Appendix 5

Noise and Blasting Assessment

(SLR Consulting Australia Pty Ltd)

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global environmental solutions

Bogo Quarry

Noise and Blasting Assessment

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Bogo Quarry

Noise and Blasting Assessment

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EXECUTIVE SUMMARY

This report presents the results and findings of an assessment of the potential impacts of the proposed future operation of the Bogo Quarry, located approximately 20km west-northwest of Yass, NSW.

The study examines the emissions from activities associated with increasing the current hard rock production from 200,000tpa to a maximum of 500,000tpa as well as the campaign operation of mobile asphalt manufacturing and concrete batching plants at the quarry.

The NSW Environment Protection Authority (EPA), has regulatory responsibility for the control of noise from "scheduled premises" under the Protection of the Environment Operations Act 1997. In implementing the NSW "*Industrial Noise Policy*", 2000 (INP), the EPA has two broad objectives for the control of noise from the scheduled premises:

- Controlling intrusive noise impacts in the short-term; and
- Maintaining noise level amenity for particular land uses for residences and other land uses over the medium to long-term.

In order to achieve these objectives, the NSW INP sets acceptable intrusive and amenity noise levels guidelines for "operating" noise emissions.

From the default background noise level established in accordance with the INP, the daytime (0700 hours to 1800 hours), evening (1800 hours to 2200 hours) and night-time (0500 hours to 0700 hours) intrusive noise level criteria at the potentially most affected residences were established.

The INP-based intrusive and amenity noise assessment criteria at each of the assessment locations are presented below. Note, compliance with the $L_{Aeq(15minute)}$ intrusive criteria would also result in compliance with the $L_{Aeq(period)}$ amenity criteria.

Operational Noise Emission Criteria - dBA 20µPA

Receiver		**Daytime and Evening - 0700 Hours to 182200 Hours / Night - 0500 Hours to 0700 Hours**	
		Intrusiveness Criterion LAeq(15minutes)	**Amenity Criterion LAeq(period)**
R1	"Bogolong Cottage"	35/35	50/40
R2	"Marilba"	35/35	50/40
R3	Walker Property	35/35	50/40
R4	"Cooinda"	35/35	50/40
R5	"Bogo Cottage"	35/35	50/40

In relation to the operational noise impact assessment conducted for the proposal, compliance with operational $L_{Aeq(15minute)}$ intrusive noise criteria would also result in compliance with the $L_{Aeq(period)}$ amenity criteria. The controlling noise criterion is therefore the intrusive criterion.

The predicted daytime/evening and night-time noise levels comply with the intrusive (and amenity) noise assessment criteria under the calm and adverse weather conditions modelled at all nearby receivers except at Receiver R5 with the concurrent use of the mobile processing plant during daytime/evening calm conditions and during winter night-time (0500 hours to 0700 hours) temperature inversion conditions where, in each case, a marginal 1dBA exceedance is predicted.

For the general case of all plant and equipment except the asphalt plant operating compliance with the daytime/evening and night-time noise criteria is met under all the noise modelling conditions.

It is therefore concluded that, based on the predicted noise levels, the operation of the Bogo Quarry would have a negligible noise impact at the nearest residences.

The predicted levels of blast emissions were determined using the appropriate distances to the near quarry pit boundary. The predicted (5% exceedance) levels of Peak Vector Sum (PVS) ground vibration velocity and peak airblast at the nearest potentially affected properties to the quarry blasting were conducted for the proposed maximum MIC of 136kg.

The following information is derived from the predicted levels of blast emissions:

- The predicted levels of ground vibration at all nearby residences comply with the ANZECC general human comfort criterion (of 5mm/s) and consequently with the ANZECC maximum human comfort criterion as well as the BS 7385 structural damage criterion of 15mm/s (at 4Hz).
- The maximum predicted ground vibration level of 0.6mm/s occurs at Receiver R5 for an MIC of 136kg (corresponding to blasting a full height 15m bench).
- The predicted levels of peak airblast at all residences comply with the ANZECC general human comfort criterion of 115dB Linear and consequently with the ANZECC maximum human comfort criterion.
- The maximum predicted peak airblast level of 114dB Linear occurs at Receiver R5 for an MIC of 136kg (corresponding to a full 15m bench).
- The predicted levels of peak airblast are clearly well below the US Bureau of Mines damage limit of 132dB Linear (2Hz cut off) at all residences.

Notwithstanding the above, it is recommended that all blasts are monitored at the closest/potentially most affected residence, in order to establish compliance with the nominated criteria and to progressively update the blast emissions site laws (ground vibration and airblast) in order to optimise future blast designs, based on actual site conditions. In this way, the site laws can be used to assist with the blast designs in order to ensure compliance with the ANZECC criteria are met at all nearby residences.

By adopting this approach, in conjunction with the inevitable future introduction of improved blasting products, it is anticipated that the blast emissions criteria can be met without imposing any significant constraints on the blast designs throughout the life of the quarry

1 INTRODUCTION

Glenella Quarry Pty Ltd (hereafter, "the Applicant") is seeking approval to increase current hard rock production activities from 200,000tpa to a maximum of 500,000tpa and campaign operation of mobile asphalt manufacture and concrete batching plants at the Bogo Quarry (hereafter, "the Quarry Site"). R.W. Corkery and Co. Pty Limited (hereafter, "RWC"), on behalf of Bogo Operations Pty Ltd, has engaged SLR Consulting Australia Pty Ltd (hereafter, "SLR") to conduct a noise and blasting impact assessment of the proposed activities to determine the potential level of impact on the surrounding environment.

Noise and Vibration Assessment Procedures

The NSW Environment Protection Authority (EPA) has regulatory responsibility for the control of noise from "scheduled premises" under the Protection of the Environment Operations Act 1997. In implementing the NSW "*Industrial Noise Policy*", 2000 (INP), the EPA has two broad objectives:

- Controlling intrusive noise impacts in the short-term.
- Maintaining noise level amenity for particular land uses over the medium to long-term.

On-Site Operating Noise Emissions

The INP provides non-mandatory procedures for setting acceptable $L_{Aeq(15minute)}$ intrusive and $L_{Aeq(period)}$ amenity noise levels for various receiver areas, as well as guidelines for assessing noise impacts from on-site noise sources.

On-Site Blast Emissions

The EPA currently adopts the Australian and New Zealand Environment Conservation Council (ANZECC) "*Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration*" dated September 1990 for assessing potential annoyance from blast emissions during daytime hours.

The assessment of blast emission impacts outside the hours advocated by ANZECC remains according to the EPA's Chapter 154 Noise Control Guideline - Blasting.

British Standard BS 7385-2 1993 *"Evaluation and Measurement for Vibration in Buildings - Part 2: Guide to Damage Levels from Ground Bourne Vibration"* (BS 7385), as called up in AS 2187-2 2006 "*Explosives - Storage and Use*", provides guideline criteria for evaluating the effects of vibration on structures.

Off-site Traffic Noise

As there are no residential receivers adjacent to the access road between the Quarry and the Hume Highway, and the maximum truck movements are 16 per hour, an off-site traffic noise assessment is considered unwarranted.

2 QUARRY SITE SETTING

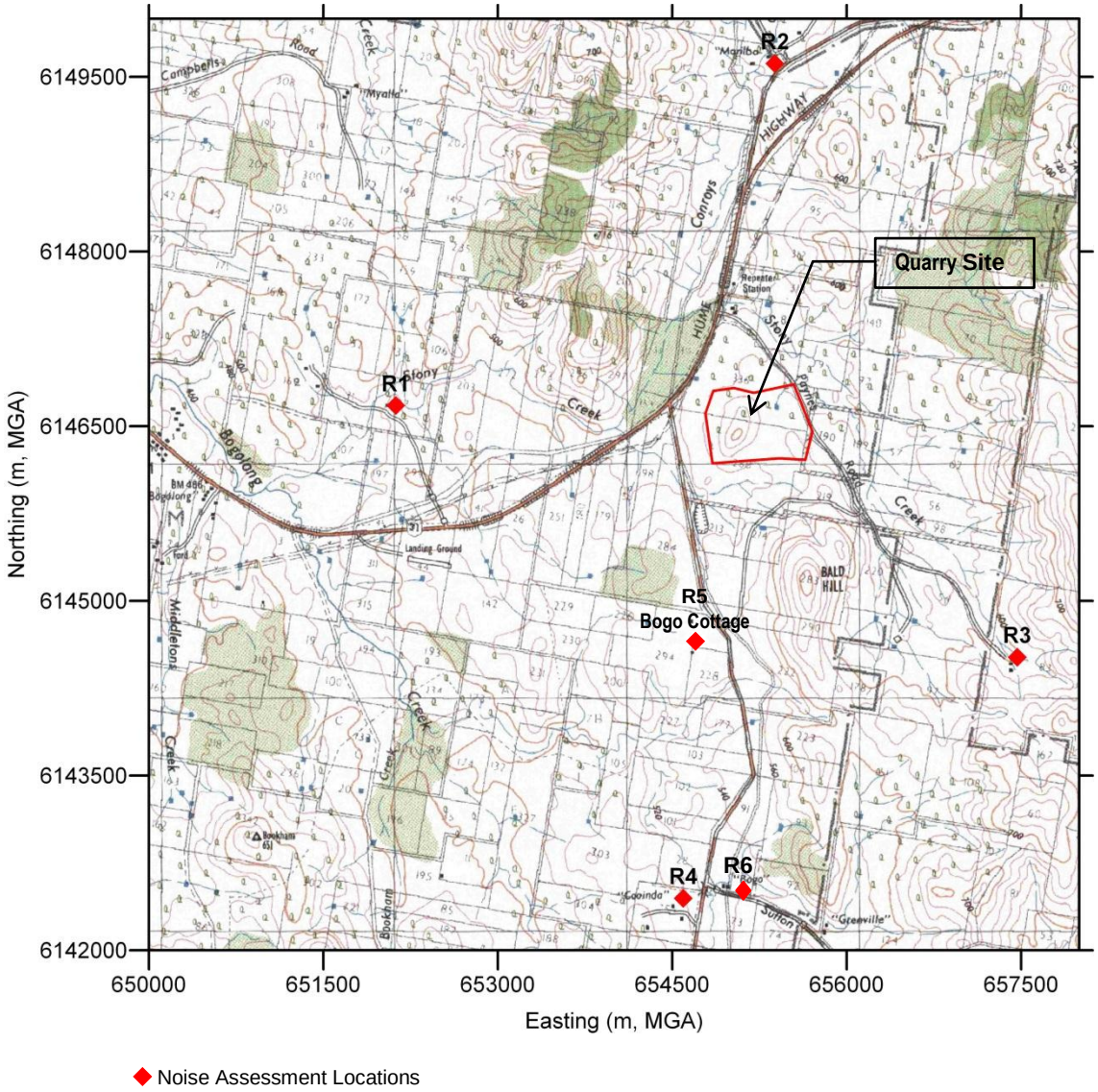
The Quarry Site is located adjacent to Paynes Road, off the Hume Highway, approximately 20km west-northwest of the town of Yass, in the Southern Tablelands region of New South Wales. The Quarry Site is situated amongst undulating terrain in rural land that is primarily agricultural including cattle and sheep grazing. A total of six non-project related residences are located within approximately 4km of the Quarry Site. The residence on the "Stoney Creek" property is deemed to be project related. The proximity of the six residences to the Quarry Site are presented in **Table 1** and these locations are illustrated on **Figure 1**.

Table 1
Nearest Non-Project Related Residential Receptors

Receptor ID	Property Name	Distance (km) / Direction from Limit of Extraction
R1	"Bogolong Cottage"	2.9 / W
R2	"Marilba"	2.9 / N
R3	Walker Property	2.9 / SE
R4	"Cooinda"	3.8 / S
R5	"Bogo Cottage"	1.4 / S
R6	"Bogo"	3.6 / S

For the purposes of this assessment, noise and vibration levels at the "Bogo" residence are considered to be comparable to those at the nearby "Cooinda" residence.

Figure 1
Nearest Non-Project Related Residential Receptors



3 NOISE IMPACT ASSESSMENT PROCEDURE

3.1 Environmental Noise Control - General Objectives

As noted in **Section 1**, the responsibility for the control of noise emission in New South Wales is vested in Local Government and the EPA. The NSW *Industrial Noise Policy* (INP), dated January 2000, provides a framework and process for deriving noise criteria for consents and licences that enables the EPA to regulate premises that are scheduled under the *Protection of the Environment Operations Act 1997.*

The specific policy objectives are to:

- establish noise criteria that would protect the community from excessive intrusive noise and preserve the amenity for specific land uses;
- use the criteria as the basis for deriving project specific noise levels;

- promote uniform methods to estimate and measure noise impacts, including a procedure for evaluating meteorological effects;
- outline a range of mitigation measures that could be used to minimise noise impacts;
- provide a formal process to guide the determination of feasible and reasonable noise limits for consents or licences that reconcile noise impacts with the economic, social and environmental considerations of the industrial development; and
- carry out functions relating to the prevention, minimisation and control of noise from the premises scheduled under the Act.

3.2 Assessing Intrusiveness

For assessing intrusiveness, the background noise generally needs to be measured. The intrusiveness criterion essentially means that the equivalent continuous noise level (L_{Aeq}) of the source should not be more than 5dBA above the measured (or default) Rating Background Level (RBL).

In relation to the default RBL, if a minimum background noise level of 30dBA is assumed as the RBL and the assessment shows no impact, then there is no need for background noise monitoring, as this represents a conservative and limiting case.

3.3 Assessing Amenity

The amenity assessment is based on noise criteria specific to the land use and associated activities. The criteria relate only to industrial-type noise and do not include road, rail or community noise. If present, the existing noise level from industry is generally measured. If it approaches the criterion value, then noise levels from new industries need to be designed so that the cumulative effect does not produce noise levels that would significantly exceed the criterion. For high-traffic areas there is a separate amenity criterion. The cumulative effect of noise from industrial sources also needs to be considered in assessing the impact.

An extract from the INP that relates to the amenity criteria is given in **Table 2**, based on the Quarry Site being located in a rural area.

Table 2
Amenity Criteria - Recommended L_{Aeq} Noise Levels from Industrial Noise Sources - Rural Land

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

Notes: For Monday to Saturday, Daytime 0700 hours - 1800 hours; Evening 1800 hours - 2200 hours; Night-time 2200 hours - 0700 hours.
On Sundays and Public Holidays, Daytime 0800 hours - 1800 hours; Evening 1800 hours - 2200 hours; Night-time 2200 hours - 0800 hours.

The L_{Aeq} index corresponds to the level of noise equivalent to the energy average of noise levels occurring over a measurement period.

3.4 INP Assessment of Prevailing Weather Conditions

Wind has the potential to increase noise at a receiver when it is light and stable and blows from the direction of the noise source. As the strength of the wind increases the noise produced by the wind will obscure noise from most industrial and transport sources.

Wind effects need to be considered when wind is a feature of the area under consideration. Where the source to receiver wind component at speeds of up to 3m/s occur for 30% or more of the time in any seasonal period (during the day, evening or night), then wind is considered to be a feature of the area and noise level predictions must be made under these conditions. The INP Section 5.3 Wind Effects states:

> *"Wind effects need to be assessed where wind is a feature of the area. Wind is considered to be a feature where source to receiver wind speeds (at 10 m height) of 3 m/s or below occur for 30 percent of the time or more in any assessment period in any season."*

In order to determine the prevailing conditions for the Quarry Site, weather data (0900 hours and 1500 hours) for the period 1 January 2001 to 16 December 2008 were obtained from the Bureau of Meteorology station at Yass (Linton Hostel), (Station No. 070091) 28km east of the Quarry Site and at equivalent elevation (520m AHD). The data was analysed in order to determine the frequency of occurrence of winds of speeds up to 3m/s in each season.

The results of the weather analysis for daytime winds are presented in **Appendix A**, in the form of a wind rose.

The wind rose indicates a maximum of 7% of wind speeds up to 3m/s (from the west). This is borne out by the analysis of the 15 minute weather data from Goulburn Airport over the period 2002 to 2006 which gives a maximum of 7% of wind speeds up to 3m/s (from the north in Autumn).

Prevailing winds of velocity less than (or equal to) 3m/s have a frequency of occurrence less than 30% and are consequently not a feature of the Quarry Site in accordance with the NSW INP.

3.5 Additional EPA Noise Assessment Information

The EPA's recommended noise assessment criteria aim to limit potential intrusive noise emissions and preserve noise amenity. In cases where the limiting noise assessment criterion (in this case $L_{Aeq(15minute)}$ intrusiveness criterion) cannot be achieved, then practicable and economically feasible noise control measures should be applied. This usually requires demonstration that Best Achievable Technology and Best Environmental Management Practices have been implemented in order to mitigate adverse acoustical impacts.

In the event that the lowest achievable noise emission levels remain above the noise assessment criteria, the potential noise impact needs to be balanced and assessed against any economic and social benefits the project may bring to the community. It then follows that where the consenting authority may consider that the development does offer community benefits, then these may be grounds for permitting achievable noise emission levels as statutory compliance levels.

4 EXISTING ACOUSTICAL ENVIRONMENT

Rather than conducting a background noise monitoring programme for the Quarry Site, a conservative approach was adopted and a background noise level of 30dBA (the INP default level) has been used to represent the background noise levels. This approach is recognised as being conservative, principally because of the existence of the Hume Highway near a number of the nearby residences. Traffic on the highway is often audible at these residences and would contribute to the background noise level. The Quarry Site specific noise emissions criteria were subsequently set with the reference to the NSW INP.

5 OPERATIONAL NOISE CRITERIA

The operational noise emission criteria have been set with reference to the INP, as outlined in **Section 3**. Establishing the operational noise criteria includes an assessment of the RBLs, the intrusiveness criteria and the amenity criteria.

The intrusiveness criteria have been set for the proposed hours of quarry operation based on the default RBL of 30dBA $L_{A90(15minute)}$ at the surrounding residences (see **Figure 1**).

The residences in the vicinity of the Quarry Site are best described by the "rural" receiver type. There being no other significant industrial noise sources in the area, the amenity criteria have been set using the recommended $L_{Aeq(period)}$ contribution from industrial noise as presented in **Table 2**.

The resulting operational intrusive and amenity noise emission criteria are given in **Table 3**.

Table 3
Operational Noise Emission Criteria - dBA 20µPa

Receiver	**Daytime and Evening - 0700 Hours to 2200 Hours / Night - 0500 Hours to 0700 Hours**	
	Intrusiveness Criterion LAeq(15minutes)	**Amenity Criterion LAeq(period)**
R1	35/35	50/40
R2	35/35	50/40
R3	35/35	50/40
R4	35/35	50/40
R5	35/35	50/40

Review of the criteria presented in **Table 3** indicates that the amenity criteria noise levels are higher than the intrusiveness criteria noise levels at all locations. Compliance with the intrusiveness criteria, therefore, will demonstrate compliance with the amenity criteria. Accordingly, the following assessment is based on the intrusiveness criteria being the controlling noise criteria.

6 BLAST EMISSIONS ASSESSMENT CRITERIA

6.1 Ground Vibration - Structural Damage

In terms of the most relevant blast vibration damage criteria, British Standard 7385:Part 2-1993 "Evaluation and Measurement for Vibration in Buildings Part 2" is a definitive standard against which the likelihood of building damage from ground vibration can be assessed. This is the Standard recommended in Australian Standard AS 2187:Part 2-2006 as the guideline values and assessment methods "are applicable to Australian conditions".

Although there is a lack of reliable data on the threshold of vibration-induced damage in buildings both in countries where national standards already exist and in the UK, BS 7385:Part 2 has been developed from an extensive review of UK data, relevant national and international documents and other published data. The standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

Sources of vibration which are considered in the standard include blasting (carried out during mineral extraction or construction excavation), demolition, piling, ground treatments (e.g. compaction), construction equipment, tunnelling, road and rail traffic and industrial machinery.

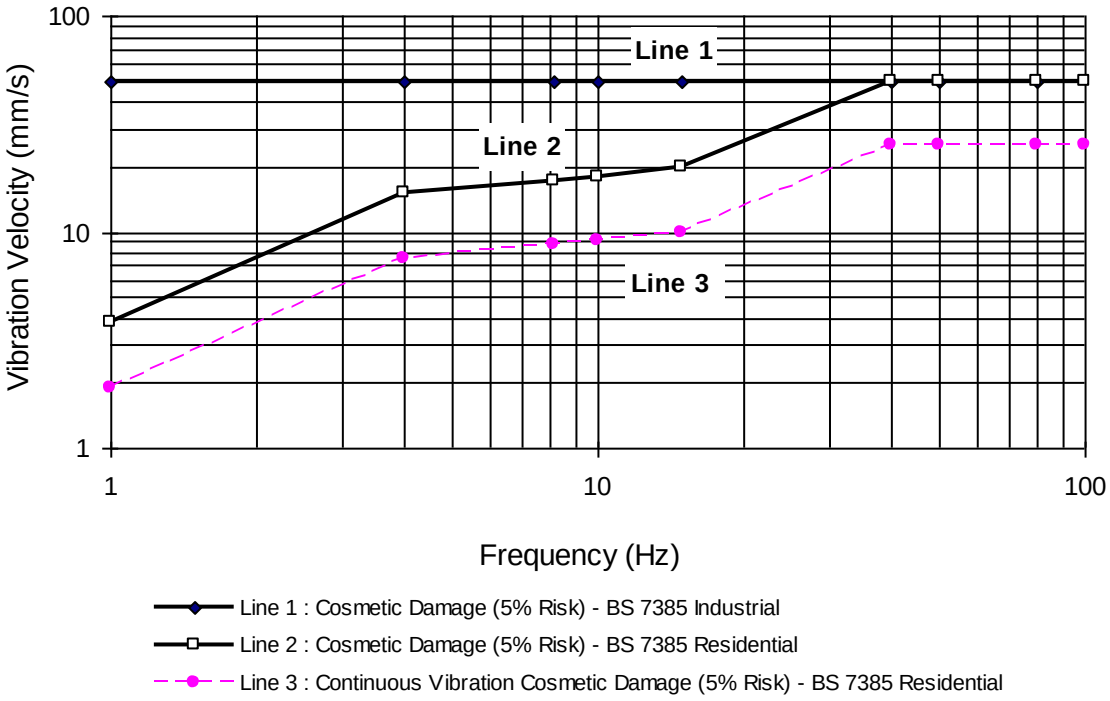
As the strain imposed on a building at the foundation level is proportional to the peak particle velocity, but is inversely proportional to the propagation velocity of the shear or compressional waves in the ground, this quantity (i.e. peak particle velocity) has been found to be the best single descriptor for correlating with case history data on the recurrence of vibration-induced damage.

The guide values from this standard for transient vibration judged to result in a minimal risk of cosmetic damage to residential buildings and industrial buildings are presented numerically in **Table 4** and graphically in **Figure 2**.

Table 4
Transient Vibration Guide Values for Cosmetic Damage

Line	Type of Building	Peak Component Particle Velocity in Frequency Range of Predominant Pulse	
		4Hz to 15Hz	**15Hz and above**
1	Reinforced or framed structures Industrial and heavy commercial buildings	50mm/s at 4Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15mm/s at 4Hz increasing to 20mm/s at 15Hz	20mm/s at 15Hz increasing to 50mm/s at 40Hz and above

Figure 2
Graph of Transient Vibration Guide Values for Cosmetic Damage



In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for the building types corresponding to Line 2 are reduced. Below a frequency of 4Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7mm/s at 1Hz.

The standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in **Table 4** and major damage to a building structure may occur at values greater than four times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in **Table 4** should not be reduced for fatigue considerations.

It is noteworthy that extra to the guide values nominated in **Table 4**, the standard states that:

> *"Some data suggests that the probability of damage tends towards zero at 12.5mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK."*

Also that:

> *"A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."*

6.2 Airblast - Structural Damage

Based largely on work carried out by the US Bureau of Mines, the US Office of Surface Mining has presented the following regulatory limits for airblast from blasting (depending on the low frequency limit of the measuring system):

Low Frequency Limit	Peak Airblast Level Limit
2Hz or lower	132dB Linear
6Hz or lower	130dB Linear

These levels are generally consistent with the level of 133dB Linear nominated in AS 2187.2-2006.

The US criteria are structural damage limits based on relationship between the level of airblast and the probability of window breakage and include a significant safety margin. It has been well documented that windows are the elements of residential buildings most at risk to damage from airblast from blasting.

While cracked plaster is the type of damage most frequently monitored in airblast complaints, research has shown that window panes fail before any other structural damage occurs (USBM, RI 8485-1980). The probabilities of damage to windows exposed to a single airblast event are as shown in **Table 5**.

Table 5
Probability of Window Damage from Airblast

Airblast dB Linear	Level kPa	Probability of Damage	Effects and Comments
140	0.2	0.01%	“No damage” - windows rattle
150	0.6	0.5%	Very occasional failure
160	2.0	20%	Substantial failures
180	20.0	95%	Almost all fail

6.3 Human Comfort and Disturbance Considerations

The ground vibration and airblast levels which cause concern or discomfort to residents are significantly lower than the damage limits. Humans are far more sensitive to some types of vibration than is commonly realised. They can detect and possibly even be annoyed at vibration levels which are well below those causing any risk of damage to a building or its contents.

The criteria recommended by the EPA for blasting in NSW, based on human discomfort, are contained in the Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines.

The ANZECC criteria for the control of blasting impacts at residences are as follows:

- The recommended maximum level for airblast is 115dB Linear.
- The level of 115dB Linear may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 120dB Linear at any time.
- The recommended maximum level for ground vibration is 5mm/s (peak particle velocity (ppv)).
- The ppv level of 5mm/s may be exceeded on up to 5% of the total number of blasts over a period of 12 months. The level should not exceed 10mm/s at any time.
- Blasting should generally only be permitted during the hours of 0900 hours to 1700 hours Monday to Saturday. Blasting should not take place on Sundays and public holidays.

7 NOISE MODELLING PROCEDURE

7.1 Prediction of Noise Emissions - General Discussion

In order to determine the acoustical impact of the increased production and additional activities at Bogo Quarry, two dimensional computer models were developed to incorporate the significant noise sources and the intervening terrain to the closest potentially affected residential properties.

The noise model was prepared using RTA Software's Environmental Noise Model (ENM for Windows, Version 3.06), a commercial software system developed in conjunction with the NSW EPA. The acoustical algorithms utilised by this software have been endorsed by the ANZECC and all State Environmental Authorities throughout Australia as representing one of the most appropriate predictive methodologies currently available.

The noise modelling takes into account source sound level emissions and locations, screening effects, receiver locations, meteorological effects, ground topography and noise attenuation due to spherical spreading and atmospheric absorption.

Noise predictions were calculated to the five nominated residential/rural receivers surrounding the Quarry Site with all the significant plant items operating concurrently in order to simulate the overall maximum energy equivalent ($L_{Aeq(15minute)}$) intrusive noise level.

The fixed plant and mobile equipment noise levels used in the Bogo Quarry noise model have been obtained from the existing SLR database. **Table 6** presents overall maximum A weighted sound power level (SWL) for each item of significant noise emitting equipment which Bogo Quarry has indicated will be used at the Quarry.

Table 6
SWLs of Fixed Plant and Mobile Equipment on the Quarry Site

Operational Scenario	Equipment	SWL L_{Aeq} (dBA)
Extraction Area	CAT D7 bulldozer on the 575m AHD bench	117
	CAT 988B FEL on the extraction floor (555m AHD)	115
	Blasthole drill (daytime only - 590m AHD)	112
Processing Area	Processing plant (555m AHD)	123
	Mobile Processing Plant	117
	Hyundai FEL loading trucks	104
	Product truck arriving site	112
	Product truck leaving site	112
	Volvo BM L120 FEL loading in a stationary truck (560m AHD)	107
Asphalt Plant	Plant operating under normal conditions (555m AHD)	115
	CAT 988B FEL on the extraction floor (555m AHD)	115
	Product truck arriving at site	112
	Product truck leaving site	112
Concrete Batching Plant	Plant operating under normal conditions (555m AHD)	111

The plant and equipment items constituting the noise modelling scenarios, the results of which are presented in **Table 7**.

Table 7
Plant and Equipment Noise Modelling Scenario

Day/Evening Calm and Summer Night Calm	All equipment listed in the extraction and processing areas plus the asphalt plant in Table 6 except the Mobile Processing Plant
Day Calm plus Mobile Processing Plant and Summer Night Calm plus Mobile Processing Plant	All equipment listed in the extraction and processing areas plus the asphalt plant in **Table 6**
Winter Night Calm and Winter Night Inversion	Product trucks, Volvo front end loader and Asphalt Plant

It should be noted that the sound power level given for each item of mobile equipment does not include noise emissions which emanate from reversing alarms. In the event that reversing alarm noise is considered to be a source of disturbance, the alarm noise level should be checked against the appropriate regulatory and health and safety requirements and the necessary mitigating action taken to achieve an acceptable noise reduction without compromising safety standards.

7.2 Meteorological Parameters

As discussed in **Section 3.4**, the frequency analysis showed that there were no prevailing winds that occurred for 30% or more during the daytime period in any season.

The INP states that temperature inversions need only be considered for the night-time noise assessment period i.e. 2200 hours to 0700 hours.

7.3 Noise Modelling Meteorology

The contributed noise emissions for the proposed operational scenarios at the nearest potentially affected residential properties have been calculated with the following meteorological parameters (refer to **Section 3.4**):

Daytime and Evening Operations (0700 hours to 2200 hours)

Calm

- During "calm" conditions (20^{o}C air temperature, 70% Relative Humidity, 0m/s wind speed and 0^{o}C/100m temperature gradient).

Night-time Operations (0500 hours to 0700 hours)

Calm - Summer

- During "calm" conditions (15^{o}C air temperature, 80% Relative Humidity, 0m/s wind speed and 0^{o}C/100m temperature gradient).

Calm - Winter

- During "calm" conditions (6^{o}C air temperature, 90% Relative Humidity, 0m/s wind speed and 0^{o}C/100m temperature gradient).

Temperature Inversion

- During "temperature inversion" conditions (6^{o}C air temperature, 90% Relative Humidity, 0m/s wind speed and 3^{o}C/100m temperature gradient).

8 NOISE IMPACT ASSESSMENT

8.1 Noise Impact Assessment - Operations

Full (concurrent) operations of the quarry will be conducted during daylight hours only. During the evening and early morning periods, outside daylight hours, operations will be restricted to product trucks, the Volvo FEL and either the asphalt plant or the concrete plant.

Based on the output from the noise model and on the noise emissions criteria presented in **Table 3**, **Table 8** presents the predicted $L_{Aeq(15minute)}$ noise level contributions from the quarrying operations together with the respective criteria.

Table 8
Daytime/Evening (0700-2200 Hours) and Night-time (0500-0700 Hours)
Noise Level Impact Assessment - dBA re 20µPa

Receiver	Predicted LAeq(15minute) Noise Level						
	Day/Evening Calm	Plus Mobile Processing Plant	Summer Night Calm	Plus Mobile Processing Plant	Winter[1] Night Calm	Winter[1] Night - Inversion 3^0C/100m	LAeq(15minute) Criterion
R1	25	26	26	26	18	30	35
R2	30	31	31	32	27	34	35
R3	29	29	29	30	22	34	35
R4	23	23	23	23	18	23	35
R5	35	36	35	35	31	36	35

Note 1: Limited operations - product trucks, Volvo loader and asphalt or concrete plant.

The results presented in **Table 8** indicate that the proposed operations will comply with the daytime/evening and night-time noise criteria at all surrounding residential receivers during calm and adverse weather conditions except at Receiver 5 with the concurrent use of the mobile processing plant during daytime calm conditions and during winter night-time (0500 hours to 0700 hours) temperature inversion conditions where, in each case, a marginal 1dBA exceedance is predicted. Given the low likelihood of this scenario occurring and the provision of a 2dBA allowance for compliance monitoring (Section 11.1.3 of the INP), this marginal exceedance is considered acceptable.

For the general case of all plant and equipment except the asphalt plant operating, compliance with the daytime/evening and night-time noise criteria is met under all the noise modelling conditions.

The occasional night-time despatch of Quarry products would also be acceptable from a noise perspective given the predicted noise levels in **Table 8**.

9 BLAST EMISSIONS IMPACT ASSESSMENT

9.1 Proposed Blasting Practices

The proposed method of material extraction below the transition is by drill and blast techniques incorporating free-face blasting. A summary of indicative blast design details is presented in **Table 9**.

Table 9
Indicative Blast Design Details

Parameter	Free-Face
Bench height	15m (typically)
Sub-drill	1m (approximately)
Stemming (using 14 mm aggregate)	3.0m
Blasthole diameter	102mm
Blasthole inclination (to vertical)	20^{o}
Blasthole spacing	3.8m
Burden	2.5m
Number of rows	3 to 5
Initiation	Non electric
Bulk explosive	ANFO
Primer	H or P - Primer
Maximum Instantaneous Charge (MIC)	136kg (for a 15m bench)

9.2 Blast Emission Levels

By adopting the nominated indicative blast design, the level of blast emissions can be predicted using the formula given in the AS 2187.2-1993 and Orica Explosives Blasting Guide, applicable to blasting to a free face in hard or highly structured rock. Also given in the Standard (and Guide) is a formula in relation to the prediction of airblast emissions. Both methods of blast emission estimation are considered conservative.

The relevant formulae are as follows:

PVS = 500 (R/Q ^0.5)^-1.6
dB = $164.2 - 24(\log_{10} R - 0.33 \log_{10} Q)$

Where,

PVS = Peak Vector Sum ground vibration level (mm/s)
dB = Peak airblast level (dB Linear)
R = Distance between charge and receiver (m)
Q = Charge mass per delay (MIC - kg)

The ground vibration and airblast criteria advocated by the EPA and ANZECC cater for the inherent variation in emission levels from a given blast design by allowing a five percent exceedance of a general criterion up to a (never to be exceeded) maximum. Correspondingly, the “5% exceedance” prediction formulae were generated for the above blast emission site laws.

The resulting 5% site laws for ground vibration and airblast are:

Ground Vibration

PVS (mm/s) (5%) = $1,435 (SD)^{-1.6}$

Airblast

SPL (dB Linear) (5%) = 173.4 -24 log (SD)

Where PVS (5%) and SPL (5%) are the levels of ground vibration (Peak Vector Sum - mm/s) and airblast (dB Linear) respectively, above which 5% of the total population (of data points) will lie, assuming that the population has the same statistical distribution as the underlying measured sample.

The relationship between distance and the peak vector sum (PVS) ground vibration and peak airblast from the quarry blasting are presented in **Figure 3** and **Figure 4** respectively for an MIC of 136kg (corresponding to firing a full 15m bench).

Figure 3
Peak Vector Sum Ground Vibration (5% Exceedance) for an MIC of 136kg

Figure 4
Peak Airblast (5% Exceedance) for an MIC of 136kg

The predicted level of blast emissions were then determined considering the closest distance of the nominated residences to the extraction area boundary. The predicted levels of Peak Vector Sum (PVS) ground vibration velocity and peak airblast at the nearest potentially affected residences to the extraction are presented in **Table 10**.

Table 10
Predicted Levels of Blast Emissions (5% Exceedance) for a 136kg MIC

Residence	Distance from Blast	PVS Ground Vibration	Peak Airblast
R1	2,890m	0.2mm/s	107dBLinear
R2	2,950m	0.2mm/s	107dBLinear
R3	2,910m	0.2mm/s	107dBLinear
R4	3,790m	0.1mm/s	105dBLinear
R5	1,450m	0.6mm/s	115dBLinear

The following information is derived from the predicted levels of blast emissions:

- The predicted levels of ground vibration at all nearby residences comply with the ANZECC general human comfort criterion (of 5mm/s) and consequently with the AS 2187-2006 (BS 7385) structural damage criterion of 15mm/s (at 4Hz).
- The maximum predicted ground vibration level of 0.6mm/s occurs at Receiver R5 for an MIC of 136kg (corresponding to firing a full 15m bench).
- The predicted levels of peak airblast at all residences comply with the ANZECC general human comfort criterion of 115dB Linear and consequently with the ANZECC's maximum human comfort criterion of 120dB Linear.
- The maximum predicted peak airblast level of 115dB Linear occurs at Receiver R5 for an MIC of 136kg (corresponding to a full 15m bench).
- The predicted levels of peak airblast are clearly well below the US Bureau of Mines damage limit of 132dB Linear.

Notwithstanding the above, it is recommended that all blasts are monitored at the closest/potentially most affected residence in order to establish, and to progressively update, blast emissions site laws (ground vibration and airblast) in order to optimise future blast designs, based on actual site conditions. In this way, the site laws can be used to assist with the blast designs in order to ensure compliance with the ANZECC criteria is met.

By adopting this approach, in conjunction with the inevitable future introduction of improved blasting products, it is anticipated that the blast emissions criteria can be met without imposing any significant constraints on the blast designs throughout the life of the quarry.

10 NOISE MANAGEMENT AND CONTROL

The INP states that the project specific criteria derived in accordance with the policy have been designed to protect at least 90% of the population living in the vicinity of industrial noise sources from the adverse effects of noise for at least 90% of the time. Provided the criteria in the INP are achieved, it is unlikely that most people would consider the resultant noise levels excessive.

In those cases where the INP project specific assessment criteria are not achieved, it does not automatically follow that all people exposed to the noise would find the noise unacceptable. In subjective terms, exceedances of the INP project specific assessment criteria can be generally described as follows:

- Negligible noise level increase of <1dBA (not noticeable by all people).

- Marginal noise level increase of 1dBA to 2dBA (not noticeable by most people).
- Moderate noise level increase of 3dBA to 5dBA (not noticeable by some people but may be noticeable by others).
- Appreciable noise level increase of >5dBA (noticeable by most people).

In view of the foregoing, exceedances of ≤5dBA above project specific criteria may not be noticeable by some people and are therefore assessed as falling within a "noise management zone", i.e. noise levels are able to be managed such that these are acceptable to the affected person. Exceedances of ≥5dB above project specific criteria are likely to be noticed by most people and would therefore be considered unacceptable. Noise levels ≥5dB above project specific criteria are assessed as falling within a "noise acquisition zone", i.e. without mitigation to reduce noise levels, acquisition of the affected residence is the most suitable option.

Noise Control

The proposal would require the use of additional equipment, i.e. mobile asphalt plant, mobile concrete batching plant and associated mobile equipment, and would potentially operate this and existing equipment for longer periods of time. In order to mitigate against potential exceedance, the Applicant would implement the following noise mitigation measures, operational controls and safeguards.

- All mobile equipment would be fitted with standard muffling apparatus and mid-frequency modulated reversing alarms.
- Whenever possible, stockpiles would be constructed and maintained within the processing areas such that they provide an acoustic barrier to the noise generating activities undertaken within the processing area, i.e. operation of the front-end loader, loading of the feed hopper, loading and unloading of trucks.
- Whenever possible, all night loading of product trucks would occur in areas shielded by product stockpiles.
- Internal roads would be maintained to minimise truck noise.
- Noise-generating activities would be restricted to the nominated hours of operation.
- Equipment with lower sound power levels would be used in preference to similar equipment with higher sound power levels.
- Regular maintenance of all equipment would be undertaken.

Dialogue with neighbours would be maintained in order to ensure any concerns over operational noise are addressed. In addition, the Applicant has adopted a complaints management protocol such that in the event a community compliant is received, a swift response would be initiated. Central to the protocol would be the requirement for a verbal response to the complainant with 24 hours (during the nominated hours of operation) confirming the source of the noise and mitigation measures proposed (or underway) to reduce the risk of future elevated noise levels. The complaints protocol has been developed as required by EPL 4219.

Recommended Noise Compliance Limits

In accordance with the procedures described in the INP, initial consultation should be undertaken with the EPA in relation to the setting of achievable noise limits for the Proposal.

11 SUMMARY OF RESULTS AND FINDINGS

This report presents the results and findings of an assessment of the potential impacts of the proposed ongoing operations of the Bogo Quarry, located approximately 20km west-northwest of Yass, NSW.

From the default background noise level established in accordance with the INP (refer to **Section 3.1**), the daytime/evening (0700 hours to 2200 hours) and night-time (0500 hours to 0700 hours) intrusive noise level criteria at the potentially most affected residences were established.

In relation to the operational noise impact assessment conducted for this project, compliance with operational $L_{Aeq(15minute)}$ intrusive noise criteria would also result in compliance with the $L_{Aeq(period)}$ amenity criteria. The controlling noise criterion is therefore the intrusive criterion.

Review of the data presented in **Table 7** indicates that the predicted daytime/evening and night-time noise levels comply with the intrusive (and amenity) noise assessment criteria under both the calm and adverse weather conditions modelled at all nearby receivers except at Receiver R5 with the concurrent use of the mobile processing plant during daytime/evening calm conditions and during winter night-time (0500 hours to 0700 hours) temperature inversion conditions where, in each case, a marginal 1dBA exceedance is predicted.

It is therefore concluded that, based on the predicted noise levels, the operation of the Bogo Quarry would have a negligible noise impact at the nearest residences.

For the general case of all plant and equipment except the asphalt plant operating compliance with the daytime/evening and night-time noise criteria is met under all the noise modelling conditions.

The predicted levels of blast emissions were determined using the appropriate distances to the nearest boundary of the extraction area. The predicted (5% exceedance) levels of Peak Vector Sum (PVS) ground vibration velocity and peak airblast at the nearest potentially affected properties to the quarry blasting were conducted for the proposed maximum MIC of 136kg.

The following information is derived from the predicted levels of blast emissions:

- The predicted levels of ground vibration at all nearby residences comply with the ANZECC general human comfort criterion (of 5mm/s) and consequently with the ANZECC maximum human comfort criterion as well as the BS 7385 structural damage criterion of 15mm/s (at 4Hz).
- The maximum predicted ground vibration level of 0.6mm/s occurs at Receiver R5 for an MIC of 136kg (corresponding to blasting a full height 15m bench).
- The predicted levels of peak airblast at all residences comply with the ANZECC general human comfort criterion of 115dB Linear and consequently with the ANZECC maximum human comfort criterion.
- The maximum predicted peak airblast level of 114dB Linear occurs at Receiver R5 for an MIC of 136kg (corresponding to a full 15m bench).
- The predicted levels of peak airblast are clearly well below the US Bureau of Mines damage limit of 132dB Linear (2Hz cut off) at all residences.

Notwithstanding the above, it is recommended that all blasts are monitored at the closest/potentially most affected residence, in order to establish compliance with the nominated criteria and to progressively update the blast emissions site laws (ground vibration and airblast) in order to optimise future blast designs, based on actual site conditions. In this way, the site laws can be used to assist with the blast designs in order to ensure compliance with the ANZECC criteria are met at all nearby residences.

By adopting this approach, in conjunction with the inevitable future introduction of improved blasting products, it is anticipated that the blast emissions criteria can be met without imposing any significant constraints on the blast designs throughout the life of the quarry.

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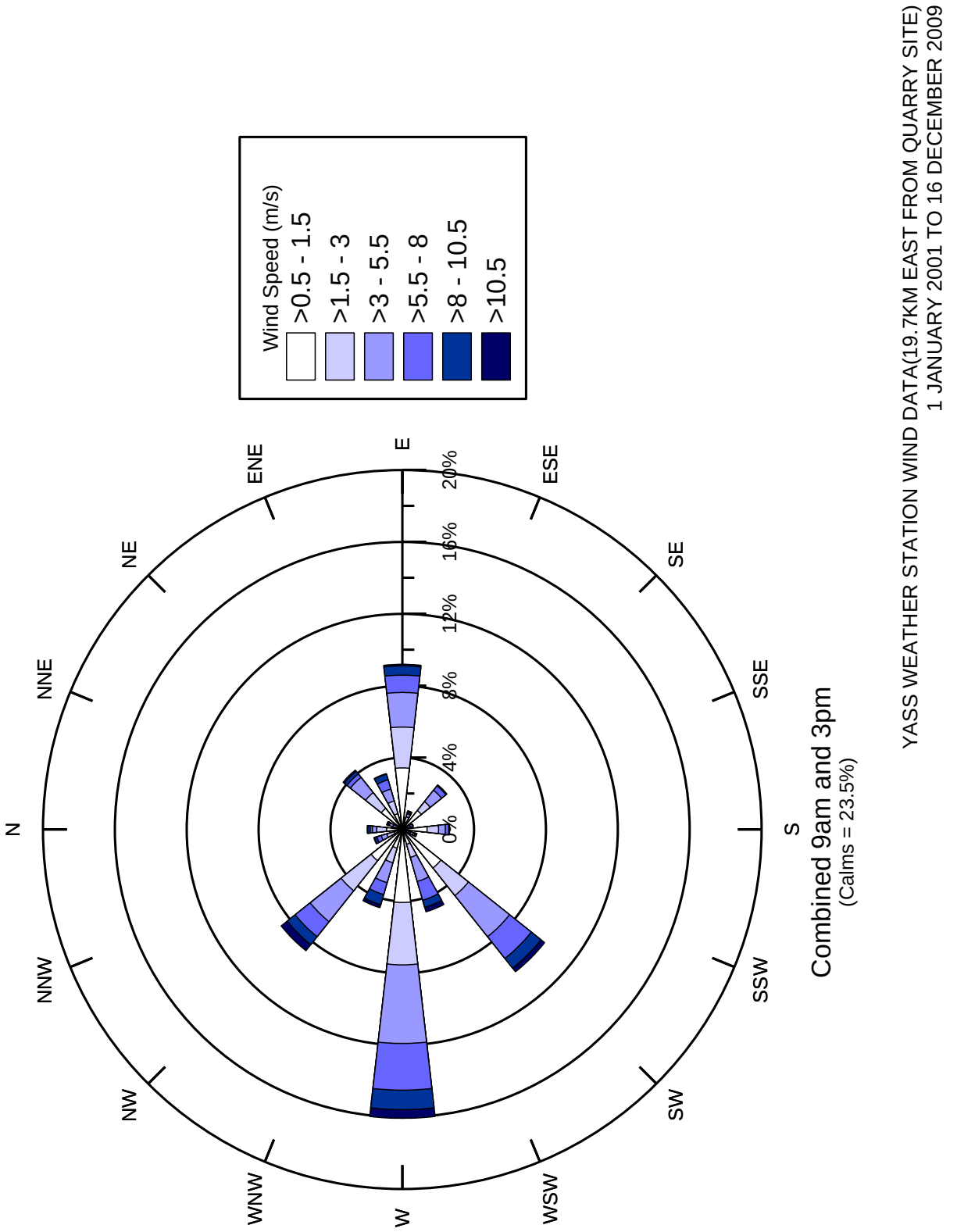
Appendix A

Yass Weather Station Wind Data (19.7km east from Quarry Site)
1 January 2001 to 16 December 2009

(No. of pages excluding this page = 1)


YASS WEATHER STATION WIND DATA(19.7KM EAST FROM QUARRY SITE)
1 JANUARY 2001 TO 16 DECEMBER 2009
Combined 9am and 3pm
(Calms = 23.5%)
Wind Speed (m/s)
>0.5 - 1.5
>1.5 - 3
>3 - 5.5
>5.5 - 8
>8 - 10.5
>10.5
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
0%
4%
8%
12%
16%
20%