Noise and Sound Services

Noise and Vibration Impact Statement

For the proposed:-

Tharbogang Quarry and Landfill Expansion, Slopes Road, Griffith, NSW 2680.

February 2010

Report No. nss 21463 Rev A – Final

Prepared at the request of:-

Coffey Environments Australia Pty Ltd
Level 1, 3 Rider Boulevard, Rhodes
NSW 2138.

Prepared by:-
NOISE AND SOUND SERVICES
Specialists in Noise and Vibration Assessments Control and Training
Spectrum House, 1, Elegans Avenue, St Ives, NSW 2075
Tel: (02) 9449 6499. Fax: (02) 9402 5849. Mob: 0411 648153
E-mail noiseandsound@optusnet.com.au
A Member Firm of the **Association of Australian Acoustical Consultants**
ABN : 7277 134 9599

Association of Australian Acoustical Consultants

C O N T E N T S

SUMMARY

This Noise Impact Statement considers a proposed expansion of the existing landfill and quarry operations at Tharbogang, near Griffith, NSW.

The site of the proposed expansion is bordered to the west by existing orchards and dwellings with the closest at a distance of approximately 600 metres. The proposed expansion includes the use of plant such as; a mobile crusher, rock drill, excavators, loaders, compacters and trucks. The noise from blasting has been predicted and assessed.

Noise criteria provided by the NSW Government have been considered. These are the Industrial Noise Policy 2000 (INP), the ANZECC guidelines and the Environmental Noise Control Manual (1994) for blasting and the Environmental Criteria for Road Traffic Noise for on-road traffic noise. The assessment procedure covers both controlling intrusive noise impacts and maintaining noise level amenity.

The existing acoustical climate has been assessed using noise loggers located at the most sensitive available dwellings to the proposed expansion. The existing background noise levels (L_{A90}) were found to be between 26 dBA and 32 dBA. The existing ambient noise levels (L_{Aeq}) were found to be 38 dBA to 47 dBA.

A noise goal (L_{Aeq}) at the nearest residential properties has been set in accordance with INP criteria. This is generally **35 dBA** in the day, evening and night time. It is proposed to work in the day time only. Goals for blasting are **115 dB** linear peak for overpressure (noise) and **5 mm/s** peak particle velocity for ground vibration.

Acoustical modelling for the proposed expansion has been carried out. This uses methods given in the International Standard ISO 9613-2 (1996).

No significant noise impact is predicted from plant within the site for day time use with mitigation measures in the form of recommended distance of crushing plant from site boundaries and/or noise barriers. The day time on-road truck noise will not exceed the Road Traffic Criteria with the possible exception of the single dwelling at the bottom of Hillside Drive. Here an upgrade of the glazing for the facades with a line of sight to the truck route on Hillside Drive is recommended. No night time truck movements should occur.

The vibration goals from blasting will be met at all residential properties. Community relation measures are recommended to minimise the impact from the blasting vibration and overpressure for all occupants of residences within 2000 metres of the blasts.

The overpressure goals from blasting are predicted to exceed the 115 dB goal with charge weights of 270 kg. Therefore it is suggested that charge weights are restricted to between 30 kg and 50 kg. Community relation measures are recommended to minimise the impact from the blasting vibration and overpressure for all occupants of residences within 2000 metres of the blasts.

1. INTRODUCTION

Noise and Sound Services was requested by Coffey Environments Australia Pty Ltd of Level 1, 3 Rider Boulevard, Rhodes, NSW 2138, to carry out a Noise Impact Statement (NIS) for the proposed expansion of the existing landfill and quarry operations at Tharbogang, NSW 2680. This updates the Noise and Sound Services report (nss20961 Rev B dated May 2008) specifically to address the current preferred project description. This NIS, which also includes vibration, is required as part of the Response to Submissions phase of the Environmental Assessment (EA) and is in line with the requirements of the NSW Government's Industrial Noise Policy (2000).

The issues addressed in this NIS are the future vibration from blasting, noise emissions from plant, and on-road traffic from the landfill and quarry.

2. SITE AND EXPANSION DESCRIPTION

This section describes the site location of the proposed expansion and provides a detailed description of the proposed working activity of the expansion.

2.1 Site Description

It is proposed to expand the existing landfill and quarry at Tharbogang to provide for the projected needs for the disposal of waste and the supply of crushed rock for Griffith City and the surrounding area for the next twenty-five years. The existing landfill and quarry were originally established at the site in 1984 and 1991 respectively.

The proposed expansion of the existing quarry and landfill site is at Lot 202 on McPherson's Range approximately 8.5 km northwest of Griffith town centre. The existing landfill (currently at 155 m) will be relocated to the existing quarry, which will be built up from approximately 135 metres in 8 cells reaching a maximum height of 155 metre. The quarry expansion is proposed to operate within Pits 101 and 103, as shown in Figure 1 below. The development Pits 205 and 303 were considered previously but are now no longer part of this application.

The site is situated approximately 900 metres north east of Slopes Road and Kidman Way Tharbogang, as shown in Figure 2 below. The surrounding area of the proposed expansion is a sparsely populated rural zone and is bordered by orchards, farmland and bush to the west. There was a previously a caretaker's cottage on site but it is understood that this has now been demolished.

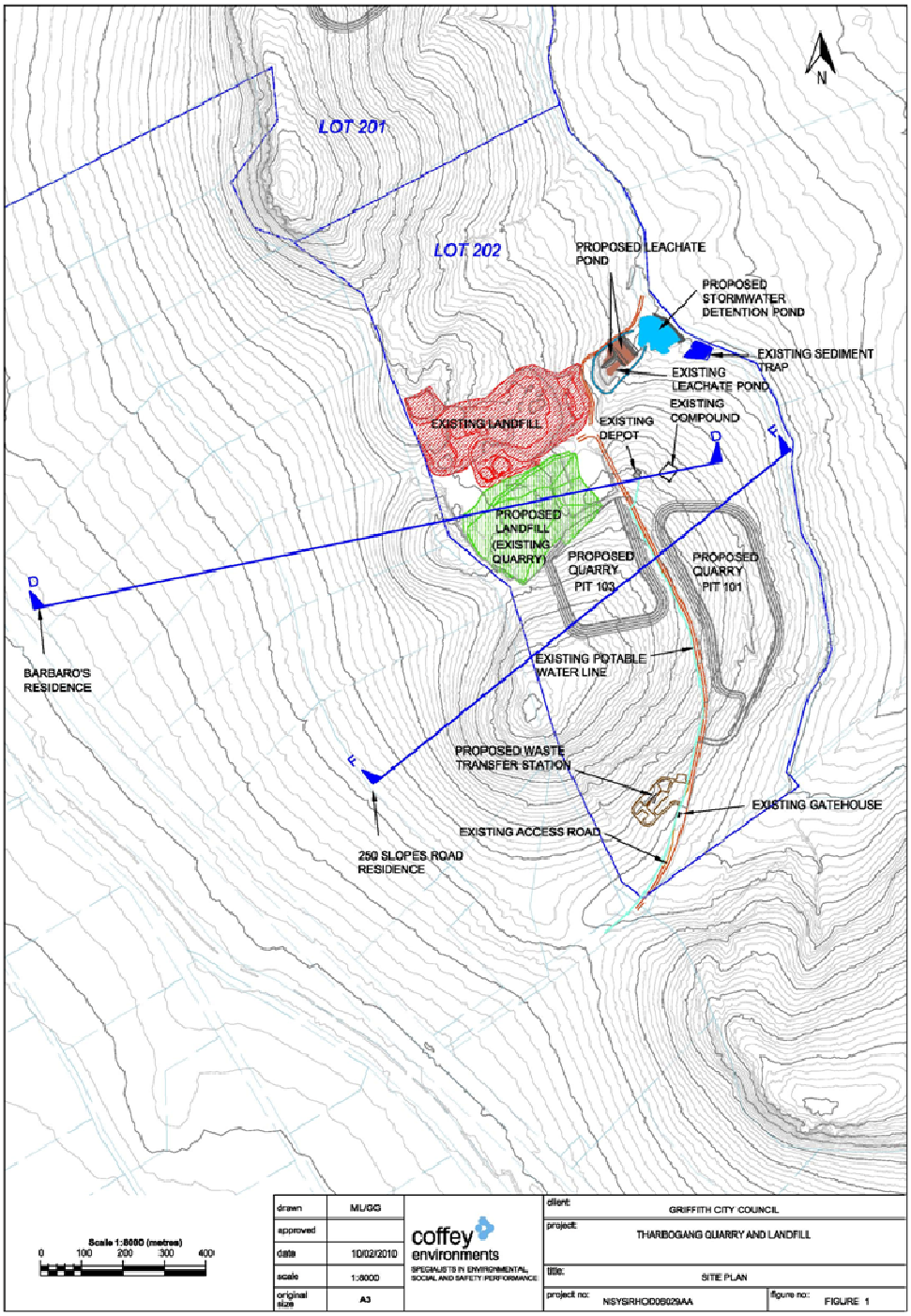


Figure 1. Site Plan (Source Coffey Environments). The Expansion is Proposed to Operate within Pits 101 and 103.

An aerial photographic site plan is shown in Figure 2 below. The nearest neighbouring residential properties and the approximate distances from the proposed expansion (as reported by Coffey Environments) are shown in Table 1 below.

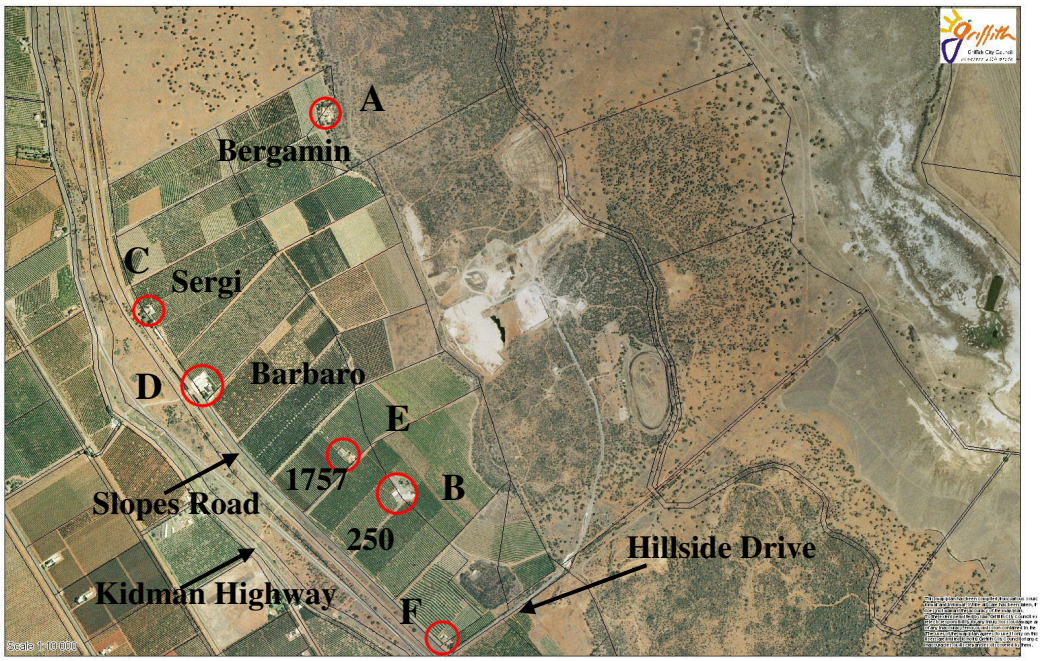


Figure 2. Site Plan (Source Griffith City Council).

TABLE 1 - ALL NEIGHBOURING RESIDENTIAL PROPERTIES WITHIN A 1500 METRE RADIUS OF THE PROPOSED SITE.

Neighbouring Property Name	Approximate Direction	Closest Distance Approximate (metres)
A. Bergamin's Residence	Northwest	1360
B. 250 Slopes Road Mr G and Mrs G Sergi	Southwest	600
C. Mr D Sergi's	West	1490
D. Mr F & Mrs F Barbaro's Residence	West	1280
E. 1757 Slopes Road Mr P J Sergi	Southwest	730
F. Residence at Hillside Drive	South	1020

*Note: - * these residences are partially or fully shielded by the natural topography.*

Strong wind patterns do exist in the area. In the summer months winds are commonly south-westerly in the afternoons and prevailing north-easterly to easterly in the mornings. In the winter months, winds are commonly influenced by westerlies ranging from south-west to north-west.

Temperature inversions are likely to occur between May and October with an average of six per month. The highest recording of surface temperature inversions has been 15 days in July 1987. The quarry and landfill is to be in operation only

in day time hours and hence, in line with the Industrial Noise policy, temperature inversions are not considered further.

2.2 Expansion Description

Details of the proposed quarry and landfill site expansion with working time periods are given below.

2.2.1 Crushing, Stockpiling, and Blending

Crushing, stockpiling and blending will be carried out between 07:00 hours and 15:00 hours Monday to Saturday. The proposed plant is as follows:-

- 42/32 Single Toggle Jaw Crusher;
- 15m^3 Hopper with Vibrating Feeder;
- 21' by 6' Flat LJ Twin deck screen
- 54" Series II LJ Cone Crusher
- 100' Radial Stockpile Conveyor
- 550 KVa Generator located within a Pantec truck body
- Cat 980G Series II Loader.

2.2.2 Landfill Plant

The existing landfill plant is as follows:-

- *'Liebherr LR634'* Track loader
- *'Tana GX260'* Landfill Compactor
- International Acco converted garbage truck with tipper back and water cart.

The landfill plant works an average of 4 hours per day (less on weekends)

2.2.3 Blasting

Blasting will only be carried out between 10:00 hours and 15:00 hours Monday to Friday excluding Public Holidays. The frequency of blasting is approximately once per month. Blasting is carried out using ammonium nitrate (Nitroprill) with 90 mm diameter holes, non-el detonators, and usually a 2 metre by 2 metre pattern, on various delays. The delays depend on the shape of the blast, and are sequenced to minimise noise and vibration levels.

2.2.4 Mobile Plant Movements

Loading and hauling of the crushed rock product for delivery to the customer is required to be carried out at any day time (between i.e. between 07:00 hours until 17:00 hours) Monday and Saturday excluding Public Holidays. A front end loader with 4 m^3 capacity *'Cat 980G Series II'* will be used for sales and stockpiling.

Griffith City Council has previously stated that gravel from the proposed quarry will take the starting volume for 2010 up to 150,000 tonnes. This will increase to approximately 315,000 tonnes per annum after 25 years (in the year 2035). It is reported that there are no residential properties within 30 metres of the haulage route from the quarry to the Kidman Highway and only one residential property on the local road (Hillside Drive) as shown in Figure 3 below.

From the GHD Road Traffic Impact Assessment Report (December 2007) it is stated that future (25 year) proposed daily traffic trips associated with the subject site would be 300 or a 50% increase over the current traffic on Hillside Drive. This report considers the predicted noise impact of the total road traffic rather than the incremental increase associated with the expansion of the quarry and landfill. According to the GHD report, this would comprise of 146 for quarry heavy vehicle traffic, 60 for landfill heavy vehicle traffic, 84 light vehicle traffic and 10 employee light vehicle traffic.

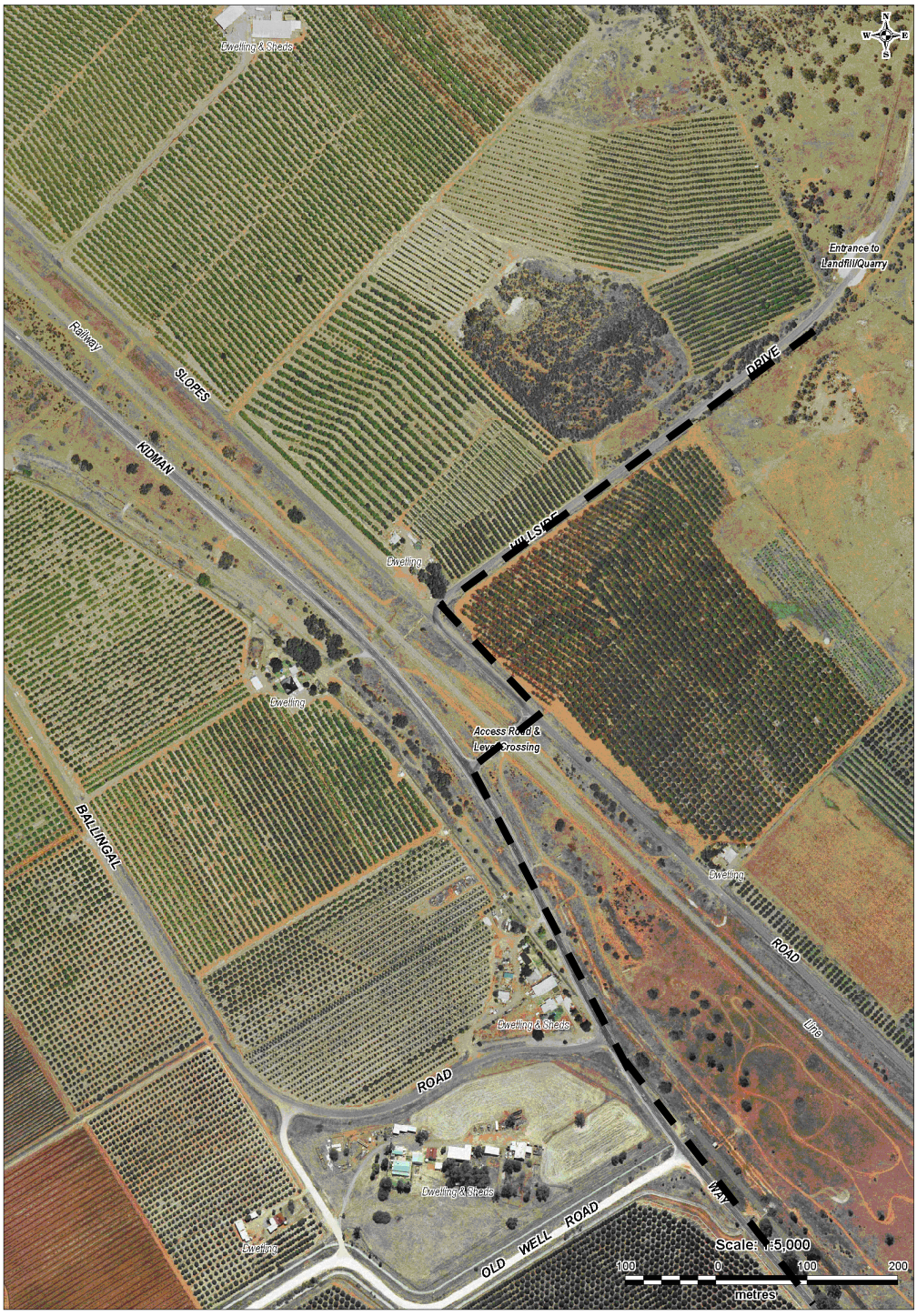


Figure 3. Site Plan Showing the Main Haulage Route (dashed line). (Source Griffith Council).

The peak hour vehicle movements as given in the GHD report are 19 for quarry heavy vehicle traffic, 8 for landfill heavy vehicle traffic, 8 for light vehicle traffic and 5 for employee light vehicle traffic.

The GHD report is based on 300,000 tonnes per annum whereas the current prediction is for 315,000 tonnes per annum. Hence a 5% increase in the number of vehicle movements is assumed.

The quarrying operations will only be on demand and active weekdays and Saturdays. The quarry is to be in operation only during the day time, from 07:00 hours until 17:00 hours.

3. CRITERIA

Noise criteria are provided by the NSW Government and were published by the Environment Protection Authority, (EPA) division of the Department of Environment and Climate Change (DECC). The criteria are generally in line with criteria given in other States of Australia and many countries of the world. This includes the Industrial Noise Policy (2000), the Environmental Criteria for Road Traffic Noise (1999) and the EPA Environmental Noise Control Manual (1994). These cover noise in urban, suburban and rural areas. Although specific local conditions can affect the criteria, convincing justification must be given for any variation to NSW Government guidelines.

3.1 Industrial Noise Policy

The assessment procedure for industrial noise sources given in the Industrial Noise Policy (2000) has two components:-

- **Controlling intrusive noise impacts, and**
- **Maintaining noise level amenity.**

In assessing the noise impact of industrial or commercial noise sources all components must be taken into account for residential receivers, but, in most cases, only one will become the limiting criterion. The project-specific noise goals reflect the most stringent noise level requirement. It is derived from intrusive and amenity criteria and this is used to set a benchmark against which noise impacts and the need for noise mitigation are assessed.

3.1.1 Intrusive Noise Impacts

The NSW Government in its Industrial Noise Policy (2000) states that:- *'The intrusiveness of an industrial noise source may generally be considered acceptable if the equivalent continuous (energy-average) A-weighted level of noise from the source (represented by the L_{Aeq} descriptor) measured over a 15 minute period, does not exceed the background noise level measured in the absence of the source by more than 5 dB.'* Thus, when considering the

environmental consequence of noise from a specific source, any increase above the background sound pressure level, which exceeds 5 dB, may be offensive.

The perception of noise and its level of offensiveness depends greatly on the broader situation within which it occurs. Noise that might intrude into a resting or sleeping place may be found offensive whereas the same noise occurring in a market place or noisy working area may pass unnoticed. The concept of *'background + 5 dB'* derives from this consideration.

The NSW Government state that where the existing background noise level at the receptor is less than 30 dBA, as may occur in a quiet suburban or rural area, then 30 dBA should be assumed to be the existing background noise level. Where the noise source contains characteristics such as prominent tonal components, impulsiveness, intermittency, irregularity or dominant low-frequency, content adjustments to the measured level are applied to allow for the increase in the annoyance value.

3.1.2 Protecting Noise Amenity

In the Industrial Noise Policy it is stated that *'To limit continuing increases in noise levels, the maximum ambient noise level within an area from industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.1.'*

The relevant parts of the NSW Government's recommended levels are given in Table 2 below:-

TABLE 2 – RECOMMENDED NOISE LEVELS FROM INDUSTRIAL NOISE SOURCES

Type of Receiver	Indicative Noise Amenity Area	Time of Day	Recommended L_{Aeq} Noise Level (dBA)	
			Acceptable	Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
Residence	Suburban	Day	55	60
		Evening	45	50
		Night	40	45
Residence	Urban	Day	60	65
		Evening	50	55
		Night	45	50

Hence the acceptable noise level ANL (L_{Aeq}) for rural areas is **50 dBA** day time; **45 dBA** evening time and **40 dBA** night time. Day time is defined as 07:00 to 18:00 hours, evening is 18:00 to 22:00 hours and night time is defined as 22:00 hours to 07:00 hours. Modifications are made to the ANL to account for the existing level of industrial noise. These are shown in Table 3 below:-

TABLE 3 – MODIFICATIONS TO THE ACCEPTABLE NOISE LEVEL TO ACCOUNT FOR THE EXISTING LEVEL OF INDUSTRIAL NOISE.

Total existing L_{Aeq} noise level from Industrial sources, dBA	Maximum L_{Aeq} noise level from new sources alone, dBA
Acceptable noise level plus 2	Existing noise level minus 10
Acceptable noise level plus 1	Acceptable noise level minus 8
Acceptable noise level	Acceptable noise level minus 8
Acceptable noise level minus 1	Acceptable noise level minus 6
Acceptable noise level minus 2	Acceptable noise level minus 4
Acceptable noise level minus 3	Acceptable noise level minus 3
Acceptable noise level minus 4	Acceptable noise level minus 2
Acceptable noise level minus 5	Acceptable noise level minus 2
Acceptable noise level minus 6	Acceptable noise level minus 1
Acceptable noise level minus 6	Acceptable noise level

3.1.3 Modifying Factor Adjustments

Where a noise source contains certain characteristics, such as tonality, impulsiveness, intermittency, irregularity or dominant low-frequency content, there is evidence to suggest that it can cause greater annoyance than other noise at the same sound pressure level. A correction should be applied to both the intrusive and the amenity measurement before a comparison is made with the criteria. An abbreviated version of the correction factors is shown in Table 4 below:-

TABLE 4 – MODIFYING FACTOR CORRECTIONS

Factor	Assessment/ Measurement	When to Apply	Correction	Comments
Tonal Noise	One-third octave band or narrow band analysis	Level of one third octave band exceeds the level of the adjacent bands by 5 dB or more (above 400 Hz)	+ 5 dB	Narrow band frequency analysis may be required to precisely detect occurrence
Low Frequency Noise	Measurement of C-weighted and A-weighted Level	Measure/assess C and A-weighted levels over same time period. Correction to be applied if the difference between the two is 15 dB or more	+ 5 dB	C-weighted is designed to be more responsive to low frequency noise
Impulsive Noise	Time weighting fast and impulse	If the difference in the A weighted maximum levels between 'fast' and 'impulse' are greater than 2 dB	Apply the difference in measured levels as the correction up to a maximum of 5 dB	Impulse time weighting is characterised by a short rise time (35msec) compared to 125msec for 'fast'.
Intermittent Noise	Subjectively Assessed	Level varies by more than 5 dB	+ 5 dB	Adjustment to be applied for night time only

3.2 Sleep Disturbance

The NSW Government recognises that many short-term high-level noises which occur at night may comply with noise criteria (as given above) and yet be undesirable because of the sleep disturbance or arousal effect. However as no night time work is predicted, sleep disturbance or arousal effect are not considered further.

3.3 NSW Government Criteria for Road Traffic Noise

The NSW Government has produced criteria for on-road traffic noise *'Environmental Criteria for Road Traffic Noise'* (May 1999). This provides noise criteria for land use developments (or expansions) with potential to create additional traffic on local roads and on existing freeways/arterials In all cases where the criteria are already exceed traffic arising from the expansion should not lead to an increase in existing noise levels of more than 2 dB.

3.3.1 Additional Traffic On Local Roads

For land use developments (or expansions) with potential to create additional traffic on local roads the noise criteria ($L_{Aeq,\ 1\ hour}$) are **55 dBA for day time** (7:00

hours until 22:00 hours) and **50 dBA for night time** (22:00 hours until 07:00 hours).

3.3.2 Additional Traffic On Existing Freeways/Arterials

For land use developments (or expansions) with potential to create additional traffic on existing freeways/arterials the noise criteria ($L_{Aeq,\ 15\ hour}$) are **60 dBA for day time** (7:00 hours until 22:00 hours) and **55 dBA for night time** (22:00 hours until 07:00 hours).

3.4 Construction Site Noise

Construction site noise guidelines are provided in the NSW Government's *'Interim Construction Noise Guideline'* (July 2009). The main objectives of the guideline are to:

- promote a clear understanding of ways to identify and minimise noise from construction works
- focus on applying all 'feasible' and 'reasonable' work practices to minimise construction noise impacts
- encourage construction to be undertaken only during the recommended standard hours, unless approval is given for works that cannot be undertaken during these hours

Feasible work practices are practical to implement, while reasonable work practices take into account the balance of costs, benefits and community views.

The guideline presents two ways of assessing construction noise impacts – the quantitative method and the qualitative method. The quantitative method is generally suited to long term construction and requires an assessment of predicted noise levels which are compared to noise management levels and community reaction. The qualitative method is generally suited to short term maintenance or renewal and small scale works undertaken during recommended standard hours and requires a series of work practices to be carried out to minimise noise emissions.

Due to the close proximity of residential properties and the potential for the properties to be highly affected by noise, the quantitative assessment method will be used to determine the noise impact.

The application of the quantitative assessment is related to a 'Management Level' of noise for work carried out within the recommended standard hours. Management levels and the method of application are reproduced in Table 5 below.

TABLE 5 – NOISE AT RESIDENCES USING THE QUANTITATIVE ASSESSMENT WITHIN RECOMMENDED HOURS

Time of Day	Management Level $L_{Aeq,15\ minute}$	How to apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise.
		Where the predicted or measured $L_{Aeq,15\ minute}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level.
		The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise.
		Where noise is above this level, the relevant authority may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: 1. times identified by the community when they are less sensitive to noise; and 2. if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.

3.5 Noise and Vibration Blasting Criteria

3.5.1 ANZECC Guidelines

The Australian and New Zealand Environment Conservation Council (ANZECC) provide guidelines in *'Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration'* (1990). These are:-

- The recommended maximum level for air blasts is 115 dB Linear Peak;
- The level of 115 dB Linear Peak may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the levels should not exceed 120 dB Linear Peak at any time;
- The recommended maximum peak particle velocity (ppv) for ground vibration is 5 mm/s. It is recommended that a level of 2 mm/s be considered as a long term regulatory goal;

- The peak particle velocity magnitude of 5 mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. However, the magnitude should not exceed 10 mm/s at any time;
- Blasting should only generally be permitted during the period between 09:00 hours and 17:00 hours Monday to Saturday;
- Blasting should generally take place no more than once per day.

3.5.2 Environmental Noise Control Manual

The EPA provides guideline criteria for the control of blasting impact at residences in chapter 154 of the Environmental Noise Control Manual (1994). This states that:-

"Blasting operations should, in most cases, be confined to the periods Monday to Saturday, 9 am to 3 pm. Blasting outside of those times should be approved only where blasting during the preferred times is clearly impracticable, and should be limited in number. Blasting at night should be avoided unless it is absolutely necessary".

The limiting criteria for the control of blasting impact at residences are shown in Table 6 below.

TABLE 6 – THE LIMITING CRITERIA FOR THE CONTROL OF BLASTING IMPACT AT RESIDENCES.

Time of Blasting	Blast Overpressure Level (dB(linear))		Ground Vibration Peak Particle Velocity (mm/s)	
	95%	100%	95%	100%
Monday to Saturday, 9 am to 3 pm	115	120	5	10
Monday to Saturday, 6 am to 9 am and 3 pm to 8 pm	105	120	2	10
Sunday. Public Holiday, 6 am to 8 pm Any Day, 8 pm to 6 am	95	120	1	10

Similar criteria are given in the Australian Standard *'AS 2187 Explosives – Storage, transport and use -Part 2 Use of explosives'.*

4. NOISE MEASUREMENTS AND SOURCE NOISE LEVELS

4.1 Existing Ambient and Background Noise Measurements

This section describes the instrumentation used for the existing background and ambient noise measurements, the measurement procedure and the results. The measurement locations were chosen to be representative of the residential area in general for the proposed expansion to the quarry and landfill site.

4.1.1 Instrumentation

The instrumentation used during the background noise survey consisted of two 'Acoustic Research Laboratories Pty Ltd' - Type 2 environmental noise loggers. The serial numbers are 194569 and 194550.

The loggers conform to Australian Standard 1259 "Acoustics - Sound Level Meters", (1990) as type 2 precision sound level meters and have an accuracy suitable for field use. The logger calibration was checked before and after the measurement period with a Brüel and Kjær acoustical calibrator model 4230 (serial number 2445349). No significant system drift occurred over the measurement periods.

4.1.2 Measurement Procedure

The measurements were carried out between Monday, 23 April 2007 and Monday, 30 April 2007. The environmental noise loggers were placed at the closest available residences to the proposed site at the properties of Mr A Bergamin and Mr D Sergi (Farm 1743).

The 'fast' time weighting and 'A' frequency weighting were used. All measurements were taken at a height of approximately 1.2 metres. The results are necessarily a "snapshot" of the noise levels on the particular days of the survey. Noise levels can vary with time due to different weather or traffic conditions, also low level measurements can be affected by animal or insect noises. However, during the noise survey it was understood that the noise levels were typical and the weather did not have an adverse effect on the measurements. It is normal practice to mount loggers away from trees where wind in the leaves can affect background levels. However, the nearest residential properties to the proposed site are mainly orange orchards and bush areas and all properties relevant to the quarry are in the vicinity of trees. It is recognised that the background measurements are affected by the noise of wind blowing through leaves, but, in this case this is considered to be part of the normal background acoustic climate.

4.1.3 Measurement Results

The assessment background noise level ABL (L_{A90}) is determined by the tenth percentile method for each period (i.e. day, evening and night) and for each day is shown in Tables 7 and 9 below. The rating background noise levels RBL (L_{A90}) over the monitoring period is found from the median ABL value for the day time, evening time, and night time respectively. This is shown in Tables 8 and 10 below together with the logarithmic average of the existing ambient noise (L_{Aeq}).

TABLE 7 – EXISTING NOISE LEVELS – 'A. Bergamin Residence'

Date	Time of Day	Assessment Background Noise Levels (L_{A90})	Existing Ambient Noise Levels (L_{Aeq})
23/04/07	Day	29	38
23/04/07	Evening	25	40
23-24/04/07	Night	26	38
24/04/07	Day	29	40
24/04/07	Evening	26	30
24-25/04/07	Night	25	32
25/04/07	Day	27	40
25/04/07	Evening	26	29
25-26/04/07	Night	25	30
26/04/07	Day	27	40
26/04/07	Evening	25	31
26-27/04/07	Night	25	40
27/04/07	Day	30	39
27/04/07	Evening	29	38
27-28/04/07	Night	27	38
28/04/07	Day	34	46
28/04/07	Evening	28	39
28-29/04/07	Night	31	40
29/04/07	Day	35	51
29/04/07	Evening	34	42
29-30/04/07	Night	29	46
30/04/07	Day	38	52

Note - all levels rounded to the nearest whole decibel

The full statistical noise measurement results are shown in graphical form in Appendix A below.

TABLE 8 – SUMMARY OF EXISTING NOISE LEVELS – 'A. Bergamin Residence'

Time of Day	Rating Background Noise Levels (L_{A90})	Log Average Existing Ambient Noise Levels (L_{Aeq})
Day	29	45
Evening	26	38
Night	26	40

TABLE 9 – EXISTING NOISE LEVELS – 'D. Sergi Residence'

Date	Time of Day	Assessment Background Noise Levels (L_{A90})	Existing Ambient Noise Levels (L_{Aeq})
23/04/07	Day	34	45
23/04/07	Evening	30	51
23-24/04/07	Night	30	40
24/04/07	Day	35	49
24/04/07	Evening	34	48
24-25/04/07	Night	29	39
25/04/07	Day	31	51
25/04/07	Evening	32	50
25-26/04/07	Night	28	41
26/04/07	Day	30	47
26/04/07	Evening	33	45
26-27/04/07	Night	34	42
27/04/07	Day	27	45
27/04/07	Evening	34	42
27-28/04/07	Night	36	38
28/04/07	Day	28	44
28/04/07	Evening	32	46
28-29/04/07	Night	32	39
29/04/07	Day	30	44
29/04/07	Evening	31	41
29-30/04/07	Night	27	38
30/04/07	Day	33	46

Note - all levels rounded to the nearest whole decibel

The full statistical noise measurement results are shown in graphical form in Appendix A below.

TABLE 10 – SUMMARY OF EXISTING NOISE LEVELS – 'D. Sergi Residence'

Time of Day	Rating Background Noise Levels (L_{A90})	Log Average Existing Ambient Noise Levels (L_{Aeq})
Day	**30**	47
Evening	**32**	47
Night	**30**	40

4.2 Quarry Equipment Noise Levels

Sample sound pressure measurements were taken by Ray Walsh and Associates, in conjunction with Noise and Sound Services, at a similar quarry, during a normal operation, in February 2007.

The measurements were taken at a height of approximately 1.5 metres in the free field and the 'A' frequency weighting, real time 1/3 octave bands and the 'fast' time weighting were used exclusively. It is understood that each process was operated under normal conditions throughout the survey and all results are considered to be representative of typical daily activity. Not all of the individual pieces of equipment could be isolated from the other plant in the quarry; hence a simple addition of all the plant would lead to an overestimate of the total noise.

Table 11 below gives typical 'A' frequency weighted sound pressure levels in decibels (re: 20 μPa) from the measurements at a standardised distance of 7 metres. These are then converted to octave band sound power levels in decibels (re: 10^{-12} Watts) and the overall 'A' frequency weighted sound power levels in decibels (re: 10^{-12} Watts).

TABLE 11 – NOISE LEVELS OF QUARRY EQUIPMENT

Source	Sound Power Levels (dB) Octave Band Centre Frequency (Hz)								Sound Power Level	Sound Pressure Level ($L_{Aeq, 15\ minutes}$) at 7 metres
	63	125	250	500	1k	2k	4k	8k	dBA	dBA
Toggle Jaw Crusher	121	117	114	117	116	113	108	101	120	95
Secondary Cone Crusher	120	113	113	115	114	113	110	102	119	94
Feeder, Conveyor and Screener	113	102	95	97	97	98	99	93	105	80
Cat 980G Loader	107	113	106	98	101	96	90	83	105	80
Tipper Truck	103	107	107	102	102	99	92	85	106	81
550 KVa Diesel Genset (Exhaust Side)	123	109	108	110	109	107	103	96	114	89
From Noise and Sound Services Data Base										
Air Track Drill	111	111	106	108	113	117	116	108	122	97

4.3 Landfill Equipment Noise Levels

Sample sound pressure measurements of similar landfill plant were taken from Noise and Sound Services data base.

TABLE 12 – NOISE LEVELS OF LANDFILL EQUIPMENT

Source	Sound Power Levels (dB) Octave Band Centre Frequency (Hz)								Sound Power Level	Sound Pressure Level ($L_{Aeq, 15\ minutes}$) at 7 metres
	63	125	250	500	1k	2k	4k	8k	dBA	dBA
Liebherr LR634' Track loader	107	113	106	98	101	96	90	83	105	80
Tana GX260' Landfill Compactor	120	113	113	115	114	113	110	102	119	94
International Acco truck	103	107	107	102	102	99	92	85	106	81

4.4 Blasting Vibration Magnitudes

It was not possible to carry out test blasting within the time frame given to complete this report. Typical drilling and blasting operations for the Tharbogang Quarry, as given by Milbrae Quarries, are shown in Table 13 below.

TABLE 13 – TYPICAL DRILLING AND BLASTING OPERATIONS

Typical Drilling and Blasting Operations	
Quantity of rock blasted	20 000 – 32 000 tonnes
No. of holes	40
Hole depth	18 metres
Hole diameter	89 mm to 90 mm
Hole pattern	1 to 2.0 m burden x 2 x 2 m spacing
Stemming length	1.5 metres
Sub drill	0.8 metres
Frequency of blasting	Approximately 1 per month
Max Instantaneous charge	270 kg

5. NOISE GOALS

It is important to note that the goals given below are for the noise level solely from the facilities in question and do not include extraneous noise from other sources.

5.1 Intrusive Noise Goals

For intrusive noise the goal is 5 dB plus the background noise level (L_{A90}) and these are shown in Table 14 below of the nearest residential receiver positions.

TABLE 14 – INTRUSIVE NOISE GOALS – ALL LOCATIONS

Time of Day	Rating Background Noise Levels (L_{A90})	Intrusive Noise Level Goal (L_{Aeq})
Day	**30**	**35**
Evening	**Not Applicable**	**Not Applicable**
Night	**Not Applicable**	**Not Applicable**

Note: based on the minimum 30 dBA background plus 5 dB.

5.2 Noise Amenity Goals

For the amenity noise the goal is dependent upon the existing ambient noise level (L_{Aeq}) from other industrial sources. As there are no other industrial sources in the immediate area the 'Rural' amenity criteria apply. These are shown in Table 15 below.

TABLE 15 – SUMMARY OF EXISTING NOISE LEVELS – ALL LOCATIONS

Time of Day	Amenity Noise Level Goal (L_{Aeq})
Day	**50**
Evening	**45**
Night	**40**

5.3 Overall Project Specific Noise Goals

In summary, the project specific noise goals (worst-case-scenario) are as shown for all relevant locations in Table 16 below:-

TABLE 16 – OVERALL PROJECT SPECIFIC NOISE GOALS

Period	Intrusive Criterion	Amenity Criterion
Day	**35 dB $L_{Aeq, 15\ minutes}$ (30 + 5)**	50 dB $L_{Aeq, Days}$
Evening	**Not Applicable**	**Not Applicable**
Night	**Not Applicable**	**Not Applicable**

Note: The goals in bold apply

5.4 Blasting Noise and Vibration Goals

This section gives overpressure, vibration and time restriction goals for blasting operations.

5.4.1 Blasting Overpressure Goals

The site specific blasting overpressure goal for air blasts is **115 dB** linear peak maximum. This is when measured at a distance of 3 metres from any window of any residential dwelling.

5.4.2 Blasting Vibration Goal

A site specific peak particle velocity vibration goal of 5 mm/s is required when measured at the foundations of any residential dwelling.

5.4.3 Time Restrictions for Blasting

A time restriction of Monday to Saturday, 9 am to 3 pm applies to all blasting operations at the site.

6. NOISE AND VIBRATION MODELLING AND ASSESSMENT

This section provides details of the noise modelling procedure and gives an assessment of the predicted noise levels.

6.1 Noise Modelling Specifications

The source noise has been modelled using the International Standard ISO 9613-2 (1996(E)) '*Acoustic – Attenuation of sound during propagation outdoors Part 2 General method of calculation'*. This Standard specifies methods for the description of noise outdoors in community environments. The method described in the Standard is general in the sense that it may be applied to a wide variety of noise sources, and covers the major mechanism of attenuation. The method allows for downwind propagation conditions namely:-

- wind direction within an angle of ± 45° of the direction connecting the centre of the dominant sound source and the centre of the specified receiver region with the wind blowing from source to receiver, and
- wind speed between approximately 1 m/s and 5 m/s measured at a height of 3 m to 11 m above the ground.

6.2 Basic Noise Modelling Equations

The equivalent continuous downwind sound pressure level (L_{Aeq}) at each receiver point has been calculated for each point source using the equation below:-

$$\mathbf{L_{Aeq} = L_w + D_c - \mathit{A}}$$

Where:
- L_w is the sound power level of the noise source;
- D_c is directivity correction; and
- A is the attenuation that occurs during the propagation from source to receiver.

The attenuation term A in the equation above is given by:-

$$\boldsymbol{A = A_{div} + A_{atm} + A_{gr} + A_{bar} + A_{misc}}$$

Where:
- A_{div} is the attenuation due to geometric divergence;
- A_{atm} is the attenuation due to atmospheric absorption;
- A_{gr} is the attenuation due to the ground effects;
- A_{bar} is the attenuation due to a barrier; and
- A_{misc} is the attenuation due to miscellaneous other effects.

With quarries and landfill sites the noise attenuation due to man made barriers (A_{bar}) is a variable and is dependent upon the stage of the works. It can range from almost zero, where a direct line of sight is applicable, to 15 dB or even as much as 25 dB when plant is in operation near to the lower parts of the quarry or landfill. Large natural barriers can provide up to 40 dB noise attenuation. An example of the natural barriers between the proposed pit and the residences 250 and 1757 Slopes Road is calculated from the contours as shown in Figure 4 below (not to equal scales).

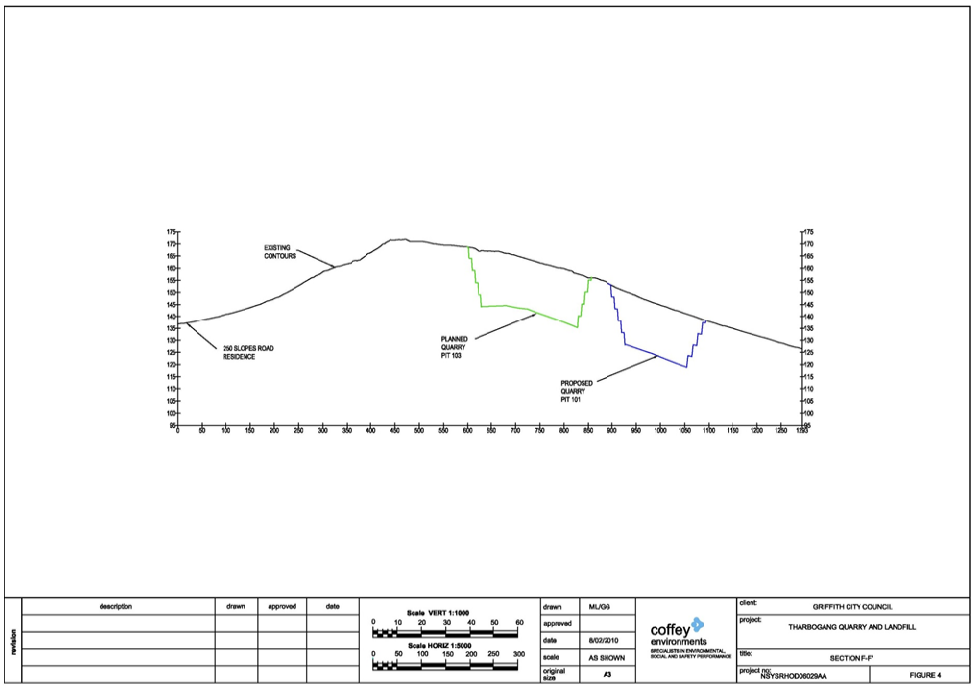


Figure 4. The Approximate Relative Levels between the Proposed Pits and Residences at 250 and 1757 Slopes Road. (Source - Coffey Environments).

This equates to a barrier effect of 12 dB to 24 dB according to the formula given in the International Standard ISO 9613-2 and depending upon the stage of the quarry (i.e. working depth of quarry plant). The crusher and gen-set will be at 135 metres irrespective of stage of quarry. Other plant, including the drilling will occur at various heights as quarries developed.

The natural barriers between the proposed pits and the residences of Mr F & Mrs F Barbaro's is calculated from the contours shown in Figure 5 below (not to equal scales). This equates to a barrier effect of 0 dB to 10 dB according to the formula given in the International Standard ISO 9613-2 and depending upon the stage of the proposed landfill (i.e. working depth of landfill plant).

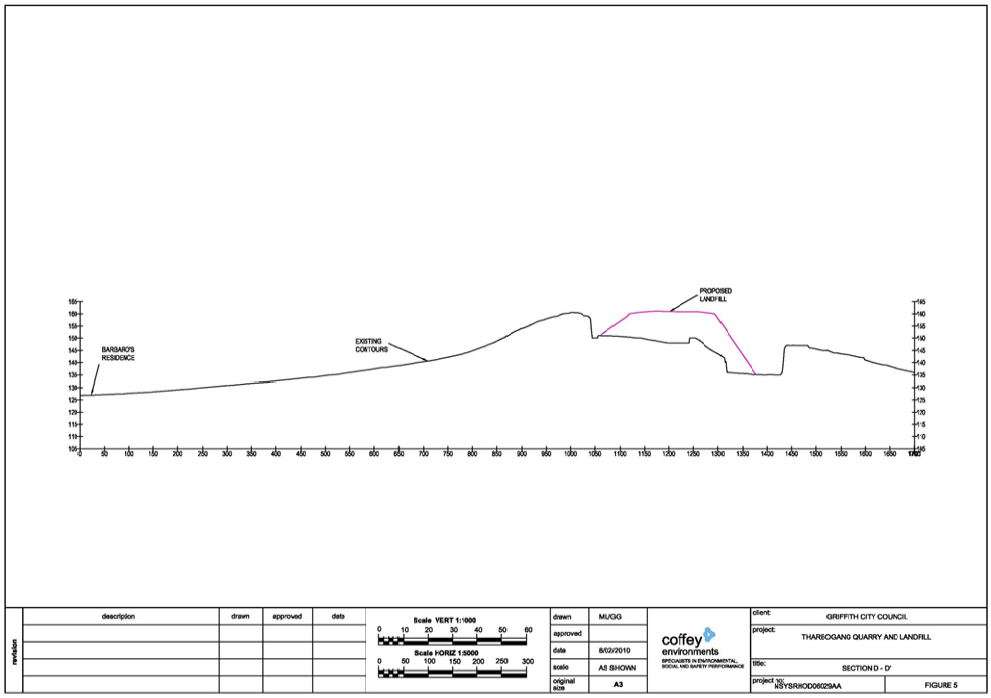


Figure 5. The Approximate Relative Levels between the Proposed Pits and the Barbaro's Residence. (Source - Coffey Environments).

The last term (A_{misc}) generally refers to miscellaneous propagation through foliage, industrial sites and areas of houses. The minor miscellaneous term for attenuation due to foliage is included due to the existing orchards. This is significant for noise at high frequencies. Other miscellaneous terms are not regarded as significantly applicable for the site in question and are not applied in this NIS.

6.3 Prediction of Plant Noise

The assessment results for constant operation of the proposed plant, at the nearest residential receivers are shown in Table 17 below.

TABLE 17 – PREDICTED QUARRY AND LANDFILL PLANT NOISE LEVELS AT THE NEAREST RESIDENCES.

Neighbouring Property Name	Direction	Approximate Distance (metres)	Predicted Sound Pressure Level ($L_{Aeq, 15\ minutes}$)
A. Bergamin's Residence	Northwest	1360	27
B. 250 Slopes Road Mr G and Mrs G Sergi	Southwest	600	30*
C. Mr D Sergi's	West	1490	25
D. Mr F & Mrs F Barbaro's Residence	West	1280	28
E. 1757 Slopes Road Mr P J Sergi	Southwest	730	31**
F. Residence at Hillside Drive	South	1020	31

Notes:
1. *All levels are rounded to the nearset whole decibel*
2. **Includes 10 dB for natural barrier attenutaion (see Figure 4 above)*
3. ***Includes 7 dB for natural barrier attenutaion (see Figure 4 above)*
4. *All Predictions have an 95% uncertainty of +4/-6 dB.*

6.4 Temperature Inversion and Wind Effects

The predictions in Table 17 above are for average propagation under a well-developed moderate ground based temperature inversion, such as commonly occurs on clear, calm early morning periods. However during unusually high wind conditions in unfavourable directions the predicted noise levels given in Table 17 above could increase by an estimated 4 dB.

6.5 Assessment of Plant Noise

The industrial noise goal ($L_{Aeq,\ day}$) will be met at the neighbouring residential properties. However vehicle reversing alarms can be the cause of complaints even if the sound levels are well below the existing background noise level. Alternative, low noise, systems such as close-circuit television, radar or sonar should be fully investigated and used provided that they meet on-site safety requirements (see Appendix B below).

6.6 Prediction of On-Road Traffic Noise

This section gives predictions of noise levels from road traffic, using the nearby Kidman Highway, by applying formulae given in the Calculation of Road Traffic

Noise (CoRTN) from the UK Department of Transport and Welsh Office (1988). The calculation procedure given in CoRTN is untested for small traffic flows. Therefore a calculation based on the sound exposure level for one truck has also been carried out.

6.6.1 Quarry On-Road Traffic

For the daily vehicles movements (trips) as given in the GHD report (see Section 2.2.4. above) and increased by 5% for current predictions the following would occur:-

- 153 for quarry heavy vehicle traffic,
- 63 for landfill heavy vehicle traffic,
- 89 for light vehicle traffic and
- 11 for employee light vehicle traffic.

From the CoRTN calculations this gives a 15 hour noise level ($L_{Aeq,\ 15\ hour}$) prediction of **54 dBA** at 30 metres from the nearest roadside. This assumes a vehicle speed of 50 km/hr and a small (2%) gradient. For the dwellings on the Kidman Highway it is assumed in a worst-case scenario that 50% of the vehicles will be at 30 metres (near side) and 50% of the vehicles at 45 metres (far side).

Based on the peak hour vehicles movements as given in the GHD report (see Section 2.2.4. above) and increased by 5% for current predictions the following would occur:-

- 20 for quarry heavy vehicle traffic,
- 8 for landfill heavy vehicle traffic,
- 8 for light vehicle traffic and
- 5 for employee light vehicle traffic

From the CoRTN calculations this gives a 1 hour noise level ($L_{Aeq,\ 1\ hour}$) prediction of **59 dBA** at 75 metres from the nearest roadside. This assumes a vehicle speed of 50 km/hr and a medium (5%) gradient. Based on a measured truck sound exposure level (L_{AE}) at 15 metres of 85 dBA the hourly level ($L_{Aeq,\ 1\ hour}$) is **64 dBA** (from $L_{Aeq,\ 1\ hour} = L_{AE} - 10\log_{10}(T) + 10\log_{10}(N)$ where T is one hour in seconds and N is the number of trucks (i.e. 14 in each direction in this case) this gives an noise level of **57 dBA**. For the single dwellings on Hillside Drive it is assumed in a worst-case scenario that 50% of the vehicles will be at 75 metres (near side) and 50% of the vehicles at 80 metres (far side).

6.6.2 Existing Road Traffic Noise

The noise levels from existing road traffic at a distance of 30 metres from the Kidman Highway have been calculated from traffic count data provided by MetroCount Traffic Executive via Griffith Council and is shown in Figure 6 below.

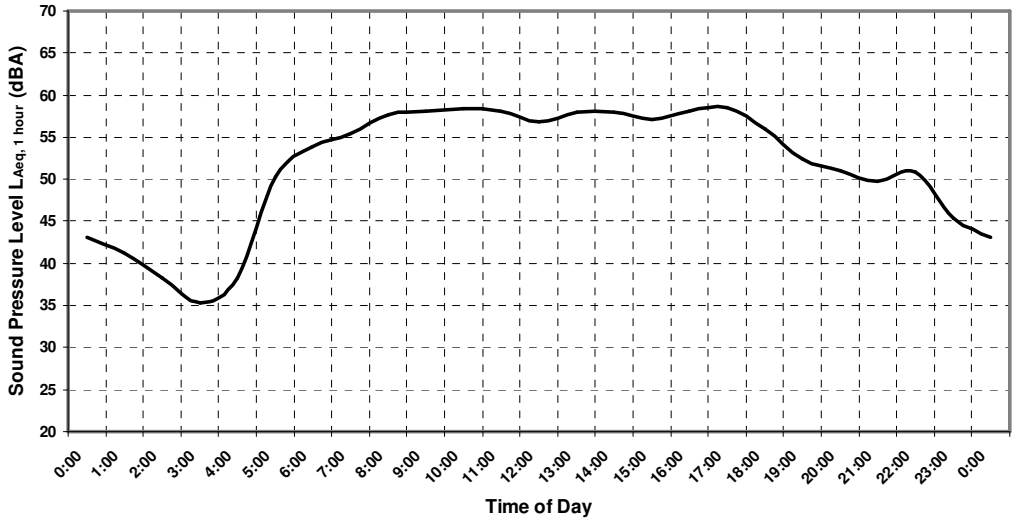


Figure 6. Calculation of the Existing Road Traffic Noise at a position 30 metres form the Kidman Highway. Based on Traffic Count Data from MetroCount Traffic Executive.

6.6.3 Assessment

Road traffic noise from the quarry is predicted to be **54 dBA** at 30 metres. This is equivalent to the existing road traffic noise shown in Figure 5 above and meets the day time NSW Government guidelines for land use developments (or expansions) with potential to create additional traffic on existing freeways/arterials for day time 15 hour road traffic noise levels.

For the single dwelling at Hillside Drive a minor exceedance of the one hour 55 dBA goal is predicted. The exceedance is predicted to be between 2 dB and 4 dB in the worst case hour only. Nevertheless mitigation measures are recommended (see section 7.4 below).

6.7 Prediction of Vibration from Blasting

The independent variables involved in the prediction of vibration peak particle velocity (mm/s) from blasting includes the energy released by the explosion (per delay) which is dependant upon the charge weight (kg) per delay ‘W’; the distance from the explosion (range in metres) ‘R’; the seismic velocity of the rock mass and the density of the rock mass. Since the density for a rock mass does not vary by more than 20% and the seismic velocity does not vary more than a factor

of 2, the variation in 'W' and 'R' are much more significant than the density and the seismic velocity. The peak particle velocity is proportional to 'W' and inversely proportional to 'R'. When both 'W' and 'R' vary, scaling of distance is necessary to predict peak particle velocity.

The two most popular approaches are square root ($R/W^{1/2}$) scaling and cube root ($R/W^{1/3}$) scaling. Square root scaling produces higher predicted vibration magnitudes than cube root scaling at the distances under consideration in this assessment. Therefore only square root scaling is considered in further detail. Calculations for predicting peak particle velocity (ppv) from square root scaling have been developed in the United States by Dowding (1985) and Hendron and Oriard (1972). The equation is:-

$$ppv = a\ (R/W^{1/2})^{-1.57}$$

There are many systematic causes of scatter in plots of peak particle velocities. The most important of these are type of explosive, geometry of the shot, stemming, direction of blast initiation, delay-time variations, burden in front of the first row of holes, spacing of holes, and free surface reflection. It has been shown in practical results from blasts that the factor 'a' in the above equation can therefore vary between approximately 125 and 1250. Therefore a statistical approach to the prediction of ppv is required. The 95% confidence approach is normally adopted giving a prediction of the ppv that will not be exceeded for 95 out of 100 blasts and is given by the equation below:-

$$ppv = 1125\ (R/W^{1/2})^{-1.57}$$

Based on the proposed maximum instantaneous charge weight of 270 kg the predicted ppv vibration for 95% of blasts at distances from the blast position is given in Table 18 below.

TABLE 18 – PREDICTED QUARRY BLASTING VIBRATION AT THE NEAREST RESIDENCES FOR 270 kg CHARGE WEIGHT.

Neighbouring Property Name	Direction	Approximate Distance (metres)	Predicted Blasting Vibration Magnitude
A. Bergamin's Residence	Northwest	1360	1.1 mm/s
B. 250 Slopes Road Mr G and Mrs G Sergi	Southwest	600	3.9 mm/s
C. Mr D Sergi's	West	1490	1.0 mm/s
D. Mr F & Mrs F Barbaro's Residence	West	1280	1.2 mm/s
E. 1757 Slopes Road Mr P J Sergi	Southwest	730	2.9 mm/s
F. Residence at Hillside Drive	South	1020	1.7 mm/s

The vibration goal of 5 mm/s will be met at all residences. The perception of blast vibration occurs at peak particle velocity of 0.5 mm/s to 1.0 mm/s; hence complaints may occur when these magnitudes arise. It is reported that the blasting regime will be similar to the current operations. Damage to residential dwellings is highly unlikely at magnitudes below 7 mm/s, nevertheless a significant degree of community relations will be required to minimise adverse comments.

6.8 Prediction of Overpressure from Blasting

The overpressure from blasting is normally predicted in terms of pressure in units of pascals (Pa) or on the decibel scale (dB(linear)).

Equations for predicting overpressure (p) from logarithmic scaling have been developed by Noise and Sound Services from quarry blast data given by Siskind and Dowding in the United States. The equation is:-

$$L_{peak} = 136 - 16 \log_{10} (R/W) \; dBL$$

Based on the proposed maximum instantaneous charge weight of 270 kg the overpressure goal of 115 dB for 95% of blasts will be exceeded at the closest six residences to the site of blasts as shown in Table 19 below. Therefore mitigation measures are recommended (see section 7.3 below).

TABLE 19 – PREDICTED QUARRY BLASTING OVERPRESSURE AT THE NEAREST RESIDENCES FOR 270 kg CHARGE WEIGHT.

Neighbouring Property Name	Direction	Approximate Distance (metres)	Maximum Overpressure (Peak Linear)
A. Bergamin's Residence	Northwest	1360	125 dB
B. 250 Slopes Road Mr G and Mrs G Sergi	Southwest	600	130 dB
C. Mr D Sergi's	West	1490	124 dB
D. Mr F & Mrs F Barbaro's Residence	West	1280	125 dB
E. 1757 Slopes Road Mr P J Sergi	Southwest	730	129 dB
F. Residence at Hillside Drive	South	1020	127 dB

6. MITIGATION AND COMMUNITY RELATIONS

This section provides suggested mitigation method and community relations advise for the blasting operations.

7.1 Quarry and Landfill Plant

It can be seen from Table 15 above that the noise goal ($L_{Aeq,\ day}$) for quarry plant will be met at the neighbouring residential properties. The jaw crushing equipment (primary jaw crushing and secondary cone crushing) is by far the predominant noise source (apart from the intermittent rock drill). The positioning of the crushing equipment should be carefully considered to ensure that it is situated at the lowest ground level practicable and close to any natural barriers as practicable.

7.2 Construction Site Noise

All construction site noise should comply with the mitigation guidelines as provided in the NSW Government's 'Interim Construction Noise Guideline' (July 2009).

7.3 Blasting Overpressure

No blasting with a charge weight of 270 kg (or similar) should be carried out within 2000 metres of any residential dwelling. It is recommended that vibration and overpressure monitoring should be carried out at two of the closest residences to the blasting position for the first 3 blasts, and then only annually if monitoring shows the measured levels are well within limit and no complaints are received. The reduction in charge to 50 kg will results in the 120 dB overpressure goals being met for 95% of blasts at all residential dwellings shown in Table 20 below. Based on the modelling is it found that to meet the 120 dB overpressure goals for 95% of blasts 600 metres the charge would need to be restricted to 30 kg and therefore it is important to monitor the overpressure and adopt an adaptive blasting regime to ensure compliance with the overpressure goals.

TABLE 20 – PREDICTED QUARRY BLASTING OVERPRESSURE AT THE NEAREST RESIDENCES WITH 50 kg CHARGE WEIGHT.

Neighbouring Property Name	Direction	Approximate Distance (metres)	Maximum Overpressure (Peak Linear)
A. Bergamin's Residence	Northwest	1360	113
B. 250 Slopes Road Mr G and Mrs G Sergi	Southwest	600	119
C. Mr D Sergi's	West	1490	112
D. Mr F & Mrs F Barbaro's Residence	West	1280	114
E. 1757 Slopes Road Mr P J Sergi	Southwest	730	117
F. Residence at Hillside Drive	South	1020	115

It is essential that all neighbours within a 2,000 metre distance of the proposed quarry expansion should be kept fully informed, well in advance of any imminent blasting to be carried out at the site. They should be provided with information such as to why the blasts need to be carried out, the times that blasts will occur and how long the blasting will last on any particular day. It is also necessary to provide a readily accessible contact point for complaints and give all complainants a fair hearing by staff who understands the blasting event, even if the complainant appears to be stressed. A register of any complaints should be kept.

Where winds are significant (i.e. over 3 metres per second and in a direction toward Slopes Road) the charge weight should be restricted to 50 kg (or less) to limit overpressure propagation. Blasting should be avoided when winds in a direction toward Slopes Road exceed 5 metres per second.

7.4 Road Traffic Noise

The NSW Government has produced criteria for on-road traffic noise *'Environmental Criteria for Road Traffic Noise'* (May 1999) which suggests that where feasible and reasonable for noise levels that exceed the noise criteria mitigation measures should be applied. Theses include acoustic barriers and acoustic treatments to affected residences. Therefore the single dwelling at Hillside Drive, where the criterion is expected to be marginally exceeded, should be offered an upgrade of the building elements on the façade facing Hillside Drive. This should be to enable the internal noise level ($L_{Aeq,\ 1\ hour}$) to be not more than 35 dBA in any habitable room during the peak hour of quarry truck movements. Usually the glazing is the weakest link and the treatment may include an upgrade of the windows and glazed door to thick laminated glass (which is

preferable to double glazing for low frequency truck noise reduction). No night time truck movements should occur.

8. CONCLUSIONS

It can be seen from the assessment results that:-

- the NSW Government noise criteria will be met for the on-site plant noise (quarry and landfill) from the proposed expansion (based on an existing day-time background noise level of 30 dBA). Nevertheless measures are recommended for day time use of the jaw crushers and diesel genset to ensure complinace. Here a noise impact will be minimised with the carefull location of the crushing plant.
- the NSW Government noise criteria for road traffic from the proposed expansion will be met for future traffic using the haulage route with the possible exception of the single dwelling at the bottom of Hillside Drive. Here an upgrade of the glazing for the facades with a line of sight to the truck route on Hillside Drive is recommended.
- the vibration goal (ppv of 5 mm/s) from blasting at the proposed expansion will be met at 600 metres from the blasts. Therefore it is unlikely that any residential structures will be affected by vibration.
- the noise goal (120 dB) for overpressure from blasting at the proposed expansion will be met at all residents providing charge weights of explosives given above (50 kg) are adhered to. For the closest residential property at 600 metres charge weights of explosives will need to be restricted to 30 kg to meet the 115 dB goal.

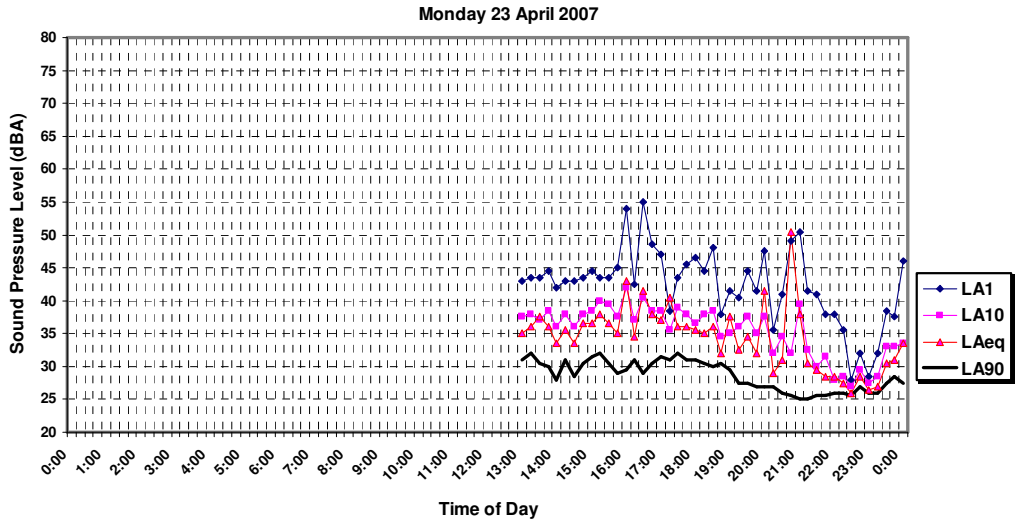
Date	Prepared by:	Status
17 February 2010	Ken Scannell MSc MAAS MIOA	Draft
18 February 2010	Ken Scannell MSc MAAS MIOA	Rev A Draft

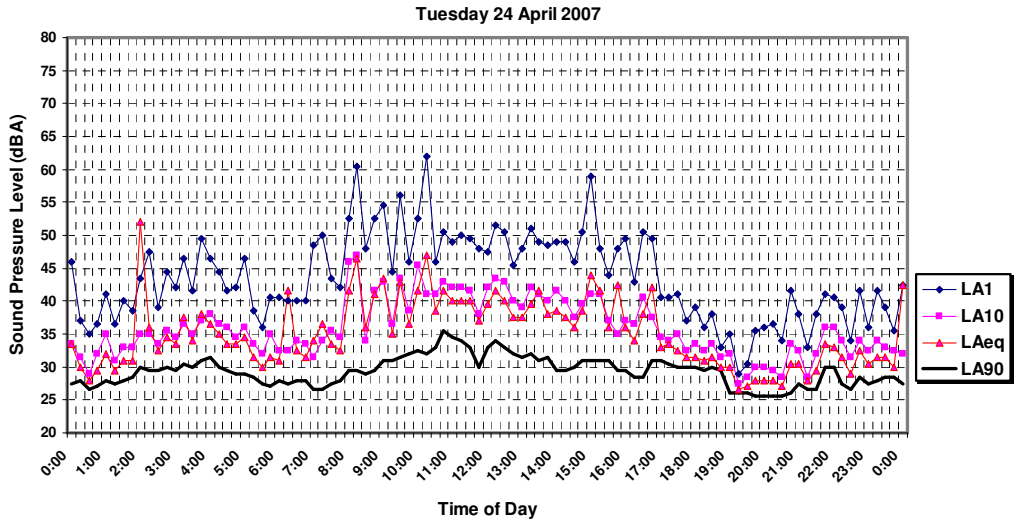
Important Note. *All products and materials suggested by 'Noise and Sound Services' are selected for their acoustical properties only. All other properties such as airflow, aesthetics, chemical, corrosion, combustion, construction details, decomposition, expansion, fire rating, smoke, ventilation, etc are outside of 'Noise and Sound Services' field of expertise and* ***must be*** *checked with the supplier or suitably qualified specialist before purchase.*

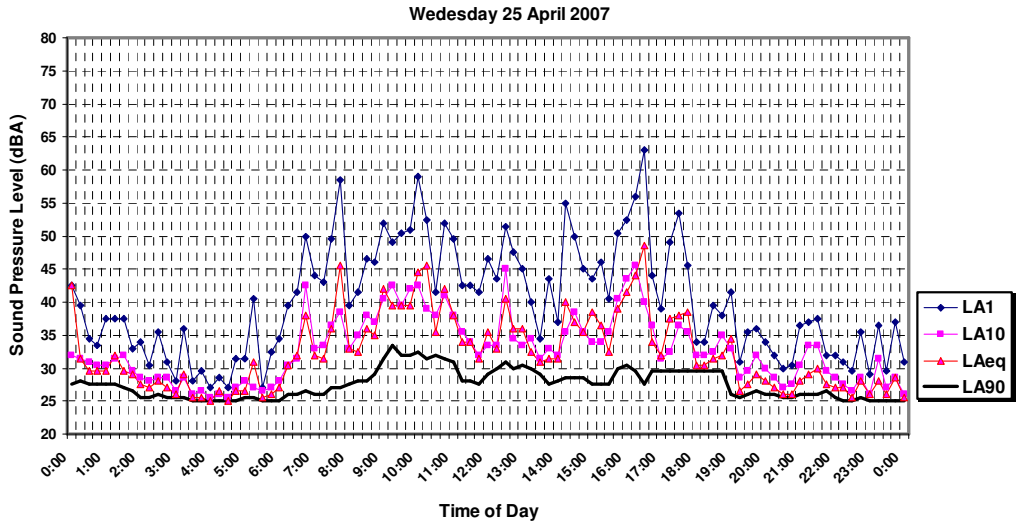
APPENDIX A – MEASURED AMBIENT AND BACKGROUND NOISE LEVELS

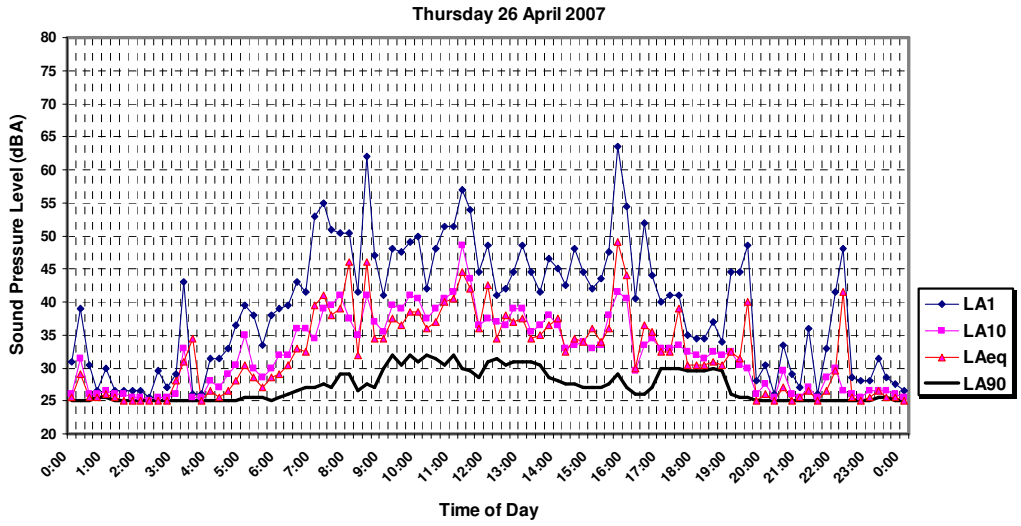
Environmental noise levels can vary considerably with time; therefore it is not adequate to use a single number to fully describe the acoustic environment. The preferred, and now generally accepted, method of recording and presenting noise measurements is based upon a statistical approach. For example, the L_{A10} noise level is the level exceeded for 10% of the time, and is approximately the average maximum noise level. The L_{A90} level is the level that is exceeded for 90% of the time, and is considered to be approximately the average of the minimum noise level recorded. This level is often referred to as the 'background' noise level. The L_{Aeq} level represents the average noise energy during the measurement period. This level is often referred to as the 'ambient' noise level.

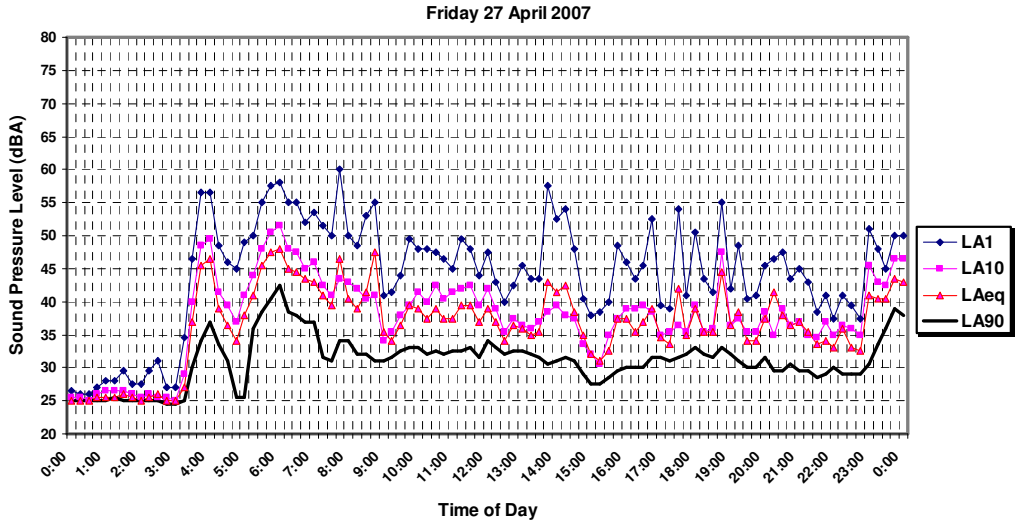
The following graphs show the noise logger results at two locations, as given in Tables 7 and 9 above, which represent the acoustic climate in all of the surrounding areas of the subject site.

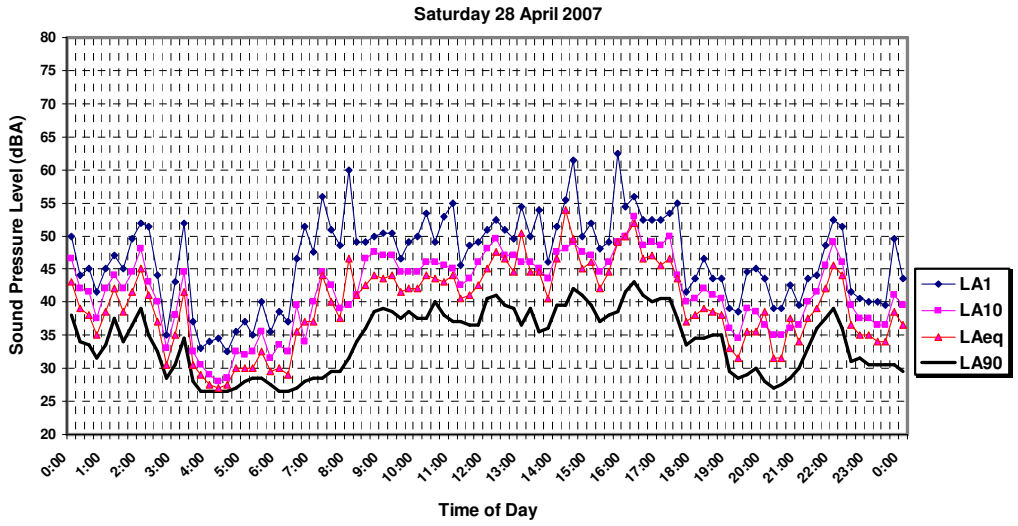


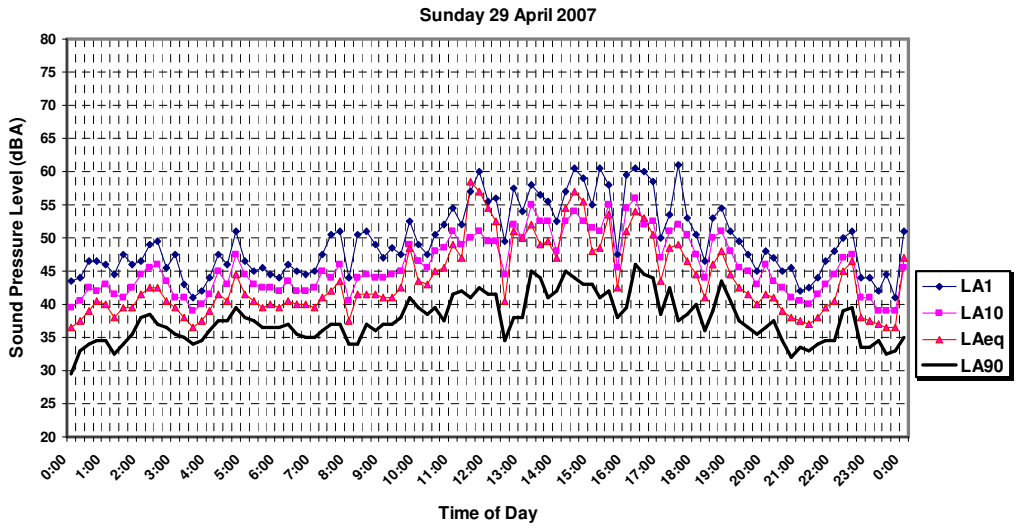

Tuesday 24 April 2007
Sound Pressure Level (dBA)
Time of Day
LA1
LA10
LAeq
LA90

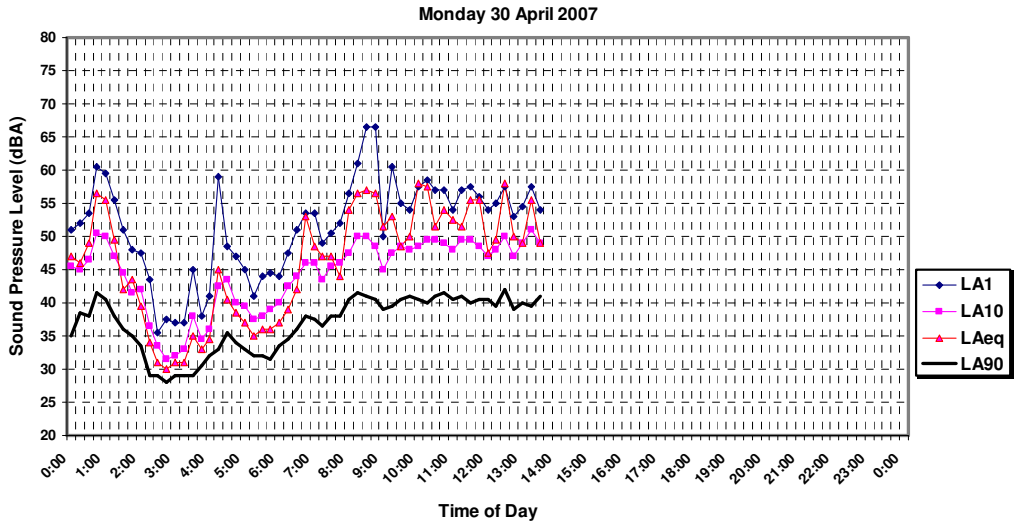

Wedesday 25 April 2007
Sound Pressure Level (dBA)
Time of Day
LA1
LA10
LAeq
LA90


Thursday 26 April 2007
Sound Pressure Level (dBA)
Time of Day
LA1
LA10
LAeq
LA90


Friday 27 April 2007
Sound Pressure Level (dBA)
Time of Day
LA1
LA10
LAeq
LA90


Saturday 28 April 2007
Sound Pressure Level (dBA)
80
75
70
65
60
55
50
45
40
35
30
25
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time of Day
LA1
LA10
LAeq
LA90


Sunday 29 April 2007
Sound Pressure Level (dBA)
80
75
70
65
60
55
50
45
40
35
30
25
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
21:00
22:00
23:00
0:00
Time of Day
LA1
LA10
LAeq
LA90


Monday 30 April 2007
Sound Pressure Level (dBA)
80
75
70
65
60
55
50
45
40
35
30
25
20
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
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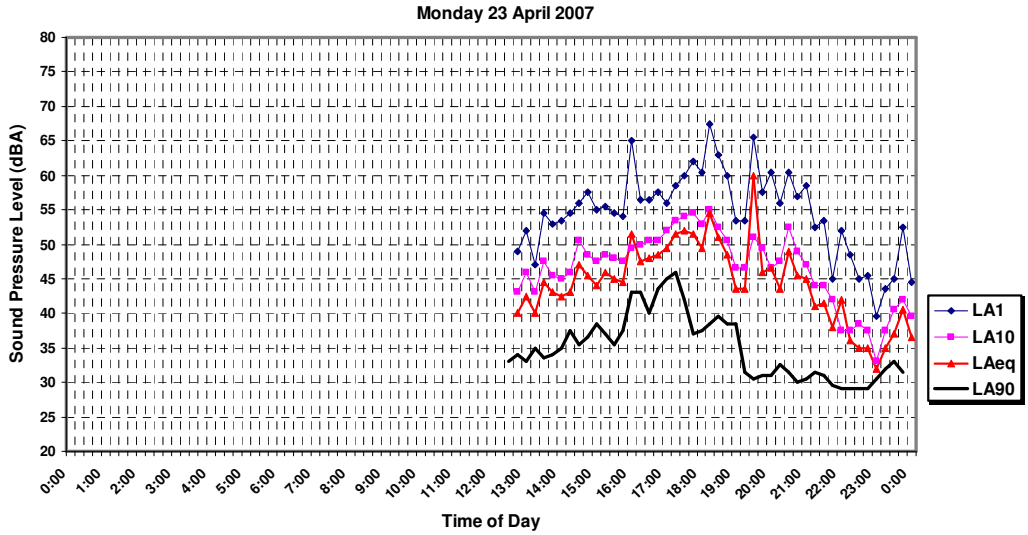
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Time of Day
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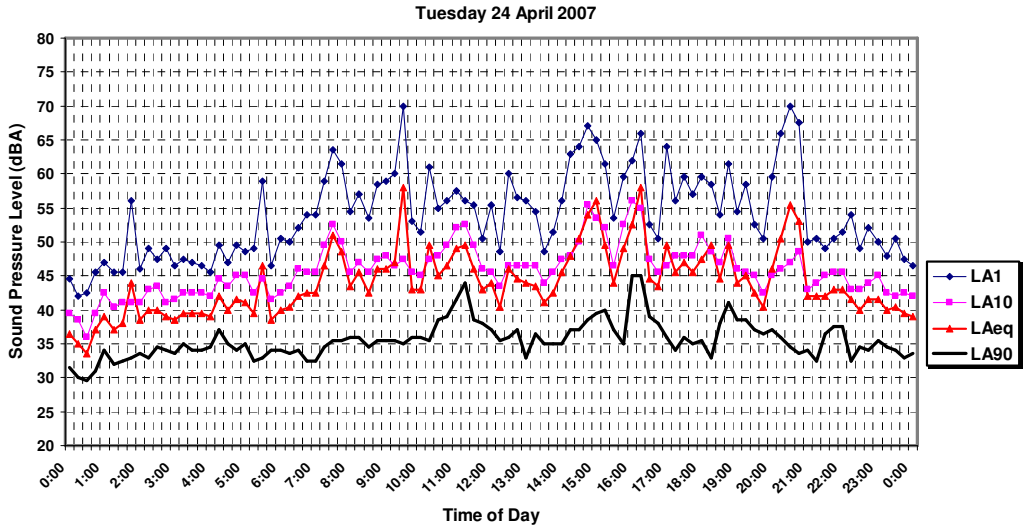
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Sound Pressure Level (dBA)
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Time of Day
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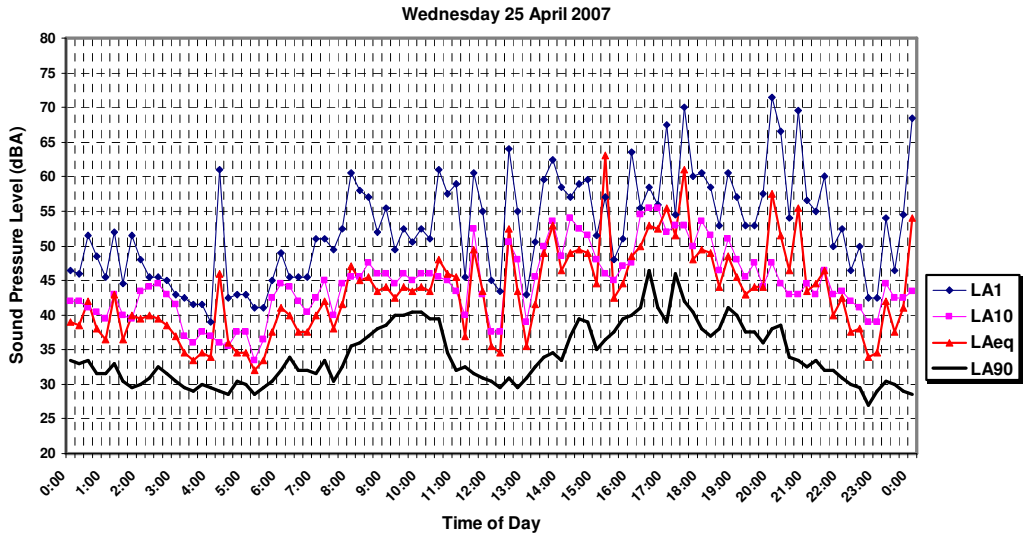
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Sound Pressure Level (dBA)
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Time of Day
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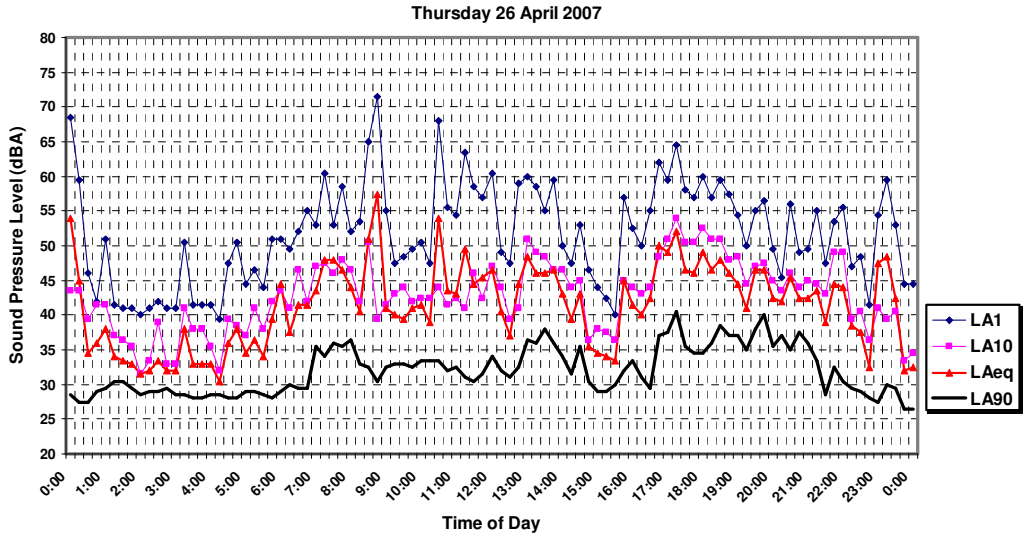
Thursday 26 April 2007
Sound Pressure Level (dBA)
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Time of Day
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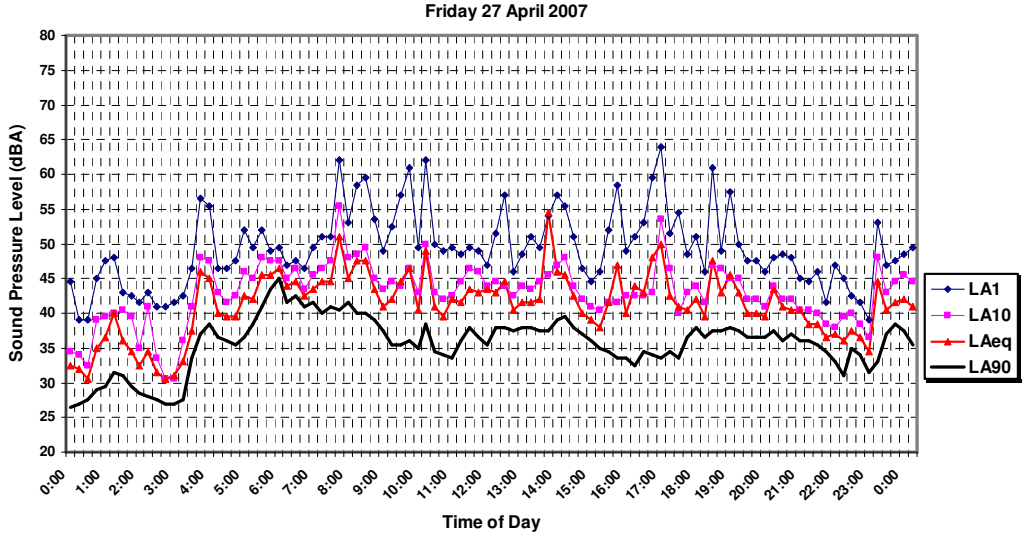
Friday 27 April 2007
Sound Pressure Level (dBA)
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Time of Day
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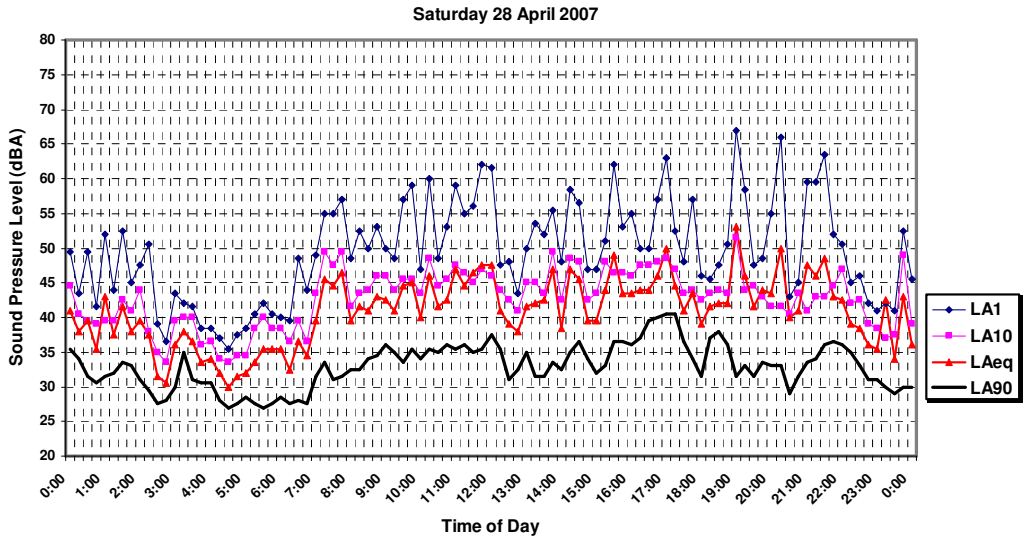
Saturday 28 April 2007
Sound Pressure Level (dBA)
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Time of Day
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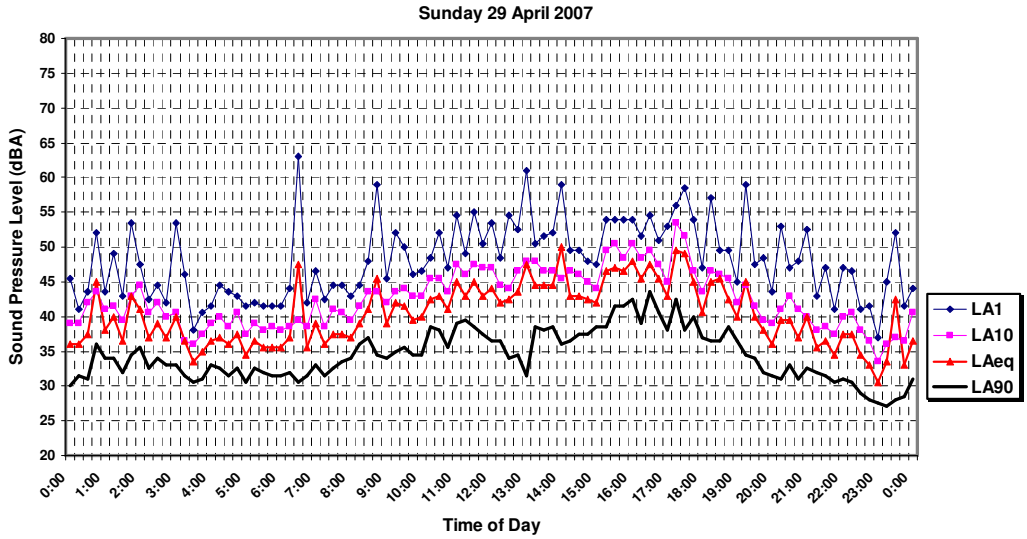
Sunday 29 April 2007
Sound Pressure Level (dBA)
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Time of Day
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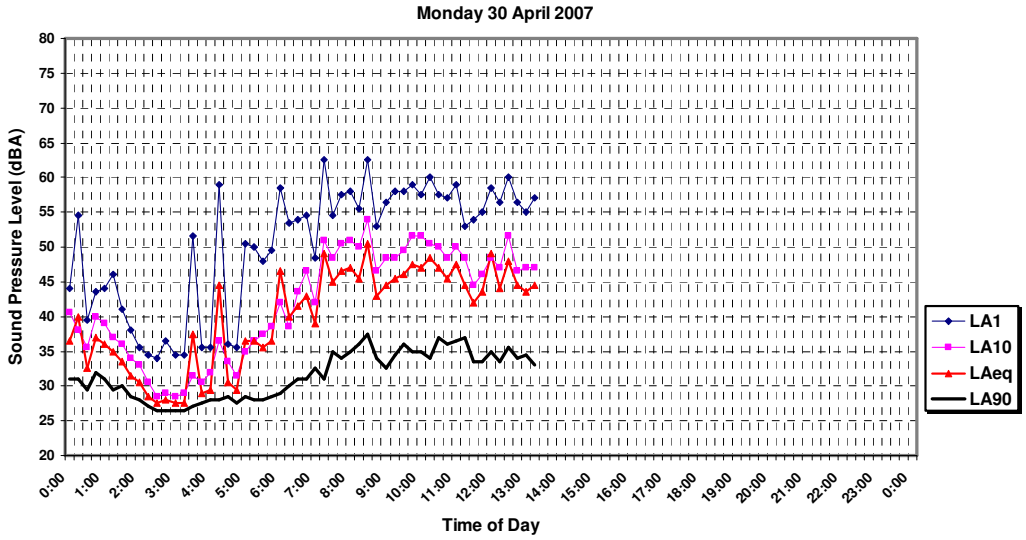
Monday 30 April 2007
Sound Pressure Level (dBA)
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APPENDIX B – ALARMS AND SIRENS

This section addresses the reversing alarm and siren noise levels for safe working and considers alternatives to audio alarms.

All mobile plant must be used in a safe manner. Employers have a legal duty of care to employees to provide and maintain systems of work which are, as far as reasonably practicable, safe from injury. However the use of tonal reversing alarms should be avoided due to the long distances the sound travels. Employers should therefore find alternative systems of work which are safe for their employees and fully comply with NSW Occupational Health and Safety Regulation (2001). It may be found that no single alternative measure will be enough. The options are:-

- remove the need for mobile plant reversing, as far as reasonably practicable, by setting up one-way, drive through loading and unloading positions;
- exclude pedestrians from the area where vehicles are permitted to reverse;
- minimise the distances mobile plant have to reverse;
- make sure all personnel on the site are adequately trained;
- design the site with driver visibility in mind;
- keep reversing mirrors clean and in good order;
- use refractive lenses at the rear;
- use a closed circuit television (cct) system in the cab;
- use mirrored surfaces in the reversing area;
- fit flashing warning lights;
- use ultrasonic reversing sensors;
- use pulsed radar rear detection systems;
- provide radio control communication with drivers.

None of these options will be sufficient on their own but a carefully chosen combination of precautions should be possible without the use of audio reversing alarms. The procedures should be reviewed as often as necessary to ensure a safe working system.

Where audio reversing alarms cannot be avoided, a broadband frequency range of sound rather than a narrow band frequency range should be considered. The broadband sound based reversing alarms address the problem of noise pollution caused by traditional narrowband alarms by providing an equally effective warning at reduced sound pressure levels with a clearly audible but more acceptable 'Shh….shh…' sound. Additionally, broadband sound is instantly and accurately locatable which provides a safety benefit over narrowband alarms. Site specific trials should be carried out on the use of audio alarms.

See also (http://www.environment.nsw.gov.au/noise/constructnoise.htm).