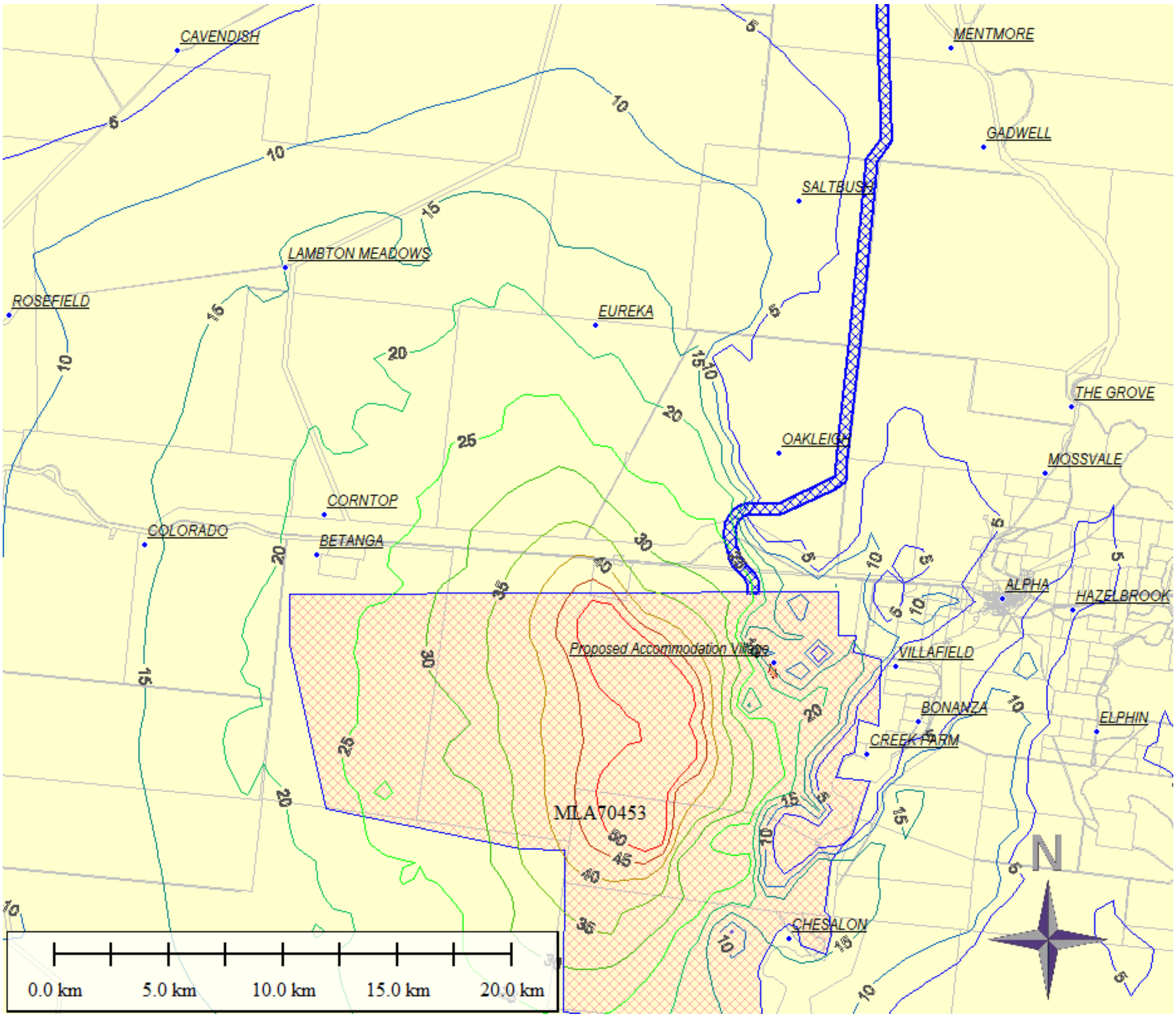

Figure 8: L_{Aeq} Noise Level For Night With East Wind - Mining Case 1

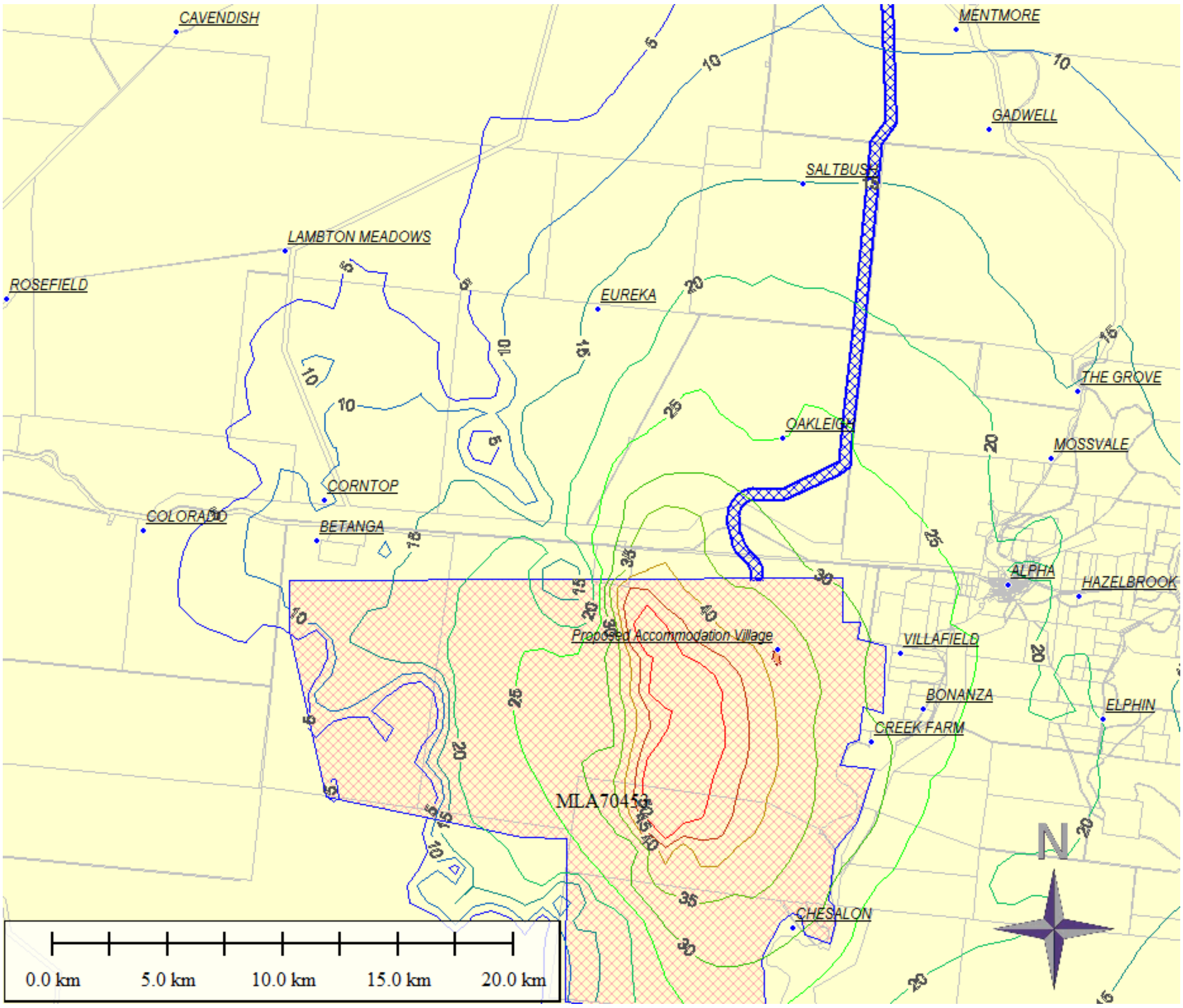

Figure 9: L_{Aeq} Noise Level For Night With West Wind - Mining Case 1

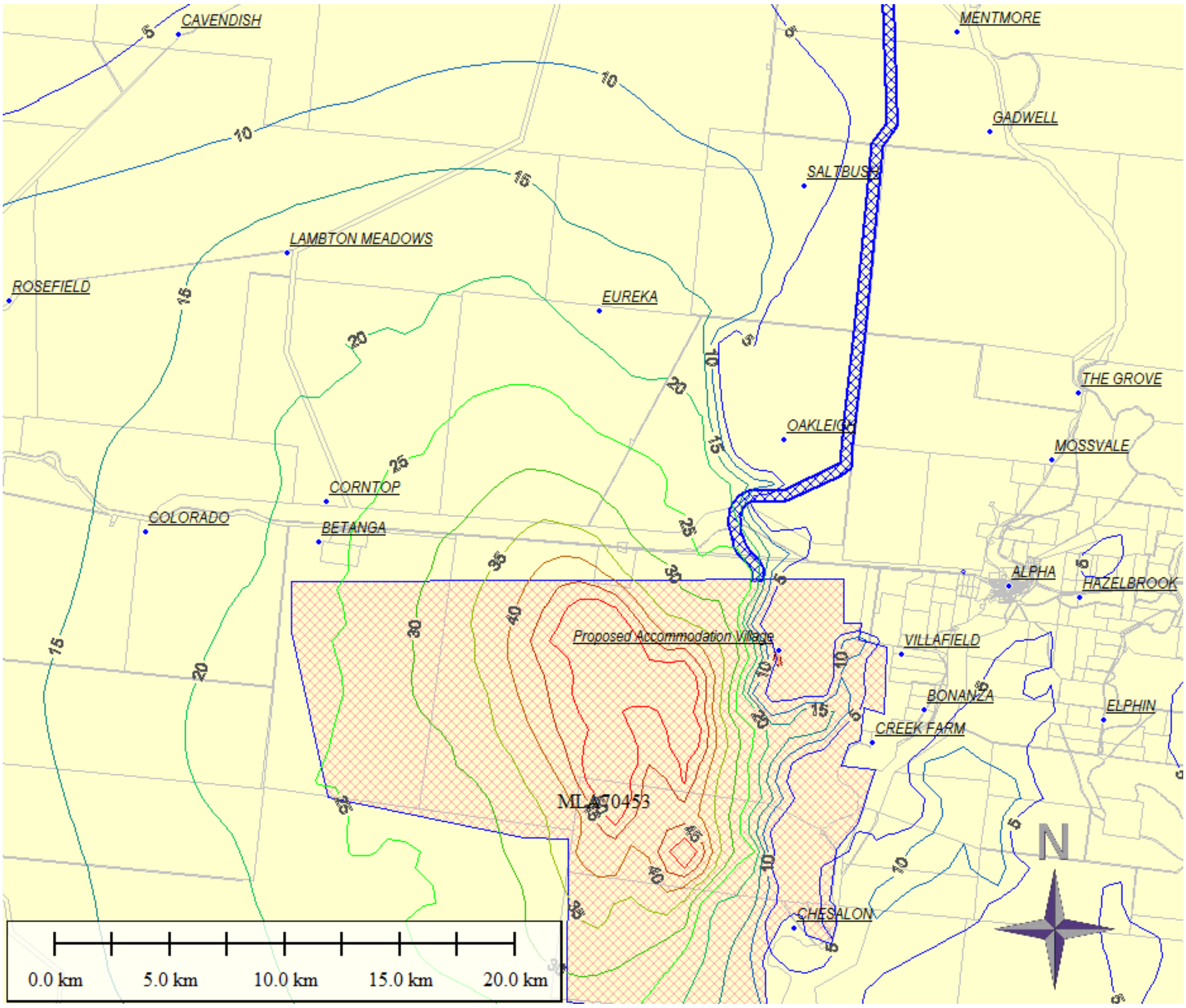

Figure 10: L_{Aeq} Noise Level For Night With East Wind - Mining Case 2

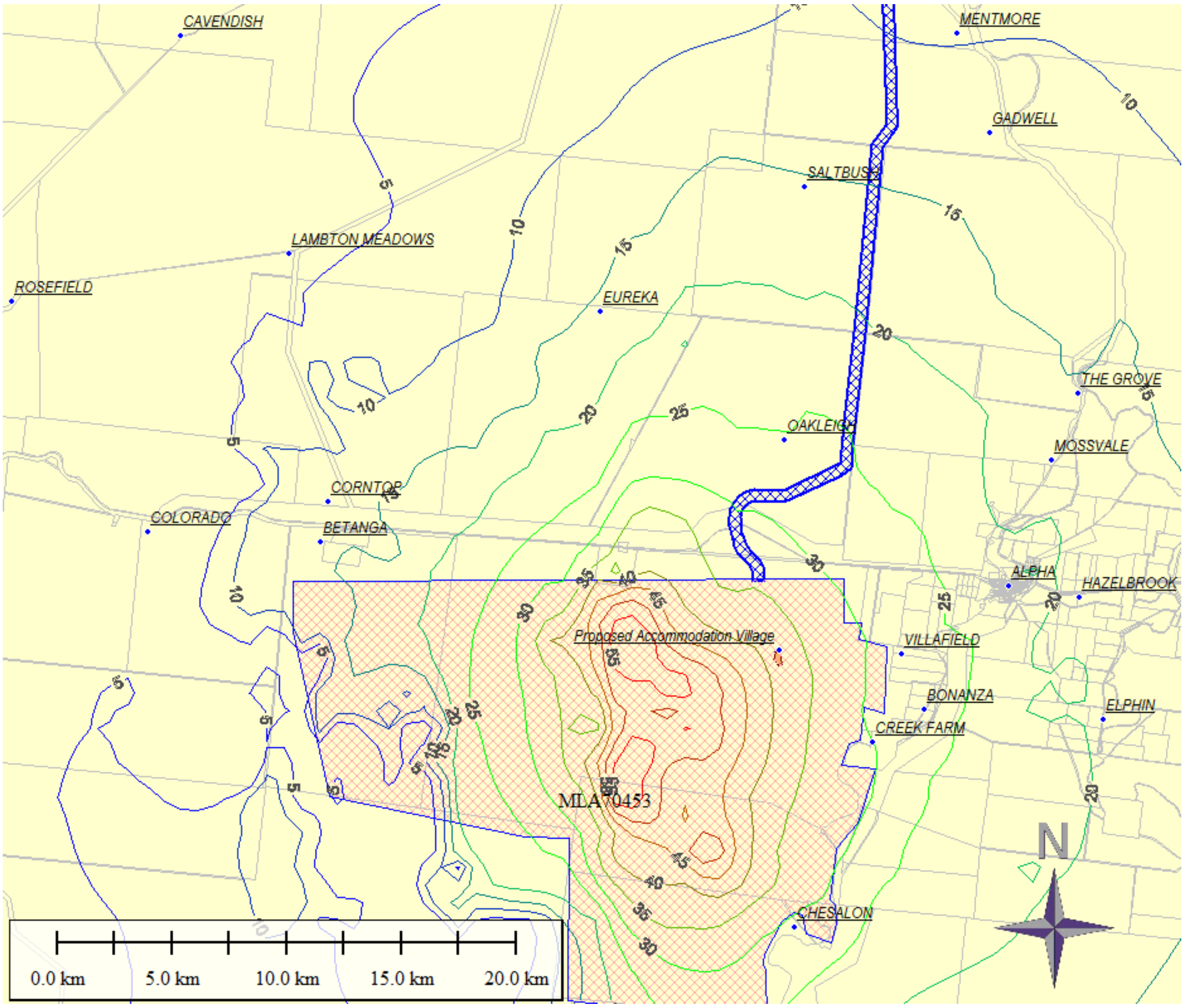

Figure 11: L_{Aeq} Noise Level For Night With West Wind - Mining Case 2

Table 20: Low Frequency Noise Levels at Night [dB(Lin)] for Mining Case 1 and Mining Case 2

Location	**Low Frequency Noise Level $L_{Aeq(1\ hour)}$ [dB(Lin])**	
	Case 1	**Case 2**
Objective	**50**	**50**
Alpha Township	25	18
Betanga Station Homestead	39	43
Chesalon Station Homestead	33	32
Colorado Station Homestead	33	38
Corntop Station Homestead	39	43
Creek Farm Station Homestead	12	12
Eureka Station Homestead	38	37
Oakleigh Station Homestead	12	12
Proposed Accommodation Village	35	19
Saltbush Station Homestead	27	28
Villafield Station Homestead	14	14

The blast overpressure and vibrations at all sensitive receptors is contained in Table 21. 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 12: Vibration Levels in mm/s for Case 1 with 500 kg MIC;
- Figure 13: Peak Sound Pressure Levels in dBLin for Case 1 with 500 kg MIC;
- Figure 14: Vibration Levels in mm/s for Case 2 with 500 kg MIC; and,
- Figure 15: Peak Sound Pressure Levels in dBLin for Case 2 with 500 kg MIC

Table 21: Predicted Noise and Vibration Levels from Blasting at SGCP (for 500 kg MIC)

Location	Case 1 Vibration and Blast Overpressure		Case 2 Vibration and Blast Overpressure	
	Blast Overpressure [dBLin]	**Vibrations [mm/s]**	**Blast Overpressure [dBLin]**	**Vibrations [mm/s]**
Objective	**115**	**5**	**115**	**5**
Alpha Township	96	0.06	93	0.05
Betanga Station Homestead	96	0.07	96	0.08
Bonanza Station Homestead	99	0.07	96	0.06
Chesalon Station Homestead	99	0.06	95	0.06
Corntop Station Homestead	96	0.07	95	0.07
Creek Farm Station Homestead	102	0.08	98	0.08
Eureka Station Homestead	95	0.07	94	0.07
Oakleigh Station Homestead	98	0.11	96	0.10
Saltbush Station Homestead	90	0.05	90	0.05
Proposed Accommodation Village	107	0.21	104	0.17
Villafield Station Homestead	100	0.08	97	0.07

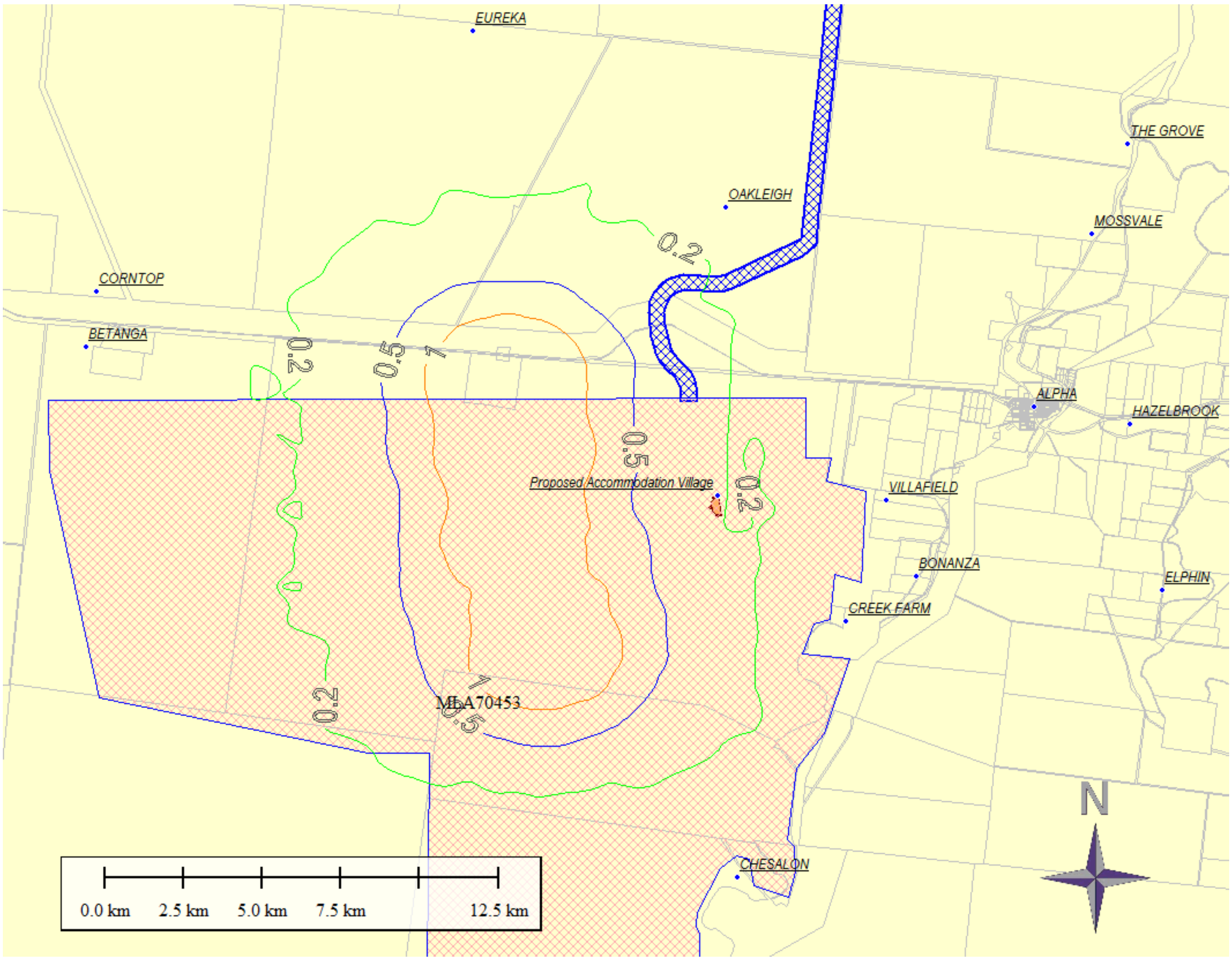

Figure 12: Vibration Levels in mm/s for Case 1 with 500 kg MIC

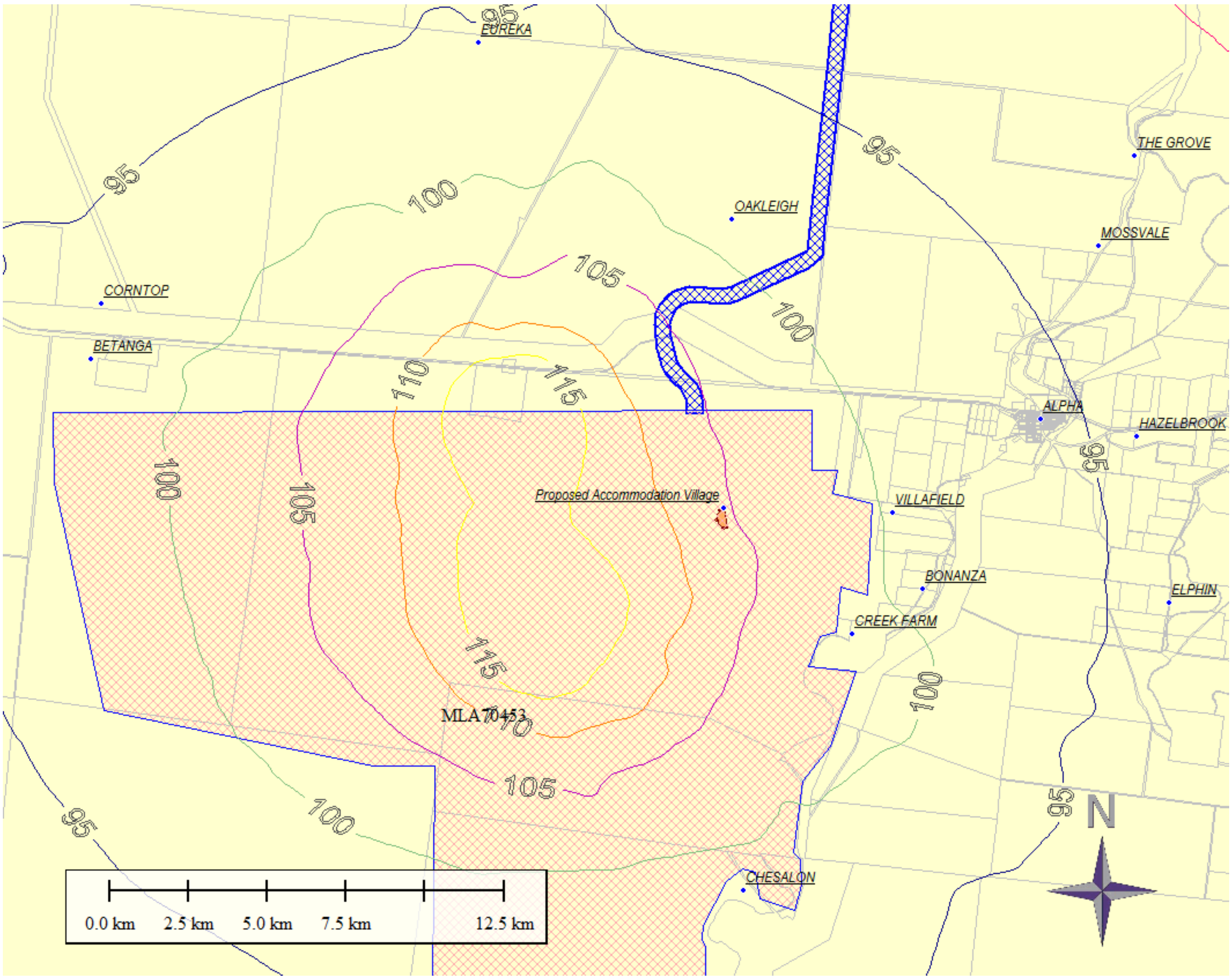

Figure 13: Peak Sound Pressure Levels in dBLin for Case 1 with 500 kg MIC

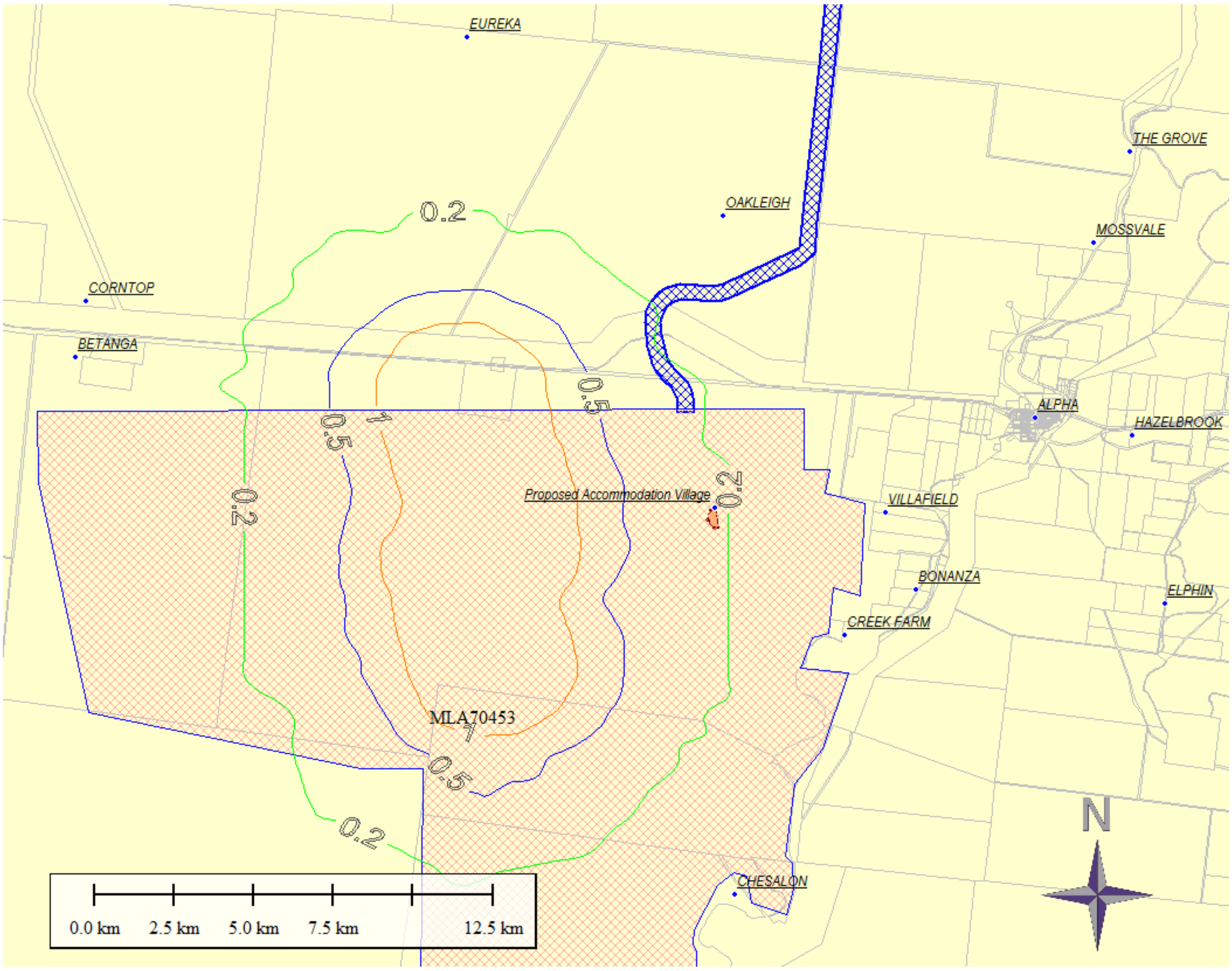

Figure 14: Vibration Levels in mm/s for Case 2 with 500 kg MIC

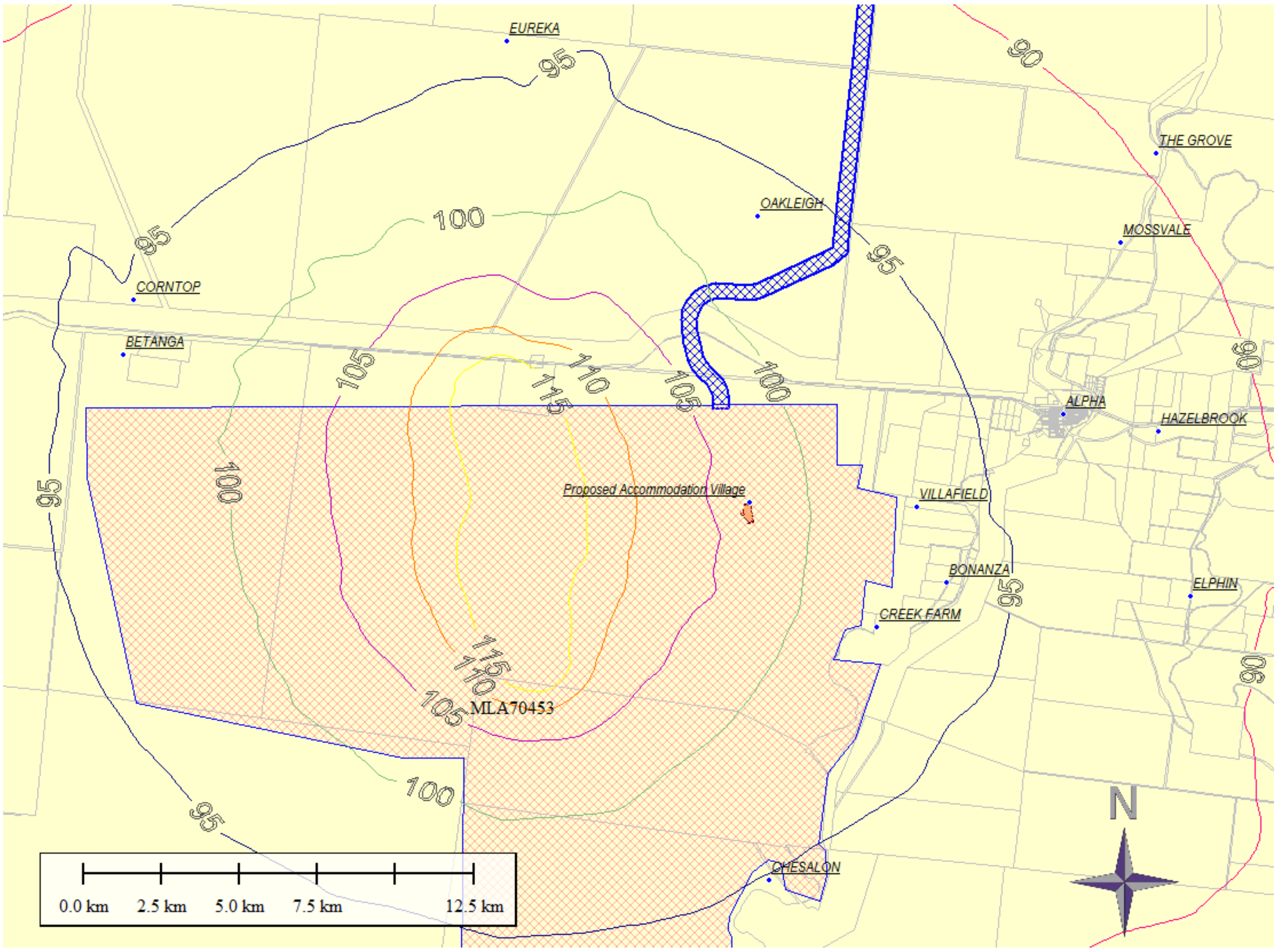

Figure 15: Peak Sound Pressure Levels in dBLin for Case 2 with 500 kg MIC

4.5 Railway Noise

The proposed rail line is likely to terminate approximately 40 km north of the SGCP where it connects to the common user rail line linking the Galilee Basin and Abbot Point Coal Terminal. It is understood the railway proposed for the Galilee Coal Project comprises a standard gauge railway to support up to 25,000 tonne trains. Furthermore a dual track is proposed, one for loaded trains and the other for empty trains returning to the mines. The coal trains are likely to comprise diesel-electric locomotives.

It is beyond the scope of this assessment to address the noise emissions for the entire rail line route. Savery & Associates Pty Ltd (2011) assessed the noise emissions for the route between the Galilee Coal Project and the Abbot Point Coal Terminal. The Savery & Associates (2011) assessment assumed a total modelled transport coal capacity of 400 Mtpa, rather than the 17 Mtpa from Waratah Coal only in order to reflect the projected cumulative impacts along the rail corridor (including use of the common user rail line by the SGCP).

4.5.1 Railway Noise Modelling

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 17 Mtpa.

The likely noise levels from trains is shown in Figure 16 and Figure 17 for the maximum noise level and the $L_{Aeq(24\ hour)}$ respectively.

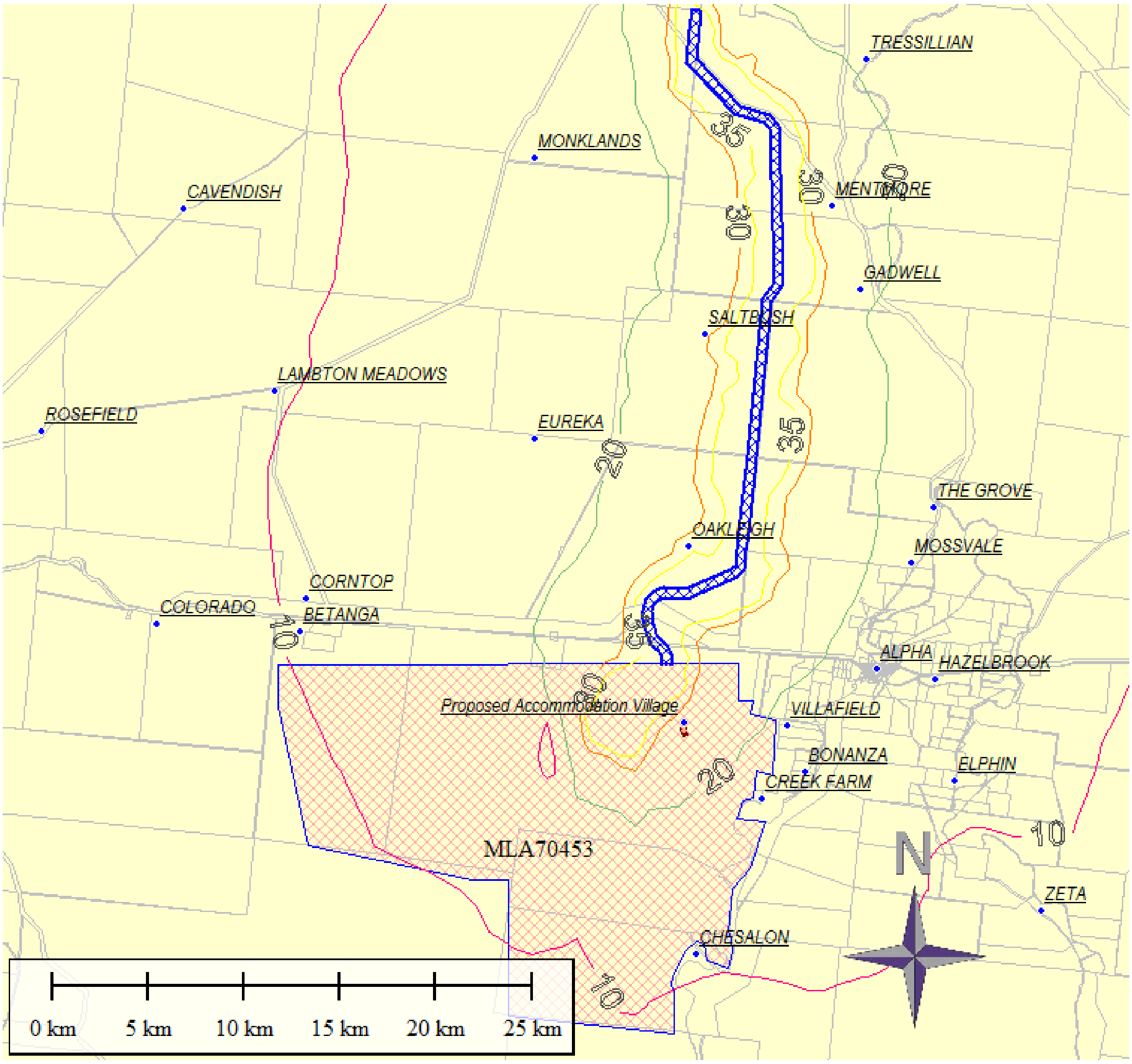

Figure 16: Calculated Maximum Noise Levels from Railway Locomotives [dB(A)]

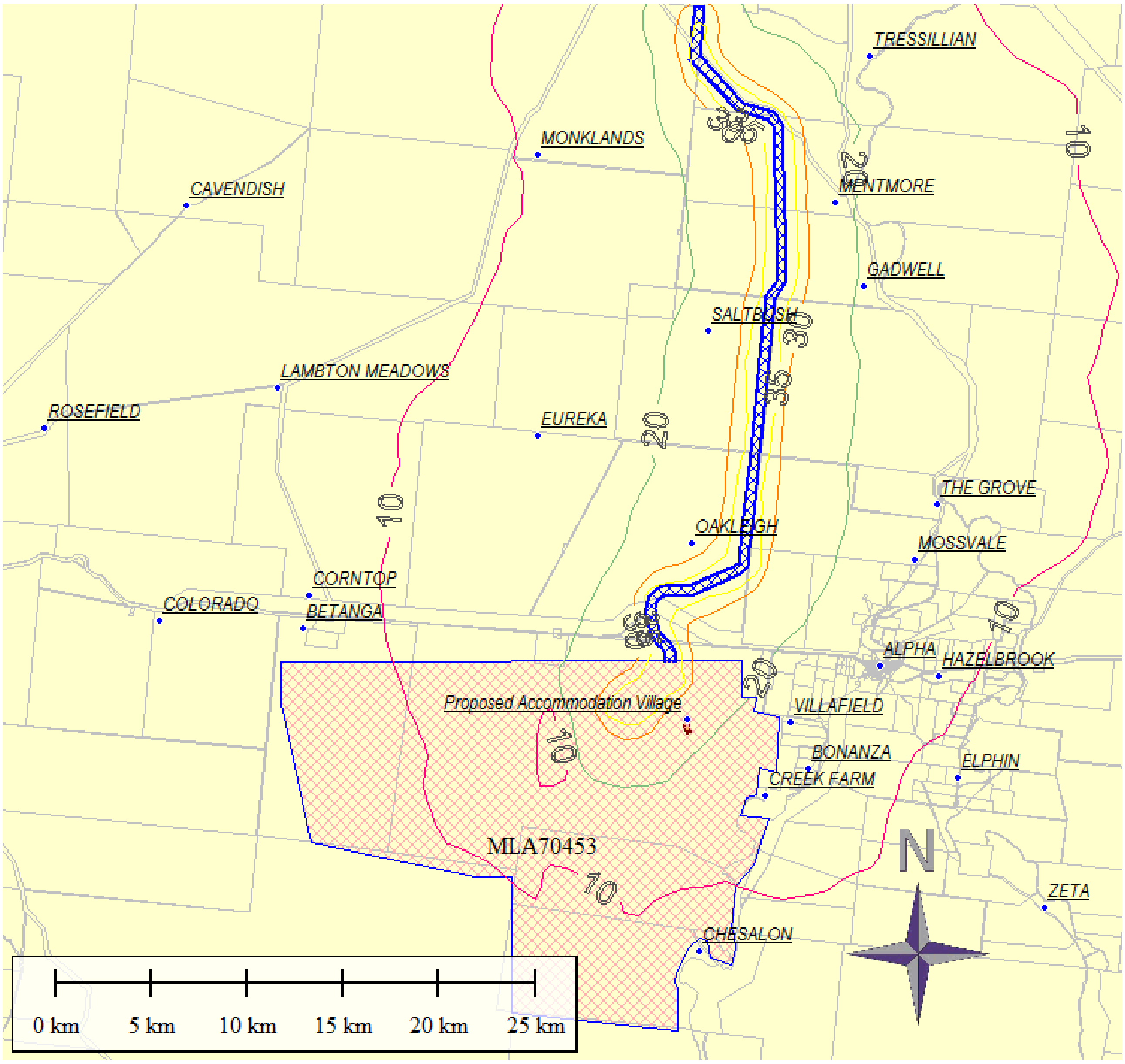

Figure 17: Calculated $L_{Aeq(24\ hour)}$ from Trains at 17 Mtpa [dB(A)]

4.6 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 SGCP comply with the acoustic quality objectives during the day, evening and night at all sensitive receptors except at the proposed accommodation village.

Noise mitigation and management measures are recommended in Section 4.6.

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 except the accommodation village with wide open windows.

Noise mitigation and management measures are recommended in Section 4.6.

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 the rural areas surrounding the SGCP 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 Alpha comply with the goals to avoid background creep for all time periods.

However, the homesteads close to the SGCP are likely to exceed the goals to avoid background creep during the evening and night (Table 22). There are meteorological conditions during the year that will lead the L_{Aeq} to exceed noise level goals to avoid background creep. The noise levels at the Creek Farm and Chesalon Station homsteads will exceed 28 dB(A) at night for approximately 15% of the time. The main contributors to these exceedances are the trucks operating in exposed locations and the shovel operating close to natural surface (whilst in the pit).

The noise goals to protect background creep will be exceeded at the accommodation village during all time periods. This exceedance is not expected to be significant as once the accommodation village is constructed and occupied, it will generate self noise from air conditioning, refrigeration and general activities. Consequently, the ambient noise levels are likely to be much higher than at present. The noise level goals to avoid background creep would therefore also be higher. The most important goal for the accommodation village is to ensure compliance with acceptable indoor noise levels. These will be readily met for the air conditioned accommodation units proposed for SGCP.

Table 22: Locations and Periods Exceeding Background Creep Noise Goals

Location	Period	Criterion [dB(A)]	Mining Case 1 Noise Levels in [dB(A)]		Mining Case 2 Noise Levels in [dB(A)]	
			Calculated 'worst case'	Average	Calculated 'worst case'	Average
Bonanza	Night	28	28.7	4.9	29.1	4.1
Chesalon	Evening	31	32.2	23.1	31.3	15.8
	Night	28	33.1	22.0	31.1	14.0
Creek Farm	Evening	31	31.6	7.5	32.7	8.0
	Night	28	31.4	5.3	32.6	6.3
Oakleigh	Night	28	-	-	28.6	13.1
Accommodation Village	Day	33	37.1	26.3	36.7	16.1
	Evening	31	39.0	27.9	39.0	17.5
	Night	28	39.0	27.7	39.0	17.8
Villafield	Night	28	28.3	6.4	28.2	6.0

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 most of the predicted noise levels from the SGCP. The accommodation village potentially exceeds the enHealth sleep noise level goal with windows open. However, with windows closed the sleep noise level goal is met at the accommodation village.

DERM Low Frequency Noise

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

DERM Blasting Noise and Vibration

The blasting contours vibration levels are expected to be met at all sensitive receptors for a MIC of 500 kg.

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.

4.7 Mitigation and Management Measures

In order for the on-site accommodation village to comply with the indoor acoustic quality objectives and sleep disturbance goals, the accommodation units will need to be air conditioned so that windows can remain closed, allowing the overall building structure to provide sufficient noise reduction.

To comply with the indoor noise levels at the accommodation village the windows will need to be closed and this implies the accommodation units will need to be air conditioned.

The background creep during the evening and night at the Creek Farm and Chesalon Station homestead can be mitigated as follows:

- the noise levels can be readily reduced by 6 dB(A) by operating trucks behind mounding (i.e. not operating dump trucks in highly exposed locations on the top of overburden at night but at a lower level with the waste rock emplacement intervening and acting as a noise barrier);
- the shovel and other heavy equipment should work deep in the pit during the night rather than near the surface.

Any noise control designed for these homesteads will work equally well for other receptors to the east of SGCP.

Although many of these measures will be standard operating procedures for the SGCP, any further opportunities for mitigation of noise emissions should be considered as relevant over the life of the mine (e.g. operational noise control measures such as enclosing the rail loader, disturbance of the minimum area necessary for mining, speed limits on site roads etc.).

A Noise Management Plan should be developed and implemented to mitigate adverse noise and vibration impacts.

5. Conclusion

Existing noise levels were measured at the Alpha township and at several homesteads surrounding the SGCP. The noise levels at all the homesteads are exceedingly 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.

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.

The assessment of noise confirms that the on-site accommodation village requires closed windows to comply with acceptable indoor noise levels.

EPP (Noise) Acoustic Quality Objectives

The EPP (Noise) acoustic quality objectives to protect human health and wellbeing are met at all locations (except the accommodation village) with wide open windows. Consequently, the windows at the accommodation village will need to be closed and the rooms will need to be air conditioned.

EPP (Noise) Sleep Disturbance

The EPP (Noise) sleep disturbance goals are met at all locations (except the accommodation village) with wide open windows. As indicated above, the accommodation village will require air conditioning to allow windows to remain closed.

EPP (Noise) Background Creep

The calculated noise levels in Alpha comply with the goals to avoid background creep for all time periods.

However, the homesteads close to and east of the SGCP are likely to exceed the goals to avoid background creep during the evening and night. The two most adversely affected locations, the Creek Farm and Chesalon Station homesteads, exceed the night goal for approximately 15% of the time.

The main contributors will be the trucks operating in exposed locations and the shovel operating close to natural surface (whilst in the pit). The noise levels can be readily reduced by 6 dB(A) by operating trucks behind mounding (i.e. not operating dump trucks in highly exposed locations on the top of overburden at night but at a lower level with the waste rock emplacement intervening and acting as a noise barrier). Similarly, the shovel and other heavy equipment should work deep in the pit during the night rather than near the surface. Any noise control designed for these homesteads will be equally effective for other receptors to the east of SGCP.

Although the noise goals to protect background creep will be exceeded at the accommodation village during all time periods, it is not significant as once the village is constructed and occupied it will generate self noise from air conditioning, refrigeration and general activities so the ambient noise levels are likely to be much higher than at present. As a result the noise level goals to avoid background creep are likely to be somewhat higher. The most important goal for the accommodation village is to ensure compliance with acceptable indoor noise levels to preserve sleep. These are readily met for the air conditioned accommodation units proposed for the SGCP.

DERM Low Frequency Noise

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

DERM Blasting Noise and Vibration

The blasting contours vibration levels are expected to be met at all sensitive receptors for a MIC of 500 kg.

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.

Therefore the noise level goals proposed for the SGCP are met subject to the following:

1. all equipment has noise level emissions similar to the assumed noise levels in this report;
2. that dump truck and haul truck operations during the night (especially during no wind conditions or winds from the western hemisphere) are operated behind mounding to ameliorate noise emissions to the east;
3. that shovel, bulldozers and other heavy equipment are operated during the night (especially during no wind conditions or winds from the western hemisphere) are operated behind mounding (or deep in the pits) to ameliorate noise emissions to the east; and
4. the accommodation village buildings have closed windows and air conditioning.

It is recommended that a Noise Management Plan be developed and implemented to mitigate adverse noise and vibration impacts. The Noise Management Plan should detail the noise and vibration monitoring program to be undertaken over the life of the SGCP.

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 Emerald

Statistic Element	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Mean maximum temperature (Degrees C) for years 1992 to 2011	34.3	33.4	32.8	29.9	26.2	23.3	23.2	25.3	28.9	31.7	33.1	34.2
Highest temperature (Degrees C) for years 1992 to 2011	45.6	41.5	40.8	36.7	34.3	31.3	31	35.2	37.7	42.4	42.9	43
Year of Highest temperature for years 1992 to 2011	1994	2005	2007	2006	2007	2003	1995	2009	1997	2003	2006	2001
Lowest maximum temperature (Degrees C) for years 1992 to 2011	24.1	20.9	21.9	17.2	17	9.7	13.6	12.6	15.7	21	20.7	19
Date of Lowest maximum temperature for years 1992 to 2011	2010	2000	2008	2011	2000	2007	2008	1996	1993	1995	1997	2006
Decile 1 maximum temperature (Degrees C) for years 1992 to 2011	30.6	29	29.8	26.6	23	19	20	21.2	24.6	27.8	29	29.5
Decile 9 maximum temperature (Degrees C) for years 1992 to 2011	38.3	37	36	33	29.1	27	26.2	29	33	36.3	37.2	38.7
Mean number of days >= 30 Degrees C for years 1992 to 2011	28.5	24.3	27.5	15.8	1.5	0.2	0.1	2.1	11.5	22	24.6	27.2
Mean number of days >= 35 Degrees C for years 1992 to 2011	12.9	9.4	6.1	0.6	0	0	0	0.1	1.1	5.3	9.3	13.7
Mean number of days >= 40 Degrees C for years 1992 to 2011	1.2	0.4	0.2	0	0	0	0	0	0	0.6	0.7	1.4
Mean minimum temperature (Degrees C) for years 1992 to 2011	22.2	22.1	20.3	17	12.9	10.1	8.8	10	13.5	17.2	19.5	21.4
Lowest temperature (Degrees C) for years 1992 to 2011	17	16.5	12.1	6.5	2	1.4	2	1	3	9.5	10.7	12.3
Year of Lowest temperature for years 1992 to 2011	2001	1996	2008	1994	2000	2009	2002	2003	1996	1992	2006	2006
Highest minimum temperature (Degrees C) for years 1992 to 2011	32.9	28.8	27.6	24	22	20	18.2	19.4	21.9	26.8	25.5	28.2
Year of Highest minimum temperature for years 1992 to 2011	1994	1995	2007	2000	1998	2002	2004	2011	1992	2003	2004	2005
Decile 1 minimum temperature (Degrees C) for years 1992 to 2011	20	19.7	17.5	13.6	8.3	5.1	4.5	6	9.5	13.9	16.7	18.6
Decile 9 minimum temperature (Degrees C) for	24.5	24.4	23	20.5	17	14.6	13.7	14.5	17.6	20.5	22.4	24.3

years 1992 to 2011												
Mean number of days <= 2 Degrees C for years 1992 to 2011	0	0	0	0	0.1	0.2	0.1	0.2	0	0	0	0
Mean number of days <= 0 Degrees C for years 1992 to 2011	0	0	0	0	0	0	0	0	0	0	0	0
Mean rainfall (mm) for years 1992 to 2011	87.9	81.5	50.9	33.7	19.3	30.8	11.8	24.2	30.5	40.1	56.1	91.2
Highest rainfall (mm) for years 1992 to 2011	231.6	216.2	335.2	130.1	66.6	143.4	76.4	128.2	167.6	213.4	143.6	264
Date of Highest rainfall for years 1992 to 2011	2004	2010	1994	1998	2005	2007	2008	1998	2010	1998	2008	2010
Lowest rainfall (mm) for years 1992 to 2011	6.2	3.7	1.4	0	0	0	0	0	0	0.2	2.8	10.2
Date of Lowest rainfall for years 1992 to 2011	1998	1993	2004	1993	2004	2004	2009	2006	2011	2002	2003	1994
Decile 1 monthly rainfall (mm) for years 1992 to 2011	15.5	17.1	3.9	1.8	0.2	1.2	0	0	0	4.5	6.2	22.5
Decile 5 (median) monthly rainfall (mm) for years 1992 to 2011	70.8	66.4	16.4	24.4	12.4	13.4	5.3	14	8.6	23.8	55.4	80.2
Decile 9 monthly rainfall (mm) for years 1992 to 2011	179.9	176	103.5	86.8	41.9	64.8	32.6	63.8	84.6	96.5	104.8	157
Highest daily rainfall (mm) for years 1992 to 2011	132	112.8	140	90.5	49.2	36	60.2	51.5	48.2	72.8	43.6	119
Year of Highest daily rainfall for years 1992 to 2011	1996	2009	1994	1998	2005	2008	2008	1993	1996	1998	1996	2010
Mean number of days of rain for years 1800 to 3000	7.7	8.4	5.2	4.3	3.4	4.2	2.3	3.1	3.4	5.4	7.6	7.9
Mean number of days of rain >= 1 mm for years 1992 to 2011	5.7	5.8	3.5	3	2.2	3	1.3	2.2	2.5	3.9	5.8	5.9
Mean number of days of rain >= 10 mm for years 1992 to 2011	2.5	2.3	1.3	1.1	0.7	1.1	0.4	0.7	1.1	1.3	1.9	2.8
Mean number of days of rain >= 25 mm for years 1992 to 2011	1.1	1	0.7	0.4	0.1	0.5	0.1	0.3	0.4	0.4	0.7	1.2
Mean daily wind run (km) for years 1998 to 2011	300	289	289	266	237	249	251	254	266	303	313	314
Maximum wind gust speed (km/h) for years 1998 to 2011	78	81	72	61	63	68	59	70	76	144	106	106
Date of Maximum wind gust speed for years 1998 to 2011	2010	2008	2005	2011	2007	2006	2008	2010	1999	2007	2004	1998
Mean daily solar exposure	25.3	23.4	22.8	19.2	16.3	14.5	15.6	18.3	21.9	24.3	25.5	26.3

(MJ/(m*m)) for years 1990 to 2011												
Mean number of clear days for years 1992 to 2010	4.7	2.6	7.9	8.6	9.1	11.2	10.2	13.9	10.7	9.7	7.8	5.1
Mean number of cloudy days for years 1992 to 2010	8.6	10.1	6.1	4.5	5.3	4	5.3	5.3	5.1	5.8	7.4	7.6
Mean 9am temperature (Degrees C) for years 1992 to 2010	27.3	26.6	25.7	23	19.1	15.8	15.1	17.1	20.9	24	25.8	27.2
Mean 9am wet bulb temperature (Degrees C) for years 1992 to 2010	22	22.3	20.4	17.9	15	12.1	11.2	12.5	15.1	17.9	19.6	21.3
Mean 9am dew point temperature (Degrees C) for years 1992 to 2010	19.2	19.7	17.3	14.1	10.6	8.5	6.9	7.7	10.3	13.1	15.4	17.6
Mean 9am relative humidity (%) for years 1992 to 2010	63	68	61	60	60	64	60	57	54	53	55	58
Mean 9am cloud cover (okas) for years 1992 to 2010	4.6	4.7	4.3	3.8	3.7	3.8	3.9	3.5	3.8	3.6	3.9	4.5
Mean 9am wind speed (km/h) for years 1992 to 2010	15	15.2	16.1	15.4	14.9	15.6	14.6	15.3	15.4	16.3	15.1	15.1
Mean 3pm temperature (Degrees C) for years 1992 to 2010	33.1	32.3	31.9	29.2	25.6	22.6	22.5	24.4	28	30.6	32.1	33.2
Mean 3pm wet bulb temperature (Degrees C) for years 1992 to 2010	22.9	23.1	21.4	19	16.8	14.8	14.1	15.1	16.8	19.1	20.5	21.9
Mean 3pm dew point temperature (Degrees C) for years 1992 to 2010	17	17.7	14.5	11.5	8.9	7.5	5.7	5.7	6.9	9.5	12	14.5
Mean 3pm relative humidity (%) for years 1992 to 2010	41	45	37	36	37	41	36	32	30	31	33	36
Mean 3pm cloud cover (oktas) for years 1992 to 2010	4.8	5.3	3.8	4.3	3.9	3.5	3.7	3.6	3.7	3.3	4	4
Mean 3pm wind speed (km/h) for years 1992 to 2010	15.4	15	15.6	14.6	13.7	13.9	13.7	14.5	14.4	14.7	15.1	15

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 SGCP and Alpha township. These are also locations with the highest noise exposure.

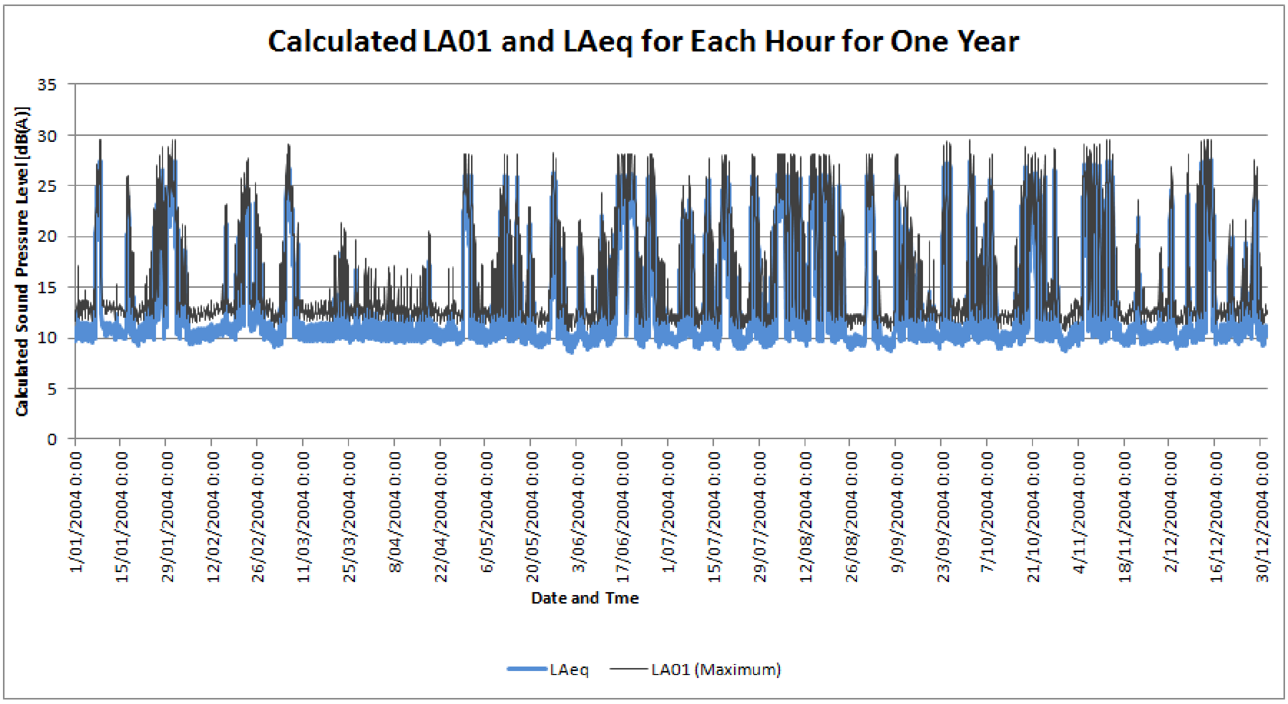

Figure 18: Calculated Noise Levels For Alpha Over 1 Year For Mining Case 1

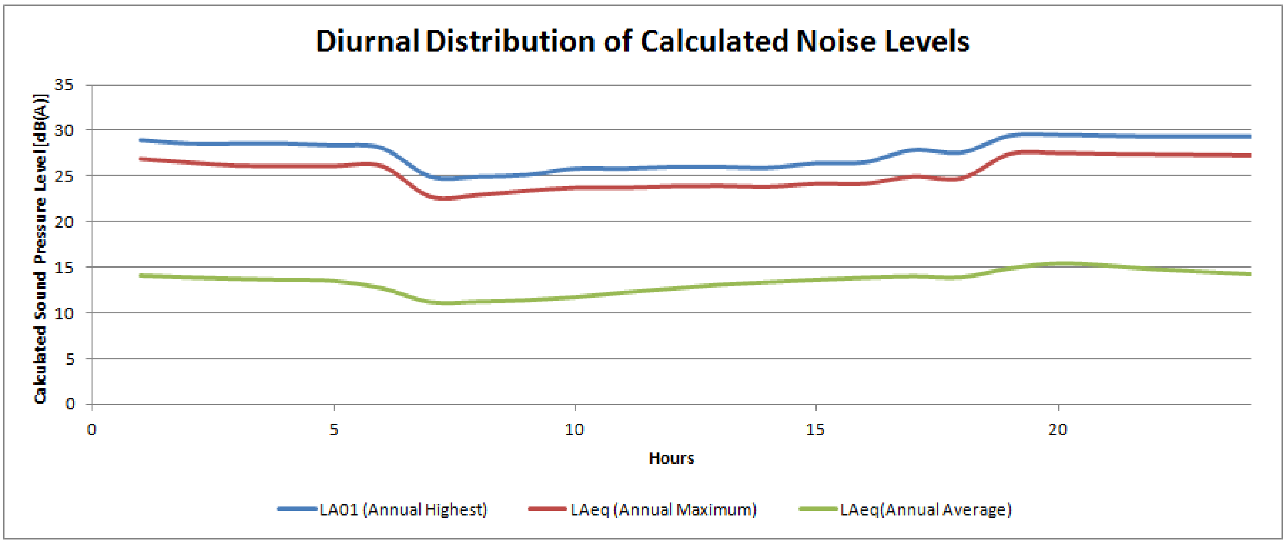

Figure 19: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Alpha Over One Year - Mining Case 1

The modelled noise levels for Alpha (Case 1) show that the lowest noise levels are likely during the day and the highest noise levels are at night. The L_{Aeq} (annual average) noise levels are likely to be of the order of 15 dB(A) with the L_{Aeq}(annual highest) of the order of 22 dB(A) during the day 27 dB(A) at night.

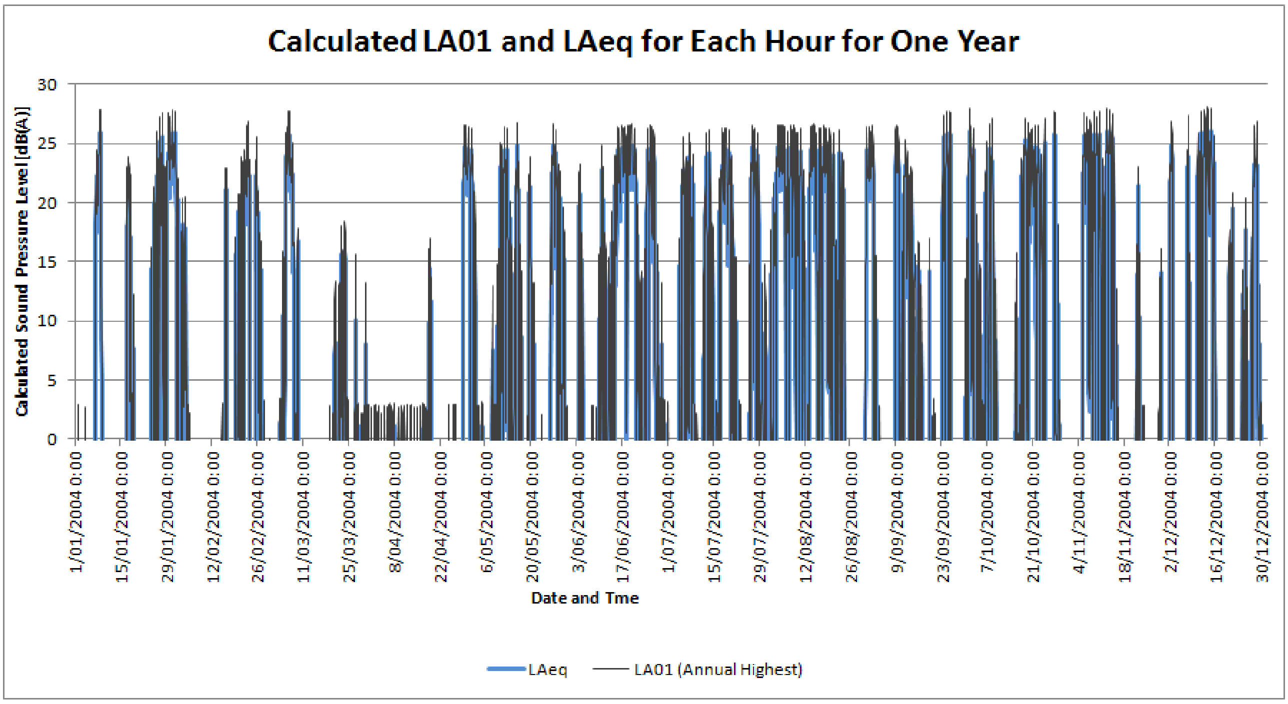

Figure 20: Calculated Noise Levels For Alpha Over One Year For Mining Case 2

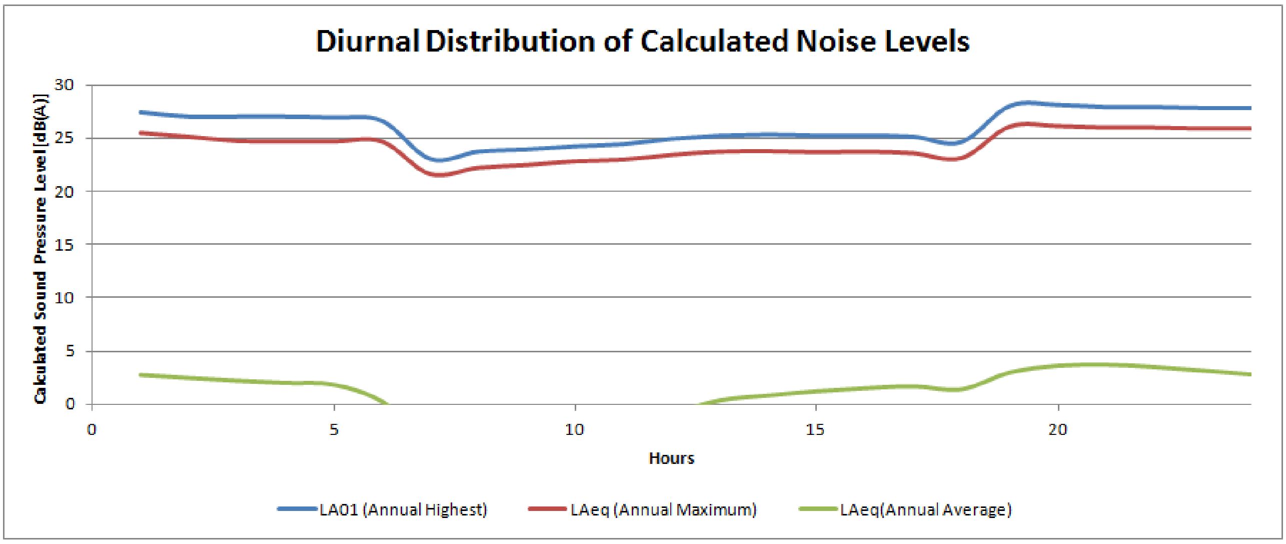

Figure 21: Diurnal Distribution of the Calculated LAeq and LA01 for Alpha Over One Year - Mining Case 2

The modelled noise levels for Alpha (Case 2) show that the (Annual Maximum) noise levels are similar to Case 1. However, the L_{Aeq} (annual average) noise levels are likely to be 10 dB(A) quieter than Case 1. This is due to the progression of the mine in a westerly direction away from Alpha.

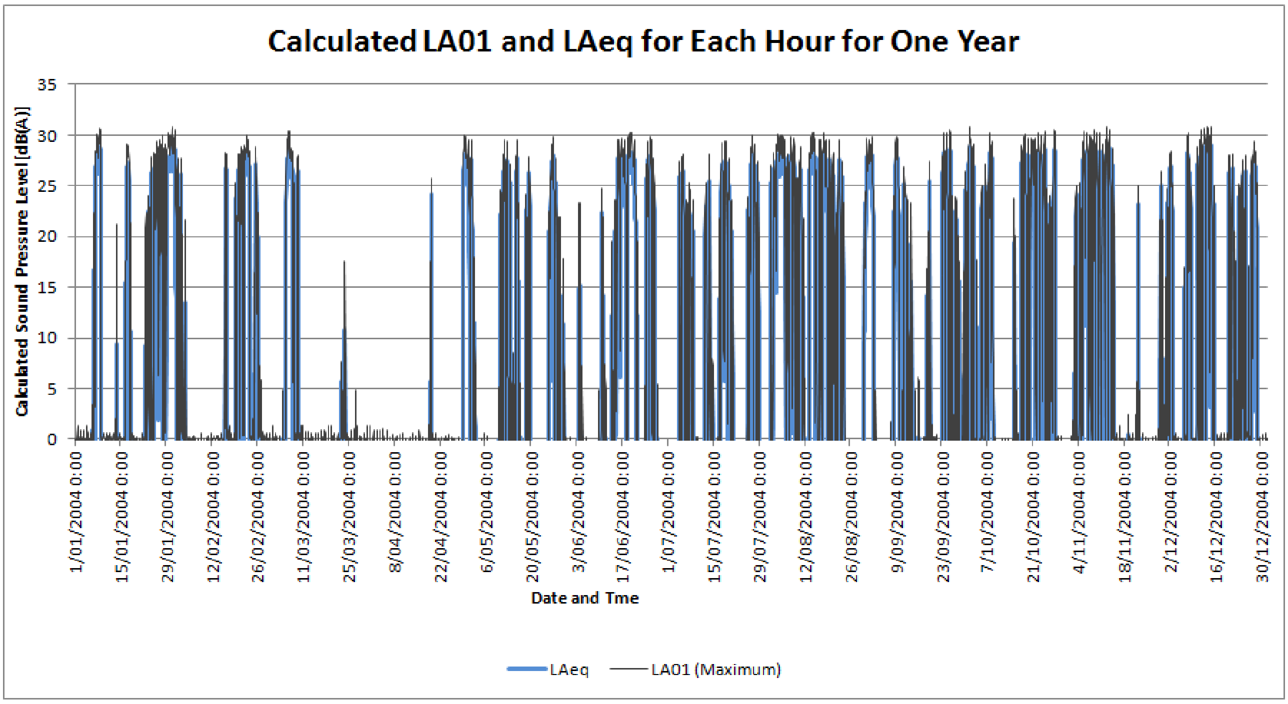

Figure 22: Calculated Noise Levels For Bonanza Over One Year For Mining Case 1

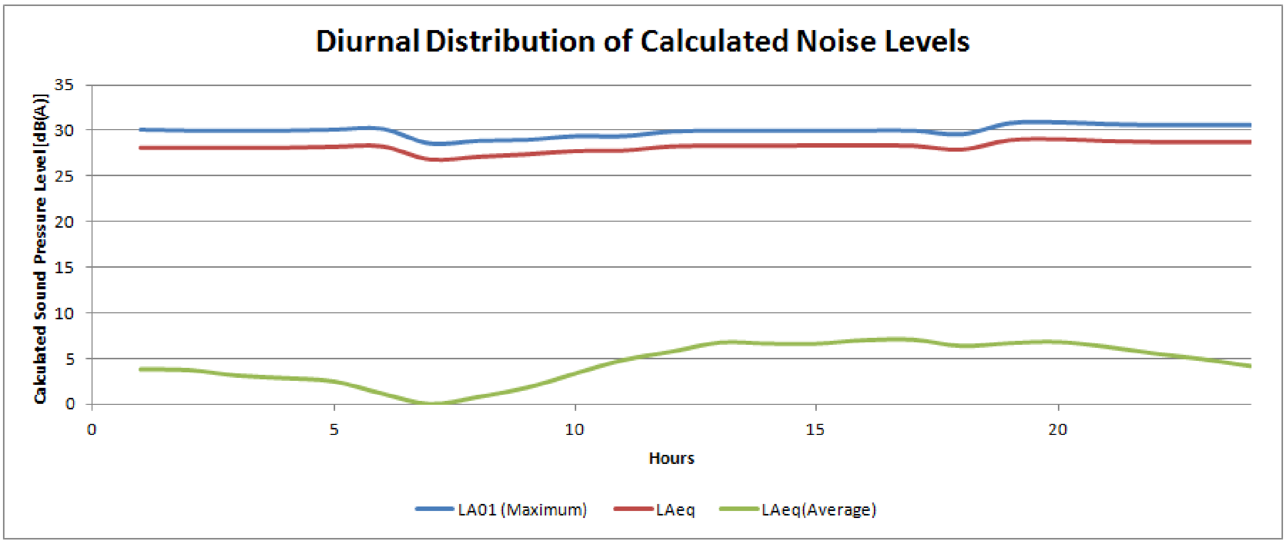

Figure 23: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Bonanza Over One Year - Mining Case 1

Bonanza Station homestead is situated to the east of the SGCP. Most of the time the noise levels are very low, below 15 dB(A). However, there are period when the L_{Aeq} noise levels increase to almost 30 dB(A) during the evening and night.

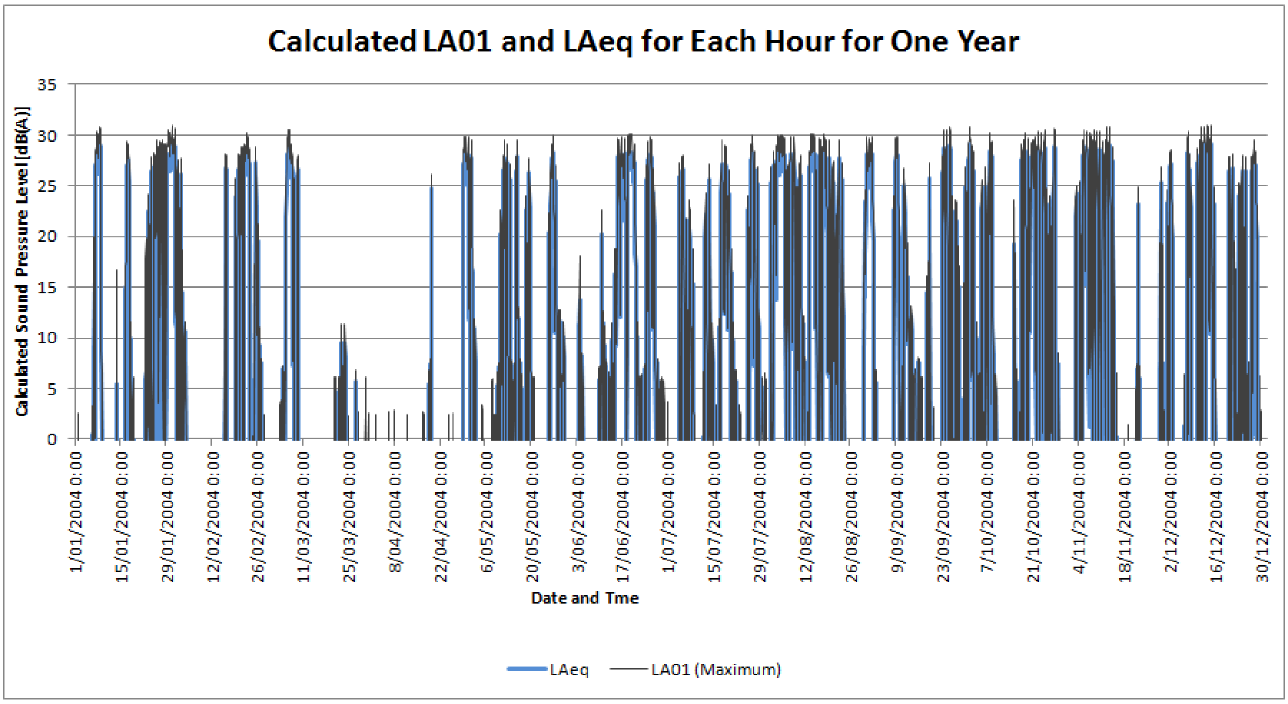

Figure 24: Calculated Noise Levels For Bonanza Over One Year For Mining Case 2

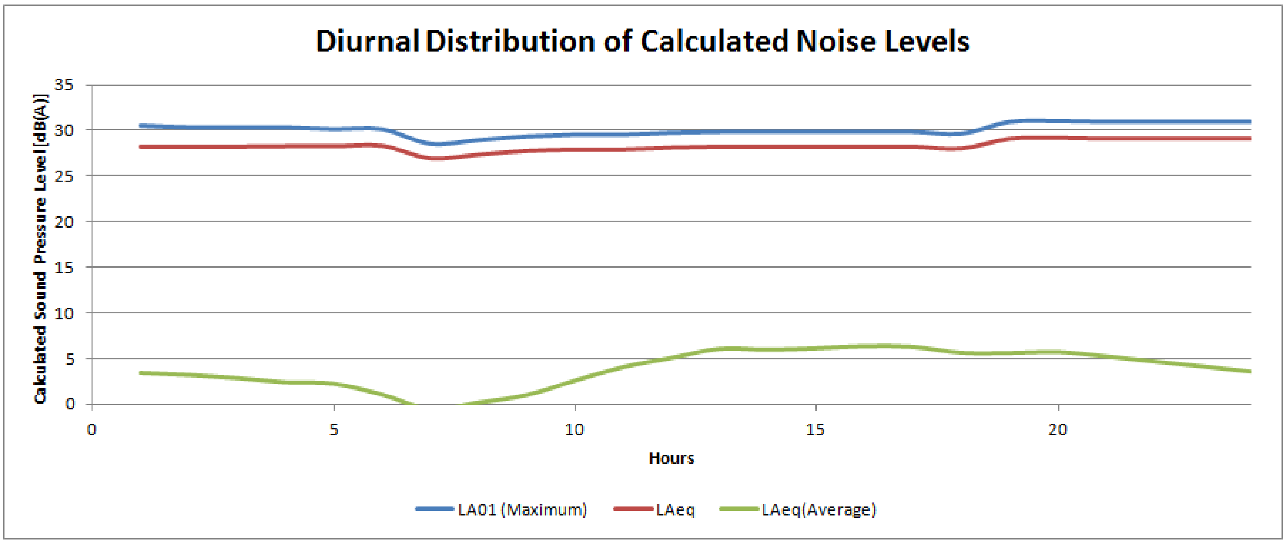

Figure 25: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Bonanza Over One Year - Mining Case 2

The modelled noise levels for Bonanza (Case 2) show that the (Annual Maximum) noise levels are similar to Case 1. However, the L_{Aeq} (annual average) noise levels are likely to be slightly quieter than Case 1. The lack of significant variation between Case 1 and Case 2 suggests that there are dominant noise sources that has not moved between cases, such as the CHPP, conveyors etc.

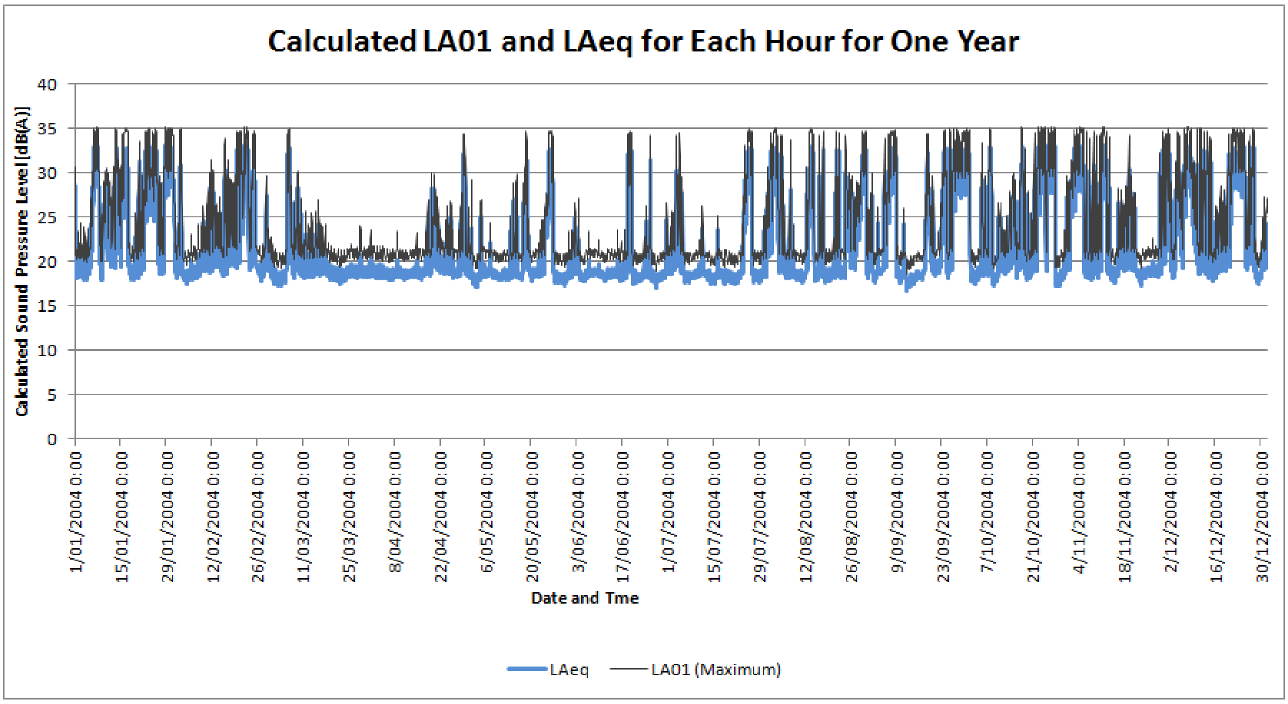

Figure 26: Calculated Noise Levels For Chesalon Over One Year For Mining Case 1

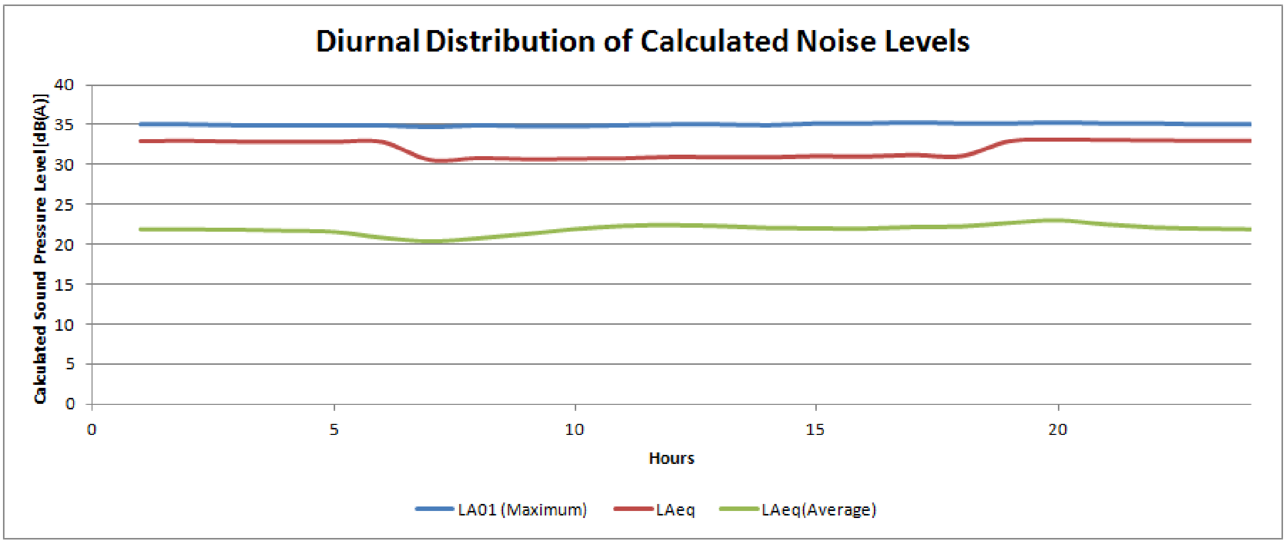

Figure 27: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Chesalon Over One Year - Mining Case 1

The modelled noise levels for Chesalon (Case 1) show that the lowest noise levels are likely during the day and the highest noise levels are at night. The L_{Aeq} (annual average) noise levels are likely to be of the order of 22 dB(A) with the L_{Aeq}(annual highest) of the order of 31 dB(A) during the day 33 dB(A) at night.

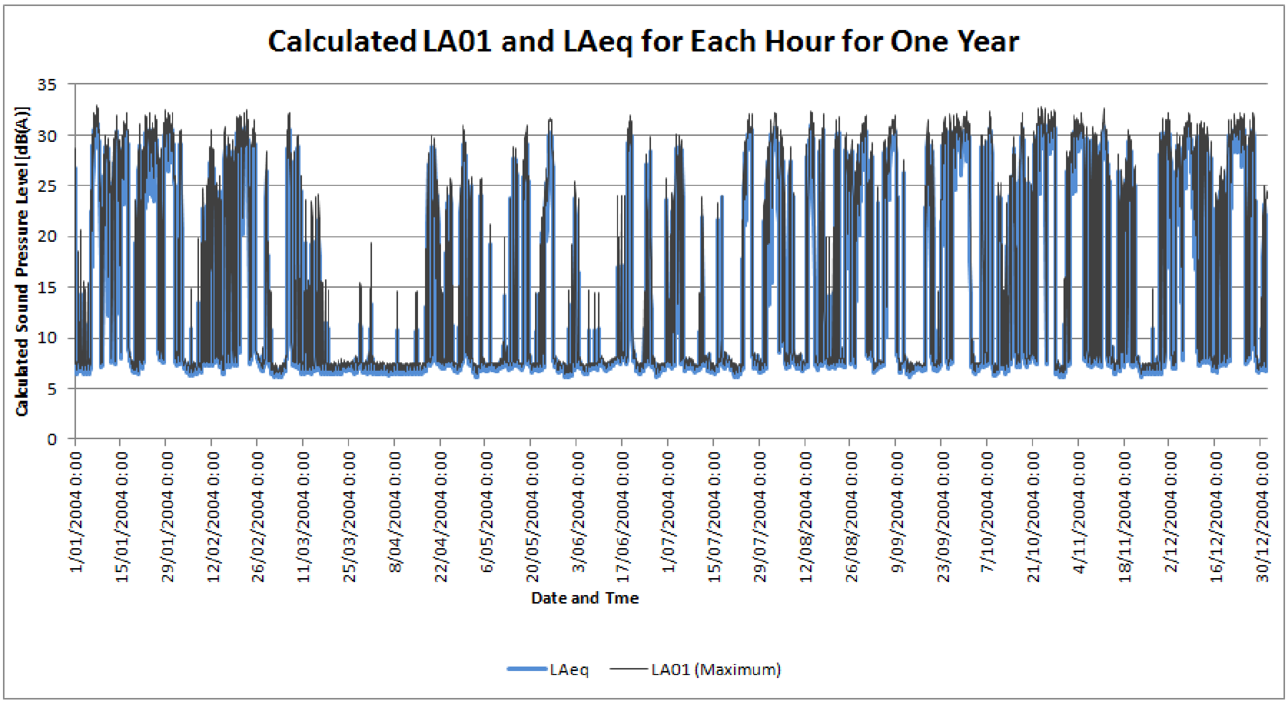

Figure 28: Calculated Noise Levels For Chesalon Over One Year For Mining Case 2

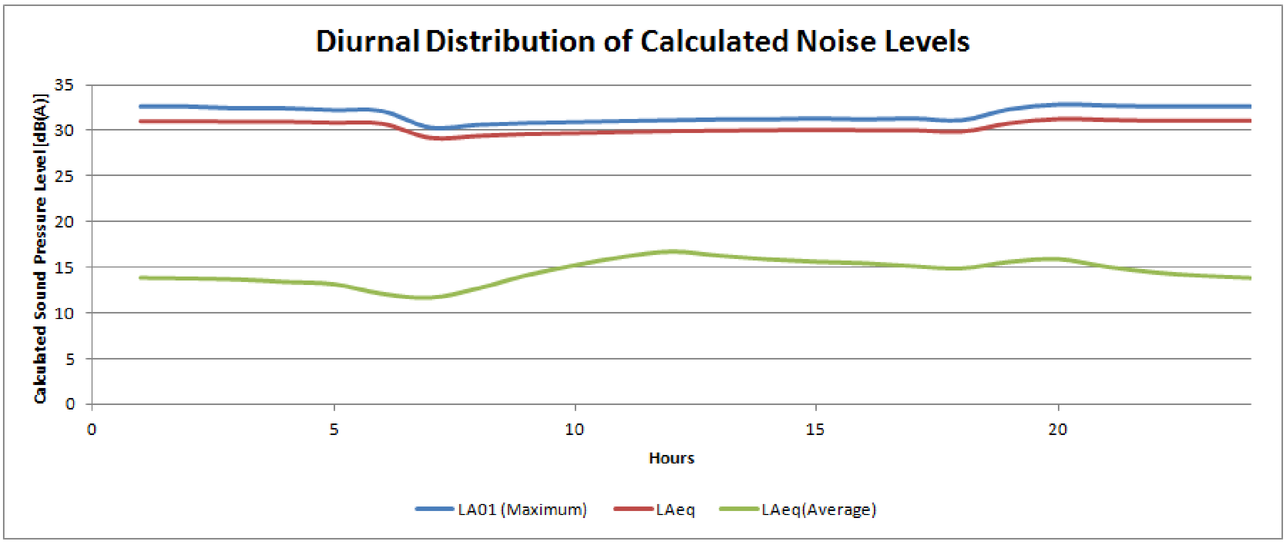

Figure 29: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Chesalon Over One Year - Mining Case 2

As the mine progresses westward the noise levels are expected to reduce at Chesalon Station Homestead. The annual maximum levels reduce by about 2 dB(A) (from case 1 to case 2) and the annual average by about 5 dB(A).

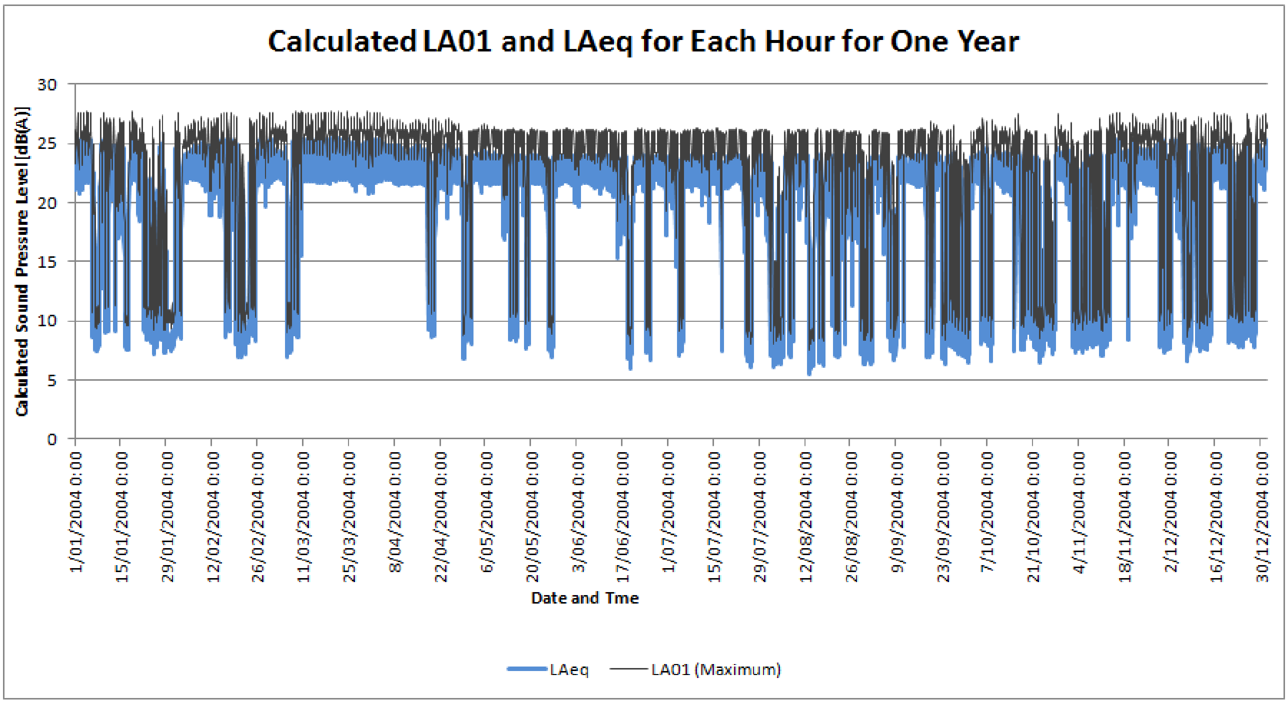

Figure 30: Calculated Noise Levels For Corntop Over One Year For Mining Case 1

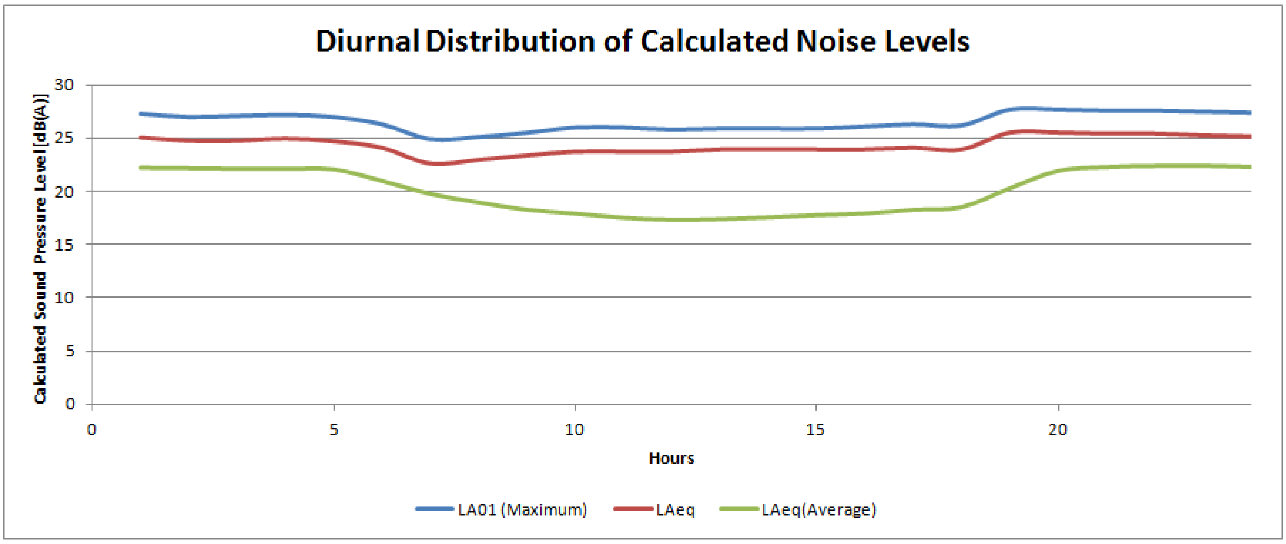

Figure 31: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Corntop Over One Year - Mining Case 1

The calculated noise levels for Corntop show the effect of the easterly wind. Although the charts suggest that the L_{Aeq} noise levels will be of the order of 25 dB(A) continuously throughout the year it must be realised that this is a modelling scenario only. It is designed to test for 'worst-case' noise levels, if maximum operations and meteorology combine at the same time.

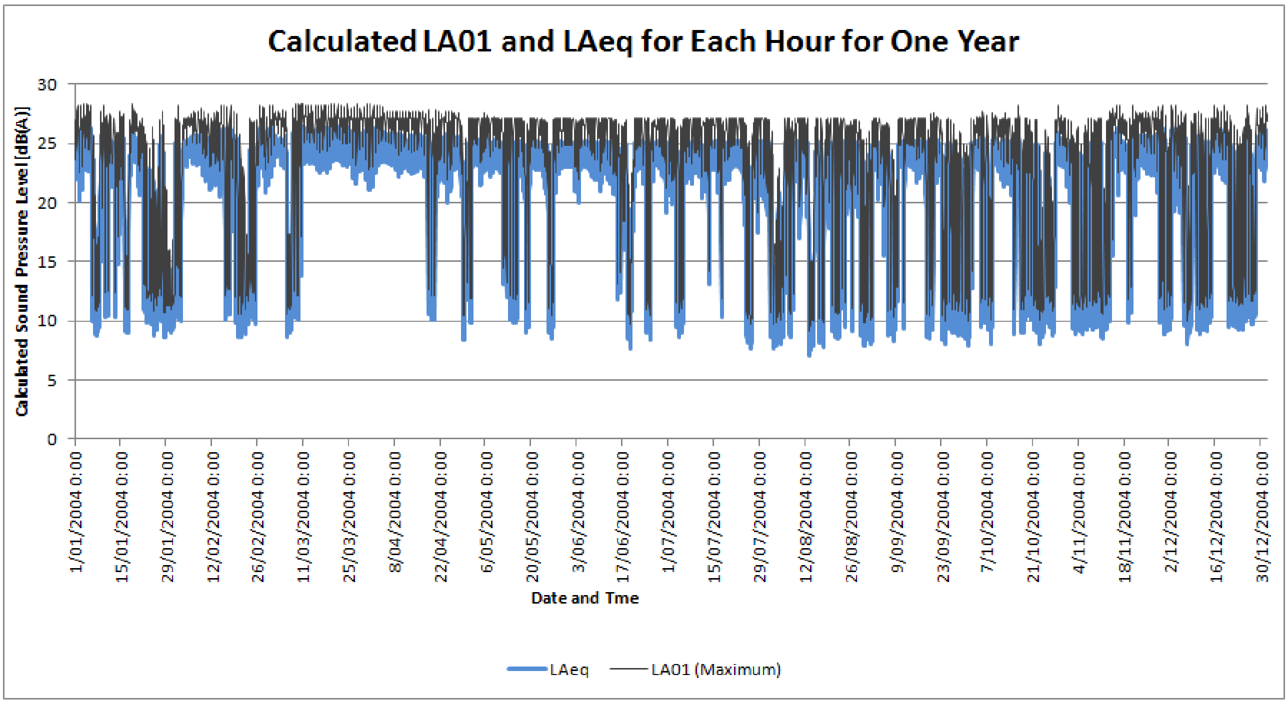

Figure 32: Calculated Noise Levels For Corntop Over One Year For Mining Case 2

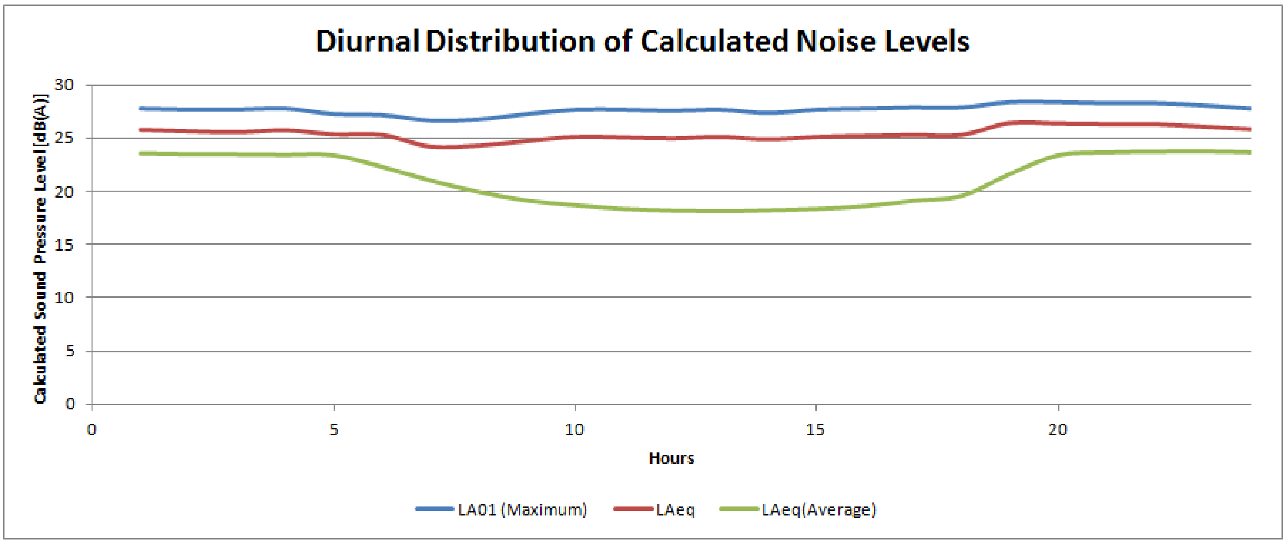

Figure 33: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Corntop Over One Year - Mining Case 2

The noise levels are likely to increase by about 1 dB(A) at Corntop as mining progresses westward, from Mining Case 1 to Mining Case 2.

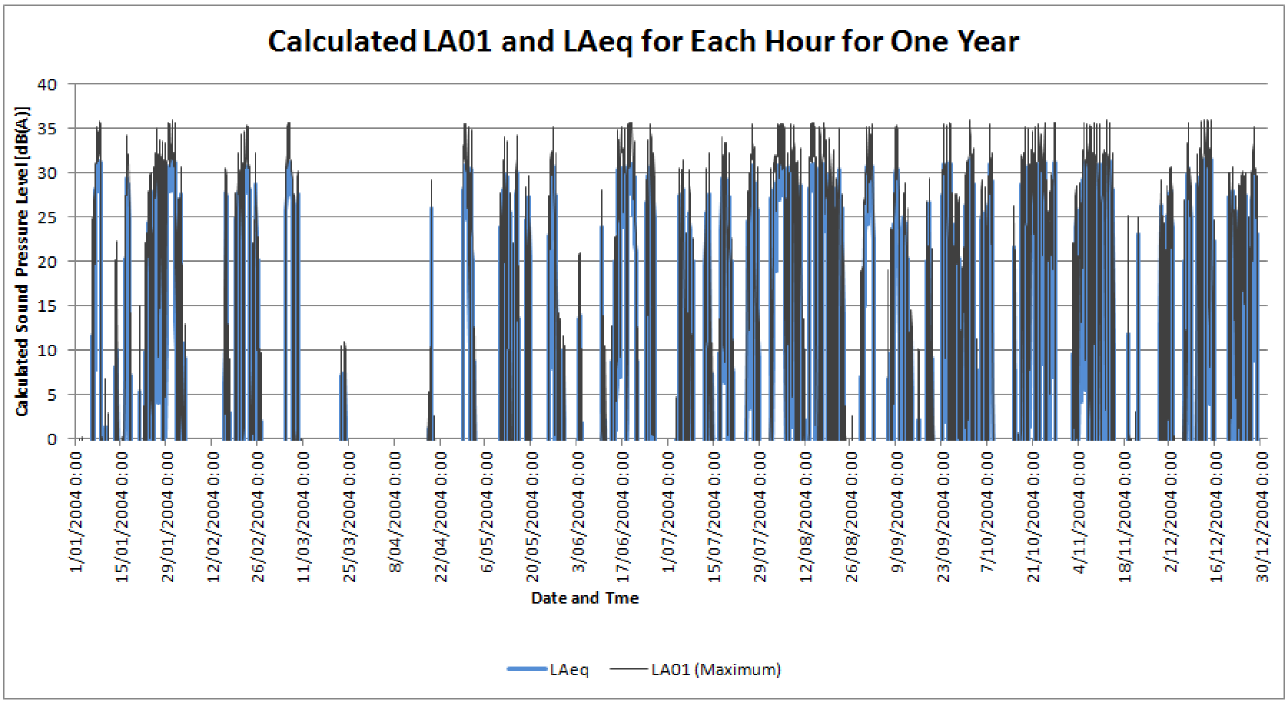

Figure 34: Calculated Noise Levels For Creek Farm Over One Year For Mining Case 1

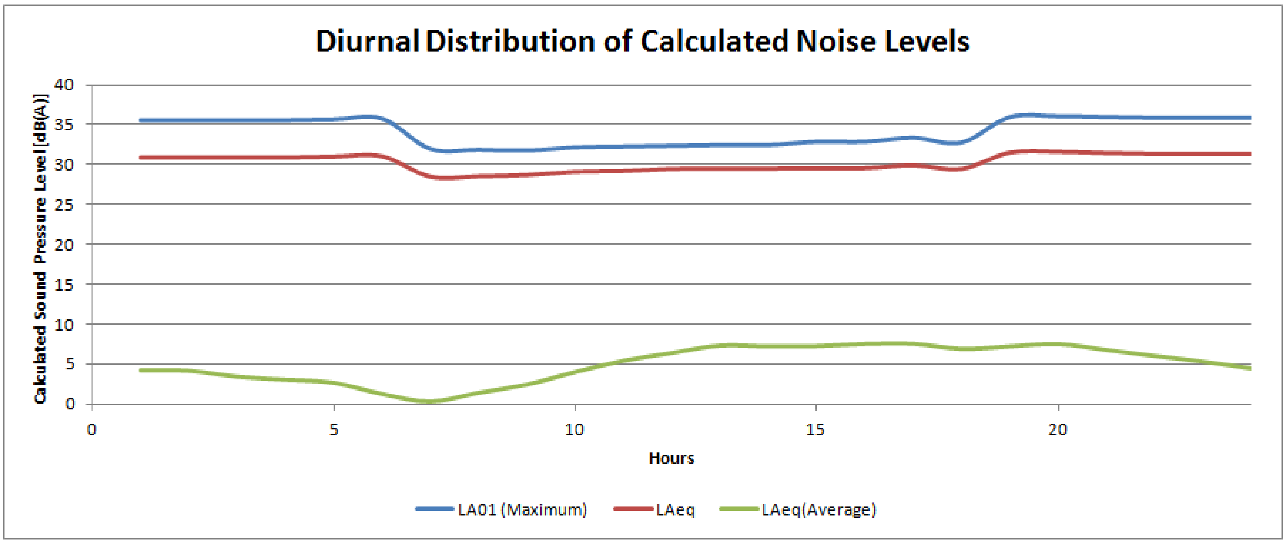

Figure 35: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Creek Farm Over One Year, Mining Case 1

Creek Farm is east of the subject site and mostly upwind. Potentially the L_{Aeq} could reach almost 30 dB(A) during the day and 32 dB(A) at night. However the average L_{Aeq} is below 10 dB(A).

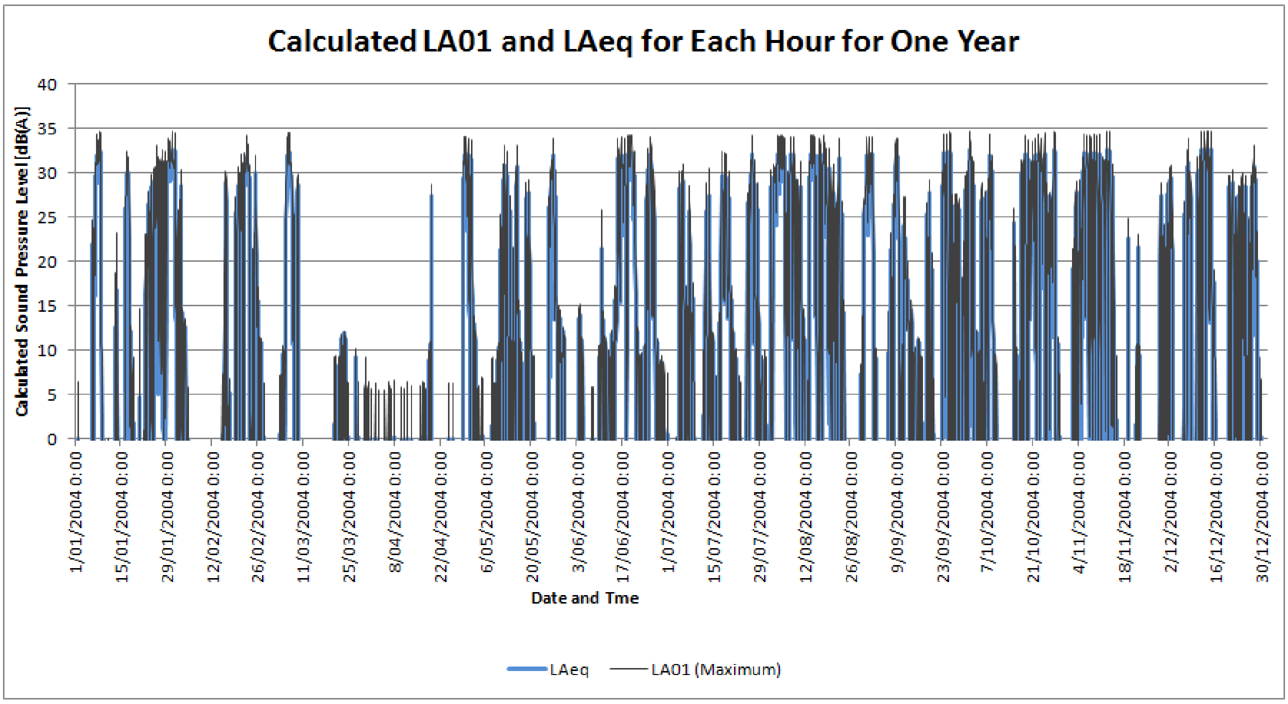

Figure 36: Calculated Noise Levels For Creek farm Over One Year For Mining Case 2

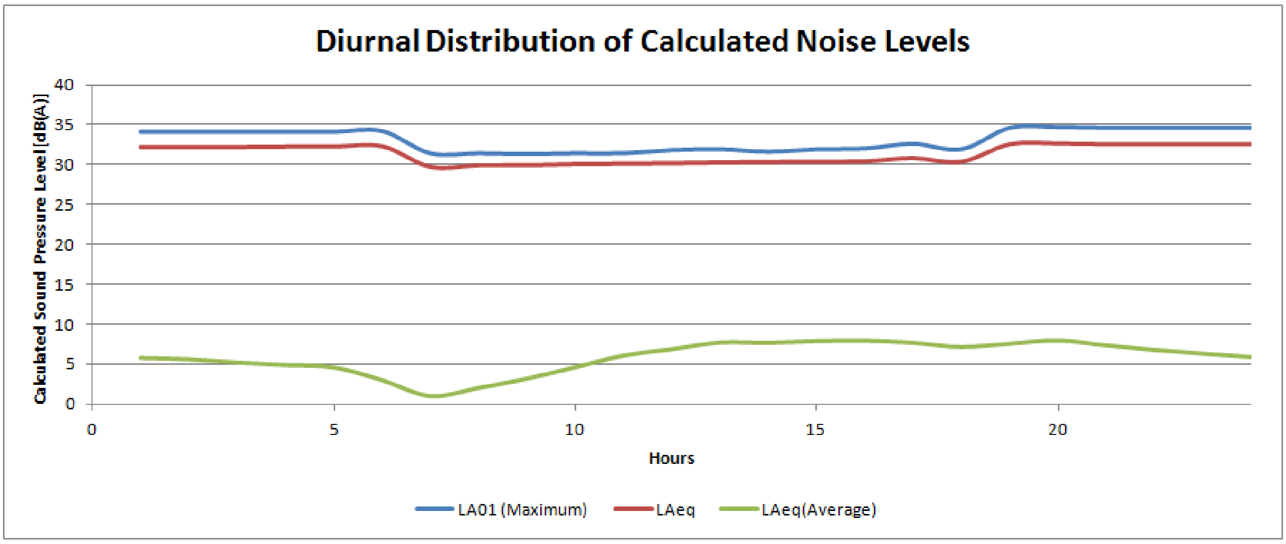

Figure 37: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Creek Farm Over One Year, Mining Case 2

The modelled noise levels for Creek Farm (Case 2) show that the (Annual Maximum) noise levels are similar to Case 1. However, the L_{Aeq} (annual average) noise levels are likely to be slightly quieter than Case 1. The lack of significant variation between Case 1 and Case 2 suggests that there are dominant noise sources that have not moved between cases, such as the CHPP, conveyors etc.

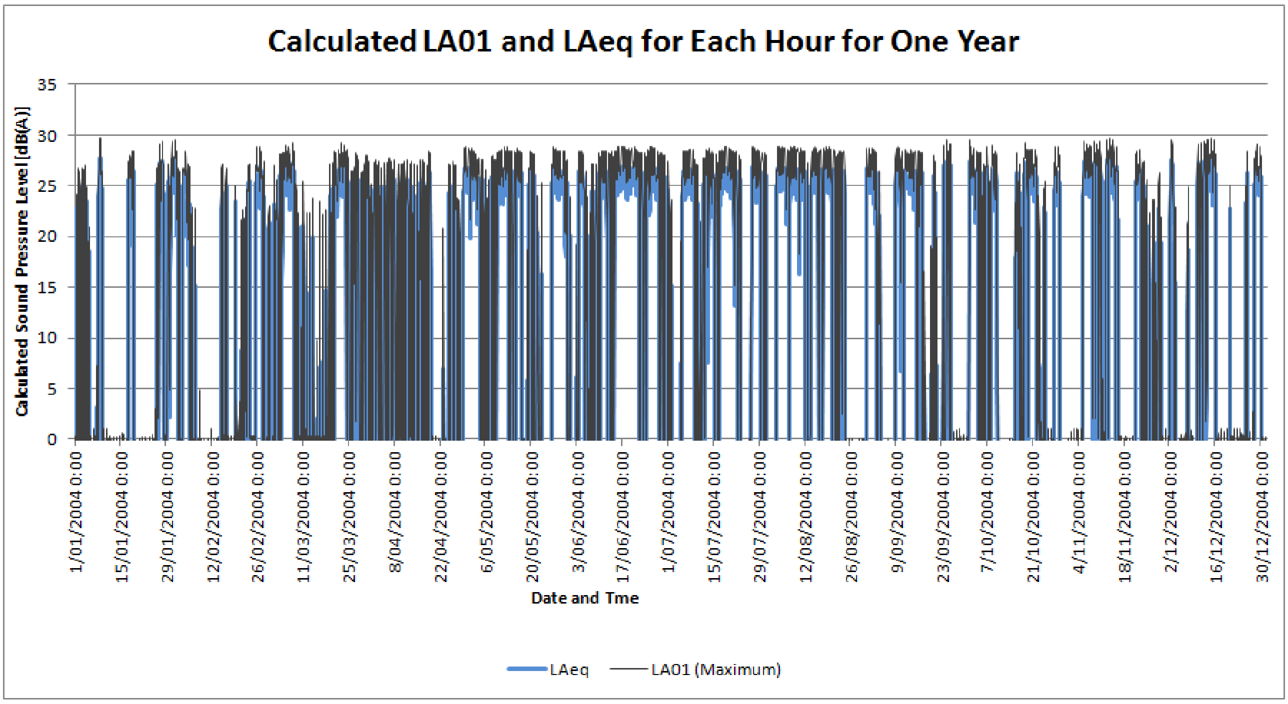

Figure 38: Calculated Noise Levels For Oakleigh Over One Year For Mining Case 1

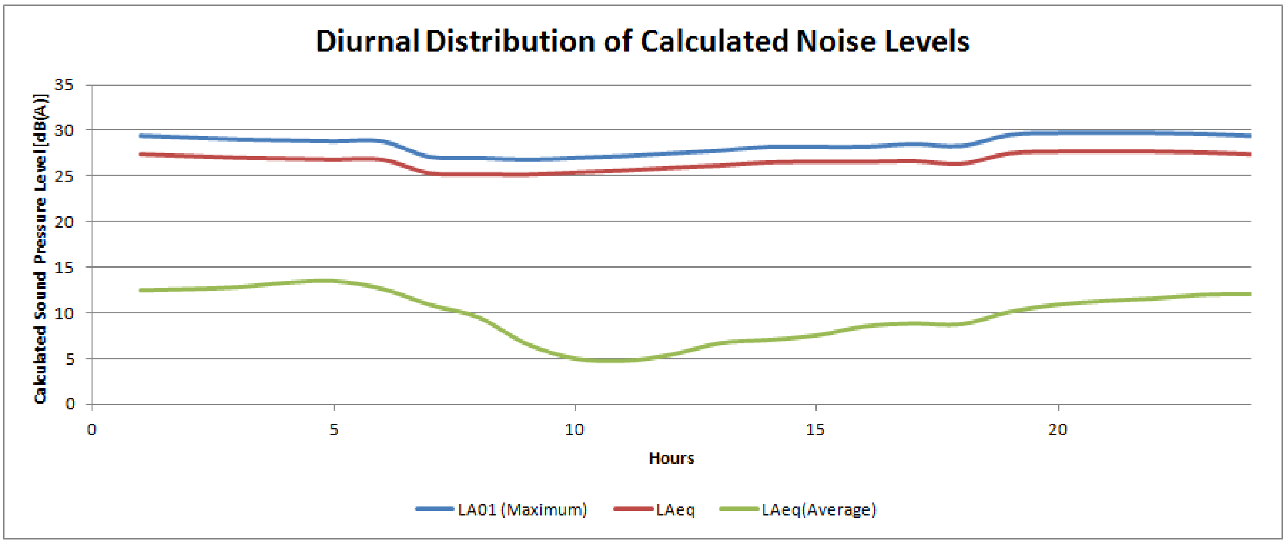

Figure 39: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Oakleigh Over One Year, Mining Case 1

Oakleigh Homestead Station is north of the subject site and is less susceptible to the dominance of the easterly wind. For this location the lowest noise levels occur during the day at about midday and the highest noise levels at night. The maximum L_{Aeq} is likely to be of the order of 28 dB(A) at night, whilst the annual average is likely to be less than 15 dB(A).

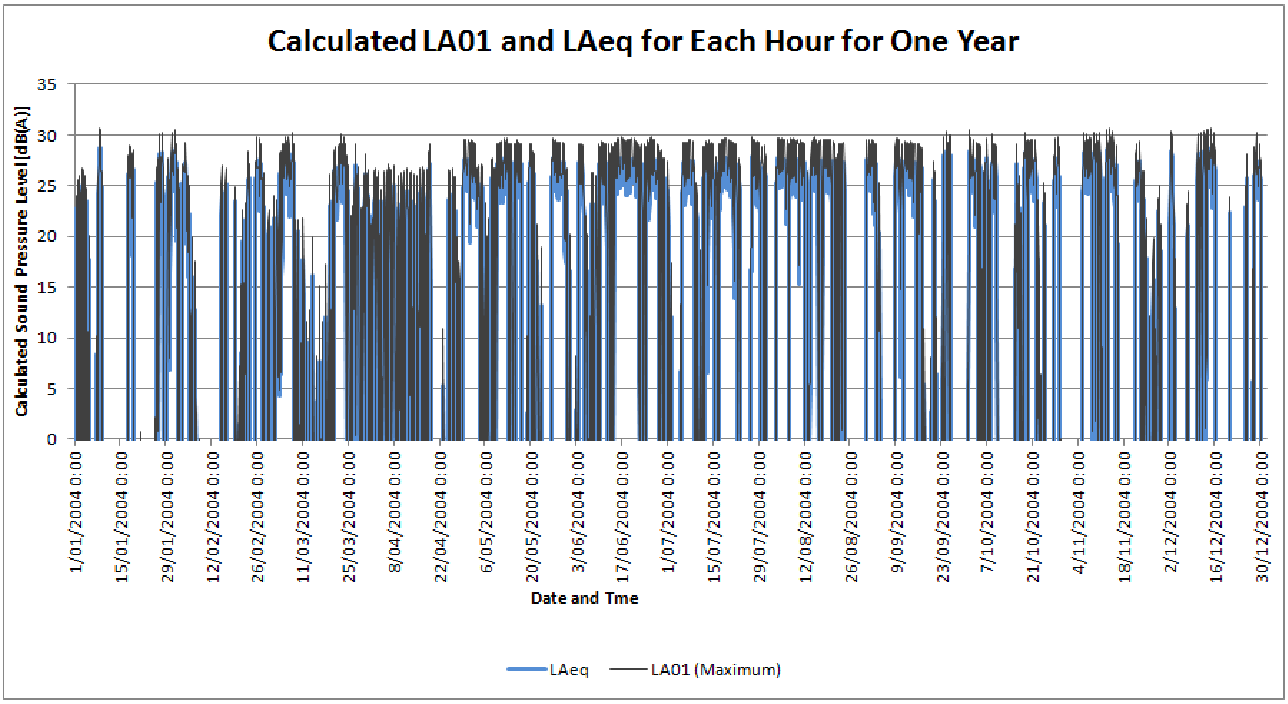

Figure 40: Calculated Noise Levels For Oakleigh Over One Year For Mining Case 2

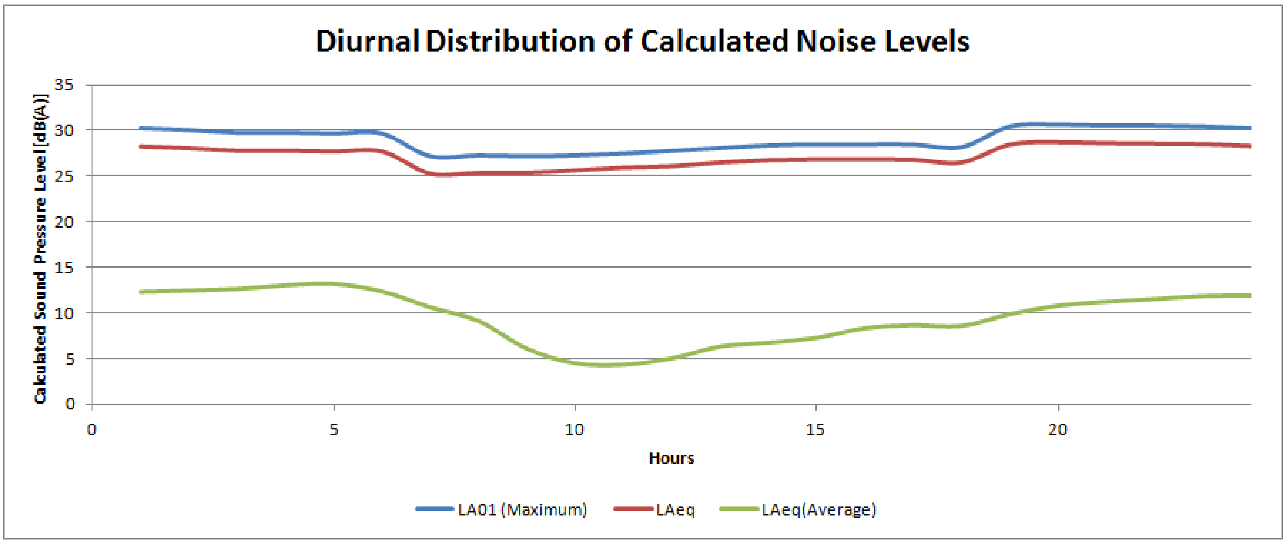

Figure 41: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Oakleigh Over One Year, Mining Case 2

There is very little change in noise levels between Case 1 and Case 2. This is not unexpected since the distance between the location of the pit operations remains relatively similar as the pit progresses westward.

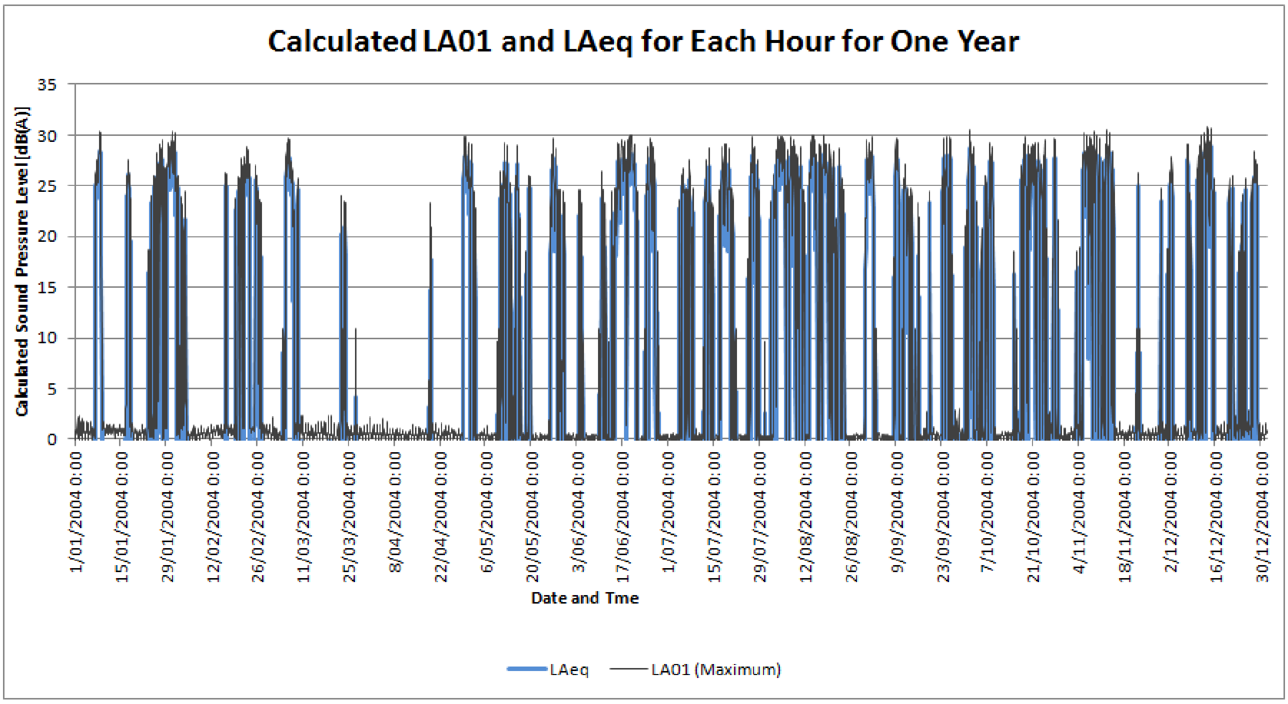

Figure 42: Calculated Noise Levels For Villafield Over One Year For Mining Case 1

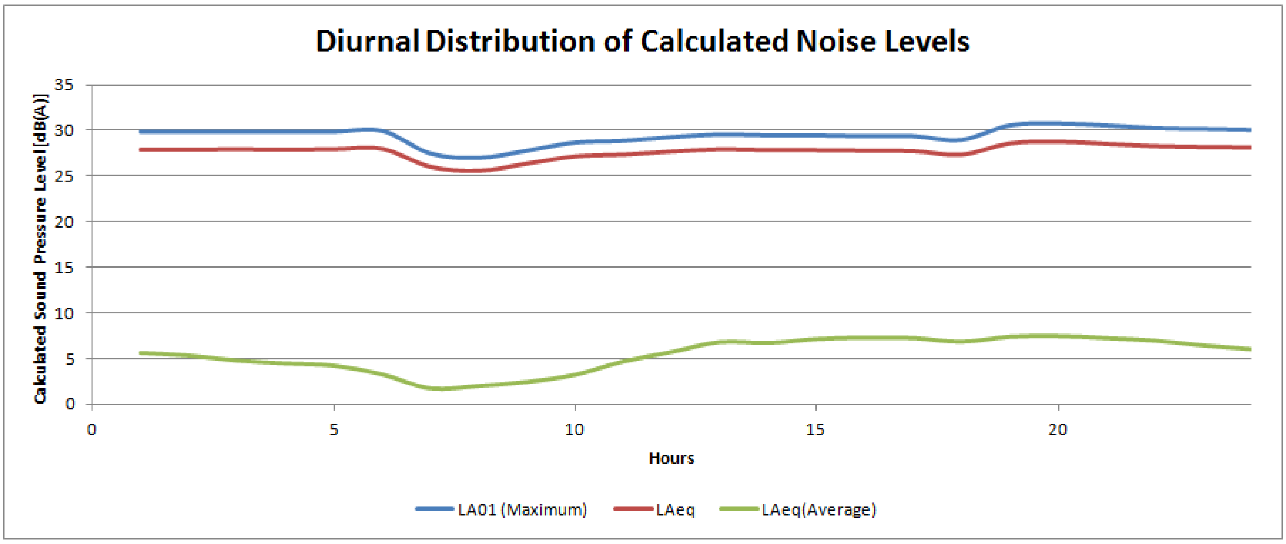

Figure 43: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Villafield Over One Year, Mining Case 1

Villafield is east of the subject site and mostly upwind. Potentially the L_{Aeq} could reach almost 28 dB(A) during the day and 29 dB(A) at night. However the average L_{Aeq} is below 10 dB(A).

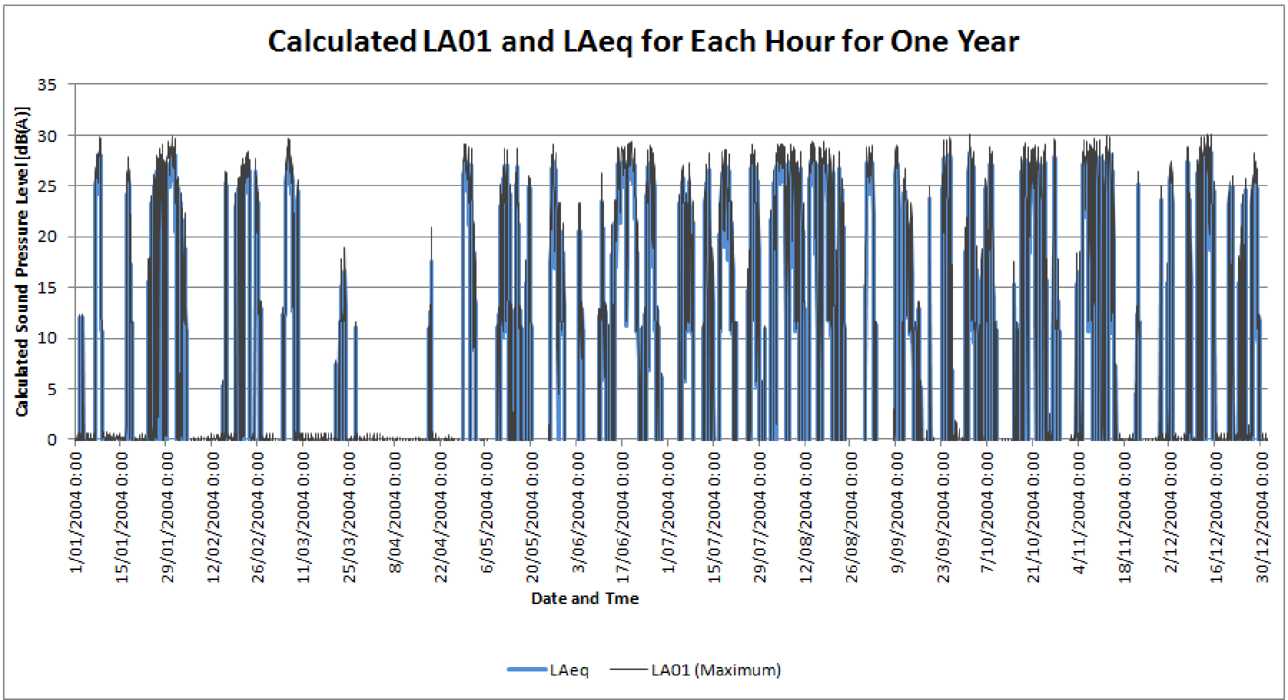

Figure 44: Calculated Noise Levels For Villafield Over One Year For Mining Case 2

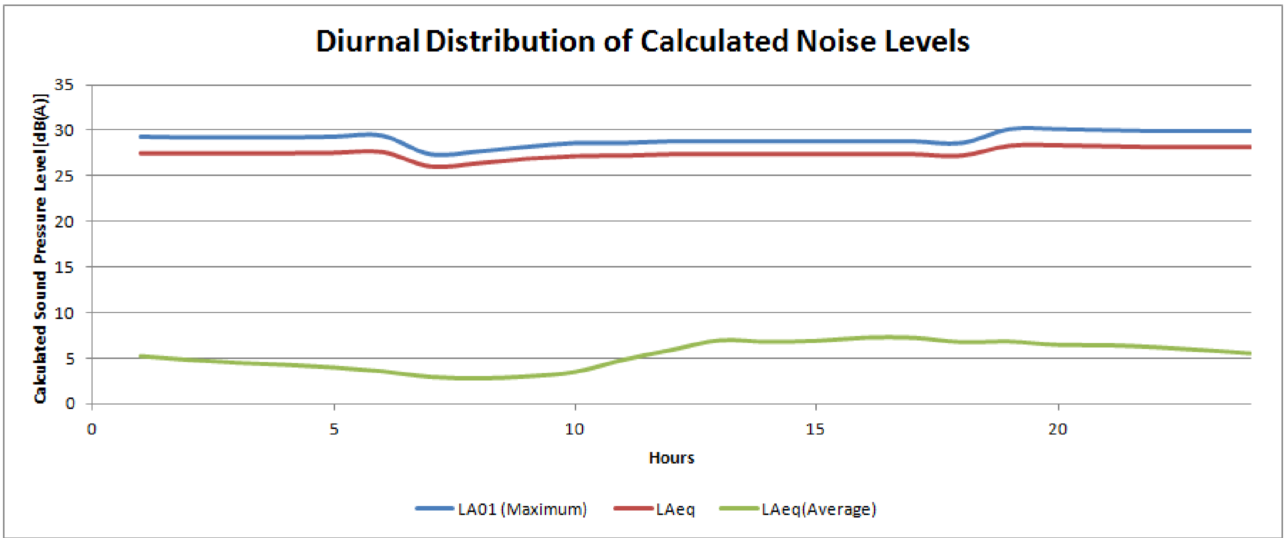

Figure 45: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Villafield Over One Year, Mining Case 2

As the mine progresses westward the noise levels are expected to reduce at Villafield Station Homestead. The annual maximum levels and annual average noise levels reduce by about 1 dB(A) (from case 1 to case 2).

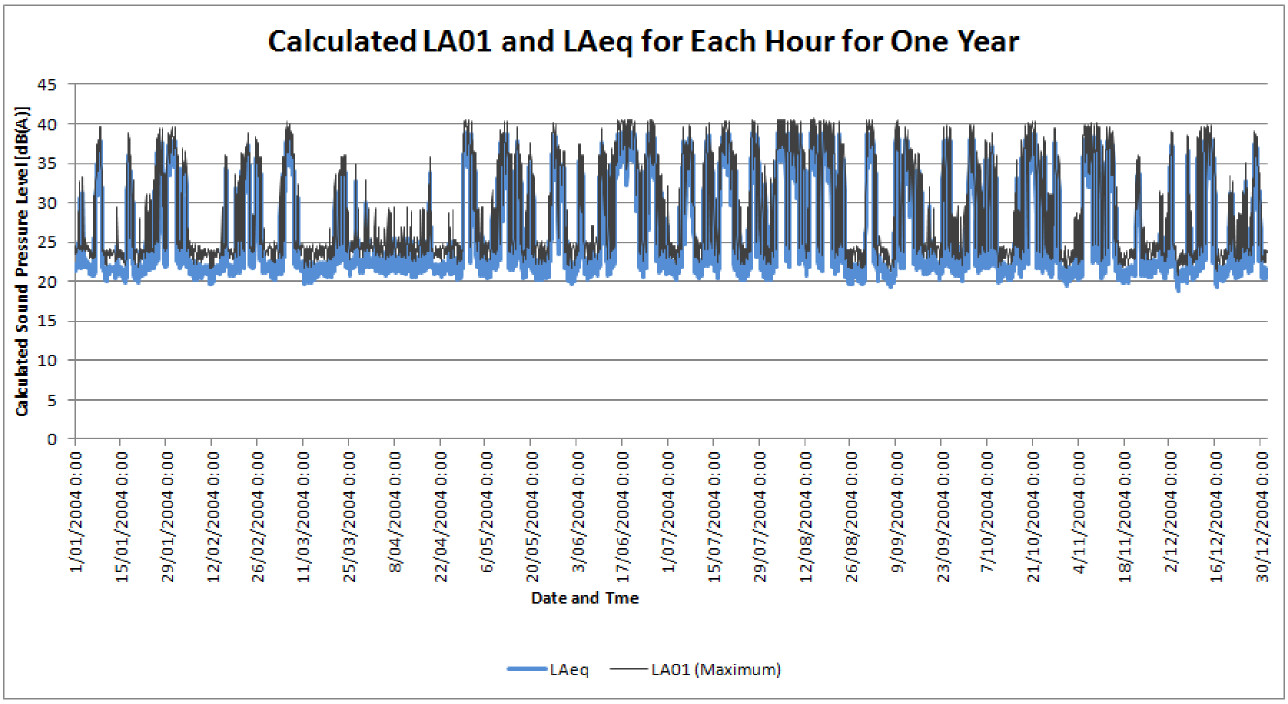

Figure 46: Calculated Noise Levels For Accommodation Village Over One Year For Mining Case 1

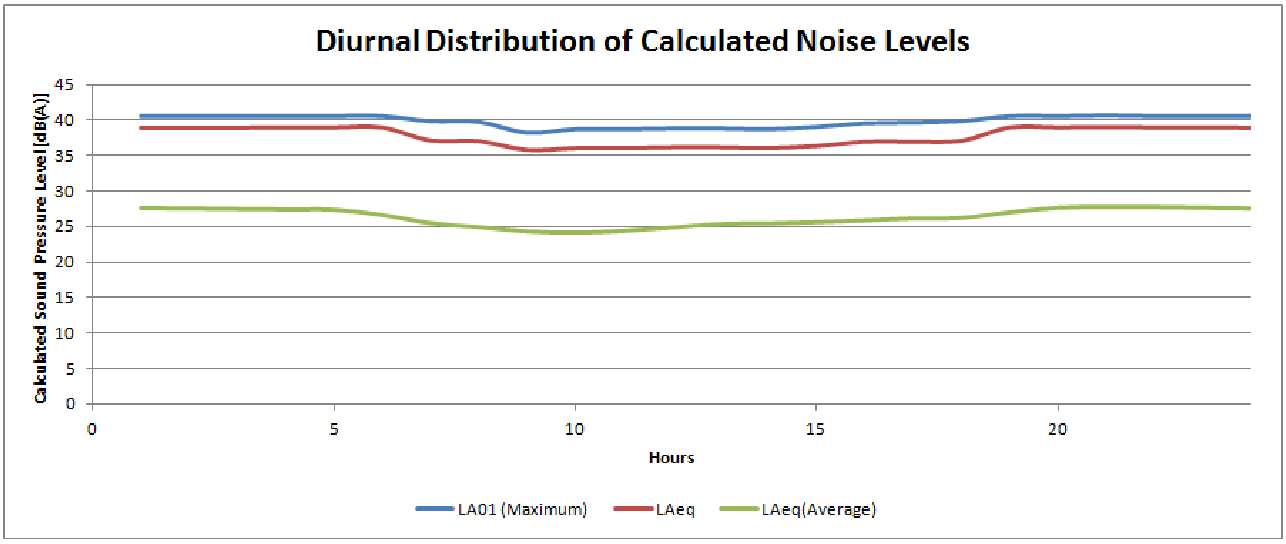

Figure 47: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Accommodation Village Over One Year, Mining Case 1

The accommodation village is the closest sensitive receptor to the SGCP operations. It is upwind of the main noise sources and for most of the year the L_{Aeq} is below 28 dB(A). However, there are periods when the L_{Aeq} noise level is likely to reach 40 dB(A).

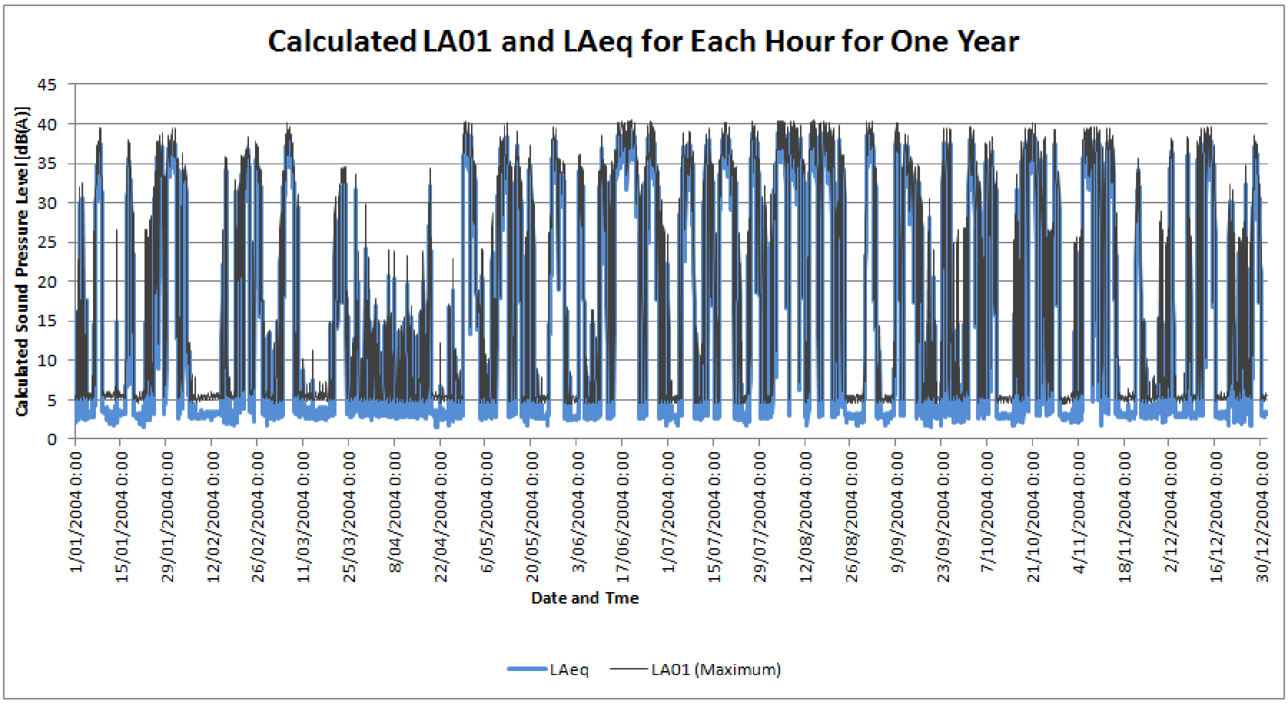

Figure 48: Calculated Noise Levels For Accommodation Village Over One Year For Mining Case 1

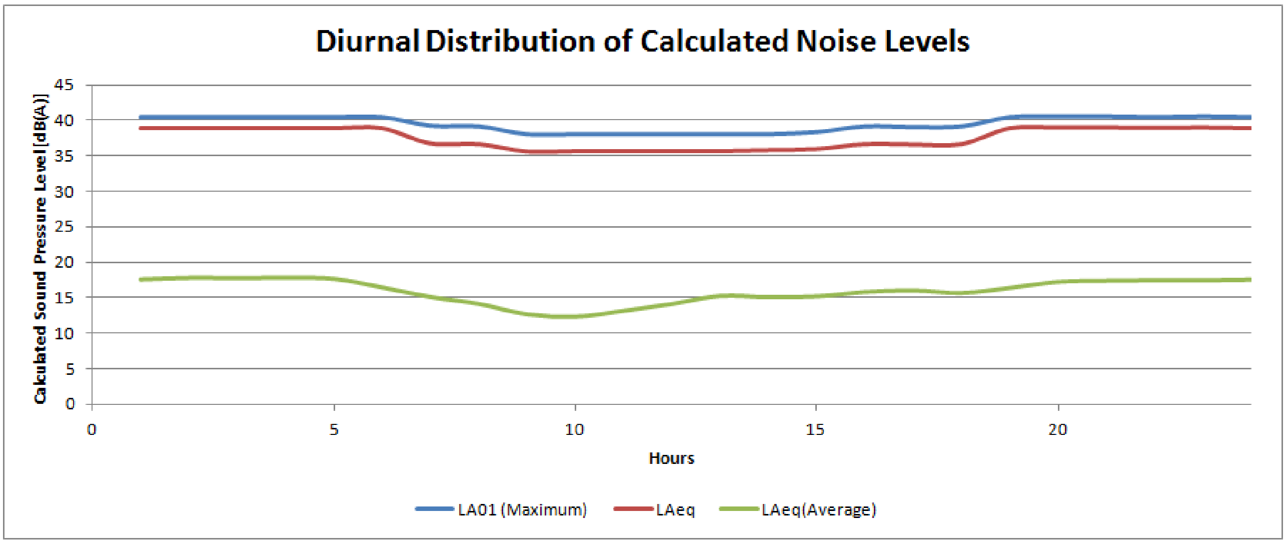

Figure 49: Diurnal Distribution of the Calculated L_{Aeq} and L_{A01} for Accommodation Village Over One Year, Mining Case 2

As the mine progresses westward there will be a significant reduction in the average noise levels. This is due to the dumping on the waste rock emplacement taking place at much larger distances (and intervening waste rock emplacement acting as a screen. However, during adverse meteorology the maximum noise levels remain similar to Case 1.