Appendix 6

Noise and Vibration Impact Assessment

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Project No: 151080

Noise and Vibration Impact Assessment
Possum Brush Quarry Stage 2 and Modification
Possum Brush, NSW

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1.0 - INTRODUCTION

This report provides the results and findings of a noise and vibration impact assessment (NVIA) for Stage 2 of the Possum Brush Quarry operated by Pacific Blue Metal (PBM) at Possum Brush, via Nabiac NSW.

The Possum Brush Quarry has been in operation since the mid 1980s. The current assessment is to support an application for the modification of the existing Development Consent to allow for the second stage of operations of the Quarry for the next 30 years as well as increasing average and maximum production levels ("the Proposal").

Site details have been obtained from on-ground inspections and also with reference to local topographic maps, site aerial photographs and Google Earth.

This NVIA has been undertaken to form part of an Environmental Assessment (EA) for the Proposal.

2.0 - BACKGROUND TO THE PROPOSAL

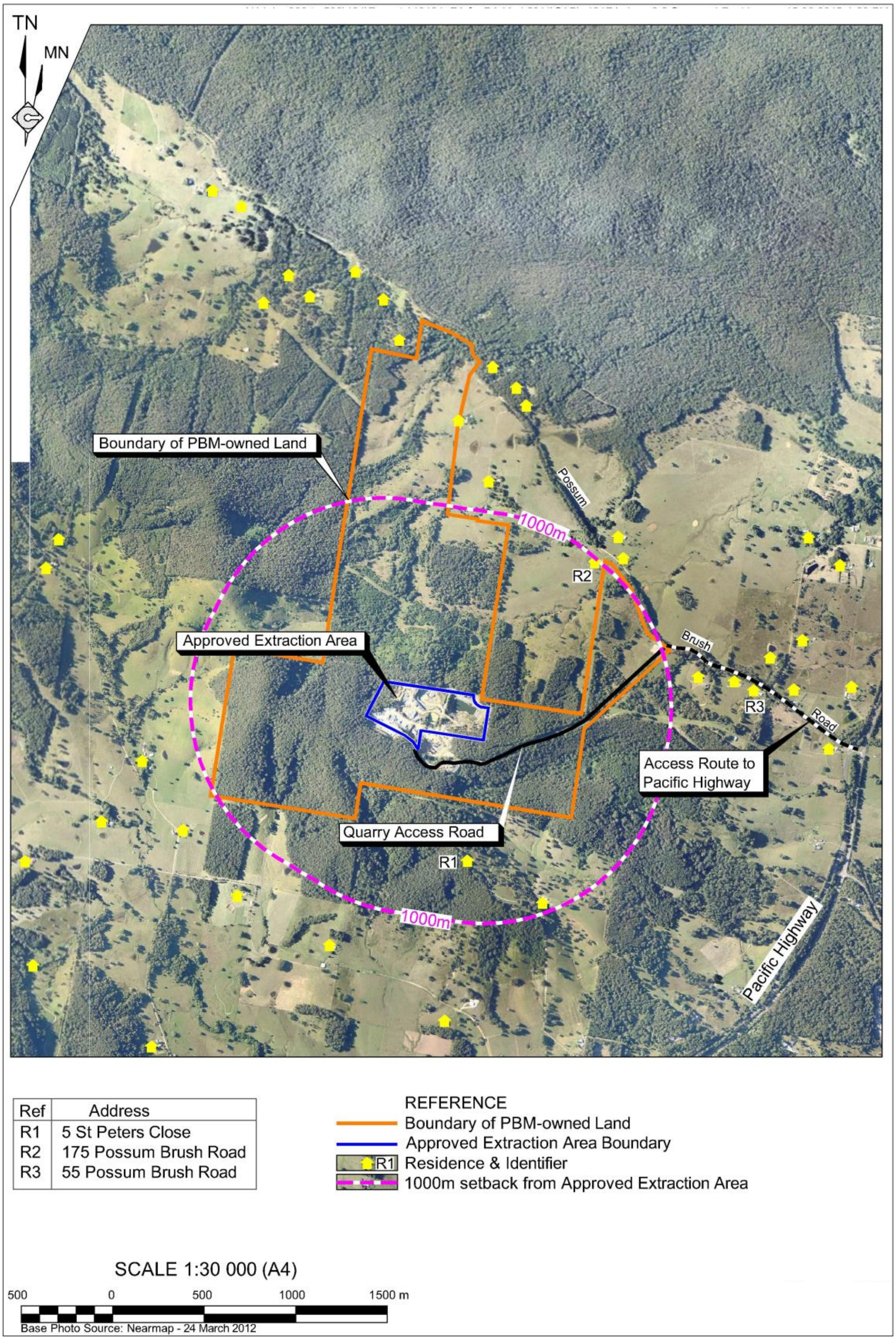
The Possum Brush Quarry has produced between approximately 125 000t and 350 000t of crushed aggregate products per annum between 1998 and 2015. The objective in modifying the existing Development Consent for the Quarry is to continue to recover the available resource within the approved extraction area.

The proposal to obtain consent for Stage 2 of the Quarry operation for a further 30 years would also involve an increase in production levels to a maximum of 500 000tpa and an average rate of 370 000tpa.

The location of the Possum Brush Quarry, including the approved extraction area, and nearby rural-residential receivers is shown in **Figure 1**.

Extraction operations will continue to be undertaken in both select material/weathered rock and fresh rock. All extraction will be undertaken by either ripping with excavators and bulldozers or drill and blast followed by load and haul.

Each blast will, typically, generate between 15 000t and 35 000t of fragmented rock, with approximately 15 blasts initiated in one year. Broken and fragmented rock suitable for processing is transported to the on-site processing plant by off-road haul trucks. All oversize rock is either sold as armour rock or transported to protected parts of the extraction area for size reduction using a hydraulic hammer.



Ref	Address
R1	5 St Peters Close
R2	175 Possum Brush Road
R3	55 Possum Brush Road

Figure 1 **– Site Location**

Processing of extracted material will be undertaken at the processing plant which incorporates crushing and screening machinery and a state-of-the-art pugmill/wetmix plant. Processing is proposed to take place throughout six days per week, typically starting at 6:30am and concluding at or before 6:00pm on a weekday and typically starting at 7:00am and concluding at or before 3:00pm on a Saturday, public holidays excluded.

The on-site asphalt plant, which commenced production in December 2008, will continue to service a range of local infrastructure projects.

Details of the mobile and fixed plant and equipment proposed for the Quarry are shown in **Table 1**.

TABLE 1
Mobile and Fixed Plant and Equipment

Equipment	No.	Usage	Frequency of Use
Bulldozer – (Cat D9 to D10 or similar)	1	Ripping weathered rock and stockpiling.	Continuous
Hydraulic drill rig	1	Drilling blast holes.	Monthly (approx.)
Excavator (30 - 85t)	1	Loading ripped and blasted rock.	Continuous
Excavator (30 - 50t)	1	Hydraulic hammering and loading oversize rock.	As required
Haul Truck (40t)	3	Transporting ripped and blasted rock to the processing area.	Continuous
Front-end Loader – (Cat 980 or similar)	4	Stockpiling and loading product trucks and pug mill.	Continuous
Water cart	1	Watering of haul roads.	As required
Crusher and Screens	1	Four stage crusher(s) for sizing of quarried material.	Continuous
Asphalt plant	1	Asphalt production.	Campaign

Product material would typically be transported off site using truck and dog vehicles with a maximum of up to 33t capacity. A number of the small capacity trucks with a 12t to 18t payload would also transport products from the Quarry for local users. Overall, the average load transported from the Quarry is approximately 26 tonnes.

All product trucks travel to and from the Pacific Highway via the Quarry Access Road and Possum Brush Road. The Quarry Access Road is a two lane, asphaltic cement road with a 40km/hr speed limit which has been designed and constructed to accommodate truck and dog configurations. PBM maintains the Quarry Access Road to a high standard, with signposts along its length highlighting to drivers the speed limit, upcoming corners and a requirement to limit compression braking.

The bulk of construction materials will continue to be despatched to Pacific Highway upgrades and local Council projects. Gabion and oversize rock would also be sold for use as rock lining/armouring.

Traffic levels associated with product deliveries from PBM reflect sales of the various products from the Quarry. On a busy day when the asphalt plant, pugmill/wetmix plant and crushing and screening plant are all operating concurrently, up to 24 loads of products are despatched hourly and sometimes in excess of 200 loads are despatched daily. Conversely, on days of limited sales, less than 30 truck loads are despatched daily.

3.0 - DESCRIPTION OF TERMS

This section of the report aims to convey an understanding of several commonly used acoustical terms to the lay reader. Various terms are explained in clear language and the effects of certain atmospheric phenomena on noise propagation are discussed. Noise level percentiles are explained with the aid of a diagram of a hypothetical noise signal.

The descriptions in this section are not formal definitions of the terms. Formal definitions may be found in AS1633-1985 "Acoustics – Glossary of terms and related symbols".

3.1 General Terms

Sound Power Level

The amount of acoustic energy (per second) emitted by a noise source. Usually written as "Lw" or "SWL", the Sound Power Level is expressed in decibels (dB) and cannot be directly measured. Lw is usually calculated from a measured sound pressure level.

Sound pressure Level

The "Noise Level", in decibels (dB), heard by our ears and/or measured with a sound level meter. Written as "SPL", the sound pressure level generally decreases with increasing distance from a source. Noise levels are often written as dB(A) rather than dB. The "A-weighting" is a correction applied to the measured noise signal to approximate the response of the human ear.

Neutral Atmospheric Conditions

An atmosphere that is at a temperature of approximately 23^{o}C from ground level to an altitude of 200m or more. There are no fluctuations in density or water vapour content and no wind. Such conditions rarely occur, as temperature will usually vary with altitude and there is always movement in various directions in different layers of the atmosphere.

Prevailing Atmospheric Conditions

Atmospheric conditions (with regards to potential effects on noise propagation) which are characteristic of the study area. These will typically include seasonal wind directions and velocities.

3.2 Noise Level Percentiles

A noise level percentile (Ln) is the noise level (SPL) in decibels which is exceeded for "n" % of a given monitoring period. Several important Ln percentiles will be explained by considering the hypothetical time signal in **Figure 2**.

The signal in **Figure 2** has a duration of 2.5 minutes (i.e. 150 seconds) with noises occurring as follows:

- The person holding the instrument is standing beside a road and hears crickets in nearby grass at a level of around 60 dB (A);
- At about the 30 second mark a motorcycle passes on the road, followed by a car;
- At 60 seconds a truck passes;
- After the truck passes it sounds its air horn at the 73 second mark;
- The crickets are frightened into silence and the truck fades into the distance;
- All is quiet until 105 seconds when the crickets slowly start to make noise, reaching full pitch by 120 seconds;
- The measurement stops at 150 seconds, just when an approaching car starts to become audible.

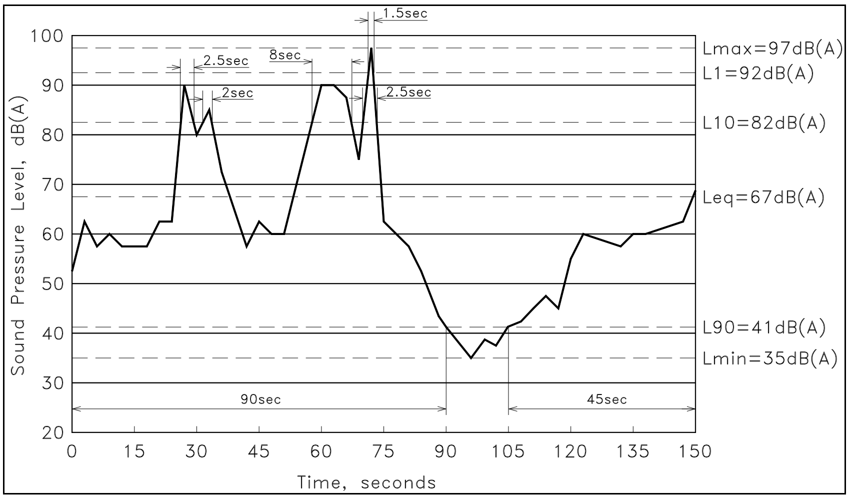


Figure 2 **– Hypothetical time-trace of 150-second sound signal.**

L1 Noise Level

Near the top of **Figure 2**, there is a dashed line at 92dB(A). A small spike of 1.5 sec duration extends above this line at around 73 seconds.

As 1.5 sec is 1% of the signal duration (150 seconds) we say that the L1 noise level of this sample is 92dB(A). The L1 percentile is often called the *average peak noise level* and is used by the Office of Environment and Heritage (OEH) as a measure of potential disturbance to sleep.

L10 Noise Level

The dashed line at 82 dB(A) is exceeded for four periods of duration 2.5 sec, 2 sec, 8 sec and 2.5 sec, respectively. The total of these is 15 sec, which is 10% of the total sample period. Therefore, the L10 noise level of this sample is 82 dB(A). The L10 percentile is called the *average maximum noise level* and has been widely used as an indicator of annoyance caused by noise.

L90 Noise Level

In similar fashion to L1 and L10, **Figure 2** shows that the noise level of 41 dB(A) is exceeded for 135 seconds (90 + 45 =135). As this is 90% of the total sample period, the L90 noise level of this sample is 41dB(A). The L90 percentile is called the *background noise level*.

Leq Noise Level

Equivalent continuous noise level. As the name suggests, the Leq of a fluctuating signal is the continuous noise level which, if occurring for the duration of the signal, would deliver equivalent acoustic energy to the actual signal. Leq can be thought of as a kind of ‘average’ noise level. Recent research suggests that Leq is the best indicator of annoyance caused by industrial noise and the *NSW Industrial Noise Policy* (INP) takes this into consideration.

Lmax and Lmin Noise Levels

These are the maximum and minimum SPL values occurring during the sample. Reference to **Figure 2** shows these values to be 97dB(A) and 35dB(A), respectively.

4.0 - THE EXISTING ENVIRONMENT AND NOISE CRITERIA

4.1 Existing Noise Sources

The principal noise source in the vicinity of the Quarry is traffic travelling on the Pacific Highway. Other noise sources include traffic on local roads, agricultural equipment, equipment used on rural-residential properties, stock and birds and wind in trees.

4.2 Meteorology

Procedures in the INP require the assessment of prevailing atmospheric conditions. These are defined as source to receiver winds, at speeds up to 3m/s, that occur for more than 30% of the time in any assessment period (day, evening or night) in any season and temperature inversions that occur for more than 30% of the night time in winter. Temperature inversions need only be considered for night time operations (i.e. between 10 pm and 7 am)

To assess regional weather patterns data from a 12 month period were analysed from the closest available full time weather stations at Taree Airport.

Data from the weather station showed that winds at speeds up to 3m/s from the west-northwest occur for more than 30% of the time during the evening and night in winter and during the evening in autumn. For the consideration of a worst case, a wind from the west-northwest was modelled for all time periods. No other winds were found to occur for more than 30% of the time and, therefore, only neutral atmospheric and default temperature inversion conditions were modelled.

In addition to the above, the following points are the most significant with respect to noise propagation and have been included in the noise model:

- Extremes of relative humidity (RH) are rarely experienced. For modelling purposes, a value of 70% RH was adopted.
- It is anticipated that temperature inversions are a prevailing site feature at night in winter. A default value of +3°/100m vertical temperature gradient has been adopted for modelling purposes (for those operations prior to 7 am).
- The topography of the area surrounding the site is sloping and the Quarry is at a higher elevation than the nearest residences to the north and northeast. To assess the worst case, a 1m/s drainage wind from the southwest associated with a temperature inversion was modelled. There is a high ridge to the south and southwest of the Quarry and, therefore, drainage winds in those directions are not considered.

Assessment of operational noise was conducted using RTA Technologies Environmental Noise Model (ENM) v3.06. Calculations were undertaken for the atmospheric conditions described in **Section 5.3**.

4.3 Background Noise Levels and Operational Criteria

The Quarry currently operates under a set of noise criteria as detailed in Environment Protection Licence (EPL) no. 3393 as shown in **Table 2**

TABLE 2
Noise Limits from EPL 3393 as dB(A)

Location	L_{eq} (15 min)	Lmax
Receiver 1 – 5 St Peters Close	39	45
Receiver 2 – 175 Possum Brush Road	38	45
Receiver 3 – 55 Possum Brush Road	37	45

These noise criteria have been derived from noise modelling results presented in a noise compliance assessment undertaken by Heggies Pty Ltd in April 2010 (Rpt No. 30-2492R1D1). The receivers listed are the closest to the Quarry and the most potentially affected by noise emissions from its operation.

The Heggies assessment modelled noise levels as a result of the typical operation of the Quarry and asphalt plant during the day, evening and night. As part of the assessment, Heggies undertook long term noise logging at each of the locations listed. The results of the noise logging are shown in **Table 3**.

TABLE 3
Measured Ambient Noise Levels (Heggies 2010)as dB(A)

Receiver	Day		Evening		Night	
	L90	Leq	L90	Leq	L90	Leq
1. 5 St Peters Close	35	43	38	44	37	44
2. 175 Possum Brush Road	35	52	41	51	37	55
3. 55 Possum Brush Road	41	51	44	51	41	47

As part of this assessment, current, ambient noise levels were measured at the same three receiver locations as previous. In August and September 2015 ARL type EL 215 noise loggers were deployed at Receiver R1 between 3 and 10 September and at Receivers R2 and R3 between 17 and 24 August, 2015.

The measured ambient noise levels from the loggers are shown below in **Table 4 and graphically in Annexure 1**.

TABLE 4
Measured Ambient Noise Levels (Spectrum Acoustics 2015) as dB(A)

Receiver	Day		Evening		Night	
	L90	Leq	L90	Leq	L90	Leq
1. 5 St Peters Close	33	46	33	48	31	48
2. 175 Possum Brush Road	32	52	33	45	29	41
3. 55 Possum Brush Road	38	51	40	47	32	51

Based on the measured ambient noise levels, the Project Specific Noise Levels for each location, derived in accordance with the procedures in the INP, would be as shown in **Table 5**.

TABLE 5
Project Specific Noise Levels (Based on measured noise levels) as dB(A)

Receiver	Day	Evening	Night
	Leq (15 min)	Leq (15 min)	Leq (15 min)
1. 5 St Peters Close	38	38	36
2. 175 Possum Brush Road	37	37[1]	35
3. 55 Possum Brush Road	43	43[1]	37

1. PSNG for evening and night cannot be higher than day (per INP)

4.4 Sleep Disturbance

Based on the measured night time background noise levels, the sleep disturbance criterion for each monitoring location is detailed in **Table 6**.

TABLE 6
Sleep Disturbance Criteria as dB(A)

Receiver	Night L1 (1 min)
1. 5 St Peters Close	46
2. 175 Possum Brush Road	47
3. 55 Possum Brush Road	45

4.5 Vehicle Noise

In NSW, noise from vehicle movements associated with an industrial source is assessed in terms of the INP if the vehicles are not on a public road. If the vehicles are on a public road, the NSW Road Noise Policy (RNP) applies.

As vehicles transporting Quarry products will travel on private roads (on site) and on public roads, noise from the proposal must be assessed against the project specific noise goals of the INP and also the criteria in the RNP.

4.6 Public Road Traffic

The RNP recommends various criteria for different road developments and uses.

The number of heavy vehicle movements generated by the Quarry per day, and the ultimate direction of travel of those vehicles, will vary depending on the end user of the Quarry product.

Traffic generated by the current proposal will travel along the site access road, onto Possum Brush Road, and from there to the Pacific Highway.

Possum Brush Road is regarded as a local road and the Pacific Highway is an arterial road in accordance with the definitions in the INP.
An extract of **Table 3** from the RNP relating to applicable noise criteria for land use developments with the potential to create traffic on local and arterial roads is shown in **Table 7**.

TABLE 7
Base Traffic Noise Objectives as dB(A)

Situation	Recommended Criteria	
	Day - (7am - 10pm)	Night (10pm – 7am)
3. Existing residences affected by additional traffic on existing freeway/arterial/sub-arterial roads generated by land use developments	60 Leq(15hr) External	55 Leq (9 hr) External
6. Existing residences affected by additional traffic on existing local roads generated by land use developments	55 Leq(1hr) External	50 Leq (1 hr) External

4.7 Blasting Criteria

4.7.1 Annoyance Criteria

Noise and vibration levels from blasting are assessable against criteria proposed by the Australian and New Zealand Environment and Conservation Council (ANZECC) in their publication *"Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration – September 1990"*. These criteria are summarised as follows:

- The recommended maximum overpressure level for blasting is 115 dB(Linear) or dB(L);
- The level of 115 dB(L) may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 120 dB(L) at any time;

- The recommended maximum vibration velocity for blasting is 5 mm/s Peak Vector Sum (PVS);
- The PVS level of 5 mm/s may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 10 mm/s at any time;
- Blasting should generally only be permitted during the hours of 9 am to 5 pm Monday to Saturday[1], and should not take place on Sundays and Public Holidays; and
- Blasting should generally take place no more than once per day.

4.7.2 Building Damage Criteria

Building damage assessment criteria are nominated in AS 2187.2-1993 *"Explosives – Storage, Transport and Use. Part 2: Use of Explosives"* and summarised in **Table 8**.

TABLE 8
Blasting Criteria to Limit Damage to Buildings (AS 2187)

Building Type	Vibration Level (mm/s)	Airblast Level (dB re 20 μPa)
Sensitive (and Heritage)	5	133
Residential	10	133
Commercial/Industrial	25	133

The annoyance (ANZECC) criteria are more stringent than the building damage criteria and will be taken as the governing criteria for the Quarry.

[1] Note: EPL 3393 currently restricts blasting to 9am-3pm Monday to Friday.

5.0 – METHODOLOGY

5.1 Overview of Quarrying Operations

As described previously, Quarrying would continue to be undertaken by ripping (using dozers and excavators) and by drill and blast methods. The extracted material would be crushed and screened at the on-site processing facility.

Products would be transported from the Quarry by highway-registered trucks.

5.2 Noise Sources

The sound power level spectra (Lw) of each of the modelled operational noise sources are shown in **Table 9**. As per convention spectral data are presented as unweighted (linear) decibel levels and the total is A-weighted.

TABLE 9
Modelled Lws and Frequency Spectra of Major Noise Sources
(as Leq 15 min)

Item	Frequency (Hz)									
	dB(A)	31.5	63	125	250	500	1k	2k	4k	8k
Cat D9 Dozer	114	95	112	118	109	111	108	108	102	95
Cat 980 FEL	107	110	113	109	106	103	101	98	94	90
85t Excavator	112	106	100	107	103	103	101	99	96	93
Water Cart	99	102	104	96	91	90	94	95	87	81
40t Haul Truck	103	97	100	96	100	100	100	96	91	83
Drill Rig	119	109	101	108	99	104	106	112	115	112
Road Truck	99	88	94	97	97	93	91	86	81	68
Crusher	114	108	125	120	111	111	109	106	102	95
Asphalt Plant	106	101	115	108	105	103	101	98	94	87

The noise sources in **Table 9** relate to both fixed and mobile plant. Over a typical 15 minute period (assessment period), the noise emissions from many of the sources would vary over time and also in relation to individual receivers. That is, mobile equipment moves around and also works at various operating levels throughout any 15 minute period.

The 15 minute Leq noise level for a Cat D9 dozer, for example, was taken from the Spectrum Acoustics technical database. The measured level shown represents a full 15 minute cycle of a dozer working on a stockpile pushing and reversing in second gear. The calculated Leq 15 minute Lw, as used in the ENM model, is that shown in **Table 9**. This is approximately 5dB(A) lower than the maximum Leq Lw for a dozer.

Similarly, the 15 minute Leq Lw for a Cat 980 Front end Loader (FEL) shown in **Table 9** (and used in the modelling) was calculated from measurements of an FEL working in and around a stockpile, loading a hopper for a full 15 minute period.

Other mobile equipment, such as the water cart, for example, has a maximum Lw of 108 dB(A), but as the vehicle is in constant movement around the site the 15 minute Leq Lw used in the modelling represents a point noise source for a water cart at the modelled location, and producing maximum Lw, for 2 minutes out of a 15 minute assessment period.

Similarly, the three haul trucks will move about throughout any 15 minute period. For the modelling, the haul trucks were considered to be three separate point noise sources producing maximum Lw, for 2 minutes out of a 15 minute assessment period. The modelled Lw of each truck is 103 dB(A) Leq (15 min).

At peak production, there may be up to 500 product truck movements per day with a maximum rate of 48 per hour, or 12 in a 15 minute assessment period. That is, typically, six trucks in and six trucks out in each 15 minute period.

To assess a worst case, six point noise sources representing road trucks were modelled at various locations along the Quarry Access Road and loading areas. Each "product truck" was considered to be at its modelled location for two minutes out of a 15 minute assessment period, therefore producing the Leq (15 min) Lw as shown in **Table 9**. This was considered to represent of one truck entering and one truck leaving the site at the modelled location during a single 15 minute period.

To consider the worst case the excavator, drill rig, crusher and asphalt plant were all considered to be producing the maximum sound power level for the entire 15 minute assessment period.

5.3 Noise Modelling

Assessment of operational noise was conducted using RTA Technologies Environmental Noise Model (ENM) v3.06. Each of the noise sources shown in **Table 9** was considered to be in a typical operating location and operating at the indicated sound levels for a 15 minute period.

The noise source locations within and adjacent to the extraction area are shown in **Figure 3** and detailed below.

OPERATIONAL SCENARIO: Annual Production – 500 000 tonnes

Noise Sources

- Haul truck (HT1) (40t) laden, approaching the hopper at 143m AHD.
- Haul truck (HT2) (40t) laden, transferring material from Area B at 128m AHD.
- Haul truck (HT3) (40t) laden, transferring product to stockpile at 145m AHD.
- Drill Rig (DR) drilling in preparation for blast at 135m AHD.
- Excavator (Ex1) (85t) loading ripped and blasted rock into haul trucks in Area B at 120m AHD.
- Excavator (Ex2) (85t) hydraulically hammering oversize rock in Area A at 90m AHD.
- Excavator (Ex3) (85t) loading oversize rock into haul trucks in Area B at 120m AHD.
- Water Cart (WC) undertaking dust suppression on internal haul road at 135m AHD.
- Front-end loader (Fel1) (Cat 980) feeding pugmill at 135m AHD.
- Front-end loader (Fel2) (Cat 980) loading product to trucks at 135m AHD.
- Front-end loader (Fel3) (Cat 980) loading product to trucks at 150m AHD.
- Bulldozer (BD) (Cat D10) ripping weathered rock at 120m AHD.
- Six incoming and outgoing road trucks, assigned locations at even distances along the access road, at elevations between 40 m and 170 m AHD (Note road trucks are not drawn in **Figure 3** – Noise source locations)

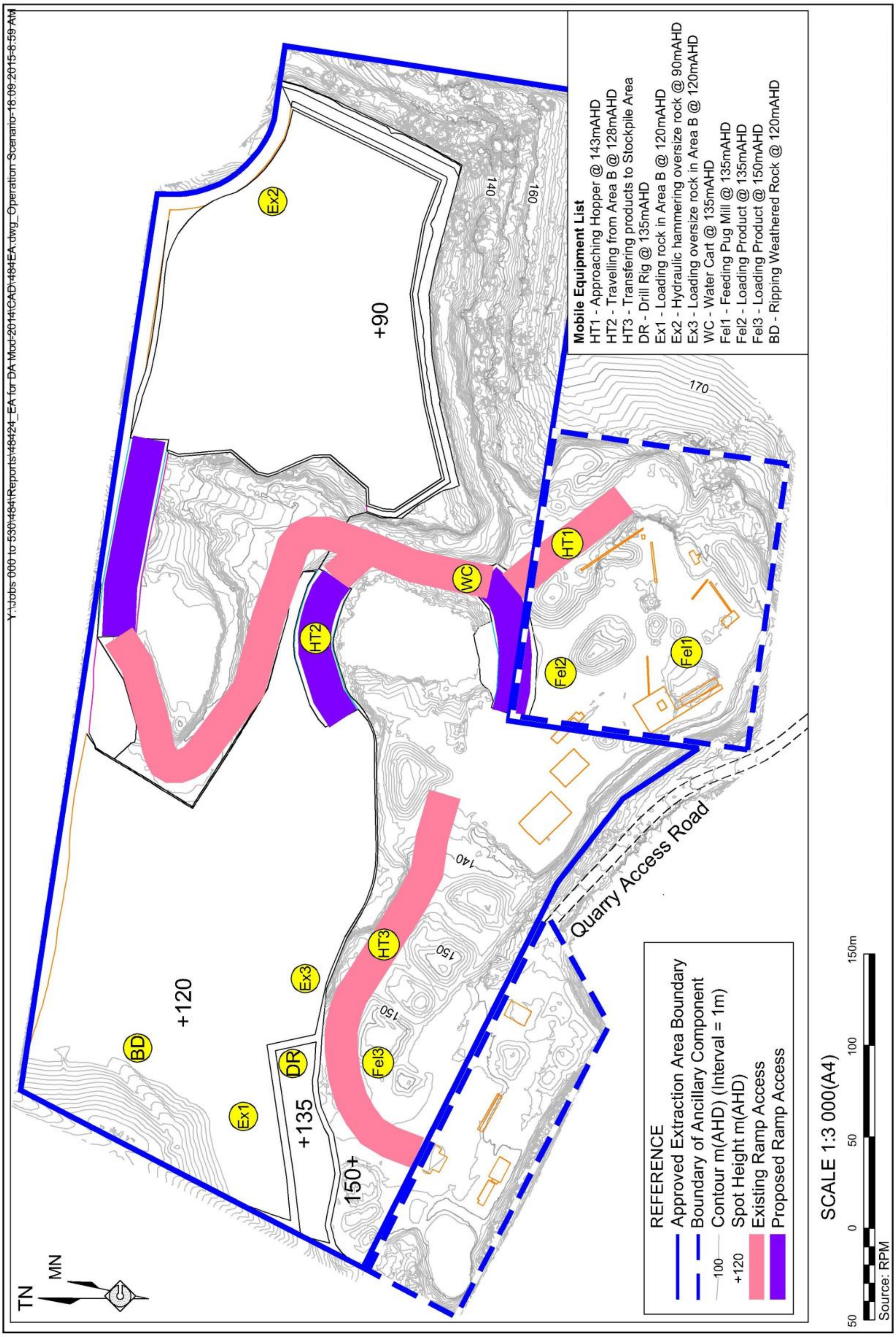
The modelling was undertaken for the atmospheric conditions described below:

Scenario 1 **-** 20^{0}C, 70% R.H., calm conditions (neutral atmospheric).

Scenario 2 - 20^{0}C, 70% R.H., 3m/s wind from 292.5° (WNW wind, prevailing atmospheric), and

Scenario 3 – 10^{0}C, 70% R.H., +3°/100m temperature gradient (temperature inversion) and 1m/s wind from the south west.

Figure 3 **– Noise Source Locations**



5.3.1 Sleep Disturbance

The main potential for maximum noise events at night will come from impact noises as trucks are loaded.

The Lw as L1 (1 min) noise level from a truck being loaded by a front end loader, as taken from the Spectrum Acoustics technical database, is shown below in **Table 10**.

TABLE 10
Maximum Sound Power Level as dB(A) L1 (1 min)

		Octave Band Centre Frequency (Hz)							
Item	dB(A)	63	125	250	500	1K	2K	4K	8K
Impact Noise	118	86	92	99	102	109	114	114	108

5.4 Public Road Traffic

Heavy vehicles will continue to be used to transport products from the Quarry. In relation to noise from heavy vehicles, there are many methods available for calculating the cumulative noise impact arising from intermittent signals of various shapes.

The methodology employed in this section was sourced from the commonly accepted US Environmental Protection Agency document No. 550/9-74-004 "Information on Levels of Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974". The document refers to 'triangular' and 'trapezoidal' time signals, which are illustrated in **Figure 4**.

A triangular time signal rises from the background level to a peak noise level and then immediately begins to subside. A trapezoidal time signal rises from the background level to a maximum level and sustains that level for a period of time before subsiding.

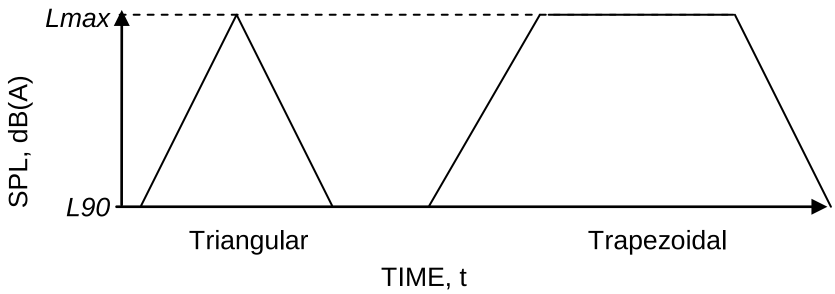


Figure 4 **– Triangular and Trapezoidal Time Signals**

A triangular time signal is a good approximation to the SPL signal of a car or truck as it passes an observation point. The value of Leq,T for a series of identical triangular time patterns having a maximum level of Lmax is given by **Equation 1.**

$$L_{eq},T = L_b + 10\log\left[1+\frac{ND}{T}\left(\frac{10^{(L\max - Lb)/10} - 1}{2.3} - \frac{(L_{\max} - L_b)}{10}\right)\right] \quad \textbf{(1)}$$

where,

L_{max} = maximum vehicle noise at residence, dB(A)
L_b = existing Leq noise level, dB(A)
T = assessment period (minutes)
D = duration of noise from each vehicle (minutes)
N = number of vehicle trips during assessment period

As detailed earlier in this report, vehicles on the Quarry site or internal access road are considered site noise whilst those on public roads are assessed separately.

The heavy vehicles on site and on the internal access road were included as noise sources in the model of operational noise (as described previously).

For the assessment of noise from vehicles on public roads, the calculated Lws of a number of trucks (both laden and unladen) transporting Quarry products were sourced from the Spectrum Acoustics technical database. The L90 of the calculated Lws from various measurements was used in **Equation 1**.

Received noise was calculated on the basis of half of the vehicles being in the near lane of traffic and half in the far lane, with the total being the log addition of the two levels.

Based on the criteria shown in **Table 7**, the traffic noise assessment has been undertaken to calculate the minimum distance a receiver must be from the centre of traffic to achieve compliance with the noise criteria for a freeway/arterial road.

5.5 Blast Impact Assessment Procedure

Each proposed blast would be designed to fragment between approximately 15 000 and 35 000 tonnes of material. This would equate to approximately 15 blasts per year or just over one production blast per month. A number of smaller, development, blasts may also occur to restructure areas for rehabilitation or to prepare areas for production blasts.

Typical hydraulic blast hole rigs would be utilised drilling holes of approximately 102mm diameter, charging the holes with explosive and firing shots using non-electric detonators with appropriate delays to control airblast overpressure and ground vibration.

The following sections provide standard equations for predicting blast overpressure and ground vibration levels, sourced from the United States Bureau of Mines.

5.5.1 Blast Overpressure

Unweighted airblast overpressure levels (OP) are predicted from **Equation 2** below.

$$OP = 165 - 24(\log_{10}(D) - 0.3 \log_{10}(Q)), dB \qquad \textbf{(2)}$$

where *D* is distance from the blast to the assessment point (m) and
Q is the weight of explosive per delay (kg).

5.5.2 Blast Vibration

The basic equations for calculation of peak particle vibration (PPV) levels from blasting are as follows:

$$PPV = 1140\left(\frac{D}{Q^{0.5}}\right)^{-1.6}, \text{ mm/s} \quad \text{(for average ground type)} \qquad \textbf{(3)}$$

$$PPV = 500\left(\frac{D}{Q^{0.5}}\right)^{-1.6}, \text{ mm/s} \quad \text{(for hard rock)} \qquad \textbf{(4)}$$

where *D* and *Q* are defined as in **Equation 2**.

A coefficient value of 1 000 has been used in **Equation 4** to approximate typical ground conditions in the blast vibration calculations.

6.0 - RESULTS

6.1 Operational Noise

Noise levels were modelled using ENM for the operational and each of the atmospheric scenarios described in Section 5.3.

The ENM noise model was utilised in point calculation mode to determine the actual predicted noise level at the three closest receivers to the Quarry (see **Figure 1**). The results of the point calculations for each of the modelled atmospheric conditions are shown in **Table 11**.

TABLE 11
ENM Point Calculation Results (dB(A) Leq (15 min))

Location	Modelled Atmospheric Conditions			
	Scenario 1	Scenario 2	Scenario 3	Criterion
1. 5 St Peters Close	31	36	35	38/38/36
2. 175 Possum Brush Road	32	33	35	37/37/35
3. 55 Possum Brush Road	35	37	37	43/43/37

The results in **Table 11** show that, under the assessed conditions, there will be no exceedance of noise criteria in any time period as a result of the modelled noise emissions from the Quarry.

It should be noted that whilst the Quarry may operate during any of the day, evening or night time periods, the operational scenario assessed is a worst case for noise generation and is only ever likely to occur during the day time period. At other times, the operation of the Quarry would likely be on a reduced scale with resultant lower noise emission levels.

The noise modelling is conducted to consider the worst case for the operation of the Quarry. That is, with the Quarry operating at maximum capacity, including six trucks on the access road and three on site in any one 15 minute period, and the atmospheric conditions as detailed. Regular noise monitoring is undertaken for the Quarry and, by necessity, this must be done under the actual operating conditions at the time and the prevailing atmospheric conditions.

Noise monitoring for the Quarry has consistently measured noise emissions from the Quarry that are below the limits in the EPL.

As detailed in Section 4.3, these noise limits in the EPL have been derived from noise modelling results presented in a noise compliance assessment undertaken by Heggies Pty Ltd in April 2010 (Rpt No. 30-2492R1D1). The current noise model reflects the configuration and proposed worst case operating conditions at the time of this EA.

To provide some validation for the model, additional noise modelling was undertaken to compare measured noise levels with modelled levels under similar atmospheric conditions.

Recent noise monitoring was undertaken for the Quarry during the morning of May 15, 2015. At the time, conditions were cool and clear with a light breeze at 0.5m/s from the west.

The noise model was configured and run under similar atmospheric conditions. The results of the monitoring and modelling are shown in **Table 12**.

TABLE 12
Modelled and Measured Noise Levels
dB(A) leq (15 min)

Receiver	Modelled Noise	Measured Noise
1. 5 St Peters Close	27	22
2. 175 Possum Brush Road	30	26
3. 55 Possum Brush Road	34	31

The results in Table 12 show an apparent disparity between the modelled and measured results. As discussed previously, however, the model is set up for maximum operating conditions at the Quarry (to assess the worst case). This includes a maximum rate of truck movements in a 15 minute period.

Analysis of the modelled results shows that the most significant contributor to the received noise at Locations 1 and 3 is emissions from trucks on the access road. At Location 2, the received noise is influenced by the emissions from truck on the access road and also the modelled drill rig.

At Location 1, the modelled noise from the truck noise source at the top of the access road contributed 24.5 dB(A) to the overall received level. As described, this is a noise source representing six truck movements with the source at the site effectively for two minutes (in a 15 minute assessment period). The measurement included noise from one truck only. Removing the modelled truck noise at the top of the access road from the results (and leaving the noise from all other sources) leaves a total received noise of 23 dB(A). This is within 1 dB(A) of the measured level and, therefore, confirms the validity of the model for this location.

At Location 2, the modelled noise from a drill rig contributed 24.1 dB(A) to the overall received level. At the time of the measurements there was no drilling underway. Removing the noise from the drill from the modelled results (and leaving the noise from all other sources) leaves a total received noise of 28 dB(A). This is within 2 dB(A) of the measured level and, therefore, confirms that the model gives a conservative prediction at this location.

At Location 3, the modelled noise from a truck at the entrance to the access road contributed 31 dB(A) to the overall level. Removing this from the modelled results (and leaving the noise from all other sources) leaves a total received noise of 30 dB(A). This is within 1 dB(A) of the measured level and, therefore, confirms its validity for this location.

6.1.1 Sleep Disturbance

To determine potential sleep disturbance impacts a noise source representing an impact from a truck being loaded was modelled at the most exposed location at 150m AHD as shown for FEL 3 in **Figure 3**. The modelling was undertaken for the assumed temperature inversion conditions.

The results of the noise modelling are shown in **Table 13**.

TABLE 13
Modelled Sleep Disturbance Noise Level as dB(A)

Receiver	Night L1 (1 min)
1. 5 St Peters Close	22
2. 175 Possum Brush Road	20
3. 55 Possum Brush Road	18

The results in **Table 13** show that there will be no exceedance of the sleep disturbance criterion as a result of the assessed impact noise.

6.2 Public Road Traffic

The nearest residence to Possum Brush Road is approximately 25m from the centre of traffic travelling on that road. The nearest residence to the Pacific Highway was assumed to be 30m from the centre of traffic.

Calculations were performed using Equation 1 (Section 5.4) to determine the maximum number of heavy vehicle movements, associated with the Quarry, that could travel on these roads and still be in compliance with the relevant criteria from **Table 7**.

For the calculations it was assumed that heavy vehicles on the Pacific Highway were travelling at an average speed of 80 kph, with a theoretical receiver at 30m from the centre of traffic. The results of this calculation are shown in **Table 14**.

The noise criterion for an arterial road is based on an Leq (15 hr) noise level. As the heavy vehicle movements will, typically, be travelled over an 11.5 hour period, to consider a worst case, only this time period has been assessed.

TABLE 14
Road Traffic Noise – Pacific Highway

	Day
Typical Operating Sound Power, @ 80 km/h dB(A)	110
Distance Loss to Receiver (30m) dB(A)	37
Received Maximum Noise dB(A)	73
Traffic Volume, (vehicles/11.5hrs)	500
Time each vehicle audible at 80 km/h (mins)	0.08
Background Noise Level dB(A)	35
Calculated Traffic Noise, dB(A)(Leq 11.5 hr)	60
Criterion dB(A) (Leq 15 hr)	60

Table 14 shows that traffic noise levels will be below the day time criterion for an arterial road, under the assessed conditions, provided there are no more than 500 heavy vehicles from the Quarry in 11.5 hours travelling on the Pacific Highway.

For the calculations, it was assumed that heavy vehicles on Possum Brush Road were travelling at an average speed of 50 kph, with a the closest receiver being 25m from the centre of the road. The results of this calculation are shown in **Table 15**.

The noise criterion for a local road is based on an Leq (1 hr) noise level.

TABLE 15
Road Traffic Noise – Possum Brush Road
Day

	Day
Typical Operating Sound Power, @ 50 km/h dB(A)	105
Distance Loss to Receiver (25m) dB(A)	36
Received Maximum Noise dB(A)	71
Traffic Volume, (vehicles per hour)	36
Time each vehicle audible at 50 km/h (mins)	0.18
Background Noise Level dB(A)	35
Calculated Traffic Noise, dB(A)(Leq 1hr)	55
Criterion dB(A) (Leq 1 hr - Day)	55

Table 15 shows that traffic noise levels will be below the day time criterion for a local road, under the assessed conditions, provided there are no more than 36 heavy vehicles from the Quarry in 1 hour, during the day, travelling on the Possum Brush Road.

As the Quarry regularly operates from 6.30am **Table 16** shows the calculation of traffic noise on Possum Brush Road at night (i.e. before 7am).

TABLE 16
Road Traffic Noise – Possum Brush Road
Night

	Night
Typical Operating Sound Power, @ 50 km/h dB(A)	105
Distance Loss to Receiver (25m) dB(A)	36
Received Maximum Noise dB(A)	71
Traffic Volume, (vehicles per hour)	10
Time each vehicle audible at 50 km/h (mins)	0.18
Background Noise Level dB(A)	35
Calculated Traffic Noise, dB(A)(Leq 1hr)	50
Criterion dB(A) (Leq 1 hr - Night)	50

The results in **Table 15** show that traffic noise levels will be below the night time criterion for a local road, under the assessed conditions, provided there are no more than 10 heavy vehicles from the Quarry during the period from 6:30am to 7:00am, travelling on the Possum Brush Road.

The results in **Tables 14, 15** and **16** are based on measured noise levels taken from the Spectrum Acoustics technical database. The measurements are of trucks travelling on public and private roads and include a mixture of road configurations including where vehicles were travelling up and down hill and slowing to turn, then accelerating away etc.

As such, the results are the theoretical calculated noise levels considered applicable to the majority of conditions and scenarios that may be encountered on the transport route. In reality, road conditions may vary from those modelled due to specific localised circumstances. Examples may include long straight stretches of road, or sections of particularly steep gradient. Road conditions may also vary over time due to deterioration or maintenance.

The calculations also assume a full line of sight of the road (through approximately 135°) and do not allow for the shielding effects of intervening structures or topography (such as where the road is in cut).

As a result, the received noise levels may differ slightly from those shown in the tables, however, this variation would not significantly affect the conclusions in this report.

6.3 Blast Impact Predictions

The nearest residence to the extraction area where blasting is conducted is approximately 700m to the south and 1 000m to the north. Substituting various representative distances and an MIC of 280 kg, to approximate a worst case, into **Equations 2** and 4 gives the following resultant overpressure and vibration impacts at surrounding areas as shown in **Table 17**.

TABLE 17
Predicted Blast Noise and Vibration Levels

Distance	PPV (mm/s)	OP dB Linear
800m	1.0	114
1 000m	0.7	112
1 500m	0.4	108
2 000m	0.2	105

The results in **Table 17** show that received noise and vibration levels from typical blasting operations will not exceed the relevant criteria at the nearest receivers. As all other receivers are more distant from the Quarry, further assessment of impacts at these receivers is not considered warranted.

Blasting at the Quarry has been monitored since 1998. The majority of the monitoring was undertaken at a location within the Quarry boundary. This is closer to the blasts than any residence.

An analysis of the results of monitoring of 123 blasts showed the ground vibration exceedance was not exceeded at any time (worst case being 2.63 mm/s). The airblast overpressure criterion was marginally exceeded on one occasion in 1998-1999. The measured airblast overpressure was 116.1dB As described, this was measured at the Quarry boundary and not at a residence. Since 1999, the noise criterion has not been exceeded.

In 2013, six blasts were monitored at both 5 St. Peters Close and 175 Possum Brush Road. Neither the airblast or ground vibration criteria were exceeded for any of these blasts.

7.0 – CONCLUSION

7.1 Operational Noise

The results of the modelling of Quarry operational noise have shown that, for the assessed scenarios, there will be no exceedance of the adopted day time noise criterion at any residential receivers.

7.1.1 Sleep Disturbance

The results of the modelling of impact noise have shown that there will be no exceedance of the sleep disturbance criterion at any receivers.

7.2 Public Road Traffic

The results of the road traffic noise assessment have determined that up to 500 heavy vehicles from the Quarry can travel on the Pacific Highway during the day time period (11.5 hrs) before the relevant noise criterion is exceeded. Similarly, up to 36 heavy vehicles per hour, from the Quarry, can travel on Possum Brush Road during the day and be in compliance with the relevant noise criterion for such a road. At night up to 10 heavy vehicle per hour can travel on Possum Brush Road and be in compliance with the relevant criterion.
Quarry.

7.3 Blast Impact Predictions

Predicted received noise and vibration levels as a result of blasting at the Quarry were shown to be below the relevant criteria at all residential receivers.

8.0 - REFERENCES

Road Traffic Noise

EPA, 2000. NSW Industrial Noise Policy, Sydney.

Annexure 1

Ambient Noise Level Measurements

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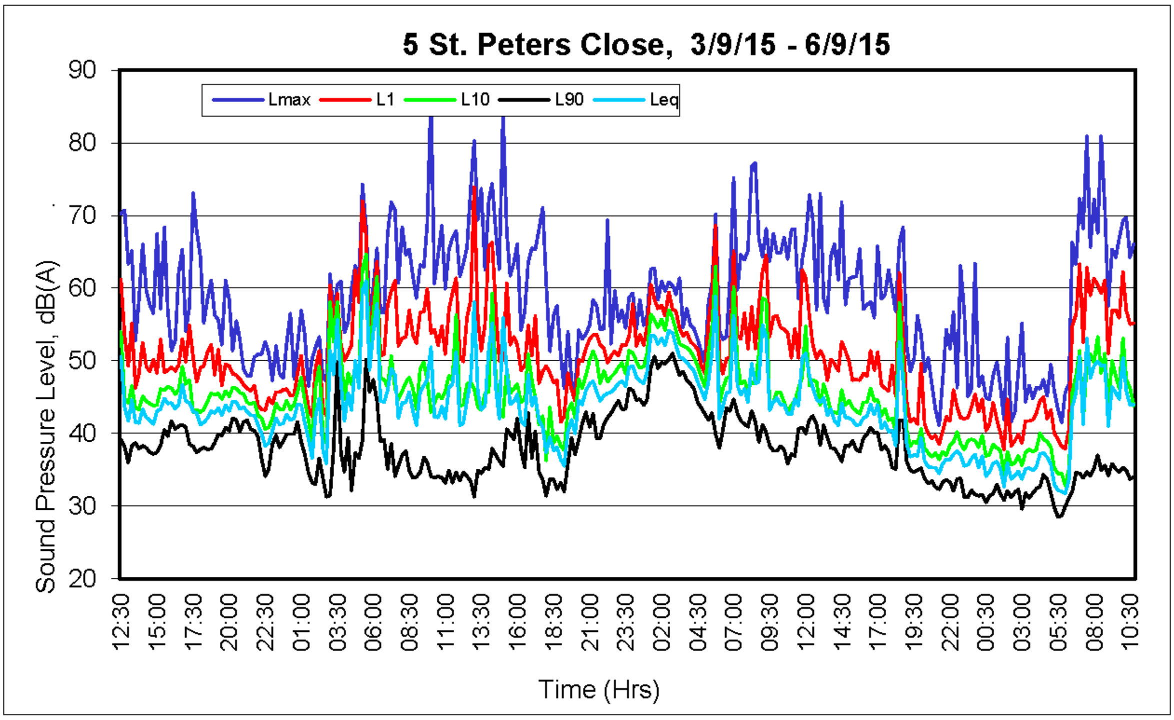
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L1
L10
L90
Leq
Sound Pressure Level, dB(A)
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80
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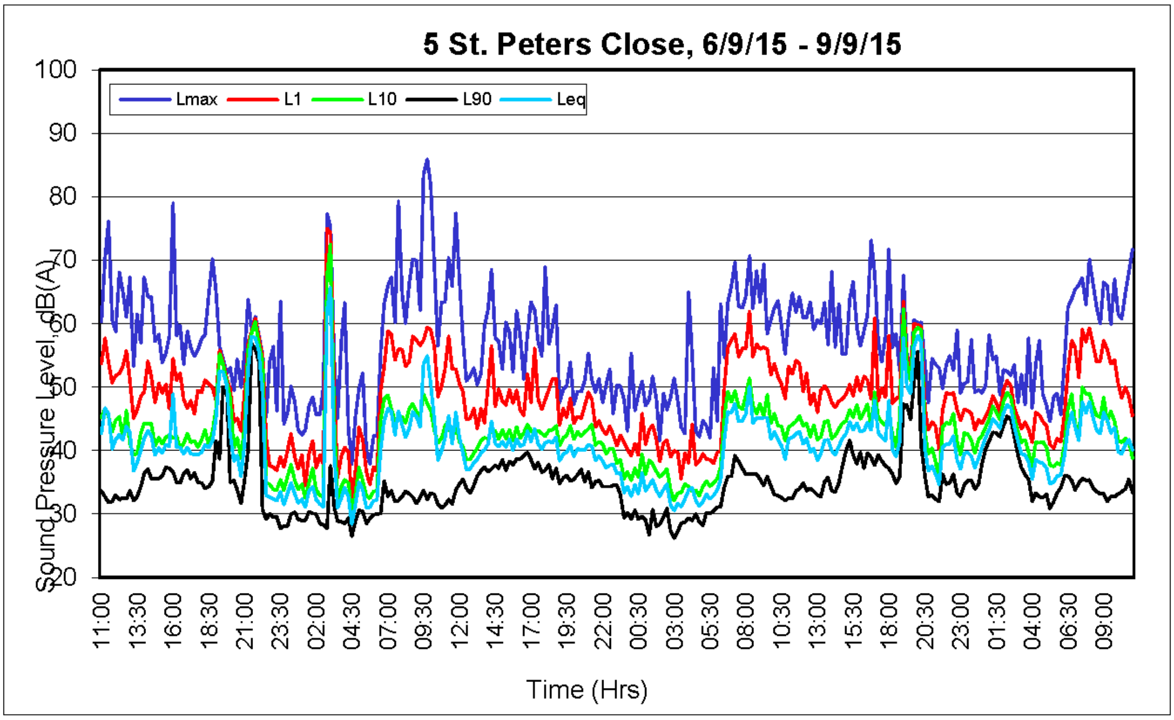
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L1
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Sound Pressure Level, dB(A)
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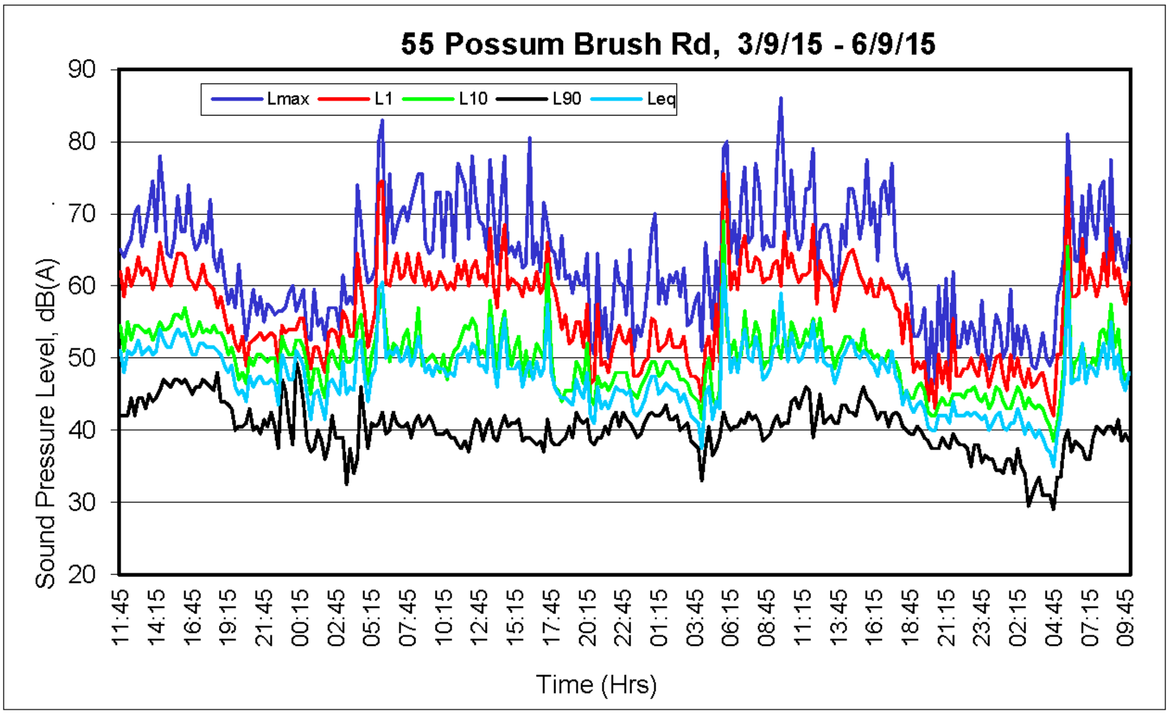
Time (Hrs)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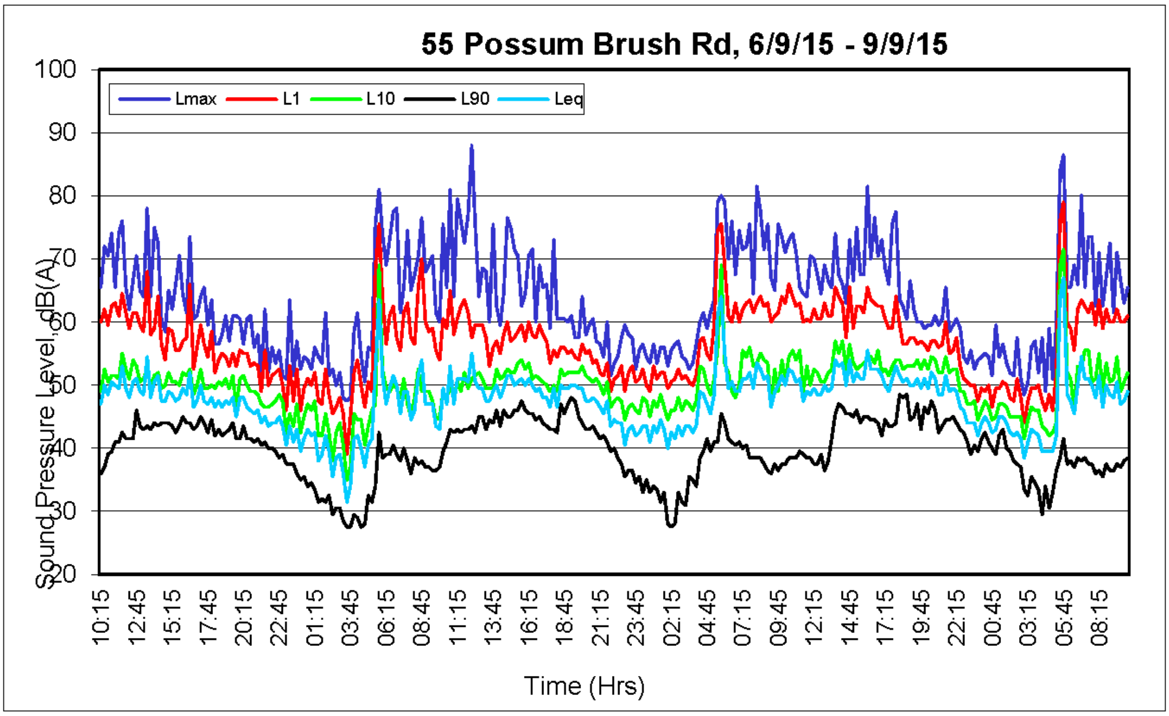
Lmax
L1
L10
L90
Leq
Sound Pressure Level, dB(A)
Time (Hrs)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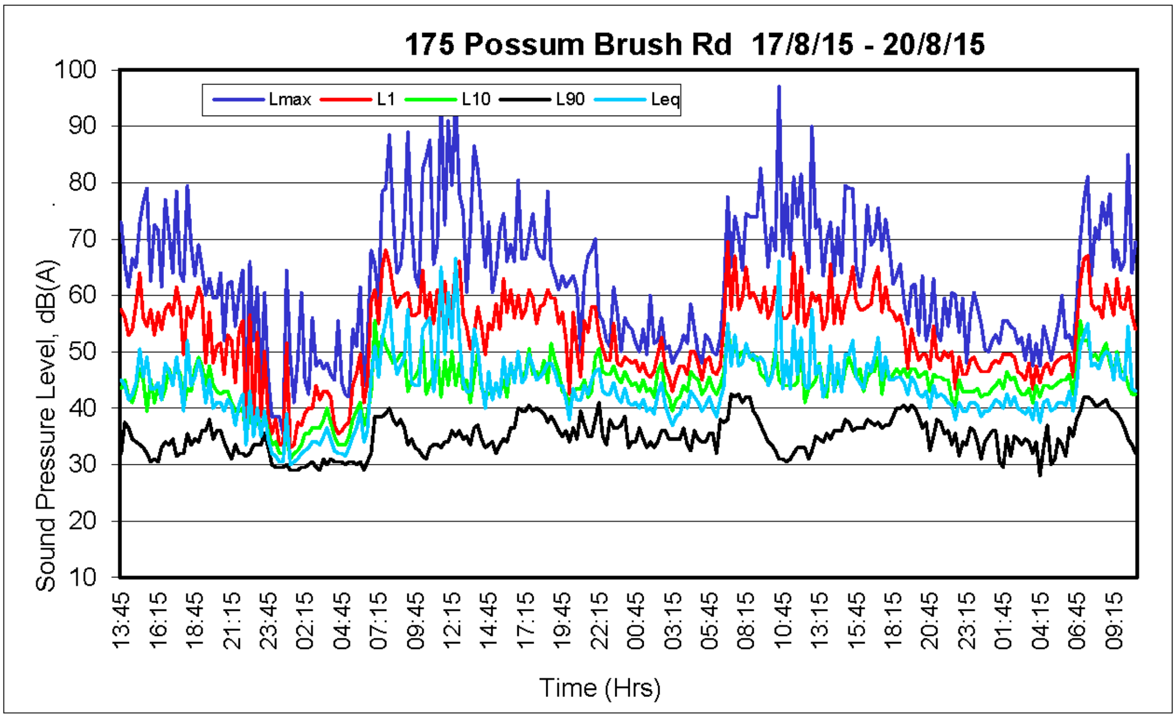
Leq
Sound Pressure Level, dB(A)
Time (Hrs)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Lmax
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Leq
Sound Pressure Level, dB(A)
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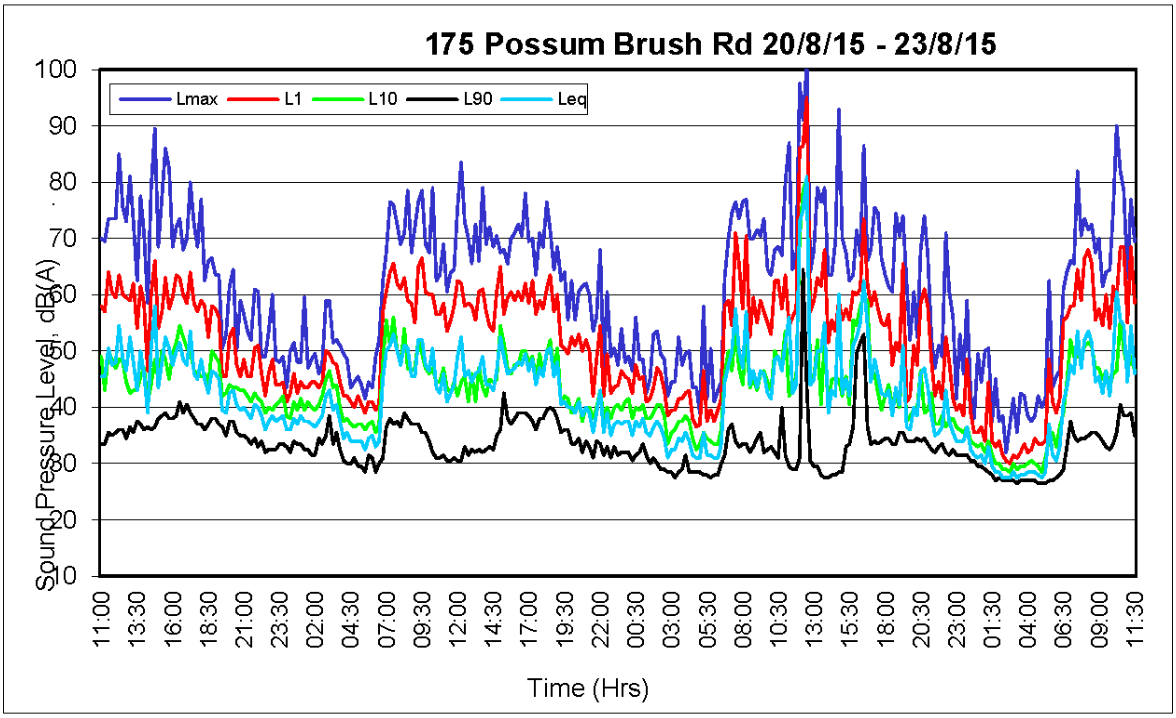
Time (Hrs)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Sound Pressure Level, dB(A)
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