Hy-Tec Industries Pty Limited

ABN: 90 070 100 702

Austen Quarry
Stage 2 Extension Project

Noise and Vibration Impact Assessment

Prepared by

Benbow Environmental

September 2014

Specialist Consultant Studies Compendium
Volume 2, Part 6

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Noise and Vibration Impact Assessment

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EXECUTIVE SUMMARY

Benbow Environmental has been engaged by RW Corkery & Co Pty Ltd on behalf of Hy-Tec Industries Pty Limited to conduct a Noise and Vibration Assessment for Stage 2 of the Austen Quarry expansion.

Austen Quarry is located approximately 3.5 km south-southwest of Hartley village and 10 km south of Lithgow. The site currently extracts rhyolite, an extrusive volcanic rock which is blasted, crushed and screened on site to produce high quality aggregates and crushed rock, for sale to regional and Sydney markets. The expansion is anticipated to increase the current production rate by 30%, resulting in a total capacity of up to 1 million tonnes per annum for the life of Austen Quarry Stage 2.

This Noise and Vibration impact assessment has been conducted in accordance with the NSW Environment Protection Authority (NSW EPA) Industrial Noise Policy (INP) and Road Noise Policy (RNP).

Long term noise monitoring was conducted in June 2013 at three residential locations in order to measure the existing background noise levels and consequently derive the project specific noise levels in accordance with the NSW EPA INP.

The acoustic data recorded by the two environmental noise loggers located along Jenolan Caves Road were utilised to determine existing road traffic noise and to establish the noise criteria for the site related off-site traffic noise in accordance with the NSW EPA Road Noise Policy.

The criteria for vibration and blasting has been obtained from the Environment Protection Licence (EPL) currently applicable at the existing Austen Quarry site (ref. EPL n.12323)

Impacts on the nearest identified receptors within the vicinity of the subject site were determined.

Noise emissions associated with the operational activities and on-site and off-site truck movements have been modelled using the NSW EPA recognised SoundPLAN v.7.2 noise model. Noise source data were obtained by on-site measurements undertaken by acoustic engineers from Benbow Environmental during operations at the Austen Quarry.

Predicted noise levels have been calculated using the Concawe algorithm present in SoundPLAN v.7.2 and three different weather conditions have been considered, based on a one year weather data analysis. The following conditions were considered:

- Condition A: neutral weather conditions.
- Condition B: 3 °C/100 m temperature inversion with 2 m/s wind from source to receiver.
- Condition C: wind speed 3 m/s blowing from north-west.

Noise levels associated with quarry on site operations have been predicted to comply with the noise criteria set in accordance with the NSW EPA Industrial Noise Policy under neutral weather conditions and the presence of 3 m/s wind blowing from the north-west.

During the shoulder period between 6:00am and 7:00am under noise enhancing temperature inversion weather conditions, noise levels have been predicted to be below the noise criteria at all the residential locations except for location R31. At this location one exceedance of 1 dB has been predicted under noise enhancing temperature inversion conditions and between 6:00am and 7:00am only when the site is fully operational. In addition, the exceedance would occur when all the equipment and vehicles on site are simultaneously operating at their full capacity. This situation is very unlikely to occur.

Under temperature inversion conditions a marginal exceedance of 0.2–0.3 dB has been predicted at location R48.

The predicted off-site road traffic levels comply with the criteria established in accordance with the NSW EPA Road Noise Policy.

The sleep disturbance criterion is not achieved at the considered residential receptors when the trucks are travelling along Jenolan Caves Road during the shoulder period between 5:00am and 7:00am. Very little can be done in order to reduce noise emissions from trucks passing by, as the nearest residence would be approximately 7 metres away from the road's centreline.

Blasting effects (vibration and overpressure) are expected to continue to readily meet levels stipulated in the Environment Protection Licence.

1. INTRODUCTION

This report presents the findings of a detailed noise and vibration impact assessment carried out for the proposed expansion of the Austen Quarry ("the Proposal") located at 391 Jenolan Caves Road, Hartley, NSW.

Austen Quarry is located approximately 3.5 km south-southwest of Hartley village and 10 km south of Lithgow. The site currently extracts rhyolite, which is an extrusive volcanic rock that is blasted, crushed and screened on site to produce high quality aggregates and crushed rock for sale to regional and Sydney markets. The expansion is anticipated to increase the production rate from the current average of 750,000 to the approved maximum of 1,100,000 tonnes per annum (tpa) for an additional 30 years (beyond 2020).

The purpose of the noise and vibration impact assessment is to apply the NSW EPA Industrial Noise Policy, Road Noise Policy and the relevant vibration and blasting criterion to the proposed development and establish the potential noise impact on the surrounding environment.

The noise and vibration impact assessment establishes project specific noise levels – these are the noise criteria that the Austen Quarry – Stage 2 development needs to meet to satisfy reasonable noise levels at nearest residences.

The project specific noise levels are established by measuring the existing background levels of noise using unattended noise logging and undertaking attended noise measurements to establish existing levels of noise from industry.

A conservative approach is adopted by Benbow Environmental in undertaking noise assessments. The potential noise impact from the quarry is assessed based on the use of an accurate noise model.

The study is focussed on the potential noise impacts associated with the proposed expansion, which includes:

- Drilling;
- Blasting;
- Mobile plant operations including excavators;
- Crushing and screening operations;
- Material loading operations; and
- On-site and off-site truck movements;

This noise impact assessment focussed on evaluating the noise impact from the aforementioned activities, as well as a qualitative assessment of vibration impacts resulting from blasting operations.

Ambient weather conditions affect noise impacts, and so the noise impact assessment considers in detail the changes that occur with the seasons and devises suitable noise controls to enable the noise criteria – the project specific noise limits – to be met.

1.1 SCOPE OF WORKS

The noise and vibration impact assessment has included the following:

- A review of current and proposed operations;
- Monitoring of existing background noise levels;
- Establishment of project specific noise levels for on-site operations and off-site traffic;
- Collect/retrieve suitable acoustic data for the proposed noise sources;
- Modelling of the proposed operations and prediction of noise levels at the nearest potentially affected receptors;
- Assessment of the predicted levels of noise against NSW EPA and other relevant guidelines;
- Recommendation of noise mitigation measures in order to reduce overall noise emission from the site; and
- Compilation of a report containing a summary of methods and a statement of the potential noise impact from the proposed development.

Supporting documentation has been included in Attachments.

2. SITE IDENTIFICATION

2.1 SITE LOCATION

The Austen Quarry Site is located at 391 Jenolan Caves Road, Hartley, NSW. Austen Quarry is located approximately 3.5 km south-southwest of Hartley village and 10 km south of Lithgow. Jenolan Caves Road is approximately 2 km north-west of the site. Coxs River is also near to the site, towards the north and clockwise to the south-east. The site location in a regional context is shown in **Figure 2.1**. The land is situated within the local government area of Lithgow City Council. The land area leased by Hy-Tec is shown in **Figure 2.2**.

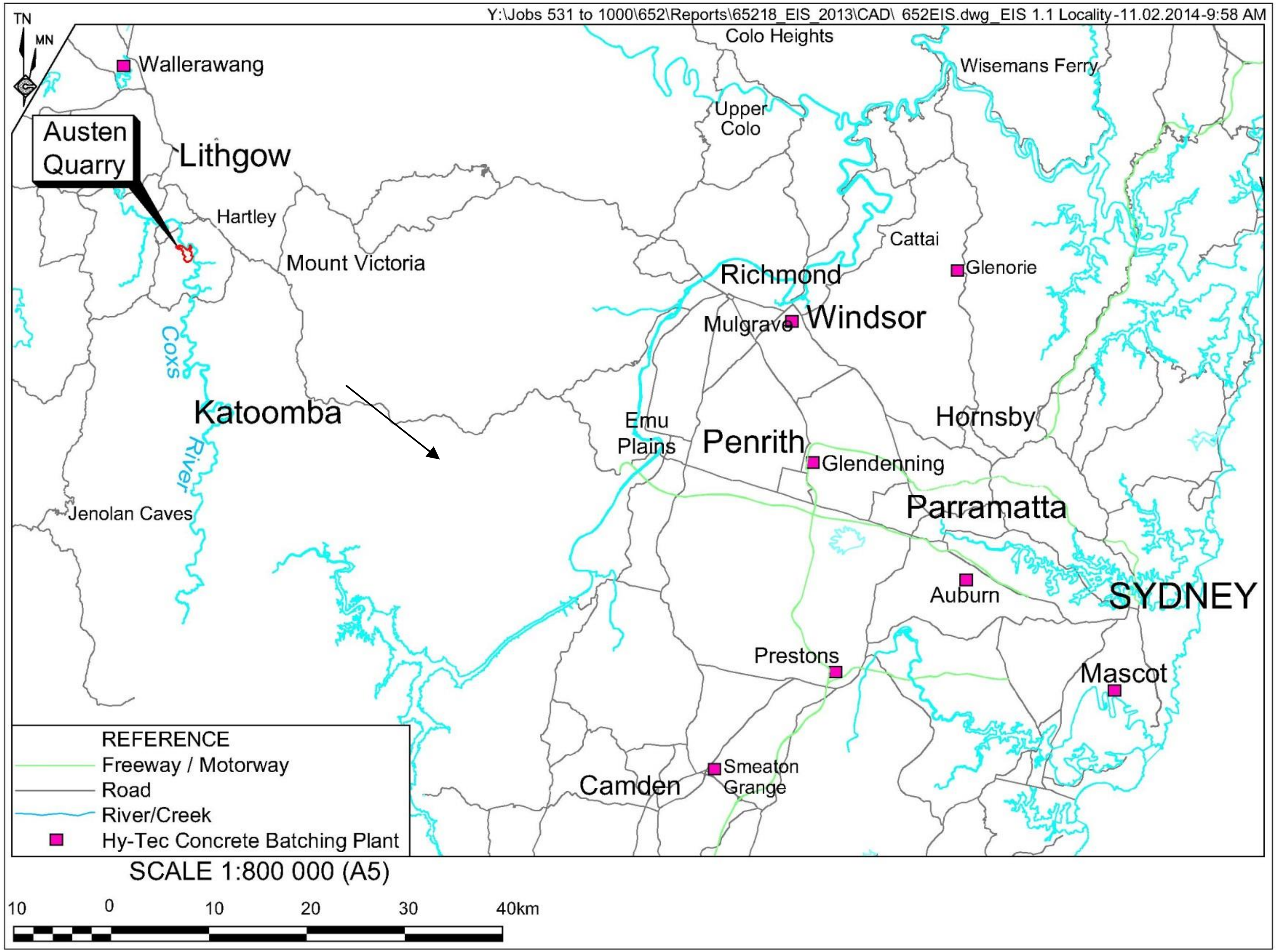
The Site is located on rural land, owned by the Hartley Pastoral Corporation Pty Ltd (HPC), and is currently operating under Development Consent No. 103/94 (DA 103/94), which approves the extraction, screening and despatch of up to 1.1 million tonnes of rhyolite products per year until March 2020.

2.2 SITE LAYOUT AND OPERATIONS

Hy-Tec Industries Pty Limited ("the Applicant") proposes to extend the extraction area and overburden emplacement of the quarry in order to extend the operational life of the quarry (until 2050).

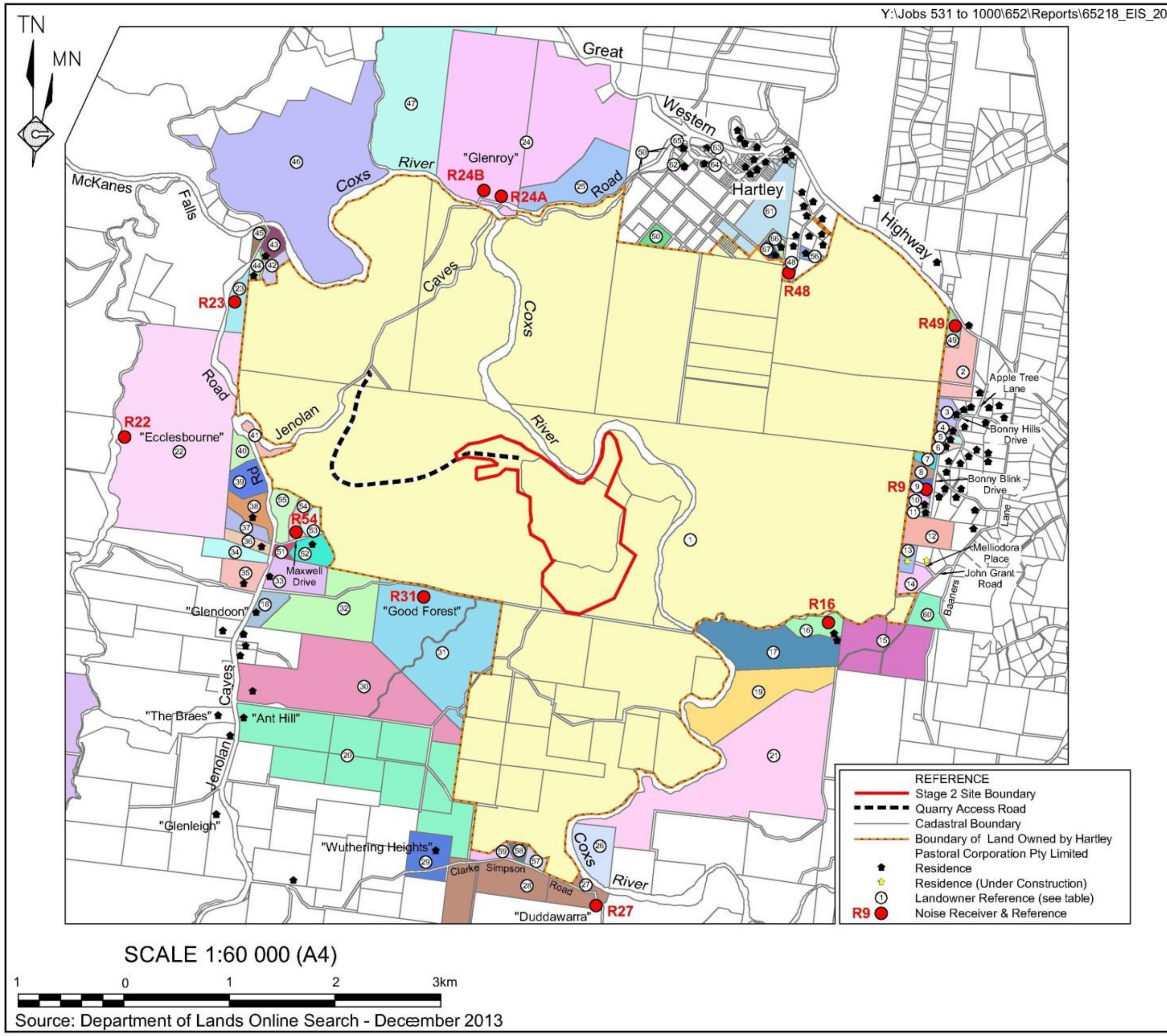
For the purposes of this document, reference is made to existing approved components or activities as "Stage 1" and new or extended components or activities as "Stage 2". The locations of all components, which together are referred to as the Site (an area of approximately 144 ha) are shown in **Figure 2.3**.

Figure 2.1: Location of Site



Source: Courtesy of R. W. Corkery & Co Pty Ltd 2014

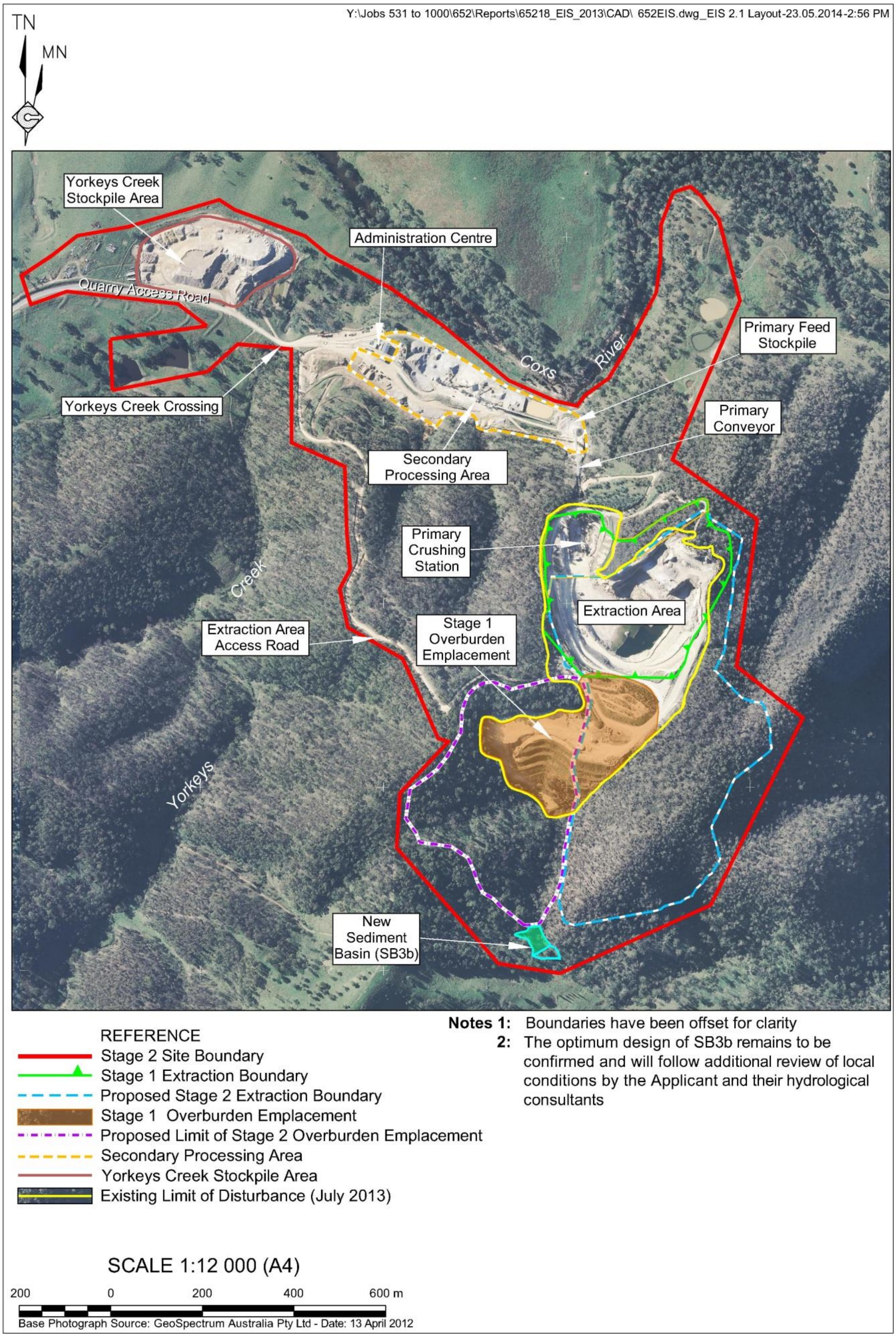
Figure 2.2: Site Boundaries and Sensitive Residential Locations



Ref	Landowner
1	Hartley Pastoral Co Pty Limited
2	T A & M Ashcroft
3	R L & D M Fairbairn
4	J W & D A Holmes
5	A E Raynor, J A Littlewood
6	B D & K N Berthon
7	D J & C Wessell
8	B R & K L Helmrich
9	M A Hilder
10	V J & J Turnbull
11	R J & S J Lawrence
12	S M Taylor, A R Thompson
13	R & W Knight
14	R D & D K Boland
15	Di Falco Brothers Pty Limited
16	J J & E E Turner
17	Lewis Brothers Pty Limited
18	R A Smith, R J Hall
19	R J Matthews
20	A V Joseph
21	P J & C A Meakin
22	B N & J K Houlison
23	J R & D A Young
24	B & R Barber
25	T Barber
26	J D & B L De Losa
27	J E Bell
28	J E & N A Bell
29	CH,CG,RA & JT Ward, ME Laidlow, MF King
30	R H & H E Berry
31	D W & L R Cullen
32	A M & B M Guinan
33	G Kitchener
34	J M & A D Luchetti
35	J A McDonald
36	C Hindle
37	D P Coates
38	L G & M L Swift
39	M Muntanion
40	K J & P F Reddacliff
41	T G Kelly, H C Kongdon
42	B L & C Fitzpatrick
43	R Bennett
44	P J & J L McPhail
45	The Minister for Public Works
46	G J & D M Corney
47	Nosbor Pty Limited
48	B J & D A Murphy
49	G M & E J Corbett
50	The State of New South Wales
51	N E Wilkinson
52	W H Samuels
53	N L Gastaldin
54	Kitchner Super Investments Pty Ltd
55	P A Deane
56	R S & J Gavin
57	T C & C H Watts
58	S K & P A Jones
59	A J & S D Jack
60	G & B M James
61	M J Dunstan
62	I Campbell
63	D Hirsch
64	J Farrag
65	J Cliffed
66	C & L B Grace
67	S J & K T Edwards

Source: Courtesy of R. W. Corkery & Co Pty Ltd 2014

Figure 2.3: Site Main Areas and Location of Interest for Stage 2



Source: Courtesy of R. W. Corkery & Co Pty Ltd 2014

The following provides a description of the relevant component areas and activities of Stage 1 and 2.

Approved Stage 1 Component Areas

- **Extraction Area**
  The approved extraction area covers 12.1 ha, however, a ridge on the northern side of the approved limit of extraction has been excised from the area to provide a visual barrier across much of the extraction area for viewers at Hassans Walls. The loading hopper of the primary crushing station is located at the northwestern corner of the Stage 1 extraction area at approximately 750 m AHD (the footings are at an elevation of approximately 735 m AHD).

- **Existing Stage 1 Overburden Emplacement**
  The overburden emplacement covers approximately 6.8 ha, and has been developed immediately adjacent to the Stage 1 extraction area. Overburden placement in this area has involved the partial in-filling of the head of a gully between 730 m AHD and 780 m AHD.

- **Secondary Processing Area**
  The secondary processing area encompasses the area from the surge stockpile at the end of the conveyor from the primary crushing station to the site office. This area covers approximately 6.1 ha and incorporates three crushers, six screens, 17 conveyors and the air separation unit. Aggregates of various sizes are separated or blended to produce customised products and temporarily stockpiled before transportation to their destination or to the Yorkeys Creek stockpile area.

- **Yorkeys Creek Stockpile Area**
  The bulk of the road pavement materials, manufactured sands, select fills, drainage materials and road construction materials are stockpiled within the Yorkeys Creek stockpile area to the northwest of the secondary processing area along the Quarry Access Road. This area covers approximately 4.4 ha and is defined by the area between the Quarry Access Road, Yorkeys Creek and the northern boundary of the Application Area.

- **Quarry Access Road**
  The sealed private Quarry Access Road from the Jenolan Caves Road to the quarry weighbridge provides the only access to the Site. The road has centre and edge line markings the full length of the road between the intersection with Jenolan Caves Road and the substantial culvert crossing of Yorkeys Creek to the west of the outgoing weighbridge.

- **Other Areas**
  The Site also incorporates additional existing infrastructure and services including:
  - The on-site road network;
  - The administration building, amenities, laboratory and other structures;
  - Water management structures;
  - The hydrocarbon storage area;
  - Two weighbridges; and
  - Facilities to house services such as power and communications.

Proposed Stage 2 Component Areas

- **Proposed Stage 2 Extraction Area**
  The proposed Stage 2 extraction area would incorporate a lateral extension of and deepening the existing Stage 1 extraction area along an adjacent southwest-northwest trending ridge. The northern side of the ridge within in the existing Stage 1 extraction area would remain as a visual barrier to views from the north. The area of the extension covers approximately 16.1 ha and lies immediately to the southeast and east of the Stage 1 extraction area. The combined area of the Stage 1 and Stage 2 extraction areas would be 28.2 ha.

- **Proposed Stage 2 Overburden Emplacement**
  The proposed overburden emplacement would laterally extend (6.7 ha) and increase the elevation of the existing Stage 1 overburden emplacement. In total, the overburden emplacement would cover approximately 13.5 ha. The Stage 2 overburden emplacement would continue to in-fill the small valley to the southwest of the Stage 2 extraction area.

2.3 ADJACENT LAND USE

The subject site is surrounded by vegetation and a number of nearby residential dwellings. A list of the nearest identified residential dwellings that have been considered as potential receptors are listed in **Table 2.1** and are shown in **Figure 2.2** provided previously.

Table 2.1: Nearest Potentially Affected Residential Receptors Considered

Receptor ID	Address	Approximate distance from site operations	Lot	DP	Coordinates	
					Easting	Northing
R9	90 Bonnie Blink Drive, Little Hartley	2,700 m	3	1130739	239213	6281542
R16	196B Baaners Lane, Little Hartley	2,000 m	10	1130701	238373	6280212
R22	650 McKanes Falls Road, Hartley	3,900 m	100	1180814	231821	6282235
R23	617 McKanes Falls Road, Hartley	3,400 m	3	620368	232739	6283330
R24A	200 Jenolan Caves Road, Hartley NSW 2790	2,600 m	10	830372	235276	6284166
R24B	200 Jenolan Caves Road, Hartley NSW 2790 (Camping)	2,500 m	113	1181546	235278	6284281
R27	40 Clarke Simpson Road, Little Hartley	2,900 m	330	1108595	236251	6277543
R31	781 Jenolan Caves Road, Good Forest NSW 2790	1,500 m	214	757063	234528	6280582
R48	61 Carroll Drive, Hartley	3,100 m	8	880798	238090	6283768
R49	2473 Great Western Hwy, Hartley	3,700 m	1	733945	239556	6283100
R54	15 Maxwell Drive, Good Forest NSW 2790	2,000 m	4	876397	233350	6281140

3. EXISTING ACOUSTIC ENVIRONMENT

The level of background noise would vary over the course of any 24 hour period, typically from a minimum at 3.00am in the morning to a maximum during morning and afternoon traffic peak hours. Therefore the NSW EPA Industrial Noise Policy (INP) requires that the level of background and ambient noise be assessed separately for the daytime, evening and night time periods. The INP defines these periods as follows:

- **Day** is defined as 7.00am to 6.00pm, Monday to Saturday and 8.00am to 6.00pm Sundays and Public Holidays;
- **Evenings** is defined as 6.00pm to 10.00pm, Monday to Sunday and Public Holidays; and
- **Night** is defined as 10.00pm to 7.00am, Monday to Saturday and 10.00pm to 8.00am Sundays and Public Holidays.

3.1 NOISE MONITORING EQUIPMENT AND METHODOLOGY

Background noise level measurements were carried out using ARL Ngara and ARL EL-215 statistical environmental noise loggers (long term unattended noise monitoring). A Svantek SVAN 957 Precision Sound Level Meter has been utilised for the short term attended noise monitoring.

To ensure accuracy and reliability in the results, field reference checks were applied both before and after the measurement period with an acoustic calibrator. There were no excessive variances observed in the reference signal between the pre-measurement and post-measurement calibration. The instruments were set on A-weighted Fast response and noise levels were measured over 15-minute statistical intervals. QA/QC procedures applied for the measurement and analysis of noise levels have been presented in **Attachment 2**. The microphones were fitted with windsocks and were positioned at 1.2 meters above ground level.

The instrument sets were calibrated by a NATA accredited laboratory within two years of the measurement period. Calibration certificates have been included in **Attachment 3**.

In assessing the background noise levels, any data affected by adverse weather conditions has been discarded according to the requirements of the NSW EPA Industrial Noise Policy (INP). The weather data was obtained from the weather station located on site and data was provided by the site's management.

3.2 MEASUREMENT LOCATIONS

Three (3) Environmental Noise Loggers were positioned at residential locations in order to measure the existing ambient and background noise environment.

Unattended long-term noise monitoring was undertaken from 4th June 2013 to 13th June 2013 at location A, B and C. The noise logger locations are shown in yellow in **Figure 3.1** and details are listed in the following **Table 3.1**. Attended noise monitoring was conducted at the same locations on the 4th June 2013 and 13th June 2013 during the daytime period and no other industrial noise was noticed. The measured noise levels have been considered as representative of the existing ambient noise environment of the area.

Table 3.1: Noise Monitoring Locations

Receptor ID	Address	Approximate distance from site's operations	Lot	DP	Description
Location A	200 Jenolan Caves Road	2,600 m	10	830372	Residence
Location B	770 Jenolan Caves Road	3,000 m	100	1058004	Residence
Location C	66 Dicker Drive, Little Hartley	5,000 m	41	865372	Residence

3.3 MEASURED NOISE LEVELS

3.3.1 Long-Term Unattended Noise Monitoring Results

The results of the long-term unattended noise monitoring and short-term attended noise monitoring are detailed in **Table 3.2**, **Table 3.3** and **Table 3.4**.

In each of these tables the 15 minute statistical noise levels are analysed for the day, evening and night time periods. The result for each day is presented provided weather conditions were within the guidelines of the NSW EPA INP.

Figure 3.1: Noise Monitoring Locations

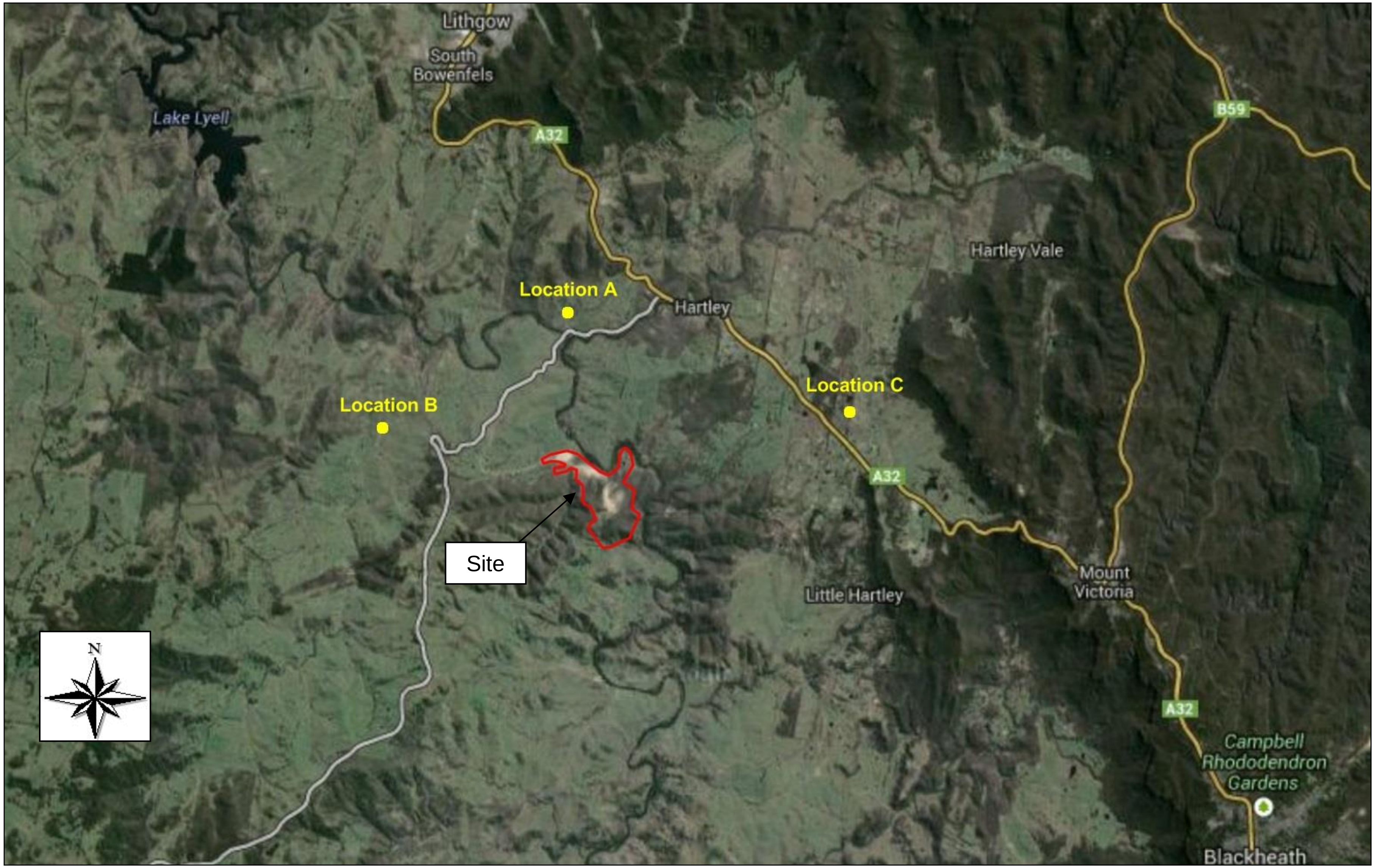


Table 3.2: Unattended Noise Monitoring Data – Location A, dB(A) – 200 Jenolan Caves Road

Measured Noise Levels – Location A												
	Average L_1			Average L_{10}			ABL (L_{90})			$L_{eq(period)}$		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
4/06/2013	74	72	49	61	53	41	41	40	39	63	60	50
5/06/2013	76	68	61	63	49	47	40	40	39	64	58	60
6/06/2013	74	72	53	60	53	42	40	39	40	66	61	54
7/06/2013	-	70	68	-	56	49	-	38	38	-	58	54
8/06/2013	73	68	57	66	54	42	38	38	37	62	57	55
9/06/2013	72	69	52	65	54	40	38	38	38	62	57	48
10/06/2013	71	67	49	64	48	39	39	39	37	62	53	46
11/06/2013	75	68	55	63	48	39	38	38	38	63	58	53
12/06/2013	76	68	60	62	50	45	39	39	37	64	58	58
13/06/2013	78	-	61	64	-	47	40	-	39	64	-	59
14/06/2013	-	-	-	-	-	-	-	-	-	-	-	-
Average	74	69	57	63	52	43	*	*	*	*	*	*
Median	*	*	*	*	*	*	39	39	38	*	*	*
Logarithmic Average	*	*	*	*	*	*	*	*	*	63	58	56

Notes: $L_{eq(period)}$ values represent $L_{eq(11\ hours)}$ for day time , $L_{eq(4\ hours)}$ for evening time and $L_{eq(9\ hours)}$ for night time.
* Indicates values that are not relevant to that noise descriptor.
– Indicates periods of inclement weather which nullifies the noise levels for that period.

At this location the noise associated with the Coxs River was found to be constant, in fact the recorded background noise levels were measured to be constant throughout day, evening and night time.

Table 3.3: Unattended Noise Monitoring Data – Location B, dB(A) – 770 Jenolan Caves Road

Measured Noise Levels – Location B												
	Average L_1			Average L_{10}			ABL (L_{90})			$L_{eq(period)}$		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
4/06/2013	72	68	49	58	46	31	23	22	21	58	55	48
5/06/2013	72	62	56	56	43	38	27	25	21	59	54	53
6/06/2013	70	67	49	55	46	36	29	27	26	57	55	49
7/06/2013	-	70	68	-	54	45	-	21	20	-	56	54
8/06/2013	72	68	53	63	50	31	27	21	20	61	55	49
9/06/2013	71	67	47	62	50	29	27	21	20	60	56	47
10/06/2013	71	65	42	60	43	29	27	24	21	60	51	44
11/06/2013	72	63	55	58	41	33	24	22	21	59	52	48
12/06/2013	73	64	55	58	43	35	26	24	21	60	54	52
13/06/2013	74	-	53	56	-	35	31	-	22	60	-	54
Average	72	66	53	58	46	34	*	*	*	*	*	*
Median	*	*	*	*	*	*	27	22	21	*	*	*
Logarithmic Average	*	*	*	*	*	*	*	*	*	59	54	51

Notes: $L_{eq(period)}$ values represent $L_{eq(11\ hours)}$ for day time , $L_{eq(4\ hours)}$ for evening time and $L_{eq(9\ hours)}$ for night time.
* Indicates values that are not relevant to that noise descriptor.
– Indicates periods of inclement weather which nullifies the noise levels for that period.

Table 3.4: Unattended Noise Monitoring Data – Location C, dB(A) – 66 Dicker Drive

Measured Noise Levels – Location B												
	Average L_1			Average L_{10}			ABL (L_{90})			$L_{eq(period)}$		
	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night	Day	Evening	Night
4/06/2013	49	49	46	44	45	41	36	34	30	44	42	38
5/06/2013	51	47	48	45	43	44	34	31	30	44	40	41
6/06/2013	51	46	48	46	42	43	39	34	32	44	40	40
7/06/2013	-	47	49	-	45	45	-	37	33	-	42	42
8/06/2013	51	44	46	44	39	41	34	31	29	44	39	39
9/06/2013	51	49	41	43	46	35	31	35	27	42	43	35
10/06/2013	52	52	45	45	46	39	36	37	28	44	43	37
11/06/2013	53	51	51	47	46	45	39	34	32	46	43	42
12/06/2013	58	64	53	49	43	43	26	24	26	54	54	46
13/06/2013	74	-	53	56	-	35	31	-	22	60	-	54
Average	52	50	47	45	44	42	*	*	*	*	*	*
Median	*	*	*	*	*	*	35	34	30	*	*	*
Logarithmic Average	*	*	*	*	*	*	*	*	*	47	46	41

Notes: $L_{eq(period)}$ values represent $L_{eq(11\ hours)}$ for day time , $L_{eq(4\ hours)}$ for evening time and $L_{eq(9\ hours)}$ for night time.
* Indicates values that are not relevant to that noise descriptor.
– Indicates periods of inclement weather which nullifies the noise levels for that period.

3.3.2 Short-Term Attended Noise Monitoring Results

Given that the results of the unattended noise monitoring are affected by all ambient noise sources such as local fauna, road traffic and industrial sources, it is not possible to determine with precision the existing industrial noise contribution based on unattended monitoring only. Therefore, the attended noise monitoring allows for a more detailed understanding of the existing ambient noise characteristics and a more meaningful final analysis.

The acoustic engineer's observations highlighted that at all residential locations, the primary contributions to existing noise levels in the area are attributable to road traffic and wildlife noise. The results of the short-term attended noise monitoring are displayed in **Table 3.5** below. Noise levels generally consistent with the values as obtained from the environmental noise loggers were obtained and meteorological conditions were observed to be satisfactory.

Table 3.5: Attended Noise Monitoring during Daytime Period

Monitoring Location	Noise Descriptor				Comments
	L_{Aeq}	L_{A1}	L_{A10}	L_{A90}	
A. 200 Jenolan Caves Road 10:50am 14/06/2013	71.9	57.7	58.0	37.4	Cows ≤ 45 dB(A) SPL Cars on Jenolan Caves Rd ≤ 70 dB(A) SPL Birds ≤ 43 dB(A) SPL Sporadic Bird (louder) ≤ 70 dB(A) SPL Trucks on Jenolan Caves Rd ≤ 76 dB(A) SPL Constant noise from Coxs River ≤ 40 dB(A) Several impact noises from residence ≤ 56 dB(A) SPL Industrial noise inaudible
B. 770 Jenolan Caves Road 1:47 pm 4/06/2013	57.5	70.9	55.7	34.1	Crickets < 33 dB(A) - 35 dB(A) Cars on Jenolan Caves Rd < 71 dB(A) Utes on Jenolan Caves Rd < 78 dB(A) Small truck < 75 dB(A) Aeroplane < 58 dB(A) Birds < 49 dB(A) Industrial noise inaudible Noise from Hartley quarry inaudible
C. 66 Dicker Drive 11:24am 14/06/2013	49.0	56.7	50.9	44.9	Traffic hum ≈ 47 dB(A) - 50 dB(A) One truck passing by on Great Western Hwy < 56 dB(A) Sporadic birds < 45 dB(A) Ute on Dicker Drive < 58 dB(A) Car door closing < 48 dB(A) Distant drill noise < 40 dB(A) Industrial noise inaudible

As no industrial noise was generated during day time and no industrial activities are known to be present, evening and night time attended noise measurements were not considered to be warranted. The project specific noise levels will be shown to be calculated based on a conservative approach.

3.3.3 Existing Road Traffic Noise

Existing road traffic noise levels have been obtained from the environmental noise loggers installed at Location A and B.

The following **Table 3.6** shows the results of the long term unattended road traffic noise monitoring.

Table 3.6: Existing Road Traffic Noise Data – Location A: 200 Jenolan Caves Road

	Existing Road Traffic Noise	
	Day $L_{Aeq\ (15\ hour)}$	Night $L_{Aeq\ (9\ hour)}$
4/06/2013	62	53
5/06/2013	64	56
6/06/2013	67	47
7/06/2013	61	55
8/06/2013	62	52
9/06/2013	61	47
10/06/2013	60	46
11/06/2013	63	55
12/06/2013	64	56
13/06/2013	66	54
Existing Road Traffic Noise	63	53

- Road traffic noise measured at 21 m from centre of Jenolan Caves Road.

Table 3.7: Existing Road Traffic Noise Data – Location B: 770 Jenolan Caves Road

	Existing Road Traffic Noise	
	Day $L_{Aeq\ (15\ hour)}$	Night $L_{Aeq\ (9\ hour)}$
4/06/2013	-	49
5/06/2013	59	51
6/06/2013	57	46
7/06/2013	57	55
8/06/2013	60	47
9/06/2013	59	45
10/06/2013	58	44
11/06/2013	59	47
12/06/2013	59	50
13/06/2013	60	49
Existing Road Traffic Noise	59	50

- Road traffic noise measured at 10 m from centre of Jenolan Caves Road.

The noise logger installed at Location A recorded road traffic noise data consistent with the road traffic noise recorded at Location B. In fact, similar noise levels would be obtained when considering the same distance from the noise source and 3 dB reduction per distance doubling is considered.

The traffic noise levels have been calculated at the residences most affected by road traffic noise located along or in the vicinity of Jenolan Caves Road. Existing road traffic noise levels have been presented in the following **Table 3.8**.

The contribution to the road traffic noise given by the Hy-Tec related trucks has been estimated based on the weighbridge data provided by the client. A daily average truck movement of 200 trucks per day was observed during the monitoring period and it has been utilised for the calculation of the road traffic noise contribution.

The calculation of the Hy-Tec trucks' contribution has been carried out by using SoundPLAN 7.2, the non Hy-Tec traffic noise includes the noise emissions from cars, utes, buses, motorcycles and other trucks travelling along Jenolan Caves Road.

Table 3.8: Existing Road Traffic Noise Levels

Receptor ID	Considered distance from road centre line	Existing Road Traffic Noise Levels		Hy-Tec Offsite road traffic noise		Non- Hy-Tec road traffic noise	
		Day $L_{Aeq\ (15\ hour)}$	Night $L_{Aeq\ (9\ hour)}$	Day $L_{Aeq\ (15\ hour)}$	Night $L_{Aeq\ (9\ hour)}$	Day $L_{Aeq\ (15\ hour)}$	Night $L_{Aeq\ (9\ hour)}$
R22	962 m	46.4	36.4	31.7	23.9	46.3	36.1
R23	1380 m	44.8	34.8	30.2	22.4	44.6	34.5
R24A	7 m	67.8	57.8	53.1	45.3	67.7	57.5
R24B	7 m (Grassed area)	67.8	57.8	53.1	45.3	67.7	57.7
R24B	Cottages at 182 m	53.7	43.7	39.0	31.2	53.3	43.4
R48	239 m	52.4	42.4	37.8	30.0	52.2	42.1

4. CURRENT LEGISLATION AND GUIDELINES

4.1 NSW EPA INDUSTRIAL NOISE POLICY

The NSW Industrial Noise Policy was developed by the NSW EPA primarily for the assessment of noise emissions from industrial sites regulated by the NSW EPA. However, the policy can also be used by Department of Planning and Infrastructure and local government to assist in their assessment of potential noise issues.

An important point to note in the policy is presented in Section 1.4.1. This section states:

> "*The industrial noise source criteria set down in Section 2 are best regarded as planning tools. They are not mandatory, and an application for a noise-producing development is not determined purely on the basis of compliance or otherwise with the noise criteria. Numerous other factors need to be taken into account in the determination. These factors include economic consequences, other environmental effects and the social worth of the development."*

The policy sets out two criteria that are used to assess potential site-related noise impacts. The first criterion aims at controlling intrusive noise impacts in the short-term for residences. This criterion is therefore called the intrusiveness criterion.

The second criterion aims at maintaining a suitable amenity for particular land uses including residences in the long-term. This criterion is called the amenity criterion.

4.1.1 Shoulder Periods

Section 3.3 of the NSW Industrial Noise Policy states that:

> *"There will be situations that call for different assessment periods. For example, where early morning (5 am to 7 am) operations are proposed, it may be unduly stringent to expect such operations to be assessed against the night-time criteria—especially if existing background noise levels are steadily rising in these early morning hours. In these situations, appropriate noise level targets may be negotiated with the regulatory/consent authority on a case-by-case basis. As a rule of thumb it may be appropriate to assign a shoulder period rating background level as the mid-point value between the rating background levels of the two assessment periods that are on either side of the shoulder period."*

Considering that the subject site would operate from 6:00am to 6:00pm but the truck movements would occur starting from 5:00am the shoulder period considered for the assessment would be from 5:00am to 7:00am Monday to Friday.

The noise assessment applies the criteria from the NSW EPA Industrial Noise Policy.

4.1.2 Intrusiveness Criterion

The intrusiveness criterion can be summarised as:

$L_{Aeq,(15minute)} \leq$ rating background level + 5 dB(A)

Where the $L_{Aeq,(15minute)}$ is the predicted or measured L_{Aeq} from the site over a fifteen minute interval at the receiver.

This is to be assessed at the most affected point on or within the residential property boundary or if that is more than 30 m from the residence, at the most affected point within 30 m of the residence.

The three (3) environmental noise loggers presented different results, however at Location A background noise levels were affected by the noise associated with the Coxs River.

At location A, a background noise level of 30 dB(A) has been considered. This would result from the event of having a dry period where the noise emission from the Coxs River would be negligible or absent and consequently a lower background noise level would then be present. The background noise level is expected to be consistent with the ones measured at the other residential locations.

The noise logger at Location B presented background levels below 30 dB(A) for the evening. The INP states that when the readings are below 30 dB, a noise level equal to 30 dB shall be considered. This level has been considered in the derivation of the project specific noise levels.

The intrusiveness criteria for each receptor location are presented in **Table 4.1** below.

Table 4.1: NSW EPA Intrusiveness Criterion – dB(A)

Receiver Location	Period	RBL L_{A90}	Intrusive Criterion $L_{Aeq,15minute}$
All Considered Residential Receivers (all receivers)	Day	30	30 + 5 = **35**
	Evening	30	30 + 5 = **35**
	Night	30	30 + 5 = **35**
	Shoulder Period	30	30 + 5 = **35**

Note: - Day is defined as 7:00am to 6:00pm, Monday to Saturday and 8:00am to 6:00pm Sundays & Public Holidays
- Evening is defined as 6:00pm to 10:00pm Monday to Sunday and Public Holidays.
- Night is defined as 10:00pm to 7:00am, Monday to Saturday and 10:00pm to 8:00am Sundays & Public Holidays.
- Shoulder period is considered as 5:00am to 7:00am.

4.1.3 Amenity Criterion

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 of the NSW INP, the applicable parts of which are reproduced in **Table 4.2**.

Table 4.2: NSW EPA Amenity Criteria – Recommended L_{Aeq} noise levels from industrial noise sources

Type of Receiver	Indicative Noise Amenity Area	Period	Recommended L_{Aeq} noise level (dB(A))	
			Acceptable	Recommended Maximum
Residence	Rural	Day	50	55
		Evening	45	50
		Night	40	45
Active Recreation Area	All	When in use	55	60

The existing industrial noise levels are compared to the acceptable level and **Table 4.3** is then used to derive the applicable amenity criteria.

Table 4.3: Modification to Acceptable Noise Level (ANL[1]) to Account for Existing Levels of Stationary Noise

Total Existing L_{Aeq} Noise Level From Industrial Sources	Maximum L_{Aeq} Noise Level for Noise from New Sources Alone
≥ ANL + 2	If existing noise level is likely to decrease in future: ANL – 10 If existing noise level is unlikely to decrease in the future: Existing level – 10
ANL + 1	ANL – 8
ANL	ANL – 8
ANL – 1	ANL - 6
ANL – 2	ANL – 4
ANL – 3	ANL – 3
ANL – 4	ANL – 2
ANL – 5	ANL –2
ANL – 6	ANL – 1
< ANL – 6	ANL

Source: Table 2.2 NSW EPA INP.
Note: [1]ANL is the recommended acceptable L_{Aeq} noise level for the specific receiver, area and time of day.

Based on **Table 4.2**, **Table 4.3** and the existing industrial noise levels for considered residential receiver locations, the amenity criteria applied to this noise impact assessment is displayed in **Table 4.4** below.

Table 4.4: NSW EPA Amenity Criterion, dB(A)

Receiver Location	Period	Existing Industrial Noise L_{Aeq}	Acceptable Noise Level L_{Aeq}	Amenity Criterion $L_{Aeq, period}$
All Considered Residential Receivers (all)	Day	–	50	50
	Evening	–	45	45
	Night	–	40	40
Location R24B recreational area	When in use		55	55

– No industrial noise has been noticed in the area.

The findings from **Table 4.1** and **Table 4.4** are then used, as discussed in Section 0, to derive the project specific noise levels which are then the noise limits that need to be satisfied to comply with the guidelines of the NSW INP and protect the acoustic amenity of the residents.

4.2 NSW EPA ROAD NOISE POLICY

The NSW Road Noise Policy (RNP) has been adopted to establish the off-site road traffic noise criteria for the potential noise impact associated with the facility. The NSW Road Noise Policy was developed by the NSW EPA primarily to identify the strategies that address the issue of road traffic noise from:

- Existing roads;
- New road projects;
- Road redevelopment projects; and
- New traffic-generating developments.

The RNP also defines criteria to be used in assessing the impacts of such noise.

4.2.1 Noise Assessment Criteria

Based on the RNP road classification description, Jenolan Caves Road would be classified as 'arterial road'.

Section 2.3 of the RNP outlines the criteria for assessing road traffic noise. The relevant sections of Table 3 of the RNP are shown in **Table 4.5** below.

4.2.2 Relative Increase Criteria

In addition to the assessment criteria outlined above, any increase in the total traffic noise level at a location due to a proposed project or traffic-generating development must be considered. Residences experiencing increases in total traffic noise level above the relative criteria should also be considered for mitigation as described in Section 3.4 of the RNP.

Table 4.5: Road Traffic Noise Assessment Criteria For Residential Land Uses, dB(A)

Road Category	Type of Project/Land Use	Assessment Criteria, dB(A)*	
		Day (7 am-10 pm)	Night (10 pm-7 am)
Freeway/ arterial/ sub-arterial roads	Existing residences affected by additional traffic on existing freeways/arterial/sub-arterial roads generated by land use developments	$L_{Aeq\ (15\ hour)}$ 60 dB	$L_{Aeq\ (9\ hour)}$ 55 dB

* measured at 1 m from a building façade.

Table 6 of the RNP outlines the relative increase criteria for residential land uses and is shown in **Table 4.6** below.

Table 4.6: Relative Increase Criteria For Residential Land Uses, dB(A)

Road Category	Type of Project/Land Use	Total Traffic Noise Level Increase, dB(A)	
		Day (7 am-10 pm)	Night (10 pm-7 am)
Freeway/arterial/sub-arterial roads and transit ways	New road corridor/redevelopment of existing road/land use development with potential to generate additional traffic on existing road	Existing traffic $L_{Aeq\ (15\ hour)}$ + 12 dB (external)	Existing traffic $L_{Aeq\ (9\ hour)}$ + 12 dB (external)

In **Table 4.6** above, the ‘existing’ traffic noise level refers to the level from all road categories which would occur for the relevant ‘do nothing’ option as described in Section 2.5.3 of the RNP. Where existing $L_{Aeq\ (period)}$ road traffic noise level is found to be less than 30 dB(A), it is deemed to be 30 dB(A). For example, in an area where the existing traffic $L_{Aeq\ (period)}$ is 25 dB(A), it is deemed to be 30 dB(A). The relative increase criteria of this area would be 30 dB(A) + 12 dB, ie. 42 dB(A).

4.3 SLEEP DISTURBANCE

The occurrence of instantaneous maximum noise levels or maximum noise levels over a very short time period have potential to cause sleep disturbance to nearby residents. The World Health Organisation recommends individual noise events to be contained under 45 dB(A) L_{Amax} indoors (fast response) in order to minimise sleep disturbance. Generally, the number of such events should be less than 10-15 events per night for a ‘good night’s sleep’.

Section 5.4 of the NSW Road Noise Policy details the effects of disruption of a person’s normal sleep patterns due to road traffic noise, outlines research regarding the causes of sleep disturbance, and states conclusions regarding the noise levels from road traffic noise correlating to sleep disturbance.

From the research on sleep disturbance to date it can be concluded that:

- Maximum internal noise levels below 50-55 dB(A) are unlikely to awaken people from sleep; and
- One or two noise events per night, with maximum internal noise levels of 65-70 dB(A), are not likely to affect health and well being significantly.

An appropriate sleep disturbance criteria of 45 dB(A) L_{Amax} (internal) was considered for all residential premises surrounding the subject site with respect to onsite noise generating activities. This approach of setting an internal limit, as opposed to an external limit, has been applied to similar noise assessments that consider night time (10pm – 7am) site operations and vehicle movements and has been accepted as a suitable noise management approach that is fair and reasonable.

A conservative 10 dB(A) reduction in sound pressure level resulting from the façade and ceiling of the house has been considered in order to derive an acceptable noise limit that is to be achieved outside the house. This is based on windows being partially open, equivalent to a summer period.

Therefore if the recommended internal noise level is to be below 45 dB(A) L_{Amax}, and the house offers a 10 dB(A) reduction in sound pressure level with the windows partially open, the exterior sound pressure level can be 55 dB(A) L_{Amax}.

However, this is not a mandatory requirement as there is currently no defined guideline in respect of sleep disturbance. The potential for an excessive disruption would therefore be dependent on the number of events per night, the level of the noise, and whether the noise had annoying characteristics. An example being reversing beeper operation, or use of unsilenced brakes.

4.4 PROJECT SPECIFIC NOISE LEVELS

4.4.1 Operational Project Specific Noise Levels

Noise limits for the site have been established in accordance with the principles and methodologies of the NSW INP, the measured background noise levels and the existing industrial operational noise levels of the area.

According to the NSW INP, it is recommended that the more stringent noise limits be applied to protect the existing acoustic amenity from deteriorating.

The selected On-Site Project Specific Noise Limits and the Sleep Disturbance Criteria associated to operational activities are presented in **Table 4.7** below.

Table 4.7: Site Project Specific Noise Limits (PSNL) for Operational Activities, dB(A)

Receiver Location	Period	Intrusive Criterion $L_{Aeq(15\ minute)}$	Amenity Criterion $L_{Aeq(period)}$	Site PSNL $L_{Aeq(15\ minute)}$	Site Sleep Disturbance L_{Amax}
All Considered Residential Receivers (all)	Day	35	50	**35**	**-**
	Evening	35	45	**35**	**-**
	Shoulder Period	35	40	**35**	**55**

Note: - indicates not applicable

It should be noted that different time periods apply for the above criteria as the intrusive criterion considers a 15 minute assessment period while the amenity criterion requires assessment over the total length of time that a site is operational within each day, evening or shoulder period.

The project specific noise levels are based on preventing intrusiveness i.e. annoyance. Meeting these low noise levels will protect the residents from unreasonable disturbance.

4.4.2 Off-Site Traffic Project Specific Noise Levels

Trucks would access the site from Jenolan Caves Road. Therefore, residential receivers located along this road have been selected for the off-site noise impact assessment associated to road traffic. These residences represent the receptors most affected by road traffic noise along Jenolan Caves Road.

Off-Site Project Specific Noise Limits and the Sleep Disturbance Criteria associated to road traffic noise are presented in **Table 4.8** below.

Table 4.8: Existing Road Traffic Noise Levels

<table>
<tr><th rowspan="2">Receptor ID</th><th colspan="2">Existing Road Traffic Noise Levels</th><th colspan="2">Off-Site PSNL L_{Aeq}</th><th colspan="2">Relative Increase Criteria L_{Aeq}</th><th rowspan="2">Sleep Disturbance Criteria L_{Amax} (outdoor)</th></tr>
<tr><th>Day $L_{Aeq\ (15\ hour)}$</th><th>Night $L_{Aeq\ (9\ hour)}$</th><th>Day $L_{Aeq\ (15\ hour)}$</th><th>Night $L_{Aeq\ (9\ hour)}$</th><th>Day $L_{Aeq\ (15\ hour)}$</th><th>Night $L_{Aeq\ (9\ hour)}$</th></tr>
<tr><td>R22</td><td>46.4</td><td>36.4</td><td>60</td><td>55</td><td>58</td><td>48</td><td rowspan="6">55 dB(A) night time</td></tr>
<tr><td>R23</td><td>44.8</td><td>34.8</td><td>60</td><td>55</td><td>57</td><td>47</td></tr>
<tr><td>R24A</td><td>67.8</td><td>57.8</td><td>60</td><td>55</td><td>80</td><td>70</td></tr>
<tr><td>R24B (grassed area)</td><td>67.8</td><td>57.8</td><td rowspan="2">60</td><td rowspan="2">55</td><td>80</td><td>70</td></tr>
<tr><td>R24B (cottages)</td><td>53.7</td><td>43.7</td><td>76</td><td>66</td></tr>
<tr><td>R48</td><td>52.4</td><td>42.4</td><td>60</td><td>55</td><td>64</td><td>54</td></tr>
</table>

4.5 BLASTING AND VIBRATION CRITERIA

The Environment Protection Licence (EPL) n.12323 currently applicable to the site contains the criteria for blasting and vibration. This has been considered also for the purpose of this assessment and it is presented in this section of the report.

The section L5 of the aforementioned EPL states the following:

> *L5.1 Blasting in or on the premises must only be carried out between 1000 hours and 1500 hours Monday to Friday. Blasting in or on the premises must not take place on Saturdays, Sundays or Public Holidays without the prior approval of the EPA.*
> *L5.2 The airblast overpressure level from blasting operations in or on the premises must not exceed:*
> *a) 115 dB (Lin Peak) for more than 5% of the total number of blasts during each reporting period; and*
> *b) 120 dB (Lin Peak) at any time.*
> *At the most affected noise-sensitive location not under the ownership or control of the licensee.*

L5.3 The ground vibration peak particle velocity from blasting operations carried out in or on the premises must not exceed:
a) 5 mm/s for more than 5% of the total number of blasts carried out on the premises during each reporting period; and
b) 10 mm/s at any time.
At the most affected sensitive location not under the ownership or control of the licensee.
L5.4 The ground vibration peak particle velocity from blasting operations carried out in or on the premises must not exceed 2 mm/s at the most sensitive location within Hartley Village.

This criteria apply to the blasting overpressure and vibration assessment included in this report.

5. OPERATIONAL NOISE IMPACT ASSESSMENT

An outline of the predictive noise modelling methodology and operational noise modelling scenarios has been provided in this section of the report.

5.1 NOISE SOURCES

The sound power levels for the identified noise sources associated to the operational activities have been calculated from measurements of sound pressure levels undertaken by acoustic engineers from Benbow Environmental during operations at the Austen Quarry.

A-weighted third octave band centre frequency sound power levels have been used and are presented in **Table 5.1** below. The noise sources utilised as part of this assessment comprise of the primary noise generating activities associated with the effective operation of the proposed development.

5.2 MODELLING METHODOLOGY

Predictive Noise Modelling was carried out using the Concawe algorithm within SoundPLAN v7.2. This model has been extensively utilised by Benbow Environmental for assessing noise emissions for existing and proposed developments, and is recognised by regulatory authorities throughout Australia. The model allows for the prediction of noise from a site, at the specified receptor, by calculating the contribution of each noise source.

The noise sources as well as the topographical features of the subject area and receiver locations, were all input into the noise model to determine the noise emissions of the proposed development at the nearest potentially affected residences. Based on inspection, the local topography for the area appears to be consistent with levels as printed on the topographic map. On-site structures were included in the model to account for shielding provided by the walls of the existing building.

The modelling scenario has been carried out using the L_{Aeq} and L_{Amax} descriptors. Noise emission levels were predicted at the nearest potentially affected sensitive receivers to determine the noise impact against the project specific noise levels and other relevant noise criteria in accordance with the NSW EPA Industrial Noise Policy.

Table 5.1: A-weighted Sound Power Levels Associated to Operational Activities, dB(A)

Noise Source	Height from Ground Level	Lmax	Overall	Third Octave Band Centre Frequency (Hz)									
				25	**31**	**40**	**50**	**63**	**80**	**100**	**125**	**160**	**200**
				250	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**	**1600**	**2000**
				2500	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**	**125000**	**16000**	**20000**
Drilling Rig	0.5	120	117.5	52	58	69	72	77	86	96	94	94	96
				96	102	109	105	102	106	105	108	108	108
				107	105	103	103	101	97	96	91	89	84
Front End Loader	1.5	78	112.5	61	64	69	82	73	78	86	92	93	96
				96	96	101	100	96	96	102	110	93	93
				93	93	87	82	83	76	71	67	63	57
Bulldozer	2	115	109	57	60	66	78	69	74	83	88	89	92
				93	92	97	97	93	92	98	107	89	90
				89	90	84	79	80	73	67	64	60	53
Excavator 28 T	2	116	114	52	68	65	71	82	84	89	90	93	92
				90	91	98	103	101	104	104	105	104	104
				104	103	100	98	95	92	86	81	74	64
Haul Truck Unloading	2	105	117	53	68	80	79	83	90	97	92	100	99
				100	104	105	106	107	106	107	107	109	106
				104	102	100	96	93	88	83	78	71	64
Haul Truck manoeuvring	2	116	114.2	47	57	59	70	72	84	100	90	91	96
				92	106	110	105	99	103	100	100	100	100
				97	96	94	91	88	86	82	78	71	63
Primary Crusher	5	125	122	69	79	88	94	92	93	99	101	103	104
				107	111	113	111	113	113	112	112	112	111
				109	107	105	102	97	93	85	79	71	60
Water Truck	1.5	110	103	46	51	62	79	79	78	79	83	81	82
				82	85	92	90	94	95	93	93	94	92
				90	89	87	84	80	76	71	68	63	57
Truck Laden	1.5 and 3	110	102	41	44	60	67	81	71	73	76	72	78
				75	78	81	87	88	89	91	89	88	87
				84	81	80	76	71	68	63	59	54	46

Table 5.1: A-weighted Sound Power Levels Associated to Operational Activities, dB(A)

Noise Source	Height from Ground Level	Lmax	Overall	Third Octave Band Centre Frequency (Hz)									
				25	**31**	**40**	**50**	**63**	**80**	**100**	**125**	**160**	**200**
				250	**315**	**400**	**500**	**630**	**800**	**1000**	**1250**	**1600**	**2000**
				2500	**3150**	**4000**	**5000**	**6300**	**8000**	**10000**	**125000**	**16000**	**20000**
Truck Unladen	1.5 and 3	110	100	42	47	69	73	75	70	70	70	78	73
				72	74	75	75	74	75	76	75	74	72
				69	68	68	69	70	70	69	68	63	52
Grader	1.5	117	113	69	75	63	75	81	78	81	93	94	95
				97	97	101	100	97	100	102	105	102	100
				103	107	101	96	100	87	84	82	76	70
Diesel Pump	1.5	104	87	17	12	21	48	36	35	46	46	53	60
				59	66	75	78	76	80	79	76	78	72
				70	69	67	65	62	60	57	54	51	46
Secondary Crusher	7	125	120	64	65	71	78	82	92	95	96	97	101
				101	102	110	106	109	114	111	111	109	108
				106	104	101	98	95	91	85	79	71	60
Tertiary Crusher	5	110	99	51	56	63	76	70	78	72	75	79	85
				86	88	89	88	87	88	88	88	88	88
				87	86	85	83	81	77	71	65	59	50
Final Screen Deck	5	–	112	63	71	74	80	80	81	83	84	89	102
				104	101	99	104	100	101	100	99	98	97
				97	97	97	95	94	92	88	84	78	70
Air Separator	1.5	116	89.5	42	49	57	72	62	66	65	70	73	77
				76	78	76	81	78	79	79	78	78	78
				76	75	73	72	69	64	59	53	45	40
Primary Screen	7	120	118	65	67	75	82	80	89	90	94	93	96
				98	101	104	106	107	105	106	107	107	107
				107	108	108	106	104	101	97	90	82	72
Reversing Beeper	2	103	1250 Hz – 100 dB(A)										

5.3 NOISE MODELLING SCENARIOS

Model scenarios were configured to provide a realistic assessment of potential operational noise emissions. Each model configuration was used to calculate noise levels at the nearest potentially affected receivers under the proposed operations.

Three (3) main operating scenarios were established for the modelling of the operational noise generation in order to provide an accurate estimation of the potential noise impacts.

- Scenario 1: Stage A
- Scenario 2: Stage C
- Scenario 3: Stage E

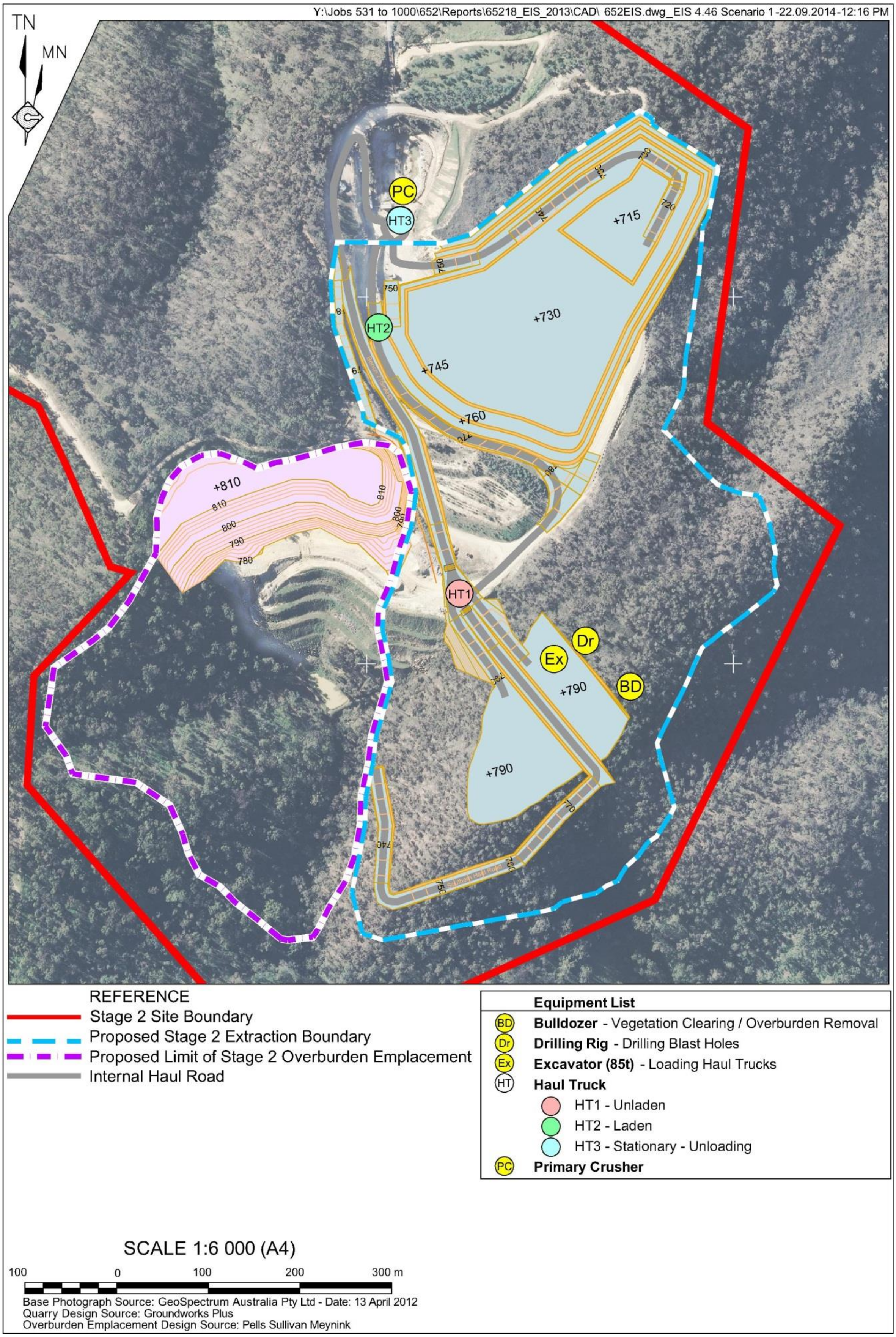
The locations of each noise source within the predictive noise model have been identified in **Figures 5.1** to **5.4**. Point to point noise levels were predicted at each of the residential receivers surrounding the Site. Noise contours were used to assess the likely noise levels that would be received on vacant lands surrounding the Site where there are no existing receiver locations to generate a point to point noise level.

5.4 ASSUMPTIONS MADE FOR NOISE MODELLING

The relevant assessment period for operational noise emissions is 15 minutes when assessing noise levels against the Intrusive Criterion; therefore noise source durations detailed throughout the following assumptions section should be considered per 15 minute period in view of potential noise impacts under worst-case scenarios. Each assessment-specific assumption has been detailed below:

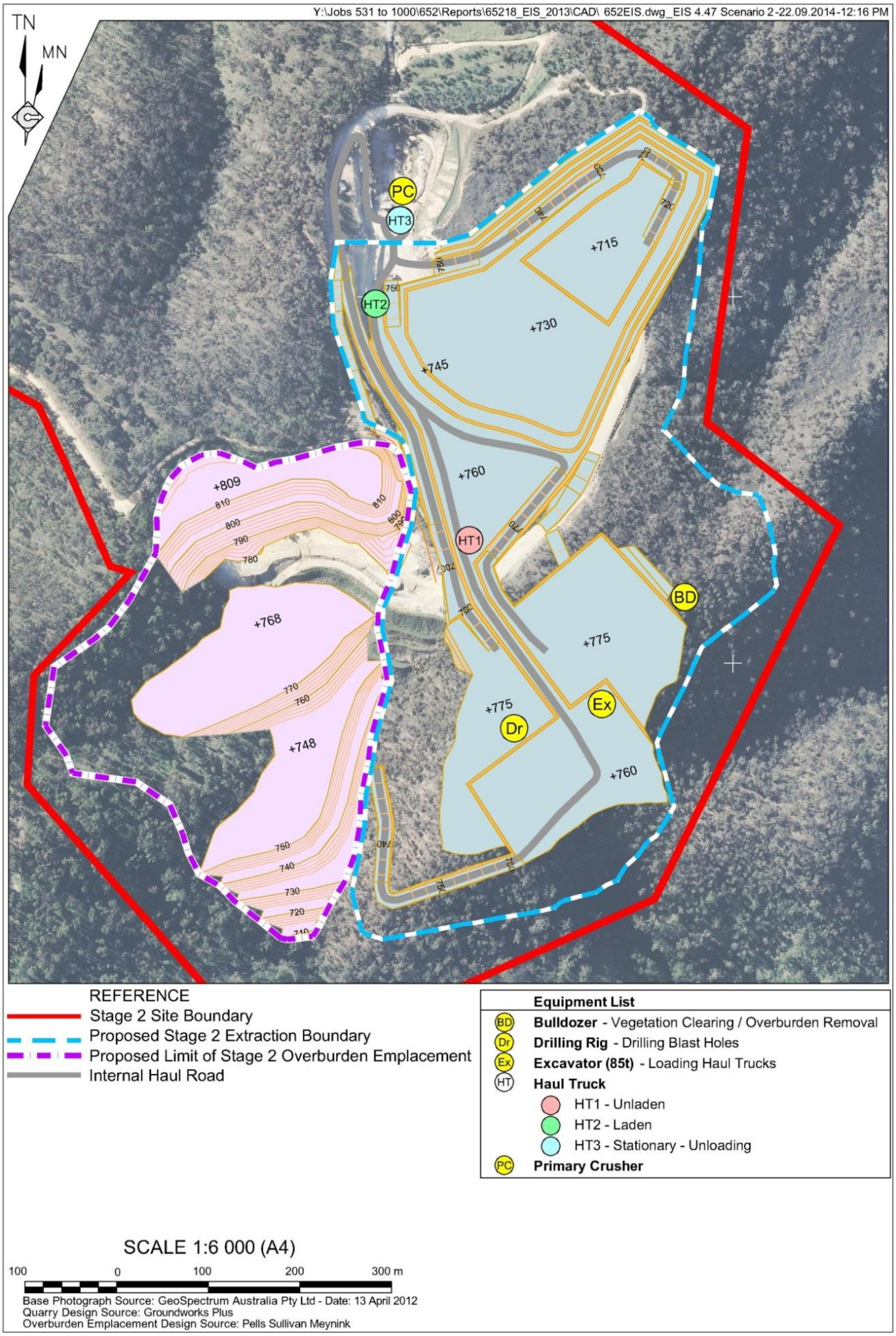
- Off-site topographical information have been obtained from U.S. Geological Survey (USGS) database and imported in SoundPLAN v.7.2.
- On-site topography has been obtained from Orthophotographic Imagery prepared by Crespection Australia Pty Ltd following aerial photograph taken on 12 April 2012 and supplied as Autocad files by the client.
- The following noise sources located within the processing area have been modelled as point source:
  - Secondary crusher;
  - Primary Screen
  - Tertiary Crusher;
  - Final Screen Deck;
  - Air Separator; and
  - Diesel pump.

Figure 5.1: Scenario 1 - Location of Equipment at the Quarry Area



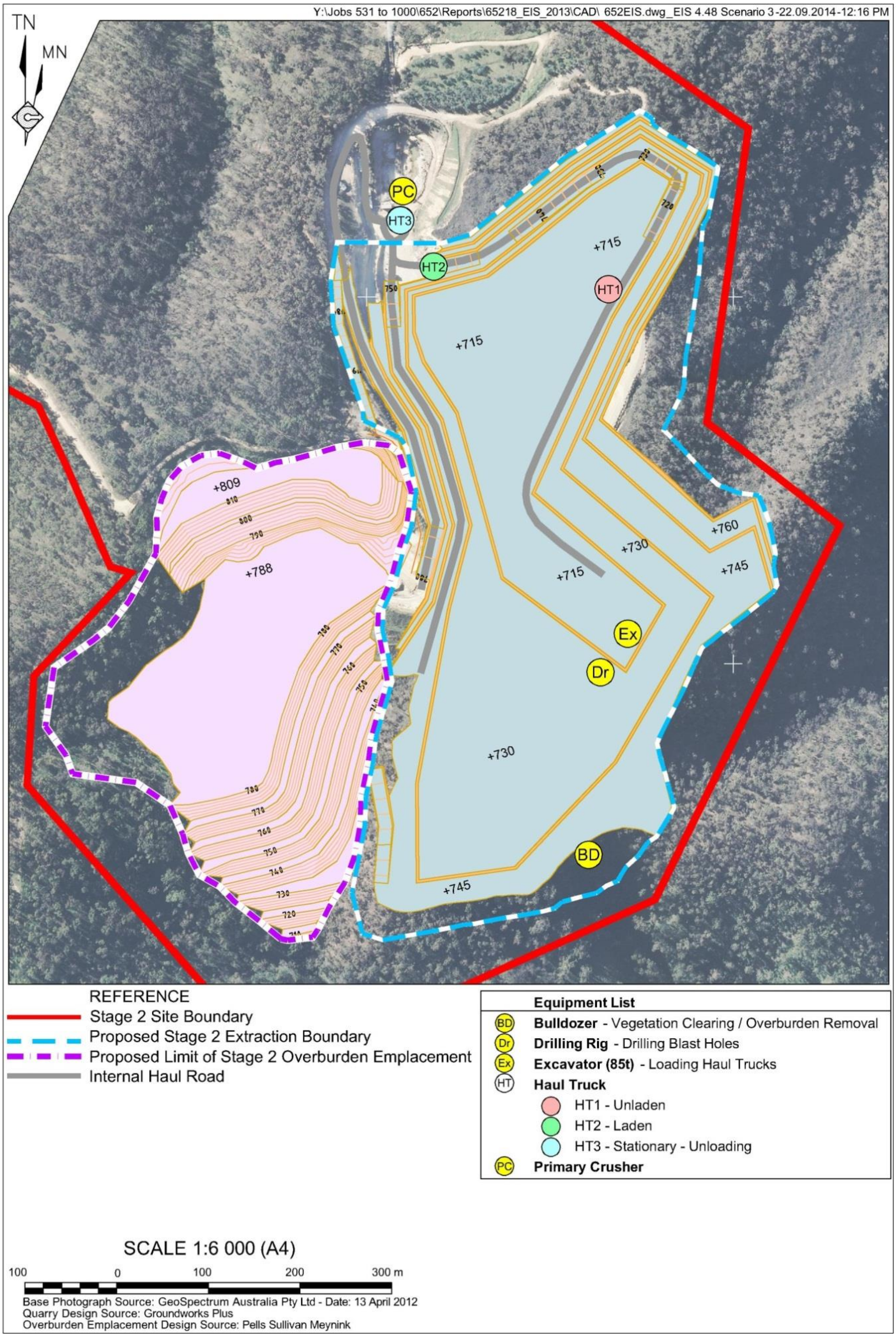
Source: R. W. Corkery & Co Pty Ltd (2014)

Figure 5.2: Scenario 2 – Location of Equipment at the Quarry Area



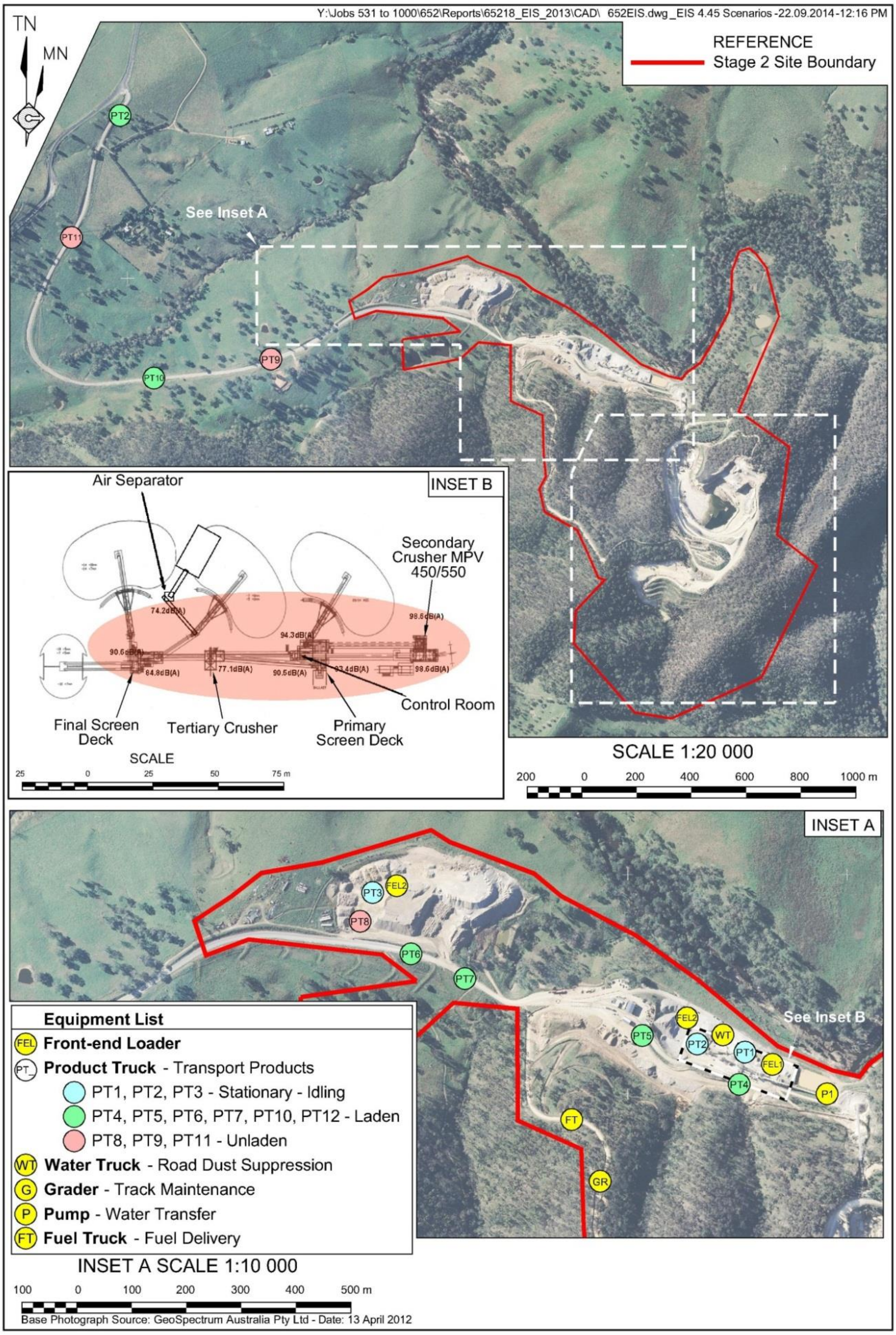
Source: R. W. Corkery & Co Pty Ltd (2014)

Figure 5.3: Scenario 3 – Location of Equipment at the Quarry Area



Source: R. W. Corkery & Co Pty Ltd (2014)

Figure 5.4: Locations of Processing Area Noise Sources (All Three Scenarios)



Source: R. W. Corkery & Co Pty Ltd (2014)

These sources have been modelled to be operating 100% of the time over a 15 minute assessment period.

- Trucks loading, haul trucks loading and unloading have been modelled as point source operating 100% of the time over a 15 minute period.
- Twenty-one (21) trucks have been modelled as two moving point sources (at 1.5 m and 3 m) accessing and leaving the site over a 15 minute period.
- Four (4) trucks have been modelled as two moving point sources travelling between the processing area to the stockpile area.
- Three (3) front end loaders have been modelled as point source. Two are located within the processing area and one is located within the stockpile area. All the front end loaders are operating simultaneously for 100% of the time over a 15 minute period.
- A water truck has been modelled within the processing area as a point source and it is operating 100% of the time.
- A grader and a pump have been modelled as point source being operative during 100% of the time over a 15 minute period.
- Within the extraction area the location of the noise sources have been modified in accordance with the stage to be represented in the scenario. The following noise sources have been modelled as point source, operating simultaneously and constantly throughout a 15 minute assessment period:
    - Drilling Rig;
    - Bulldozer;
    - Excavator (85 t);
    - Haul Truck loading;
    - Haul truck Unloading; and
    - Primary Crusher.
- One (1) haul truck has been modelled as a moving point source travelling between the excavator location and the primary crusher location.
- Eighty-four (84) truck movements per hour have been modelled along the access road (from the site's entrance to the stockpile area) as line source.
- All residential receivers were modelled at 1.5 m above ground level at the most noise-affected point within 30 m of the residence and also at the residence facade.

5.5 METEOROLOGICAL FACTORS

Wind and temperature inversions may affect the noise emission from the site and these need to be assessed when these are considered to be a feature of the area.

5.5.1 Wind

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% of the time or more in any assessment period in any season.

A site-representative meteorological data file was generated for Austen Quarry for the year 2012 with TAPM. The TAPM file contained values for temperature, wind speed, wind direction, mixing height, stability class and the sigma theta parameters.

Seasonal wind rose plots for the site-representative meteorological file have been included in the following section. **Figure 5.5** provides the site-specific wind rose plot for the subject area, based on TAPM.

Based on the wind rose analysis source-to receiver wind speeds of 3 m/s or below are present for more than 30% of the time from the north-west, therefore wind effects are to be considered in the assessment of the potential noise impact.

5.5.2 Temperature Inversion

Temperature inversion is considered a feature where this occurs more than 30% of the nights in winter.

Temperature inversion conditions would be best associated with F-class stability conditions – generally associated with still/light winds and clear skies during the night time or early morning period (these are referred to as stable atmospheric conditions).

The analysis conducted on the 2012–2013 weather data highlighted that during winter 59.87% of the nights in winter presented temperature inversion conditions, therefore these effects must be included in the noise impact assessment.

5.5.3 Weather Conditions Considered in the Assessment

The following conditions were considered:

- Condition A: neutral weather conditions.
- Condition B: 3 °C/100 m temperature inversion with 2 m/s wind from source to receiver.
- Condition C: wind speed 3 m/s blowing from North-west.

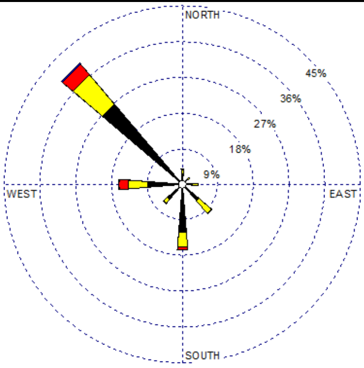
These meteorological conditions have been displayed in detail in **Table 5.2** below.

Table 5.2: Meteorological Conditions Assessed in Noise Propagation Modelling

Condition	Classification	Ambient Temp.	Ambient Humidity	Wind Speed	Wind Direction	Temperature Inversion	Affected Receiver	Applicability
A	Neutral	10 °C	70%	–	–	–	All	All periods
B	Inversion	10 °C	70%	2 m/s	Source to Receiver	3 °C/100 m	All	Shoulder Period
C	Wind Effects	10 °C	70%	3 m/s	NW	–	SW-S-SE	All periods

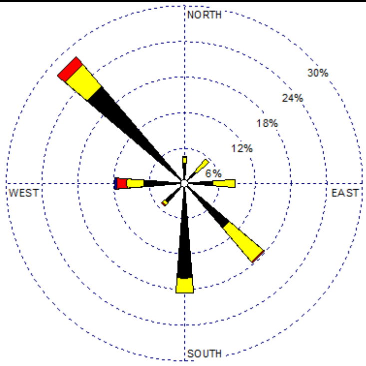
Figure 5.5: Wind Rose Plots for the Meteorological Station at Hartley Quarry (TAPM)

All Seasons



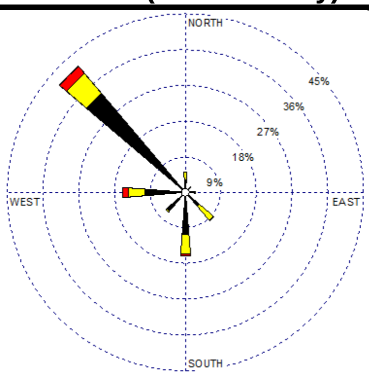
Average Wind Speed: 1.92 m/s
Calms Frequency: 5.75 %
Axis Frequencies: 9%, 18%, 27%, 36%, 45%

Summer (December – February)



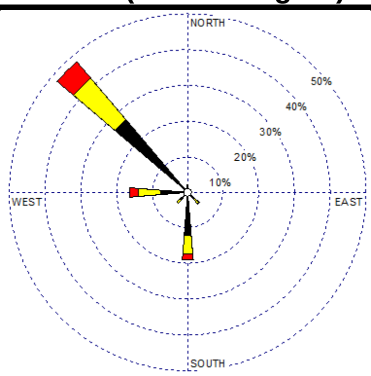
Average Wind Speed: 1.76 m/s
Calms Frequency: 6.62 %
Axis Frequencies: 6%, 12%, 18%, 24%, 30%

Autumn (March – May)



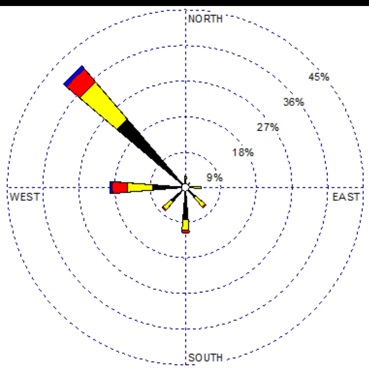
Average Wind Speed: 1.73 m/s
Calms Frequency: 6.30 %
Axis Frequencies: 9%, 18%, 27%, 36%, 45%

Winter (June – August)



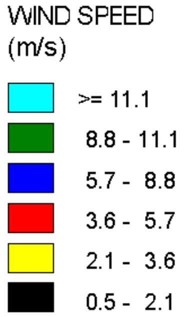
Average Wind Speed: 2.08 m/s
Calms Frequency: 4.66 %
Axis Frequencies: 10%, 20%, 30%, 40%, 50%

Spring (September – November)



Average Wind Speed: 2.09 m/s
Calms Frequency: 5.45 %
Axis Frequencies: 9%, 18%, 27%, 36%, 45%

Legend



5.6 PREDICTED OPERATIONAL NOISE LEVELS

Residential Receiver Locations

Noise levels at the nearest residential receptors have been calculated and results of the predictive noise modelling considering operational activities are shown in the following **Table** 5.1, **Table 5.2** and **Table 5.3**. Comments with respect to the predicted noise levels for each scenario follow.

Scenario 1:
The L_{Aeq} noise levels associated to the standard operational conditions were predicted to readily achieve compliance with the noise criteria at all the considered residential receivers under weather conditions A and C.

During temperature inversion and wind blowing from source to receiver the predicted noise levels at location R31 would exceed the criteria during the shoulder period by 1.1 dB.

This exceedance would occur when temperature inversion is present and all the equipment and vehicles located within the processing area, extraction area and stockpile area are operating at full capacity and simultaneously. This is a very particular circumstance that is highly unlikely, in fact, during the several site inspections carried out, the authors observed that starting from 6:00am the various site's operators would start setting up the equipment and the site would operate at its full capacity around 7:00am. During daytime the temperature inversion is unlikely to occur.

At location R48 an exceedance of 0.3 dB has been predicted during temperature inversion conditions. This is considered a marginal exceedance based on the aforementioned observations and the conservativeness utilised in implementing the noise model.

The neutral weather condition and wind blowing from North-west condition represent the conditions which will be present for the majority of the time.

Scenario 2:
Similarly to Scenario 1, Scenario 2 presents predicted noise levels that readily comply with the project specific noise levels during neutral weather conditions and presence of wind blowing from North-west.

An exceedance at location R31 of 1.3 dB and at location R48 of 0.2 dB above the criteria have been predicted during the shoulder period when temperature inversion condition exists. However, as explained earlier, this would be very unlikely.

Scenario 3:
The L_{Aeq} noise levels associated with the quarry operation have been predicted to comply with the noise criteria at all the considered receivers under all the three weather condition considered.

Tonal Components and Low Frequency Noise

Frequency analysis was undertaken for the predicted noise levels and no tonal components or low frequency noise were found at the considered residential receptors.

Vacant Lands

Three additional receptors have been included in the noise model (see **Figure 5.6** and **Table 5.6**). These represent land that is currently vacant on which a residence may be constructed and occupied in the future. The objective in assessing these lands, which are considered to represent the most proximal to the north, southeast and southwest, is to confirm that predicted noise levels do not exceed the Project Specific Noise Criteria over more than 25%.

Table 5.3: Predicted Noise Levels – Scenario 1 – Stage A

Location	Neutral Weather Conditions				With Temperature Inversion*				With Wind Speed 3 m/s from NW			
	Day (L_{Aeq})	Evening (L_{Aeq})	Shoulder Period (L_{Aeq})	Day/ Evening/ Shoulder Period (L_{Amax})	Day (L_{Aeq})	Evening (L_{Aeq})	Shoulder Period (L_{Aeq})	Day/ Evening/ Shoulder Period (L_{Amax})	Day (L_{Aeq})	Evening (L_{Aeq})	Shoulder Period (L_{Aeq})	Day/ Evening/ Shoulder Period (L_{Amax})
R31	30.5	30.5	30.5	45.2	-	-	36.1	50	31.7	31.7	31.7	46
R54	29.9	29.9	29.9	35.8	-	-	34.7	40.5	32	32	32	33.8
R22	< 20	< 20	< 20	< 20	-	-	< 20	22.5	< 20	< 20	< 20	< 20
R23	24.9	24.9	24.9	36.7	-	-	30.7	42.3	< 20	< 20	< 20	29.3
R24A	28.2	28.2	28.2	43.3	-	-	34	48.7	22.1	22.1	22.1	36.7
R24B	27.4	27.4	27.4	42.8	-	-	33.3	48.2	21.3	21.3	21.3	36.2
R48	29.5	29.5	29.5	40.3	-	-	35.3	45.8	28.6	28.6	28.6	41.4
R49	20.2	20.2	20.2	28.2	-	-	26.2	33.5	23.4	23.4	23.4	33.4
R9	< 20	< 20	< 20	35.7	-	-	25.6	41.4	25.8	25.8	25.8	41.6
R16	22	22	22	22.3	-	-	28	28.3	27.9	27.9	27.9	28.3
R27	< 20	< 20	< 20	< 20	-	-	< 20	< 20	< 20	< 20	< 20	< 20

* Temperature Inversion is likely to occur during night time periods only.

Table 5.4: Predicted Noise Levels – Scenario 2 – Stage C

Location	Neutral Weather Conditions				With Temperature Inversion*				With Wind Speed 3 m/s from NW			
	Day (L_{Aeq})	Evening (L_{Aeq})	Shoulder Period (L_{Aeq})	Day/ Evening/ Shoulder Period (L_{Amax})	Day (L_{Aeq})	Evening (L_{Aeq})	Shoulder Period (L_{Aeq})	Day/ Evening/ Shoulder Period (L_{Amax})	Day (L_{Aeq})	Evening (L_{Aeq})	Shoulder Period (L_{Aeq})	Day/ Evening/ Shoulder Period (L_{Amax})
R31	30.7	30.7	30.7	45.2	-	-	36.3	50	31.7	31.7	31.7	46
R54	29.9	29.9	29.9	35.8	-	-	34.7	40.5	32	32	32	33.8
R22	< 20	< 20	< 20	< 20	-	-	< 20	22.5	< 20	< 20	< 20	< 20
R23	24.9	24.9	24.9	36.7	-	-	30.7	42.3	< 20	< 20	< 20	29.3
R24A	28.1	28.1	28.1	43.3	-	-	33.9	48.7	22	22	22	36.7
R24B	27.4	27.4	27.4	42.8	-	-	33.2	48.2	21.2	21.2	21.2	36.2
R48	29.5	29.5	29.5	40.3	-	-	35.2	45.8	28.6	28.6	28.6	41.4
R49	< 20	< 20	< 20	28.2	-	-	25.8	33.5	23.2	23.2	23.2	33.4
R9	20.5	20.5	20.5	35.7	-	-	26.6	41.4	26.8	26.8	26.8	41.6
R16	23.9	23.9	23.9	< 20	-	-	30.1	20	30	30	30	20
R27	< 20	< 20	< 20	< 20	-	-	< 20	< 20	< 20	< 20	< 20	< 20

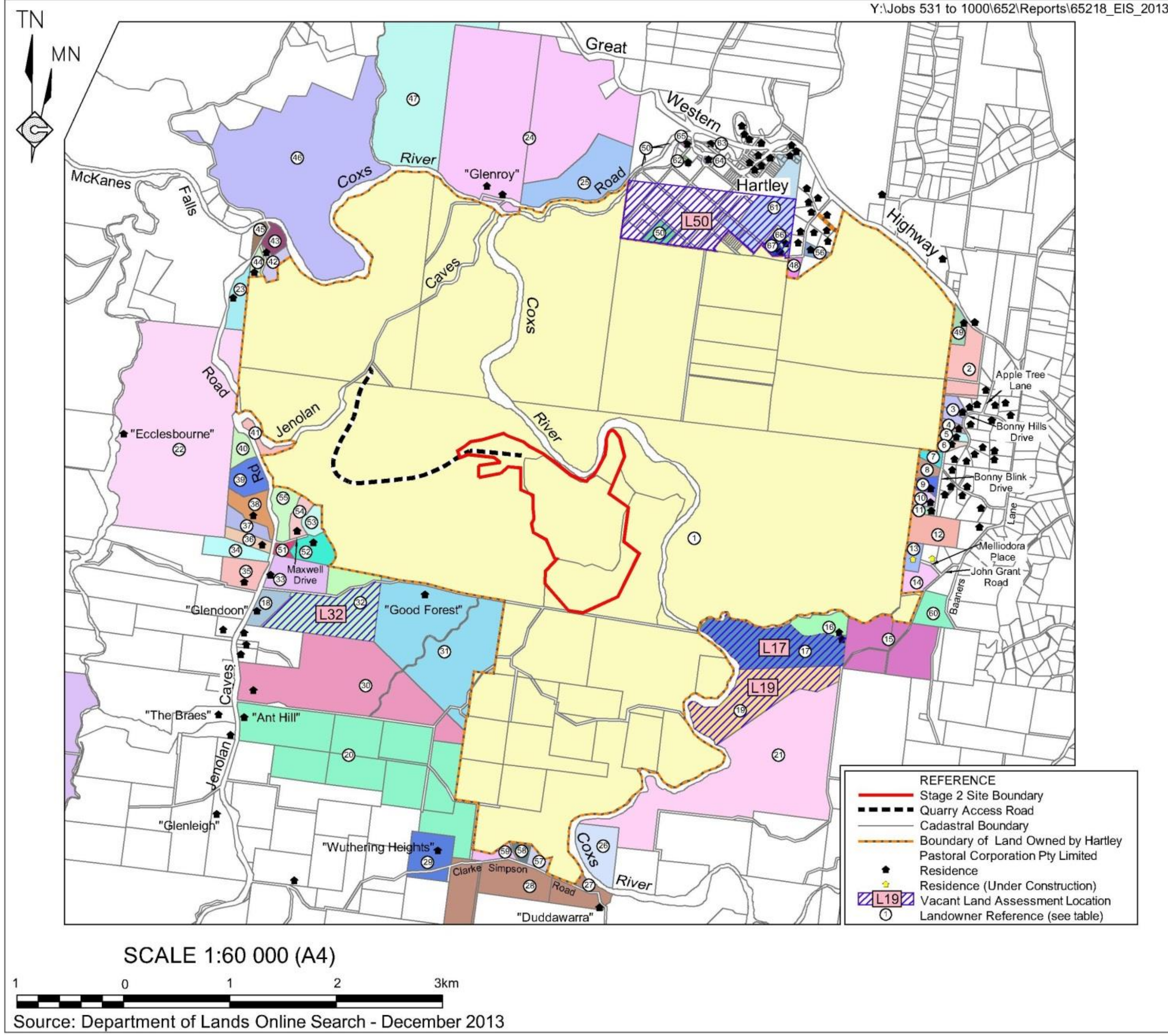
***** Temperature Inversion is likely to occur during night time periods only.

Table 5.5: Predicted Noise Levels – Scenario 3 – Stage E

Location	Neutral Weather Conditions				With Temperature Inversion*				With Wind Speed 3 m/s from NW			
	Day (L_{Aeq})	Evening (L_{Aeq})	Shoulder Period (L_{Aeq})	Day/ Evening/ Shoulder Period (L_{Amax})	Day (L_{Aeq})	Evening (L_{Aeq})	Shoulder Period (L_{Aeq})	Day/ Evening/ Shoulder Period (L_{Amax})	Day (L_{Aeq})	Evening (L_{Aeq})	Shoulder Period (L_{Aeq})	Day/ Evening/ Shoulder Period (L_{Amax})
R31	27.3	27.3	27.3	45.1	-	-	30.7	50	31.4	31.4	31.4	46
R54	29.9	29.9	29.9	45.2	-	-	34.6	40.5	32	32	32	33.8
R22	< 20	< 20	< 20	< 20	-	-	< 20	22.5	< 20	< 20	< 20	< 20
R23	25.1	25.1	25.1	36.7	-	-	25.2	42.3	< 20	< 20	< 20	29.3
R24A	27.9	27.9	27.9	43.3	-	-	28.1	48.7	21.8	21.8	21.8	36.7
R24B	27	27	27	42.8	-	-	27.4	48.2	20.9	20.9	20.9	36.2
R48	29.3	29.3	29.3	40.	-	-	35.0	45.8	28.5	28.5	28.5	41.4
R49	< 20	< 20	< 20	28.2	-	-	< 20	33.5	22.9	22.9	22.9	33.4
R9	< 20	< 20	< 20	35.7	-	-	20.5	41.4	22.2	22.2	22.2	41.6
R16	< 20	< 20	< 20	< 20	-	-	23.9	20	< 20	< 20	< 20	20
R27	< 20	< 20	< 20	< 20	-	-	< 20	< 20	< 20	< 20	< 20	< 20

***** Temperature Inversion is likely to occur during night time periods only.

Figure 5.6 Vacant Lands Location



Ref	Landowner
1	Hartley Pastoral Co Pty Limited
2	T A & M Ashcroft
3	R L & D M Fairbairn
4	J W & D A Holmes
5	A E Raynor, J A Littlewood
6	B D & K N Berthon
7	D J & C Wessell
8	B R & K L Helmrich
9	M A Hilder
10	V J & J Turnbull
11	R J & S J Lawrence
12	S M Taylor, A R Thompson
13	R & W Knight
14	R D & D K Boland
15	Di Falco Brothers Pty Limited
16	J J & E E Turner
17	Lewis Brothers Pty Limited
18	R A Smith, R J Hall
19	R J Matthews
20	A V Joseph
21	P J & C A Meakin
22	B N & J K Houlison
23	J R & D A Young
24	B & R Barber
25	T Barber
26	J D & B L De Losa
27	J E Bell
28	J E & N A Bell
29	CH,CG,RA & JT Ward, ME Laidlow, MF King
30	R H & H E Berry
31	D W & L R Cullen
32	A M & B M Guinan
33	G Kitchener
34	J M & A D Luchetti
35	J A McDonald
36	C Hindle
37	D P Coates
38	L G & M L Swift
39	M Muntanion
40	K J & P F Reddacliff
41	T G Kelly, H C Kongdon
42	B L & C Fitzpatrick
43	R Bennett
44	P J & J L McPhail
45	The Minister for Public Works
46	G J & D M Corney
47	Nosbor Pty Limited
48	B J & D A Murphy
49	G M & E J Corbett
50	The State of New South Wales
51	N E Wilkinson
52	W H Samuels
53	N L Gastaldin
54	Kitchner Super Investments Pty Ltd
55	P A Deane
56	R S & J Gavin
57	T C & C H Watts
58	S K & P A Jones
59	A J & S D Jack
60	G & B M James
61	M J Dunstan
62	I Campbell
63	D Hirsch
64	J Farrag
65	J Cliffed
66	C & L B Grace
67	S J & K T Edwards

Table 5.6 Vacant Lands Included in Assessment

Land ID	Lot DP number	Approximate Distance from Site
L 17 and L 19	Lot 11 and Lot 4 DP1113701	1 000m
L 32	Lot 2 DP870895	1 650m
L 50 Subdivision	Various lot subdivisions	2 300m

Table 5.7 summarises the scenarios and weather conditions considered for the calculation of the noise contour maps at each identified vacant lot. These represent the worst-case noise enhancing conditions likely to result in elevated noise levels on the vacant land.

Table 5.7: Assessed Weather Conditions

Land ID	Noise Map Scenarios	Weather Conditions
L 17, L 19 and L 50 Subdivision	Scenario 1	• Temperature Inversion
	Scenario 2	
	Scenario 3	
L 32	Scenario 1	• Temperature Inversion • 3m/s Wind from the northwest
	Scenario 2	• Temperature Inversion • 3m/s Wind from the northwest
	Scenario 3	• Temperature Inversion • 3m/s Wind from the northwest

The noise contour maps generated for each of the vacant lots, under Scenarios 1 to 3 and weather conditions noted in Table 5.7 are presented as **Figure 5.7** to **Figure 5.18**.

<u>Assessment of Noise at Locations L17 and L19</u>

The predicted noise levels for Scenario 1 and Scenario 3 comply with the noise criteria on 100% of the land at both L17 and L19.

The noise levels predicted for Scenario 2 comply with the noise criteria on 100% of the land at L19. Noise levels exceed the applicable noise criteria over L17 approximately 8-10% of the land.

<u>Assessment of Noise at Locations L50</u>

The predicted noise levels for the vacant lands located at L50 exceed the noise criteria on approximately 10-15% of the land on one lot subdivision in the area.

<u>Assessment of Noise at Locations L32</u>

The predicted noise levels over the land identified as L32 comply with the noise criteria over 100% of the land under 'wind' weather conditions. Noise levels predicted under temperature inversion conditions exceed the noise criteria on approximately 1% of the land for Scenario 1 and Scenario 2.

The noise levels predicted for Scenario 3 comply with the noise criteria over 100% of the land.

Figure 5.7: Scenario 1 – Location L17 and L19 – Adverse Weather Conditions (Temperature Inversion)

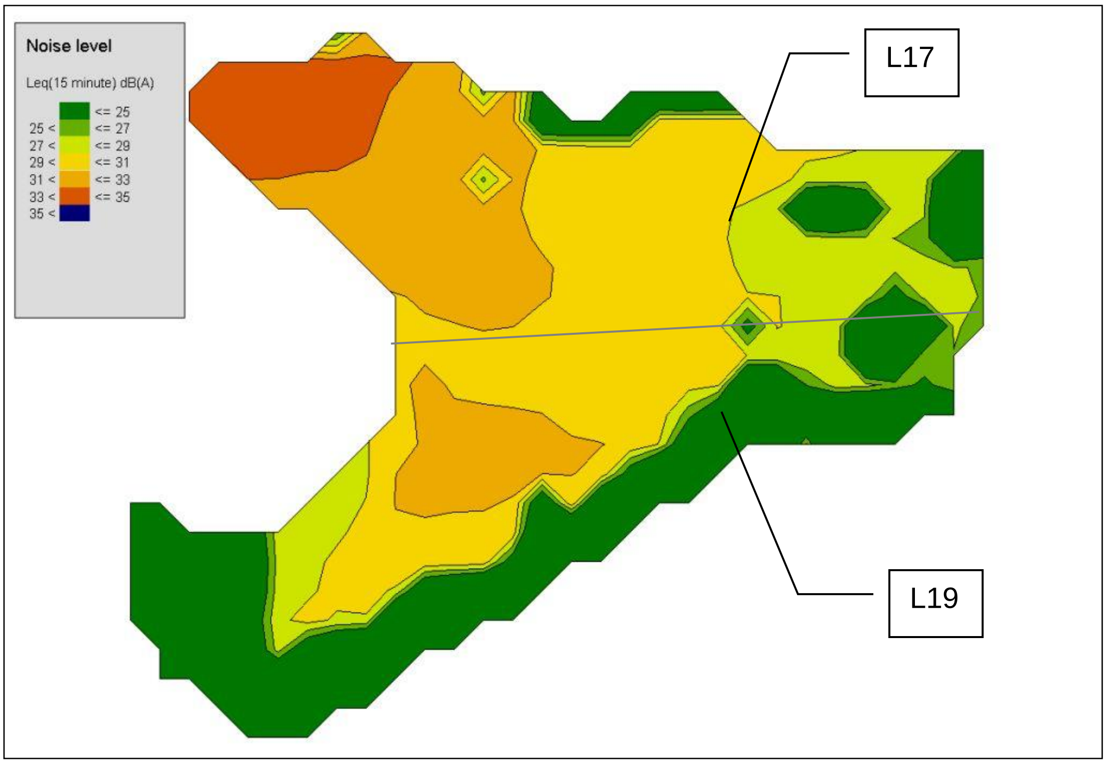


Figure 5.8: Scenario 2 – Location L17 and L19 – Adverse Weather Conditions (Temperature Inversion)

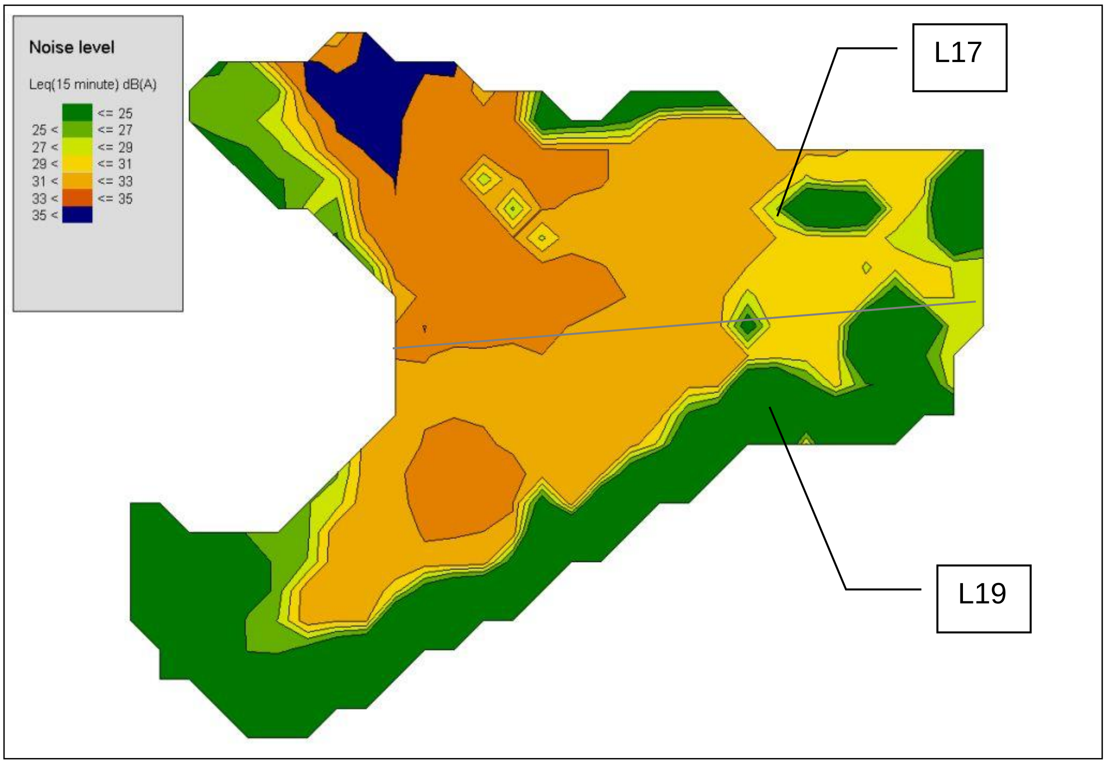


Figure 5.9: Scenario 3 – Location L17 and L19 – Adverse Weather Conditions (Temperature Inversion)

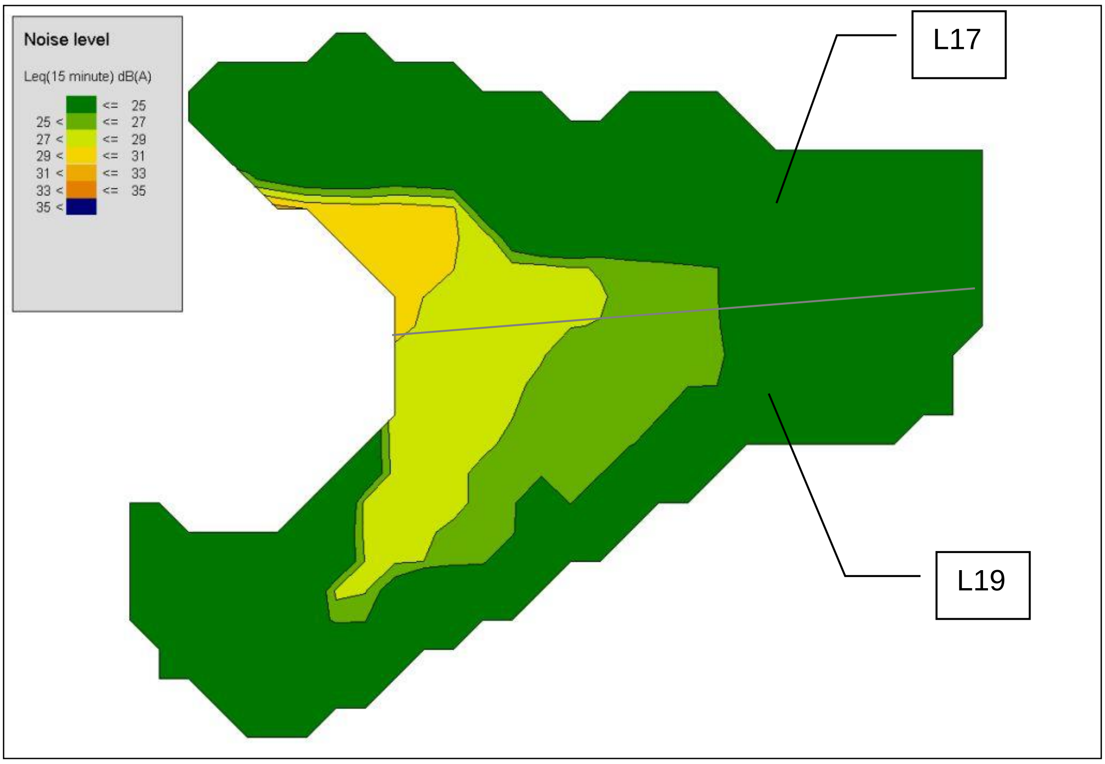


Figure 5.10: Scenario 1 – Location L50 Subdivision – Adverse Weather Conditions (Temperature Inversion)

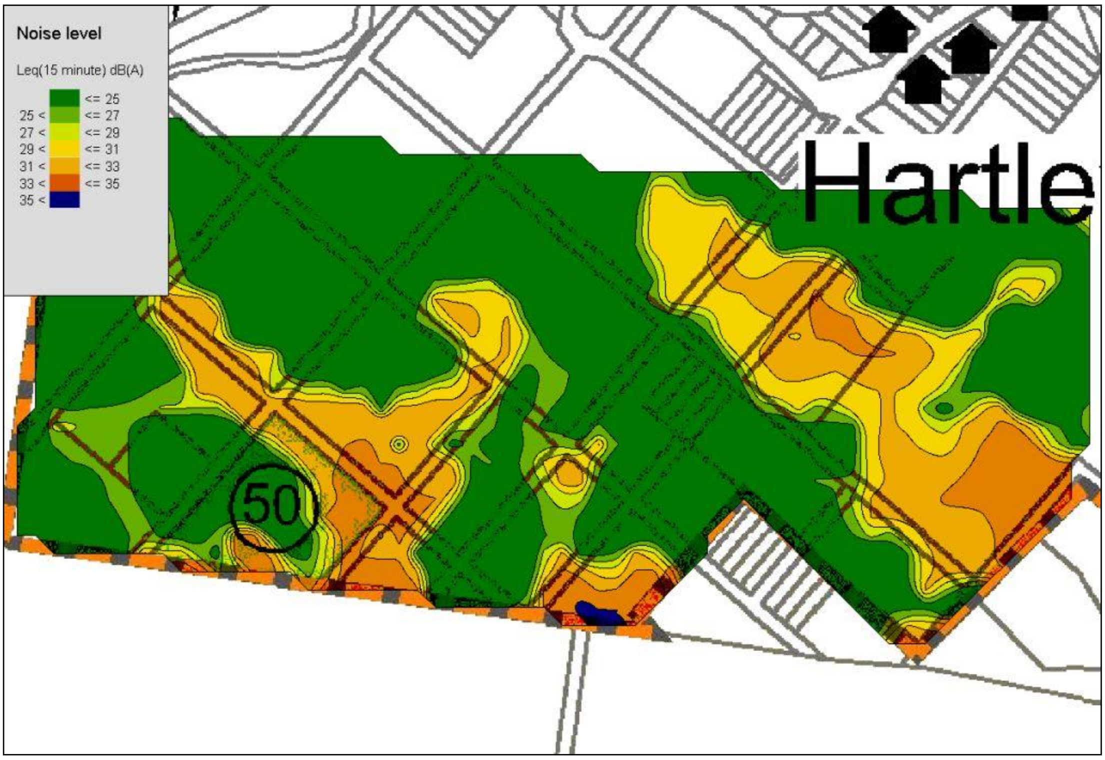


Figure 5.11: Scenario 2 – Location L50 Subdivision – Adverse Weather Conditions (Temperature Inversion)

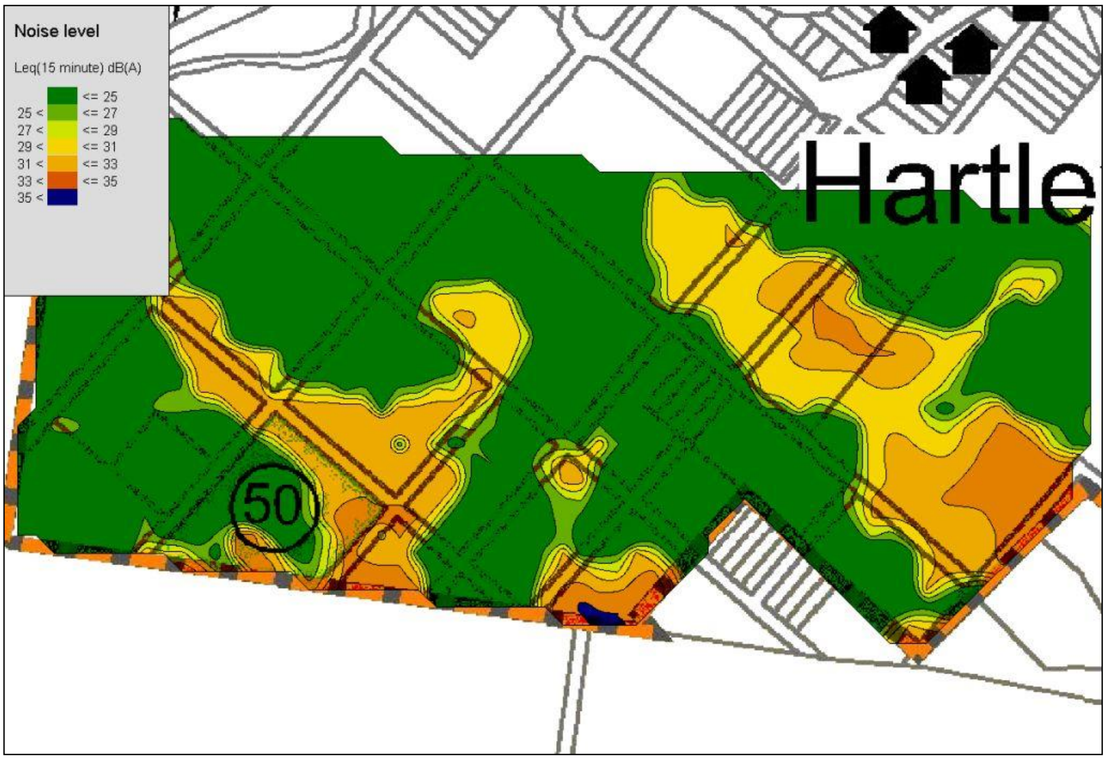


Figure 5.12: Scenario 3 – Location L50 Subdivision – Adverse Weather Conditions (Temperature Inversion)

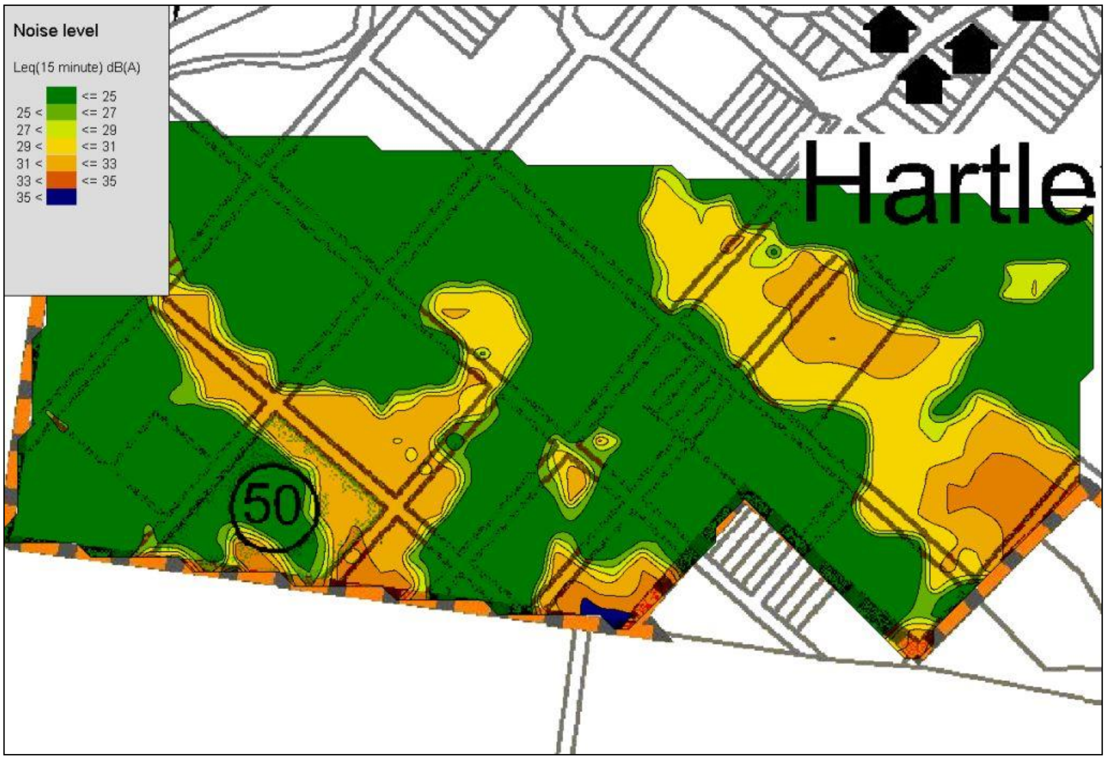


Figure 5.13: Scenario 1 – Location L32 – Adverse Weather Conditions (Temperature Inversion)

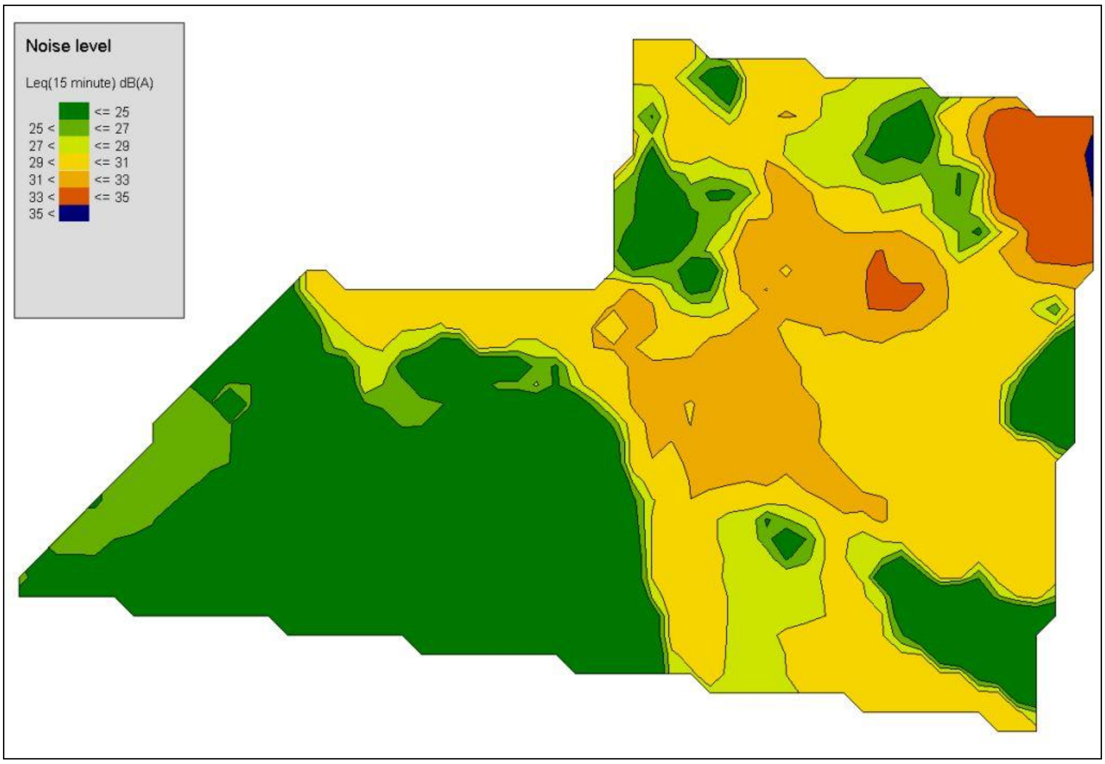


Figure 5.14: Scenario 2 – Location L32 – Adverse Weather Conditions (Temperature Inversion)

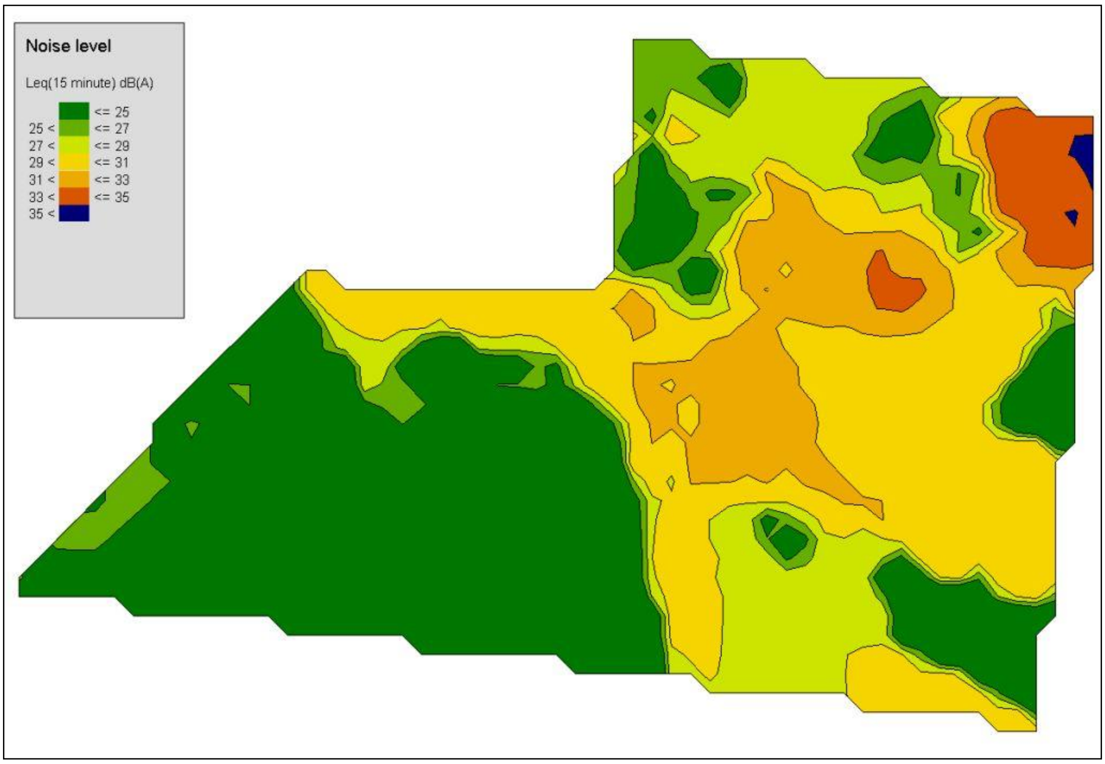


Figure 5.15: Scenario 3 – Location L32 – Adverse Weather Conditions (Temperature Inversion)

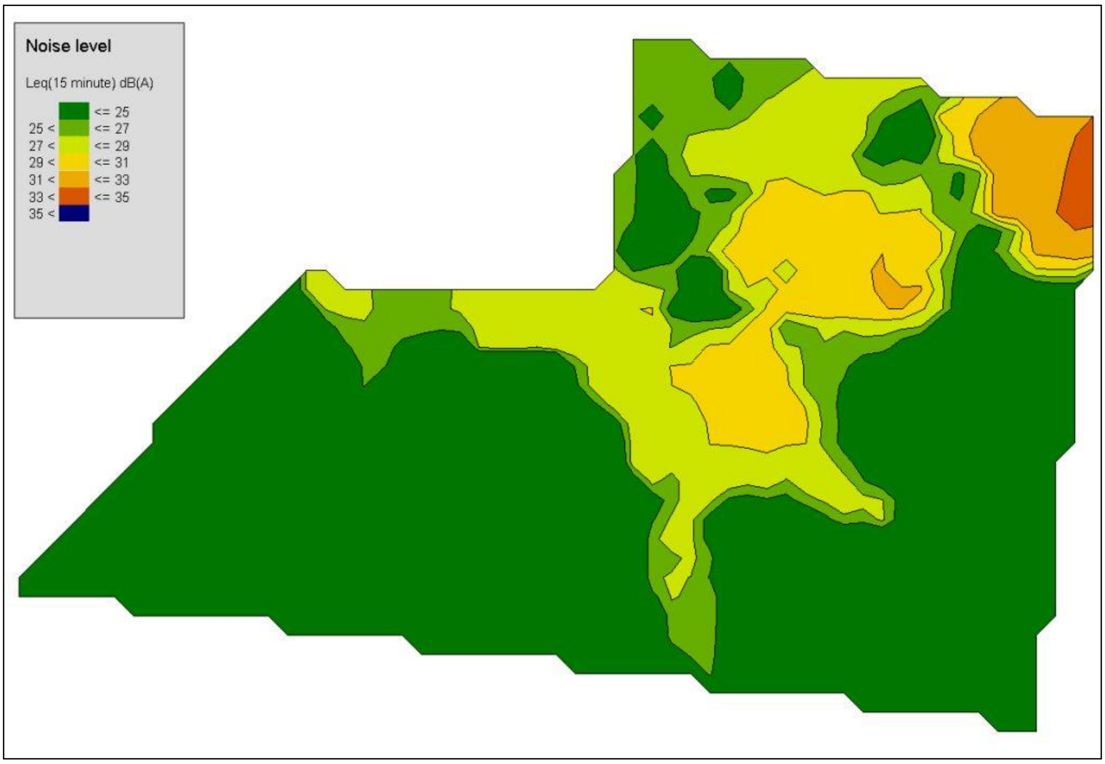


Figure 5.16: Scenario 1 – Location L32 – Adverse Weather Conditions (3m/s Wind Speed from NW)

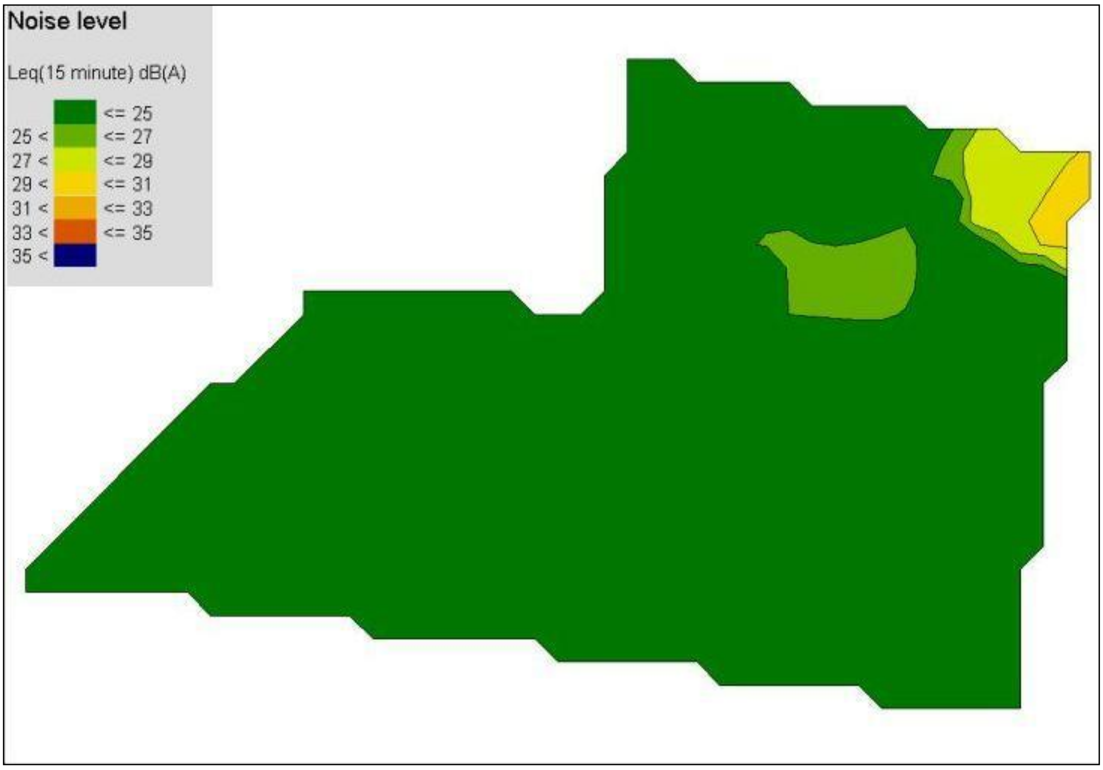


Figure 5.17: Scenario 2 – Location L32 – Adverse Weather Conditions (3m/s Wind Speed from NW)

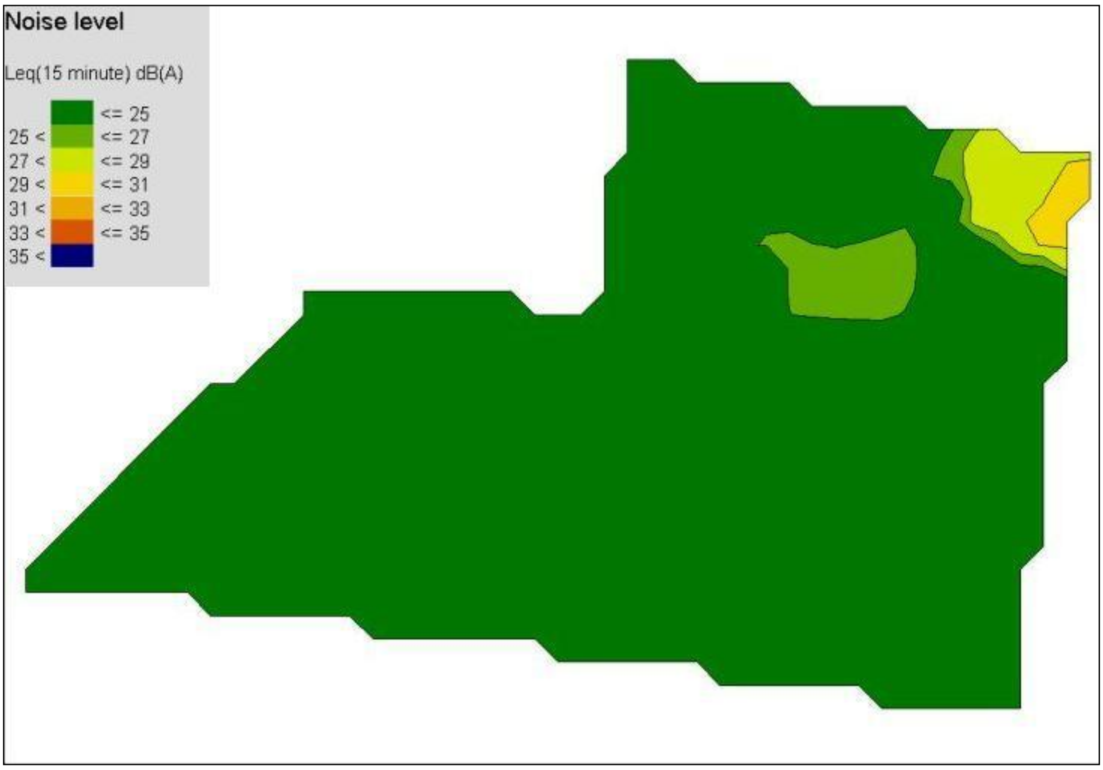
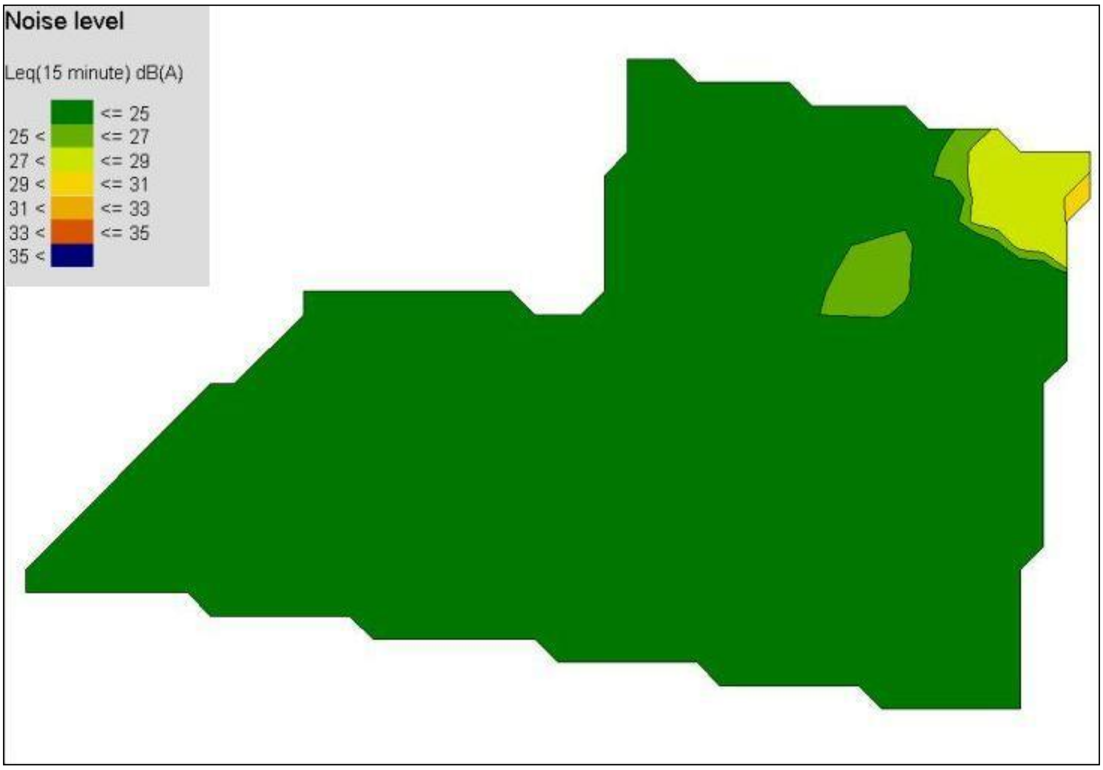


Figure 5.18: Scenario 3 – Location L32 – Adverse Weather Conditions (3m/s Wind Speed from NW)



6. ROAD TRAFFIC NOISE IMPACT ASSESSMENT

A description of the calculation methodology and the noise predictions associated with road traffic has been provided below.

Calculation of road traffic noise contribution has been undertaken using SoundPLAN v7.2.

6.1 LIST OF ASSUMPTIONS

Each assessment-specific assumption has been detailed below:

- A total of 440 trucks have been considered when calculating the daytime $L_{Aeq(15 hour)}$. A total of sixty (60) truck movements have been considered when calculating the night-time $L_{Aeq(9hour)}$. In total, 500 truck movements have therefore been considered which represents the maximum anticipated traffic volume from the Austen Quarry. The Road Transport Assessment (GTA Consultants, 2014) notes that this volume of quarry related traffic is anticipated only during two to three periods over the life of the Proposal. The road traffic noise is therefore considered a conservative estimate of quarry-related traffic noise.

- A shoulder period was applied to the assessment of night time noise, in accordance with guidance provided by the RNP, to more accurately assess road traffic noise during the night time period (which would only occur between the hours of 5:00am and 7:00am).

- Truck speed was considered to be 50 km/h. This is believed to be a reasonable average speed for trucks along Jenolan Caves Road due to the nature of the road having tight bends and curves, truck speeds above 50 km/h are not feasible. Where receiver R24 is located there is a road bridge across the Cox's River. BE has undertaken previous noise studies of the truck movements across this bridge and speeds are typically less than 50 km/h on both approaches due to the nature of the road (i.e. tight curves and bends).

- The distance from the façade of the property to the centre of the road has been considered in the calculations.

6.2 ROAD TRAFFIC PREDICTED NOISE LEVELS

The following noise descriptors have been calculated at the most affected residential receptors:

- $L_{Aeq(15 hour)}$;
- $L_{Aeq(9hour)}$; and
- $L_{Amax (night)}$.

The predicted noise levels are displayed in the following **Table 6.1**.

<table>
<tr><th colspan="11">Table 6.1: Predicted Road Traffic Noise Levels</th></tr>
<tr><th rowspan="2">Receptor ID</th><th colspan="2">Predicted Road Traffic Noise
Hy-Tec Contribution</th><th colspan="2">Calculated Non Hy-Tec related traffic noise contribution</th><th colspan="4">Cumulative Road Traffic Noise Levels
(non-Hy-Tec + Hy-Tec)</th><th colspan="2">Sleep Disturbance</th></tr>
<tr><th>Day
$L_{Aeq\ (15\ hour)}$</th><th>Night
$L_{Aeq\ (9\ hour)}$</th><th>Day
$L_{Aeq\ (15\ hour)}$</th><th>Night
$L_{Aeq\ (9\ hour)}$</th><th>Day
$L_{Aeq\ (15\ hour)}$</th><th>Maximum Increase to Existing Traffic noise</th><th>Night
$L_{Aeq\ (9\ hour)}$</th><th>Increase to Existing Traffic noise</th><th>Day
L_{Amax}</th><th>Shoulder Period
L_{Amax}</th></tr>
<tr><td>R22</td><td>35.7</td><td>27.9</td><td>46.3</td><td>36.1</td><td>46.7</td><td rowspan="5">+ 0.3</td><td>36.7</td><td rowspan="5">+0.2</td><td rowspan="5">N/A</td><td>64.6</td></tr>
<tr><td>R23</td><td>34.2</td><td>26.4</td><td>44.6</td><td>34.5</td><td>45.0</td><td>35.1</td><td>63.1</td></tr>
<tr><td>R24A</td><td>57.1</td><td>49.3</td><td>67.7</td><td>57.5</td><td>68.1</td><td>58.1</td><td>86</td></tr>
<tr><td>R24B (grassed area)

R24B (cottages)</td><td>57.1

43.0</td><td>49.3

35.2</td><td>67.7

53.3</td><td>57.7

43.4</td><td>67.8

53.7</td><td>58.3

44.0</td><td>86

71.9</td></tr>
<tr><td>R48</td><td>41.8</td><td>34.0</td><td>52.2</td><td>42.1</td><td>52.6</td><td>42.7</td><td>70.7</td></tr>
</table>

N/A Not Applicable

The predicted $L_{Aeq,\ 15\ hour}$ and $L_{Aeq,\ 9\ hour}$, road traffic noise levels comply with the noise criteria established in the NSW EPA Road Noise Policy.

In the interest of conservatism, the predicted traffic noise if all 500 trucks were distributed during the 15 hour day period was assessed. This would result in an overall increase of the Proposal related $L_{Aeq(15\ hour)}$ road traffic noise level by approximately 0.5 dB(A). This is considered to be negligible for the purpose of this assessment considering that the noise contribution from the site-related truck movements is well below the existing road traffic noise levels.

Given the vicinity of some of the residences to the road, most of the vehicles that drive along Jenolan Caves Road would exceed the sleep disturbance criteria. As shown in the logger charts presented in **Attachment 4** there are currently numerous night time truck movements not related to the activities of the Austen Quarry which are exceeding the sleep disturbance criteria with L_{Amax} levels up to 88 dB(A) (at the logger location 10 m from the centre of the road) along Jenolan Caves Road.

Exceedances of the sleep disturbance criteria for the off-site traffic have been predicted also for the site related off-site truck movements.

7. BLASTING EFFECTS

The quarry operates within limits on overpressure and ground vibration stipulated in Environment Protection Licence 12323.

This section of the Noise Impact Assessment addresses this issue and firstly provides an explanation of blasting impacts.

References 2, 3 and 4 provide an industry and governmental explanation of blasting impacts.

Reference 2: Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC, 1990)
(R T Benbow, the author of this section of this Noise Impact Assessment has monitored in excess of 300 blasts at quarries around Australia.)

Reference 3: Blasting and the NSW Minerals Industry

Reference 4: Ecoaccess, Guidelines Noise and Vibration from Blasting, Queensland Government

There are two main impacts that may occur as a result of blasting. These impacts may not result in annoyance and in the situation at this quarry, there have been no impacts arise due to a combination of factors which are discussed.

Blasting involves the detonation of explosive placed into holes drilled through the rock and into the subfloor of the quarry pit. The array of holes that are drilled are accurately spaced apart and are placed behind the face of the quarry, again in an accurate manner.

Prior to drilling the first row of holes nearest to the free face, the face is surveyed to ensure there are no zones of weak rock structure. Holes are drilled at a precise angle so that the amount of horizontal throw of the rock across the quarry floor suits the extraction of the blasted rock.

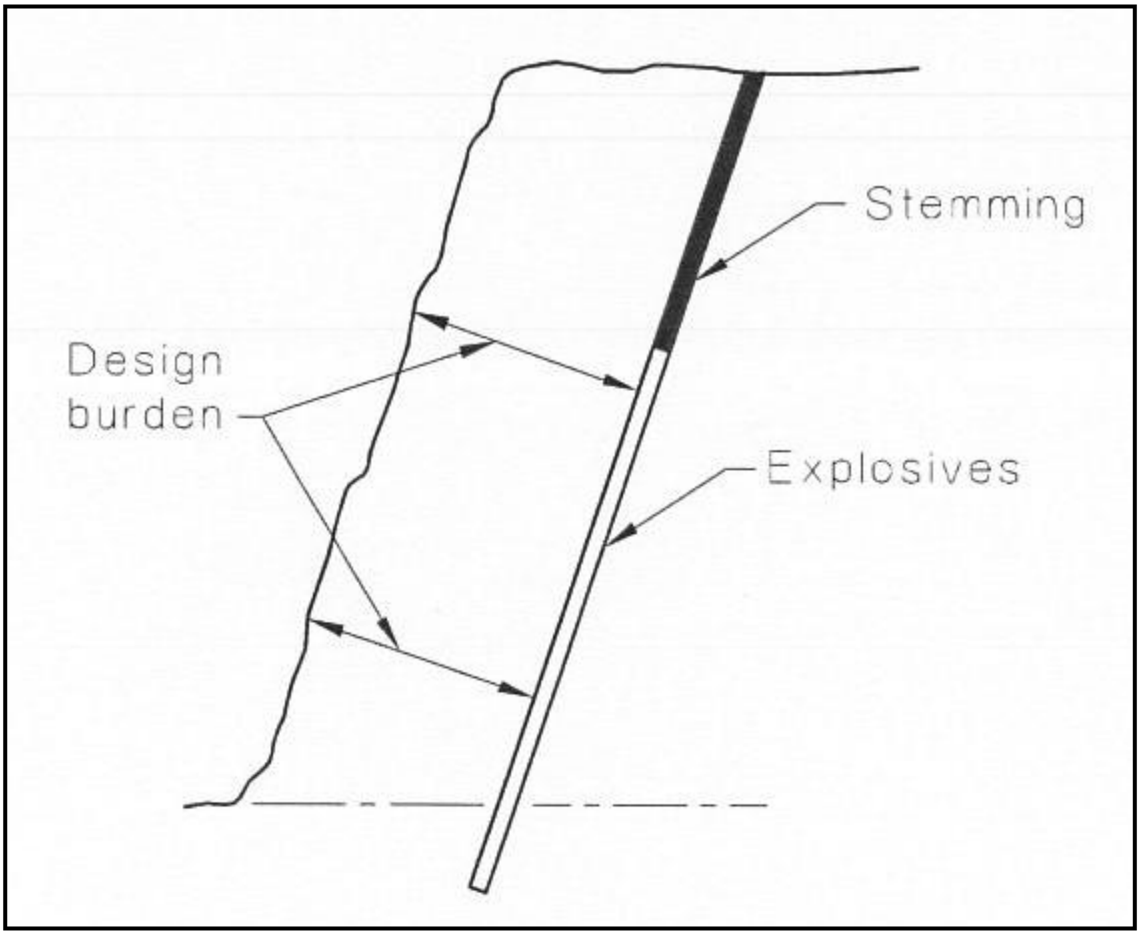
Spacing of the holes and the depth between rows – the burden – are established by the geological properties of the rock and its ability to fragment.

Fragmentation of the rock is critical as this enables the rock to be fed into the primary jaw crusher and maximise the crushing through pit of the first crushing operation.

The explosive contractor fills the holes with a slurry form of explosive up until a set distance from the upper level of the blast face. Stemming is used from this upper level down to the commencement of the explosive.

The following diagram displays the use of stemming:

Figure 7.1: Use of Stemming



Detonation of the holes occurs in a precise manner determined by the explosives contractor and Hy-Tec.

As the explosives are detonated, overpressure and ground vibration are generated. Overpressure, also known as the air blast, is air wave consisting of very low frequency wavelength travelling through the air to the receiver's location.

The level of overpressure is reduced over distance. The minimisation of annoyance is achieved by setting the level of overpressure to 115 dB(L in Peak). This can only exceed up to 5% of the total number of blasts in a 12 month period. The overpressure level is not to exceed 120 dB(L in Peak) at any time.

At the same time as overpressure is generated, a ground borne wave is generated. The ground borne vibration is transmitted as a series of waves that are able to travel rapidly through the ground arriving before the air wave.

The level of ground vibration is also reduced over distance. The minimisation of potential annoyance from ground vibration is achieved by setting the level of ground vibration to 5 mm/second peak particle velocity.

This level may exceed on up to 5% of blasts in a 12 month period. The level of the ground vibration is not to exceed 10 mm/second at any one time.

Time and frequency of blasting are set by the Environment Protection Licence. Environment Protection Licence 12323 sets a 2 mm/second limit on the level of ground vibration at the historic village of Hartley.

The levels of overpressure and ground vibration that can be generated are able to be estimated using a site law that was originally developed from extensive studies undertaken by the US Bureau of Mines.

AS 2187.2–2006 presents these site lows in Appendix J and expresses the site low for inground vibration as:

$$V = K\left(\frac{R}{Q^{\frac{1}{2}}}\right)^{-1.6}$$

V is the predicted level of ground vibration at a separate distance between free blast face and the receiver R in metres.

Q is the effective charge per delay – also described as the maximum instantaneous charge (MIC) in kilograms of explosive. This is the maximum amount of explosive detonated at any instant when the array of holes that make up the blast are detonated.

Electronic delays between sets of holes determine how many holes would be detonated. This number of holes determines the weight of the explosive that would be detonated.

The levels of overpressure and ground vibration that are generated can be predicted with reasonable certainty if data is available for a number of blasts (e.g. 5-10) with levels of overpressure and ground vibration measured to the front, side and rear of the blast.

A site law also exists for overpressure and enables a reasonably accurate prediction of the levels of overpressure that may be generated.

The relationship is based on:

$$OP = K\left(\frac{R}{Q^{\frac{1}{3}}}\right)^{-1.2}$$

OP is the level of overpressure as dB(L in Peak), R is the separation distance between the blast face and the receiver location in metres.

Q is the effective charge weight per delay (i.e. maximum instantaneous charge).

K is a scaling factor, a number, derived from site measurements.

For the assessment of blasting effects the use of site law is not warranted as the blasting are conducted to a high standard and monitoring by engineers from the explosive contractor show ready compliance. This is further supported by the absence of a complaints history.

Blast design details practiced at the quarry have been provided by the Technical Centre of Orica Quarry Service.

The typical blast details are:

- Hole diameter – 102 mm
- Drill angle - 10 degrees
- Front row burden – 3.7 m
- Design burden – 3.7 m
- Design spacing – 4.2 m
- Sub drilling (into the floor of the quarry) – 0.7 m
- Stemming height – 2.5 m
- Average hole length – 8 m
- Average bench length (i.e. height of the force being blasted) – 6.55 m
- Powder factor – 0.55

Details of MIC have been included in **Attachment 5**. However, the available blasting data is not sufficient to undertake a quantitative assessment, in fact, the available blast overpressure and ground vibration data measured at Hartley Village are all below the trigger level of the blast monitor. 100 dB (in peak) and D.51 mm / second were set out.

Blast monitoring is undertaken using an Instantech Minimate Blaster with Serial Number BE18005 V10, 40-1.1. The unit is understood to be regularly calibrated for use on site. The levels of blast overpressure and ground vibration are not expected to alter from the existing levels as the proven blasting practice for this quarry would be maintained, including the separation distances and assentation of the blast faces. These would not be substantially different to source increases in overpressure. The blasting effects are expected to continue to readily meet the levels stipulated in Environment Protection Licence n.12323.

8. RECOMMENDATIONS AND CONCLUSION

A detailed noise impact assessment has been undertaken for the proposed expansion of the existing Hartley Quarry located at 391 Jenolan Caves Road, Hartley, NSW.

The study is focussed on the potential noise impacts associated with the proposed expansion, which includes:

- Drilling;
- Blasting;
- Mobile plant operations including excavators;
- Crushing and screening operations;
- Material loading operations; and
- On-site and off-site truck movements;

This noise impact assessment focussed on evaluating the noise impact from the aforementioned activities, as well as a qualitative assessment of vibration impacts resulting from blasting operations. Off-site road traffic noise was also assessed as was the potential for sleep disturbance.

Background and ambient noise levels were measured at three residential locations in the proximity of the site through short-term attended and long-term unattended noise monitoring. Noise design objectives were set in accordance with the criteria set out in the Industrial Noise Policy (INP) and the Road Noise Policy (RNP). Noise emissions resulting from the proposed development operations were predicted based on current NSW Environment Protection Authority's (EPA) guidelines with conservative factors throughout.

Off-site truck movements have also been included in the model and noise levels predicted at the most affected residences along the Jenolan Caves Road.

Noise levels associated with the quarry operations have been predicted to comply with the noise criteria set in accordance with the NSW EPA INP under neutral weather conditions and presence of 3 m/s wind speed blowing from north-west.

During the shoulder period between 6:00am and 7:00am under noise enhancing temperature inversion weather condition the noise levels have been predicted to be below the noise criteria at all the residential location except for location R31 and R48. At these locations a maximum exceedance of 1.3 dB and 0.3 dB respectively has been predicted under noise enhancing temperature inversion condition and between 6:00am and 7:00am only when the site is fully operating. In addition, the exceedances would occur when all the equipment and vehicles on site are simultaneously operating at their full capacity. This situation is very unlikely to occur.

The main noise contribution is the drill rig which rarely commences prior to 7:00am. However, should drilling be undertaken during the shoulder period and coincide with a temperature inversion, an exceedance at location R31 may occur.

Benbow Environmental believes that given the conservatism of the assessment methodology, which assumes the simultaneous operation of all noise sources operating during shoulder periods, and the small extent of the exceedance, compliance with noise criteria is likely to be achieved even during shoulder periods under noise enhancing weather conditions. It is proposed that a noise compliance assessment be carried out during the early stage of the proposed operations in order to determine the operational noise levels at location R31 during the shoulder periods and under noise enhancing weather conditions.

Should non-compliance be found, the operations of the drilling rig would be limited to daytime hours only i.e. from 8:00 am, and further noise compliance undertaken. Alternatively, the use of mobile noise barriers could be adopted for the site. Additional alternative noise control measures would be investigated in the case of further non-compliance recorded during these weather conditions.

The predicted off site road traffic levels comply with the criteria established in accordance with the NSW EPA Road Noise Policy.

The sleep disturbance criterion is not achieved at the considered residential receptors when the trucks are travelling along Jenolan Caves Road during the shoulder period between 5:00am and 7:00am. Very little can be done in order to reduce noise emissions from trucks passing by as the nearest residence would be approximately 7 metres away from the road.

This exceedance is not considered to be significant as there are currently multiples traffic noise events during night time generating L_{Amax} noise levels up to 88 dB(A) along Jenolan Caves Road.

In order to verify all assumptions made, and strengthen all conclusions drawn, the undertaking of post-commissioning validation measurements is recommended.

This concludes the report.

Daniele Albanese
Senior Acoustic Engineer

R T Benbow
Principal Consultant

9. LIMITATIONS

Our services for this project are carried out in accordance with our current professional standards for site assessment investigations. No guarantees are either expressed or implied.

This report has been prepared solely for the use of Hy-Tec Industries Pty Ltd, as per our agreement for providing environmental services. Only Hy-Tec Industries Pty Ltd is entitled to rely upon the findings in the report within the scope of work described in this report. Otherwise, no responsibility is accepted for the use of any part of the report by another in any other context or for any other purpose.

Although all due care has been taken in the preparation of this study, no warranty is given, nor liability accepted (except that otherwise required by law) in relation to any of the information contained within this document. We accept no responsibility for the accuracy of any data or information provided to us by Hy-Tec Industries Pty Ltd for the purposes of preparing this report.

Any opinions and judgements expressed herein, which are based on our understanding and interpretation of current regulatory standards, should not be construed as legal advice.

10. REFERENCES

1. Standards Australia, AS 2187.2–2006 *Explosives – Storage and use Part 2: Use of Explosives*, February 2006.

2. Australian and New Zealand Environment Council (ANZEC), *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration,* September 1990.

3. NSW Minerals Council Ltd, *Blasting and the NSW Minerals Industry,* November 2009.

4. Ecoaccess , Guideline Noise, *Noise and Vibration from Blasting*, Queensland Government Environmental Protection Agency,

5. National Park Service Handbook for the Storage, Transportation And Use of Explosives, Chapter 8 Blast Design, National Park Service 1999.

ATTACHMENTS

Note: Attachments 2 to 5 are only available on the Project CD

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Attachment 1: Noise Terminology

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'A' FREQUENCY WEIGHTING

The 'A' frequency weighting roughly approximates to the Fletcher-Munson 40 phon equal loudness contour. The human loudness perception at various frequencies and sound pressure levels is equated to the level of 40 dB at 1 kHz. The human ear is less sensitive to low frequency sound and very high frequency sound than midrange frequency sound (i.e. 500 Hz to 6 kHz). Humans are most sensitive to midrange frequency sounds, such as a child's scream. Sound level meters have inbuilt frequency weighting networks that very roughly approximates the human loudness response at low sound levels. It should be noted that the human loudness response is not the same as the human annoyance response to sound. Here low frequency sounds can be more annoying than midrange frequency sounds even at very low loudness levels. The 'A' weighting is the most commonly used frequency weighting for occupational and environmental noise assessments. However, for environmental noise assessments, adjustments for the character of the sound will often be required.

AMBIENT NOISE

The ambient noise level at a particular location is the overall environmental noise level caused by all noise sources in the area, both near and far, including all forms of traffic, industry, lawnmowers, wind in foliage, insects, animals, etc. Usually assessed as an energy average over a set time period 'T' (L_{Aeq},T).

AUDIBLE

Audible refers to a sound that can be heard. There are a range of audibility grades, varying from "barely audible", "just audible" to "clearly audible" and "prominent".

BACKGROUND NOISE LEVEL

Total silence does not exist in the natural or built-environments, only varying degrees of noise. The Background Noise Level is the minimum repeatable level of noise measured in the absence of the noise under investigation and any other short-term noises such as those caused by all forms of traffic, industry, lawnmowers, wind in foliage, insects, animals, etc.. It is quantified by the noise level that is exceeded for 90 % of the measurement period 'T' (L_{A90}, T). Background Noise Levels are often determined for the day, evening and night time periods where relevant. This is done by statistically analysing the range of time period (typically 15 minute) measurements over multiple days (often 7 days). For a 15 minute measurement period the Background Noise Level is set at the quietest level that occurs at 1.5 minutes.

'C' FREQUENCY WEIGHTING

The 'C' frequency weighting approximates the 100 phon equal loudness contour. The human ear frequency response is more linear at high sound levels and the 100 phon equal loudness contour attempts to represent this at various frequencies at sound levels of approximately 100 dB.

DECIBEL

The decibel (dB) is a logarithmic scale that allows a wide range of values to be compressed into a more comprehensible range, typically 0 dB to 120 dB. The decibel is ten times the logarithm of the ratio of any two quantities that relate to the flow of energy (i.e. power). When used in acoustics it is the ratio of square of the sound pressure level to a reference sound pressure level, the ratio of the sound power level to a reference sound power level, or the ratio of the sound intensity level to a reference sound intensity level. See also Sound Pressure Level and Sound Power Level. Noise levels in decibels cannot be added arithmetically since they are logarithmic numbers. If one machine is generating a noise level of 50 dB, and another similar machine is placed beside it, the level will increase to 53 dB (from $10 \log_{10} (10^{(50/10)} + 10^{(50/10)})$ and not 100 dB. In theory, ten similar machines placed side by side will increase the sound level by 10 dB, and one hundred machines increase the sound level by 20 dB. The human ear has a vast sound-sensitivity range of over a thousand billion to one so the logarithmic decibel scale is useful for acoustical assessments.

dBA – See 'A' frequency weighting

dBC – See 'C' frequency weighting

EQUIVALENT CONTINUOUS SOUND LEVEL, LAeq

Many sounds, such as road traffic noise or construction noise, vary repeatedly in level over a period of time. More sophisticated sound level meters have an integrating/averaging electronic device inbuilt, which will display the energy time-average (equivalent continuous sound level - L_{Aeq}) of the 'A' frequency weighted sound pressure level. Because the decibel scale is a logarithmic ratio, the higher noise levels have far more sound energy, and therefore the LAeq level tends to indicate an average which is strongly influenced by short term, high level noise events. Many studies show that human reaction to level-varying sounds tends to relate closer to the L_{Aeq} noise level than any other descriptor.

'F'(FAST) TIME WEIGHTING

Sound level meter design-goal time constant which is 0.125 seconds.

FLETCHER–MUNSON EQUAL LOUDNESS CONTOUR CURVES

The Fletcher–Munson curves are one of many sets of equal loudness contours for the human ear, determined experimentally by Harvey Fletcher and Wilden A. Munson, and reported in a 1933 paper entitled "Loudness, its definition, measurement and calculation" in the Journal of the Acoustic Society of America.

FREE FIELD

In acoustics a free field is a measurement area not subject to significant reflection of acoustical energy. A free field measurement is typically not closer than 3.5 metres to any large flat object (other than the ground) such as a fence or wall or inside an anechoic chamber.

FREQUENCY

The number of oscillations or cycles of a wave motion per unit time, the SI unit is the hertz (Hz). 1 Hz is equivalent to one cycle per second. 1000 Hz is 1 kHz.

IMPACT ISOLATION CLASS (IIC)

The American Society for Testing and Materials (ASTM) has specified that the IIC of a floor/ceiling system shall be determined by operating an ISO 140 Standard Tapping Machine on the floor and measuring the noise generated in the room below. The IIC is a number found by fitting a reference curve to the measured octave band levels and then deducting the sound pressure level at 500 Hz from 110 decibels. Thus the higher the IIC, the better the impact sound isolation. Not commonly used in Australia.

'I' (IMPULSE) TIME WEIGHTING

Sound level meter time constant now not in general use. The 'I' (impulse) time weighting is not suitable for rating impulsive sounds with respect to their loudness. It is also not suitable for assessing the risk of hearing impairment or for determining the 'impulsiveness' of a sound.

IMPACT SOUND INSULATION ($L_{nT,w}$)

Australian Standard AS ISO 717.2 – 2004 has specified that the Impact Sound Insulation of a floor/ceiling system be quantified by operating an ISO 140 Standard Tapping Machine on the floor and measuring the noise generated in the room below. The Weighted Standardised Impact Sound Pressure Level ($L_{nT,w}$) is the sound pressure level at 500 Hz for a reference curve fitted to the measured 1/3 octave band levels. Thus the lower $L_{nT,w}$ the better the impact sound insulation.

IMPULSE NOISE

An impulse noise is typified by a sudden rise time and a rapid sound decay, such as a hammer blow, rifle shot or balloon burst.

LOUDNESS

The volume to which a sound is audible to a listener is a subjective term referred to as loudness. Humans generally perceive an approximate doubling of loudness when the sound level increases by about 10 dB and an approximate halving of loudness when the sound level decreases by about 10 dB.

MAXIMUM NOISE LEVEL, LAFmax

The root-mean-square (rms) maximum sound pressure level measured with sound level meter using the 'A' frequency weighting and the 'F' (Fast) time weighting. Often used for noise assessments other than aircraft.

MAXIMUM NOISE LEVEL, LASmax

The root-mean-square (rms) maximum sound pressure level measured with sound level meter using the 'A' frequency weighting and the 'S' (Slow) time weighting. Often used for aircraft noise assessments.

NOISE RATING NUMBERS

A set of empirically developed equal loudness curves has been adopted as Australian Standard AS1469-1983. These curves allow the loudness of a noise to be described with a single NR number. The Noise Rating number is that curve which touches the highest level on the measured spectrum of the subject noise. For broadband noise such as fans and engines, the NR number often equals the ‘A’ frequency weighted dB level minus five.

NOISE

Noise is unwanted, harmful or inharmonious (discordant) sound. Sound is wave motion within matter, be it gaseous, liquid or solid. Noise usually includes vibration as well as sound.

NOISE REDUCTION COEFFICIENT – See: "Sound Absorption Coefficient"

OFFENSIVE NOISE

Reference: Dictionary of the NSW Protection of the Environment Operations Act 1997).
"Offensive Noise means noise:
(a) that, by reason of its level, nature, character or quality, or the time at which it is made, or any other circumstances:
(i) is harmful to (or likely to be harmful to) a person who is outside the premise from which it is emitted, or
(ii) interferes unreasonably with (or is likely to interfere unreasonably with) the comfort or repose of a person who is outside the premises from which it is emitted, or
(b) that is of a level, nature, character or quality prescribed by the regulations or that is made at a time, or in other circumstances prescribed by the regulations."

PINK NOISE

Pink noise is a broadband noise with an equal amount of energy in each octave or third octave band width. Because of this, Pink Noise has more energy at the lower frequencies than White Noise and is used widely for Sound Transmission Loss testing.

REVERBERATION TIME, T60

The time in seconds, after a sound signal has ceased, for the sound level inside a room to decay by 60 dB. The first 5 dB decay is often ignored, because of fluctuations that occur while reverberant sound conditions are being established in the room. The decay time for the next 30 dB is measured and the result doubled to determine the T_{60}. The Early Decay Time (EDT) is the slope of the decay curve in the first 10 dB normalised to 60 dB.

SOUND ABSORPTION COEFFICIENT, α

Sound is absorbed in porous materials by the viscous conversion of sound energy to a small amount of heat energy as the sound waves pass through it. Sound is similarly absorbed by the flexural bending of internally damped panels. The fraction of incident energy that is absorbed is termed the Sound Absorption Coefficient, α. An absorption coefficient of 0.9 indicates that 90 % of the incident sound energy is absorbed. The average α from 250 to 2 kHz is termed the Noise Reduction Coefficient (NRC).

‘S’ (SLOW) TIME WEIGHTING

Sound level meter design-goal time constant which is 1 second.

SOUND ATTENUATION

A reduction of sound due to distance, enclosure or some other devise. If an enclosure is placed around a machine, or an attenuator (muffler or silencer) is fitted to a duct, the noise emission is reduced or attenuated. An enclosure that attenuates the noise level by 20 dB reduces the sound energy by one hundred times.

SOUND EXPOSURE LEVEL (LAE)

Integration (summation) rather than an average of the sound energy over a set time period. Use to assess single noise events such as truck or train pass by or aircraft flyovers. The sound exposure level is related to the energy average (L_{Aeq}, T) by the formula L_{Aeq}, T = L_{AE} – 10 $\log_{10}$ T. The abbreviation (SEL) is sometimes inconsistently used in place of the symbol (L_{AE}).

SOUND PRESSURE

The rms sound pressure measured in pascals (Pa). A pascal is a unit equivalent to a newton per square metre (N/m^2).

SOUND PRESSURE LEVEL, Lp

The level of sound measured on a sound level meter and expressed in decibels (dB). Where $L_P = 10 \log_{10} (Pa/Po)^2$ dB (or 20 log10 (Pa/ Po) dB) where Pa is the rms sound pressure in Pascal and Po is a reference sound pressure conventionally chosen is 20 µPa (20×10^{-6} Pa) for airborne sound. L_p varies with distance from a noise source.

SOUND POWER

The rms sound power measured in watts (W). The watt is a unit defined as one joule per second. A measures the rate of energy flow, conversion or transfer.

SOUND POWER LEVEL, Lw

The sound power level of a noise source is the inherent noise of the device. Therefore sound power level does not vary with distance from the noise source or with a different acoustic environment. Lw = Lp + 10 $\log_{10}$ 'a' dB, re: 1pW, (10^{-12} watts) where 'a' is the measurement noise-emission area (m^2) in a free field.

SOUND TRANSMISSION CLASS (STC)

An internationally standardised method of rating the sound transmission loss of partition walls to indicate the sound reduction from one side of a partition to the other in the frequency range of 125 Hz to 4000 kHz. (Refer: Australian Standard AS 1276 – 1979). Now not in general use in Australia see: weighted sound reduction index.

SOUND TRANSMISSION LOSS

The amount in decibels by which a random sound is reduced as it passes through a sound barrier. A method for the measurement of airborne Sound Transmission Loss of a building partition is given in Australian Standard AS 1191 - 2002.

STATISTICAL NOISE LEVELS, Ln.

Noise which varies in level over a specific period of time 'T' (standard measurement times are 15 minute periods) may be quantified in terms of various statistical descriptors for example:-

- The noise level, in decibels, exceeded for 1 % of the measurement time period, when 'A' frequency weighted and 'F' time weighted is reference to as L_{AF1}, T. This may be used for describing short-term noise levels such as could cause sleep arousal during the night.

- The noise level, in decibels, exceeded for 10 % of the measurement time period, when 'A' frequency weighted and 'F' time weighted is reference to as L_{AF10}, T. In most countries the LAF10, T is measured over periods of 15 minutes, and is used to describe the average maximum noise level.

- The noise level, in decibels, exceeded for 90 % of the measurement time period, when 'A' frequency weighted and 'F' time weighted is reference to as L_{AF90}, T. In most countries the LAF90, T is measured over periods of 15 minutes, and is used to describe the average minim um or background noise level.

STEADY NOISE

Noise, which varies in level by 6 dB or less, over the period of interest with the time-weighting set to "Fast", is considered to be "steady". (Refer AS 1055.1 1997).

WEIGHTED SOUND REDUCTION INDEX, Rw

This is a single number rating of the airborne sound insulation of a wall, partition or ceiling. The sound reduction is normally measured over a frequency range of 100 Hz to 3.150 kHz and averaged in accordance with ISO standard weighting curves (Refer AS/NZS 1276.1:1999). Internal partition wall Rw + C ratings are frequency weighted to simulate insulation from human voice noise. The R_w + C is similar in value to the STC rating value. External walls, doors and windows may be R_w + C_{tr} rated to simulate insulation from road traffic noise. The spectrum adaptation term Ctr adjustment factor takes account of low frequency noise. The weighted sound reduction index is normally similar or slightly lower number than the STC rating value.

WHITE NOISE

White noise is broadband random noise whose spectral density is constant across its entire frequency range. The sound power is the same for equal bandwidths from low to high frequencies. Because the higher frequency octave bands cover a wider spectrum, white noise has more energy at the higher frequencies and sounds like a hiss.

'Z' FREQUENCY WEIGHTING

The 'Z' (Zero) frequency weighting is 0 dB within the nominal 1/3 octave band frequency range centred on 10 Hz to 20 kHz. This is within the tolerance limits given in AS IEC 61672.1-2004: 'Electroacoustics - Sound level meters – Specifications'.

Attachment 2: QA/QC Procedures

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Calibration of Sound Level Meters

A sound level meter requires regular calibration to ensure its measurement performance remains within specification. Benbow Environmental sound level meters are calibrated by a National Association of Testing Authority (NATA) registered laboratory or a laboratory approved by the NSW Environment Protection Authority (EPA) every two years and after each major repair, in accordance with AS 1259-1990.

The calibration of the sound level meter was checked immediately before and after each series of measurements using an acoustic calibrator. The acoustic calibrator provides a known sound pressure level, which the meter indicates when the calibrator is activated while positioned on the meter microphone.

The sound level meters also incorporate an internal calibrator for use in setting up. This provides a check of the electrical calibration of the meter, but does not check the performance of the microphone. Acoustical calibration checks the entire instrument including the microphone. Calibration certificates for the instrument sets used have been included as **Attachment 3**.

Care and Maintenance of Sound Level Meters

Noise measuring equipment contains delicate components and therefore must be handled accordingly. The equipment is manufactured to comply with international and national standards and is checked periodically for compliance. The technical specifications for sound level meters used in Australia are defined in Australian Standard AS 1259 – 1990 "*Sound Level Meters"*.

The sound level meters and associated accessories are protected during storage, measurement and transportation against dirt, corrosion, rapid changes of temperature, humidity, rain, wind, vibration, electric and magnetic fields. Microphone cables and adaptors are always connected and disconnected with the power turned off. Batteries are removed (with the instrument turned off) if the instrument is not to be used for some time.

Investigation Procedures

All investigative procedures were conducted in accordance with AS 1055.1-1997 *Acoustics – "Description and Measurement of Environmental Noise (Part 1: General Procedures)"*.

The following information was recorded and kept for reference purposes:

- type of instrumentation used and measurement procedure conducted;
- description of the time aspect of the measurements, ie. measurement time intervals; and
- positions of measurements and the time and date were noted.

As per AS 1055.1-1997, all measurements were carried out at least 3.5 m from any reflecting structure other than the ground. The preferred measurement height of 1.2 m above the ground was utilised. A sketch of the area was made identifying positions of measurement and the approximate location of the noise source and distances in meters (approx.).

UNATTENDED NOISE MONITORING

NOISE MONITORING EQUIPMENT

ARL noise loggers type EL-215 and ARL Ngara were used to conduct the long-term unattended noise monitoring. This equipment complies with Australian Standard 1259.2-1990 "Acoustics - Sound Level Meters" and is designated as a Type 2 instrument suitable for field use.

The measured data is processed statistically and stored in memory every 15 minutes. The equipment was calibrated prior and subsequent to the measurement period using a Rion NC-73 sound level calibrator. There were no significant variances observed in the reference signal between the pre-measurement and post-measurement calibrations. Instrument calibration certificates have also been included in **Attachment 3**.

METEOROLOGICAL CONSIDERATION DURING MONITORING

For the long-term attended monitoring, meteorological data for the relevant period were provided by the Bureau of Meteorology, which was considered representative of the site for throughout the monitoring period.

Measurements affected by wind speeds greater than 5 m/s or rain was excluded from the final analyses of the recorded data in accordance with the EPA's Industrial Noise Policy (INP). The wind data were modified to take into account the difference of height between the AWS (Automatic Weather Station) used by the Bureau of Meteorology (10m above ground level), and the microphone (1.5m above ground level). The correction factor applied to the data was calculated according to the Australian Standard AS1170.2 1989 Section 4.2.5.1.

DESCRIPTORS & FILTERS USED FOR MONITORING

Noise levels are commonly measured using A-weighted filters and are usually described as dB(A). The "A-weighting" refers to standardised amplitude versus frequency curve used to "weight" sound measurements to represent the response of the human ear. The human ear is less sensitive to low frequency sound than it is to high frequency sound. Overall A-weighted measurements quantify sound with a single number to represent how people subjectively hear different frequencies at different levels.

Noise environments can be described using various descriptors depending on characteristics of noise or purpose of assessments. For this survey the L_{A90}, L_{Aeq} and L_{Amax} levels were used to analyse the monitoring results. The statistical descriptors L_{A90} measures the noise level exceeded for 90% of the sample measurement time, and is used to describe the "Background noise". Background noise is the underlying level of noise present in the ambient noise, excluding extraneous noise or the noise source under investigation. The L_{Aeq} level is the equivalent continuous noise level or the level averaged on an equal energy basis which is used to describe the "Ambient Noise". The L_{Amax} noise levels are maximum sound pressure levels measured over the sampling period and this parameter is commonly used when assessing noise impact.

Measurement sample periods were fifteen minutes. The Noise -vs- Time graphs representing measured noise levels at the noise monitoring locations are presented in **Attachment 4**.

ATTENDED NOISE MONITORING

NOISE MONITORING EQUIPMENT

The attended short-term noise monitoring was carried out using a SVANTEK SVAN957 Class 1 Precision Sound Level Meter. The instrument was calibrated by a NATA accredited laboratory within two years of the measurement period. The instrument sets comply with AS 1259 and was set on A-weighted, fast response.

The microphone was positioned at 1.2 to 1.5 metres above ground level and was fitted with windsocks. The instrument was calibrated using a Rion NC-73 sound level calibrator prior and subsequent to the measurement period to ensure the reliability and accuracy of the instrument sets. There were no significant variances observed in the reference signal between the pre-measurement and post-measurement calibrations. Instrument calibration certificates have also been included in **Attachment 3**.

WEATHER CONDITIONS

It was clear, find without significant breeze.

METHODOLOGY

The attended noise measurements were carried out generally in accordance with Australian Standard AS1055-1997 - "Acoustics – Description and Measurement of Environmental Noise".

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Attachment 3: Calibration Certificates

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CERTIFICATE OF CALIBRATION

CERTIFICATE NO: 14197

EQUIPMENT TESTED: Sound Level Calibrator

Manufacturer: Rion
Type No: NC-73 **Serial No:** 10186522
Owner: Benbow Environmental
13 Daking Street
North Parramatta NSW 2151

Tests Performed: Measured output pressure level was found to be:

Parameter	Pre-Adj	Adj Y/N	Output: (db re 20 μPa)	Frequency: (Hz)	THD&N (%)
Level 1:	94.29	Y	94.28	993.7	0.28
Level 2:	NA	N	NA	NA	NA
Uncertainty:			±0.1 dB	±0.5 Hz	±0.2 %
Uncertainty (at 95% c.l.) k=2					

CONDITION OF TEST:
Ambient Pressure: 1007 hPa ±1.5 hPa **Relative Humidity:** 22% ±5%
Temperature: 23 °C ±2° C
Date of Calibration: 05/03/2013 **Issue Date:** 05/03/2013
Acu-Vib Test Procedure: AVP02 (Calibrators)
Test Method: AS IEC 60942 - 2004
CHECKED BY: AK **AUTHORISED SIGNATORY:** ....
Jack Kielt

Accredited for compliance with ISO/IEC 17025
The results of the tests, calibration and/or measurements included in this document are traceable to Australian/national standards.

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Accredited Lab. 9262
Acoustic and Vibration Measurements

ACU-VIB ELECTRONICS
HEAD OFFICE
Unit 14, 22 Hudson Ave. Castle Hill NSW 2154
Tel: (02) 96808133 Fax: (02)96808233
Mobile: 0413 809806
Web site: www.acu-vib.com.au

Page 1 of 1 End of Calibration Certificate
AVCERT02 Rev 1.1 29.01.13

CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: **SLM 39146 & FILT 3839**

Equipment Description: Sound & Vibration Analyser

Manufacturer: Svantek

Model No: Svan-957 **Serial No:** 15336

Microphone Type: 7052H **Serial No:** 40814

Filter Type: 1/3 Octave **Serial No:** 15336

Comments: All tests passed for type 1.

Owner: Benbow Environmental
13 Daking Street
North Parramatta 2151

Ambient Pressure: 1018 hPa ±1.5 hPa

Temperature: 23 °C ±2° C **Relative Humidity:** 45 %RH ±5% RH

Date of Calibration: 21/07/2012 **Issue Date:** 25/07/2012

Acu-Vib Test Procedure: AVP05 (SLM) & AVP06 (Filters) if applicable

CHECKED BY: AK **AUTHORISED SIGNATORY:** ....
Jack Kielt

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CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: **SLM 38276 & FILT 2465**

Equipment Description:	Sound Level Meter		
Manufacturer:	Svantek		
Model No:	Svan-957	**Serial No:**	15335
Microphone Type:	7052E	**Serial No:**	47869
Filter Type:	1/3 Octave	**Serial No:**	15335
Comments:	All tests passed for type 1.		
Owner:	Benbow Environmental 13 Daking Street North Parramatta NSW 2151		
Ambient Pressure:	992 hPa ±1.5 hPa		
Temperature:	23 °C ±2° C	**Relative Humidity:**	36 %RH ±5% RH
Date of Calibration:	06/07/2011	**Issue Date:**	06/07/2011
Acu-Vib Test Procedure:	AVP05 (SLM) & AVP06 (Filters) if applicable		
CHECKED BY: AH		**AUTHORISED SIGNATORY:**	Jack Kielt

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Acoustic Research Laboratories
Proprietary Limited A.B.N. 47 050 100 804
Noise and Vibration Monitoring Instrumentation for Industry and the Environment

Sound Level Meter Test Report

Report Number : C11621

Date of Test :	2/12/2011
Report Issue Date :	5/12/2011
Equipment Tested/ Model Number:	**Ngara S-Pack Sound Acquisition System**
Instrument Serial Number:	8780AC
Microphone Serial Number:	317859
Preamplifier Serial Number:	27984
Client Name :	Benbow Environmental 13 Daking Street North Parramatta NSW 2151
Contact Name :	Daniel Albanese
Tested by :	Ken Williams
Approved Signatory :	[signature]
Date :	**5th December 2011**

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Acoustic Research Laboratories
Proprietary Limited A.B.N. 47 050 100 804
Noise and Vibration Monitoring Instrumentation for Industry and the Environment

Sound Level Meter Test Report

Report Number : C11622

Date of Test :	2/12/2011
Report Issue Date :	2/12/2011
Equipment Tested/ Model Number:	**Ngara S-Pack Sound Acqusition Systen**
Instrument Serial Number:	8780AD
Microphone Serial Number:	317856
Preamplifier Serial Number:	27983
Client Name :	Benbow Environmental
	13 Daking Street
	North Parramatta NSW 2151
Contact Name :	Daniel Albanese
Tested by :	Adrian Walker
Approved Signatory :	[signature]
Date :	**2nd December 2011**

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CERTIFICATE OF CALIBRATION

CERTIFICATE NO.: **SLM 38288**

Equipment Description: Noise Logger

Manufacturer: ARL

Model No: EL-215 **Serial No:** 194702

Microphone Type: Electret **Serial No:** 194702

Filter Type: - **Serial No:** -

Comments: All tests passed for type 2.

Owner: Benbow Environmental
13 Daking Street
North Parramatta NSW 2151

Ambient Pressure: 1013 hPa ±1.5 hPa

Temperature: 23 °C ±2° C **Relative Humidity:** 31 %RH ±5% RH

Date of Calibration: 14/07/2011 **Issue Date:** 15/07/2011

Acu-Vib Test Procedure: AVP05 (SLM) & AVP06 (Filters) if applicable

CHECKED BY: ..AH.. **AUTHORISED SIGNATORY:** ....
Jack Kielt

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Attachment 4: Logger Graphs

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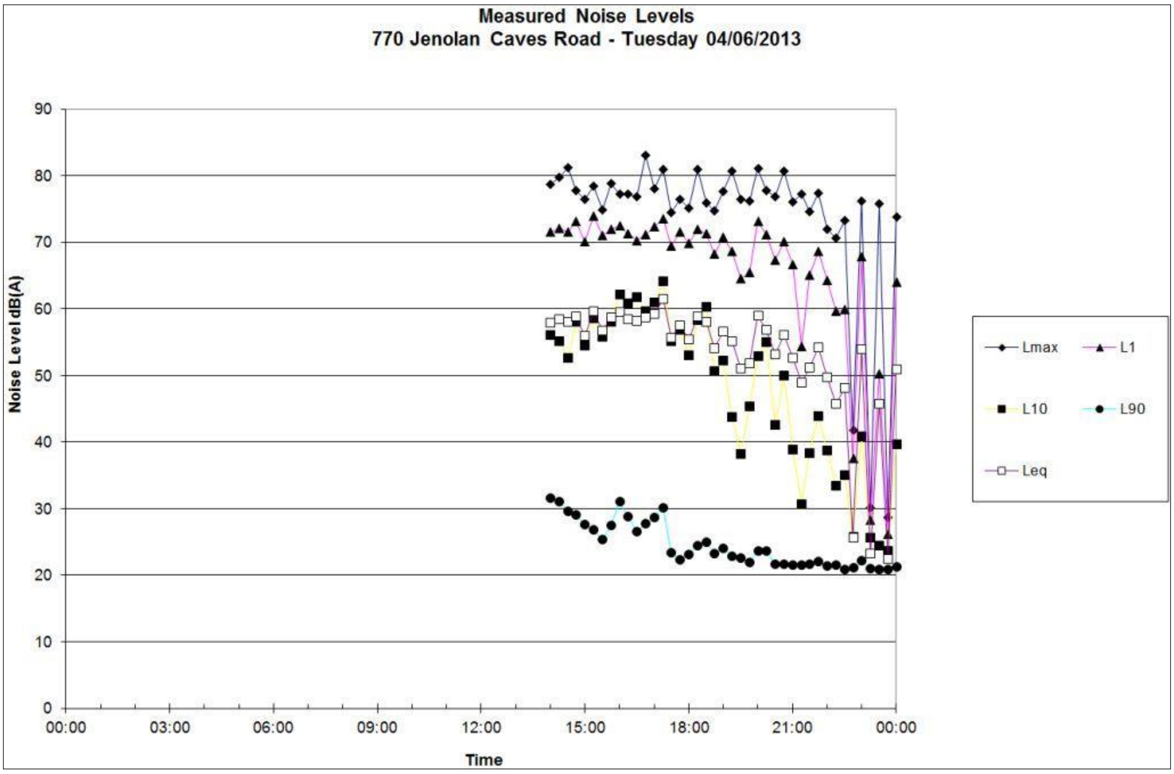
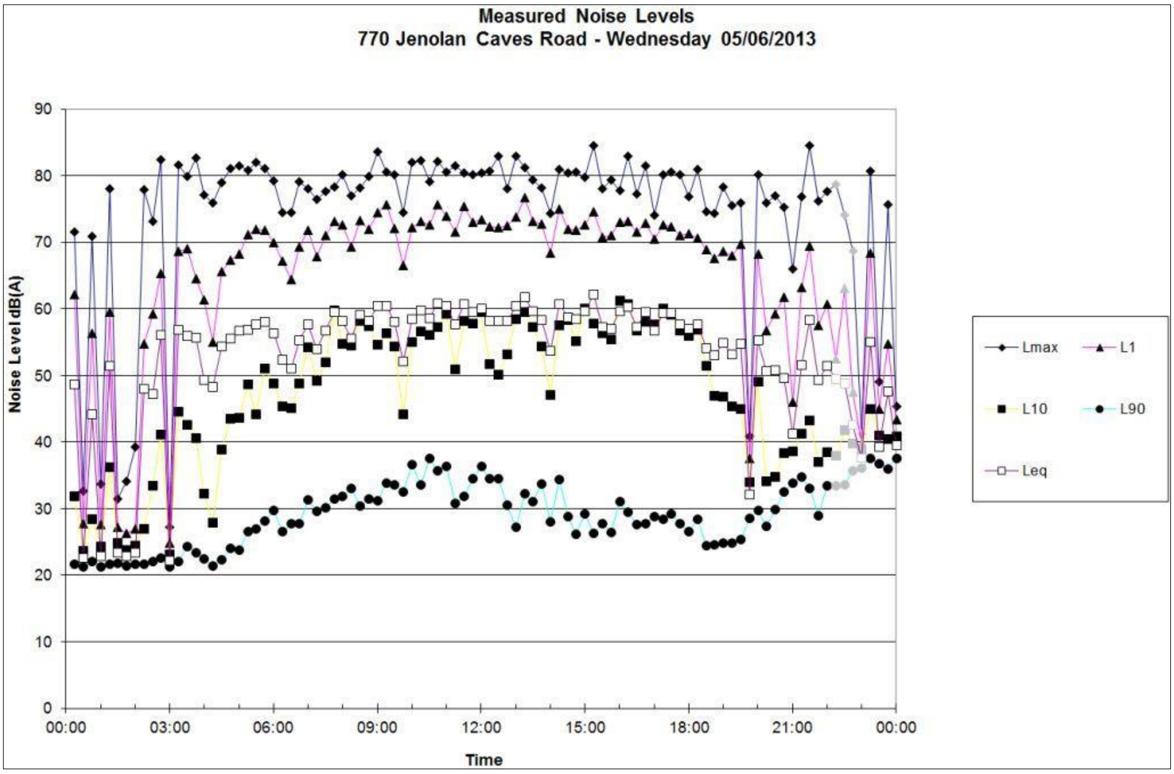
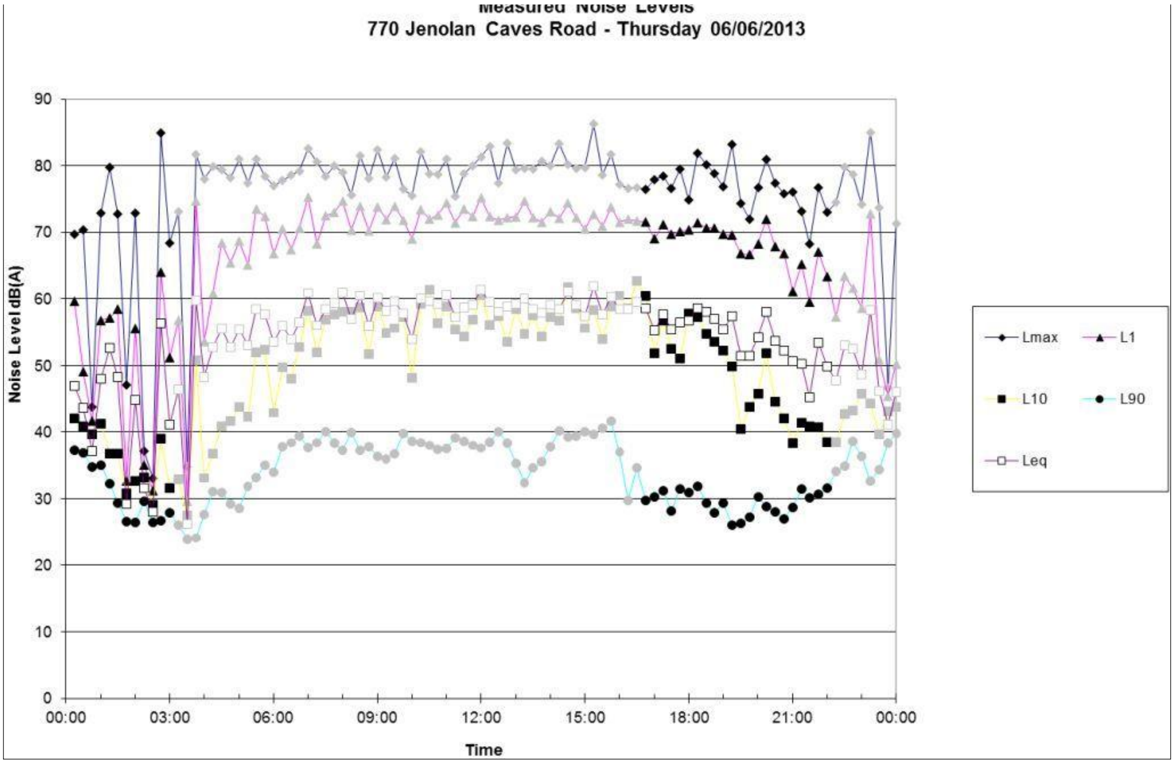
770 Jenolan Caves Road



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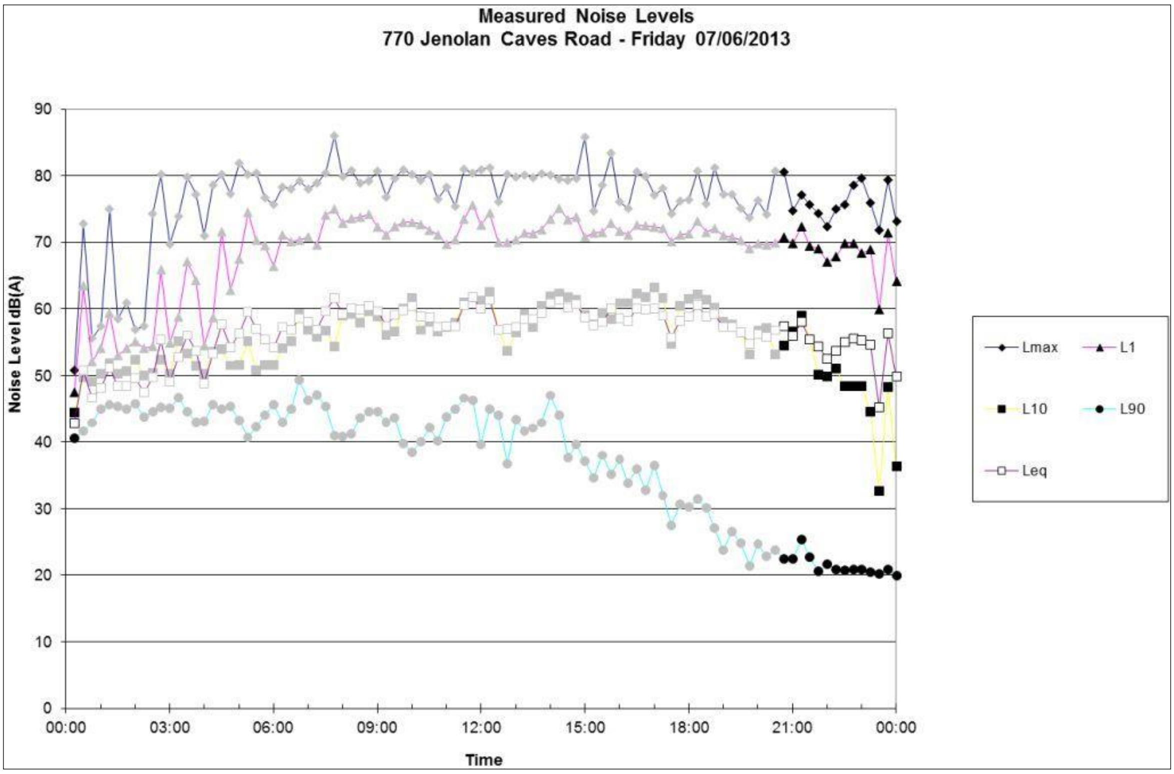
770 Jenolan Caves Road - Thursday 06/06/2013
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq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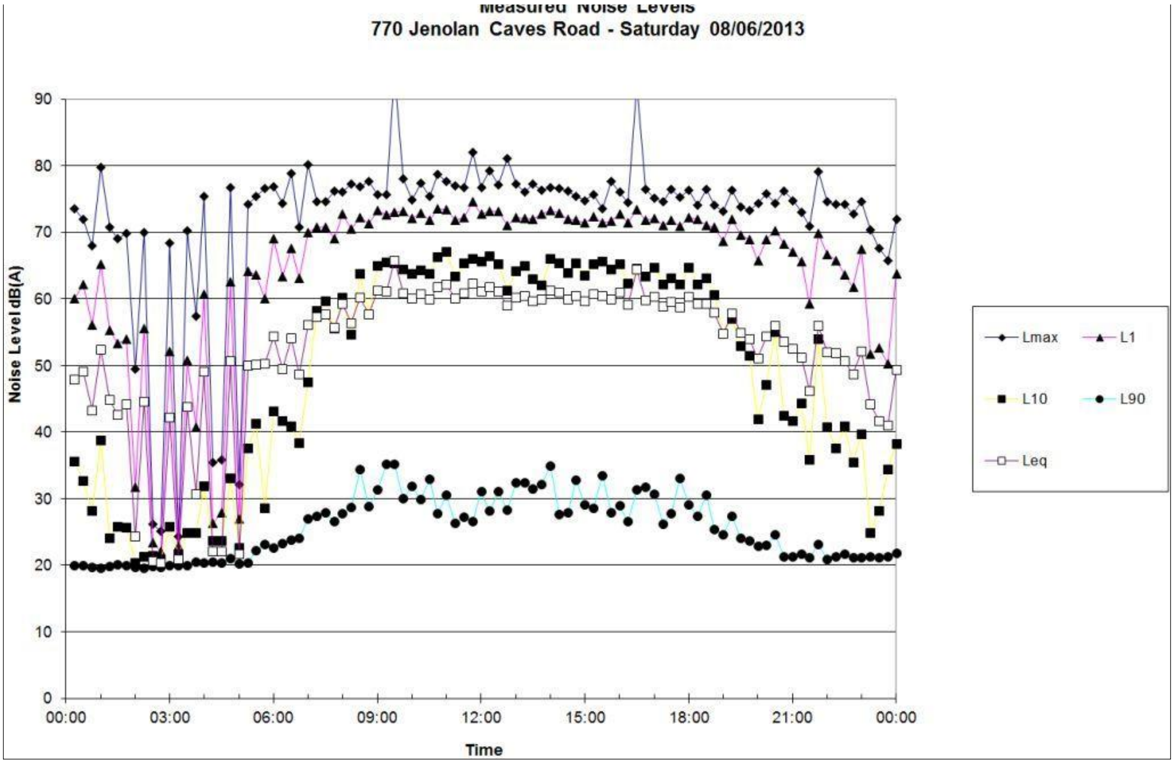
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq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770 Jenolan Caves Road - Saturday 08/06/2013
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq
0
10
20
30
40
50
60
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80
90
00:00
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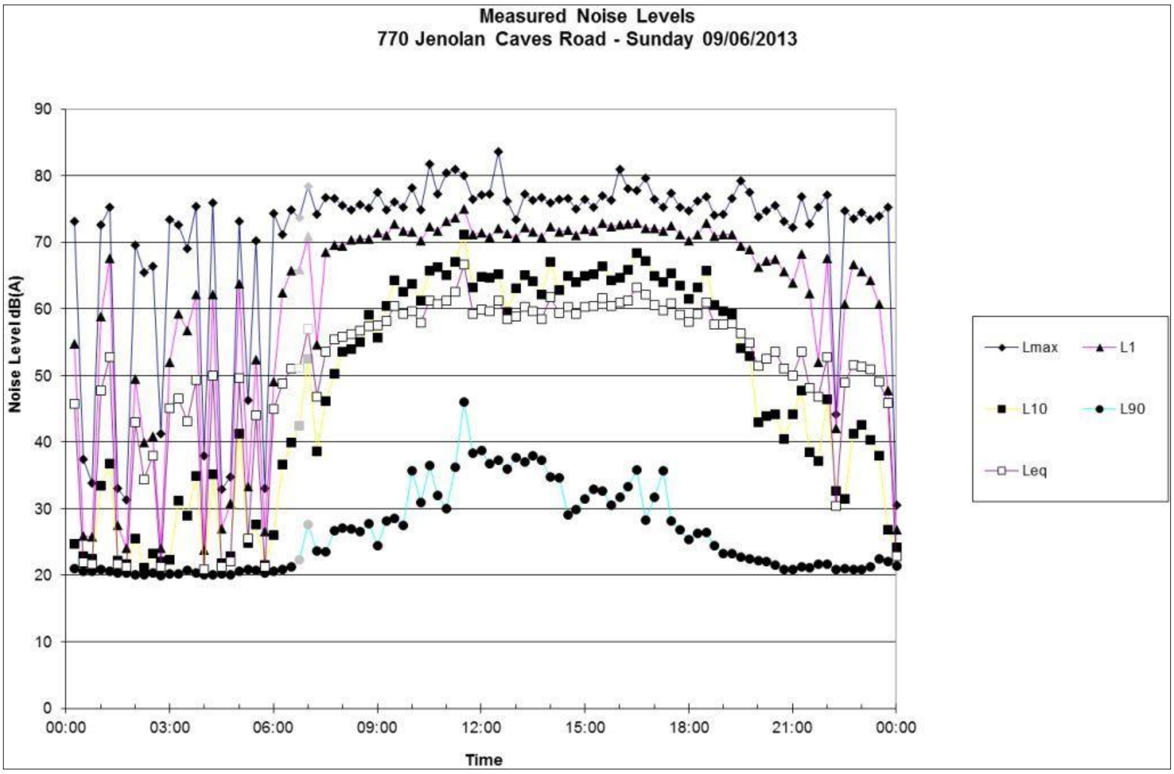
18:00
21:00
00:00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770 Jenolan Caves Road - Sunday 09/06/2013
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq
0
10
20
30
40
50
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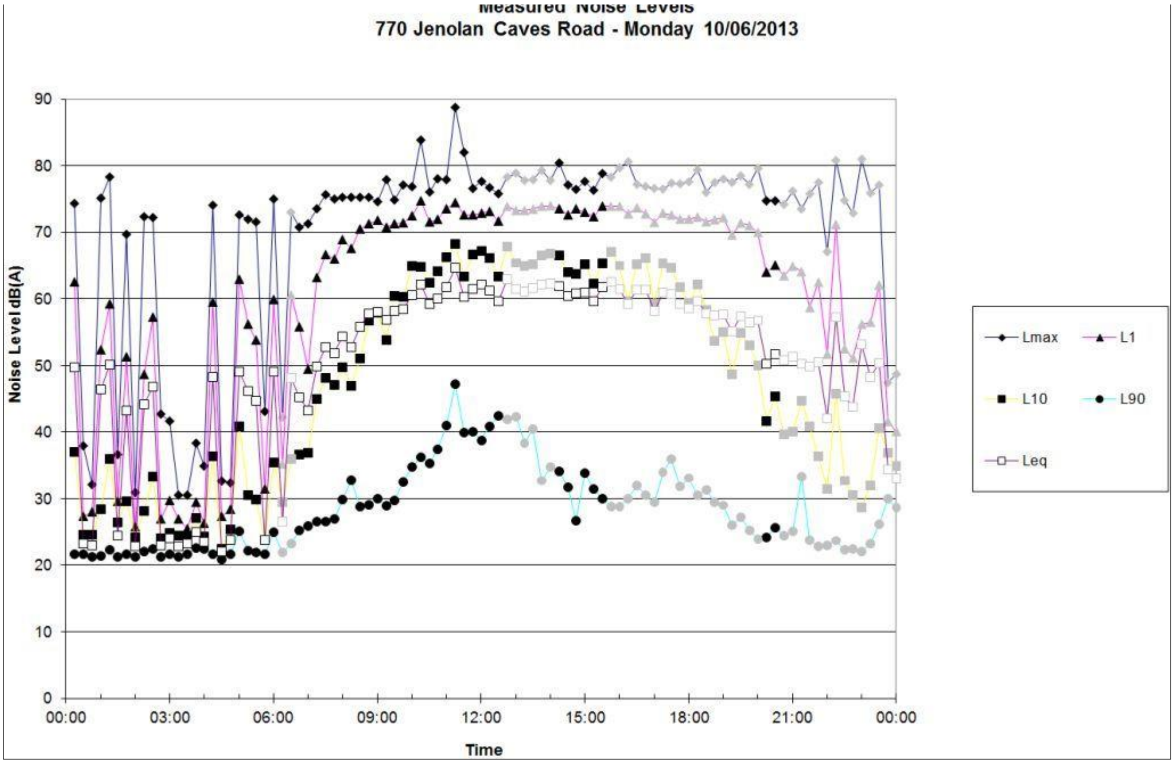
18:00
21:00
00:00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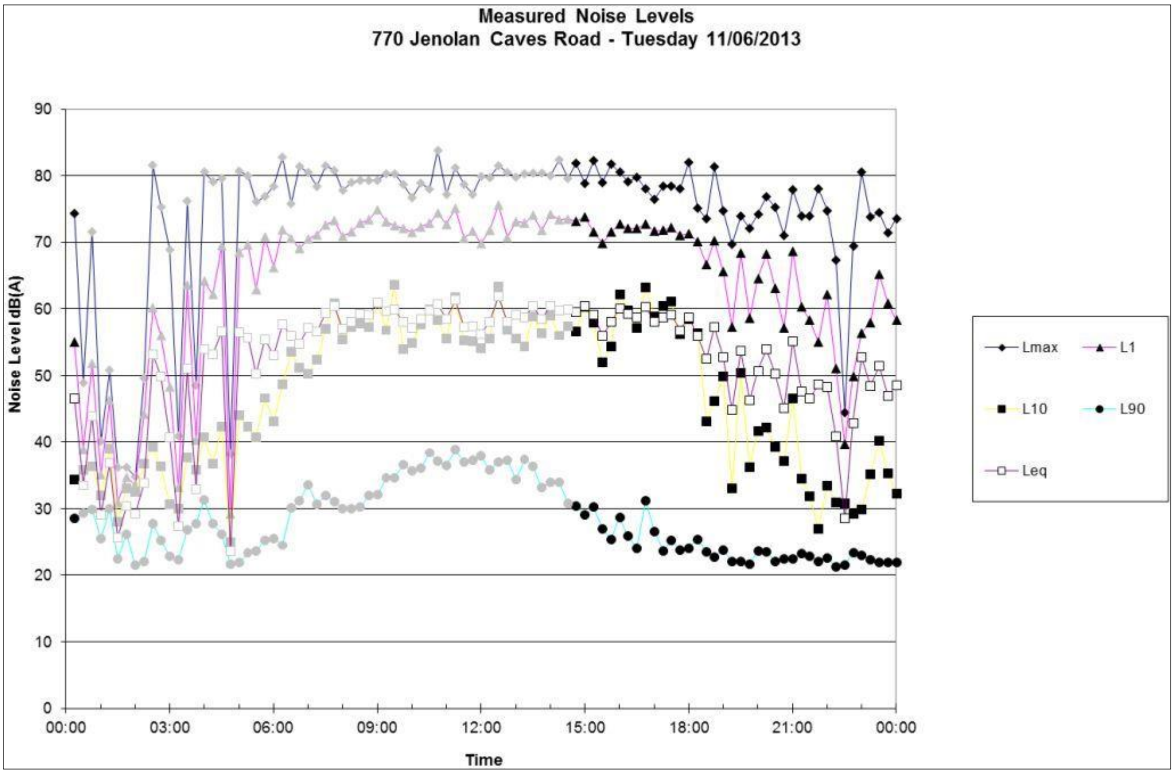
770 Jenolan Caves Road - Monday 10/06/2013
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq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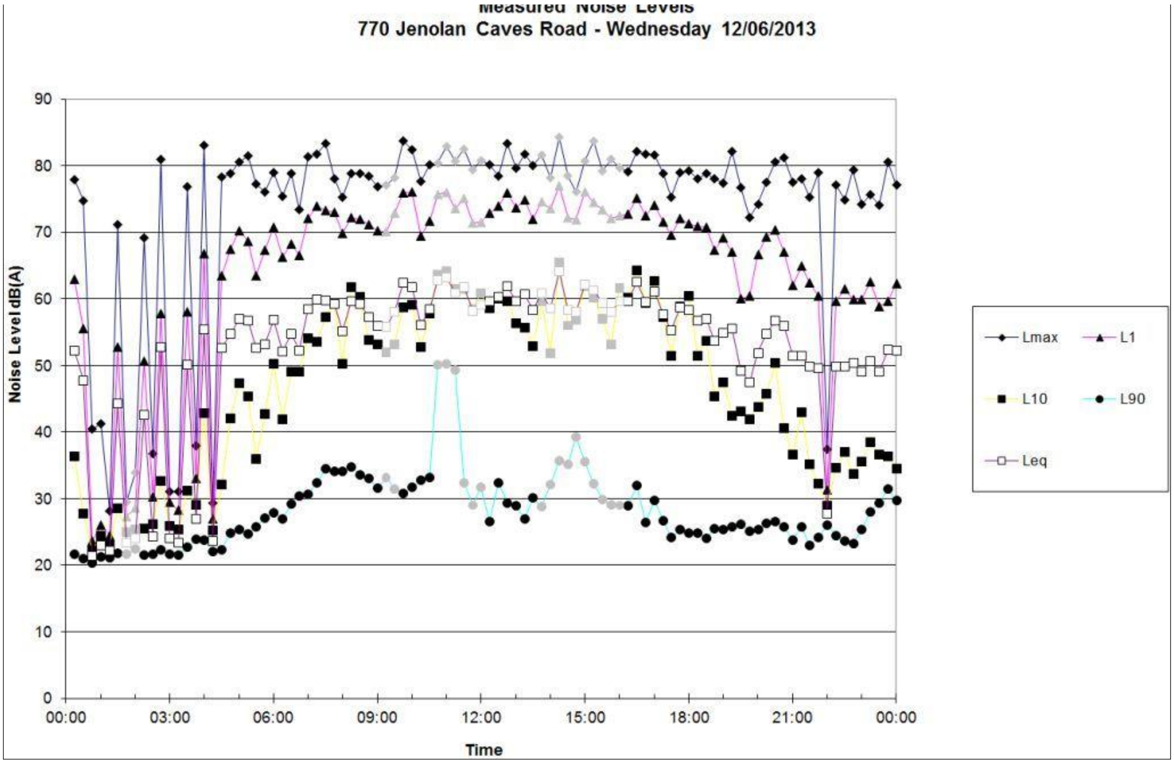
770 Jenolan Caves Road - Tuesday 11/06/2013
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq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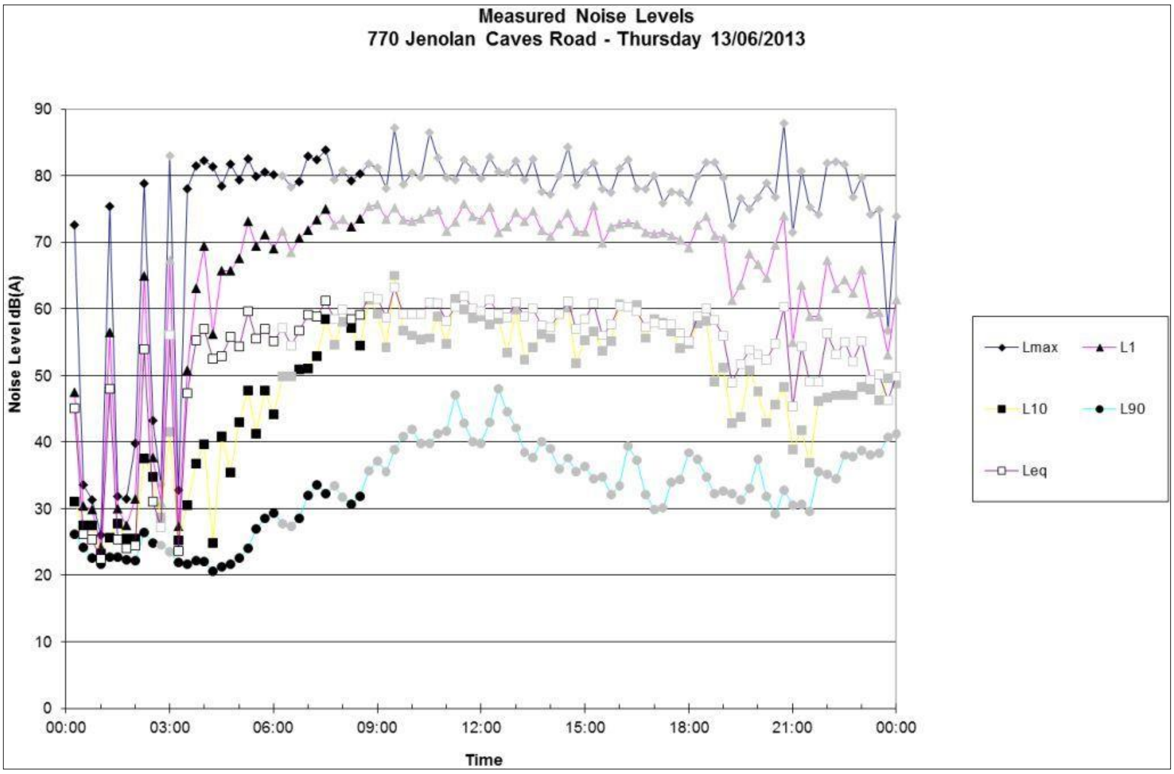
770 Jenolan Caves Road - Wednesday 12/06/2013
Noise Level dB(A)
0
10
20
30
40
50
60
70
80
90
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq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770 Jenolan Caves Road - Thursday 13/06/2013
Noise Level dB(A)
0
10
20
30
40
50
60
70
80
90
00:00
03:00
06:00
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12:00
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18:00
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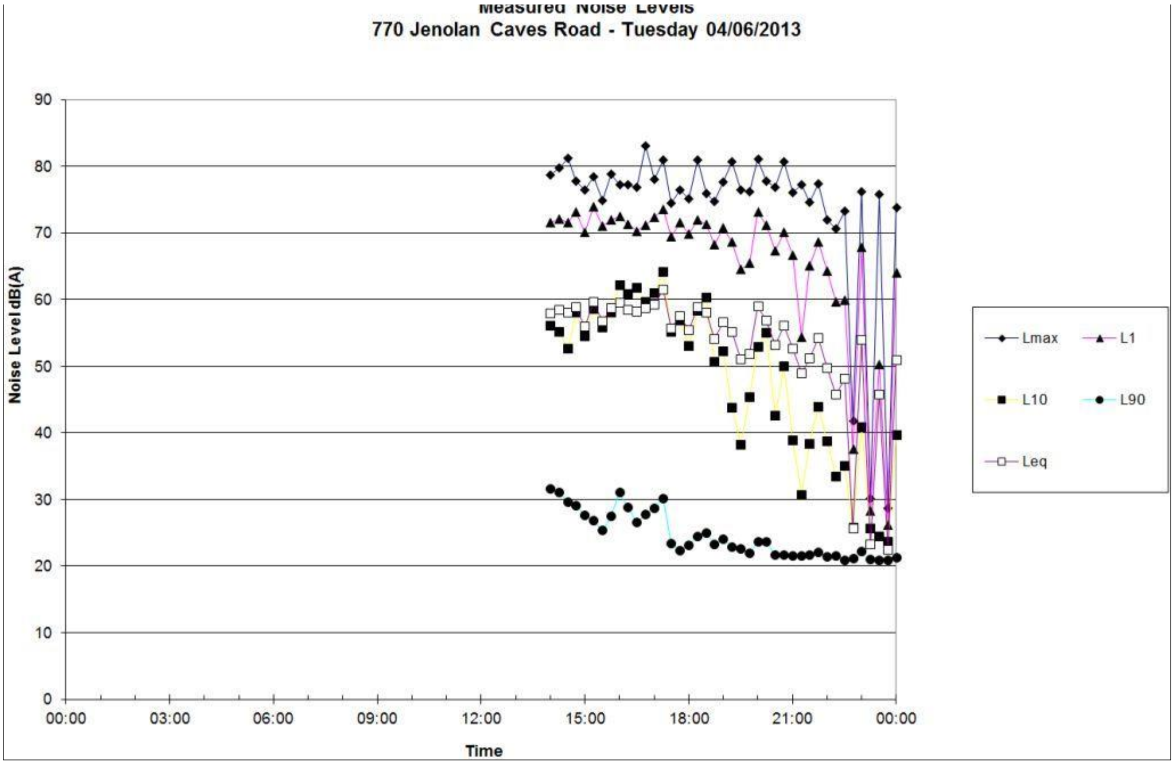
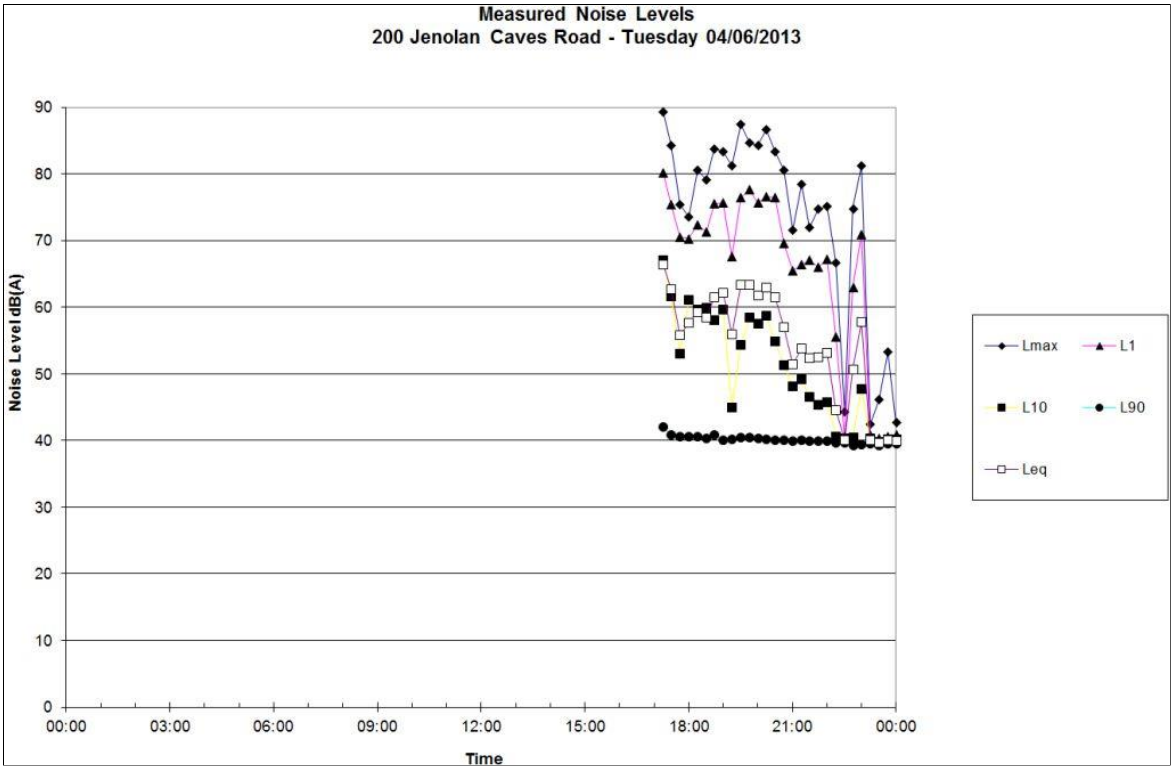
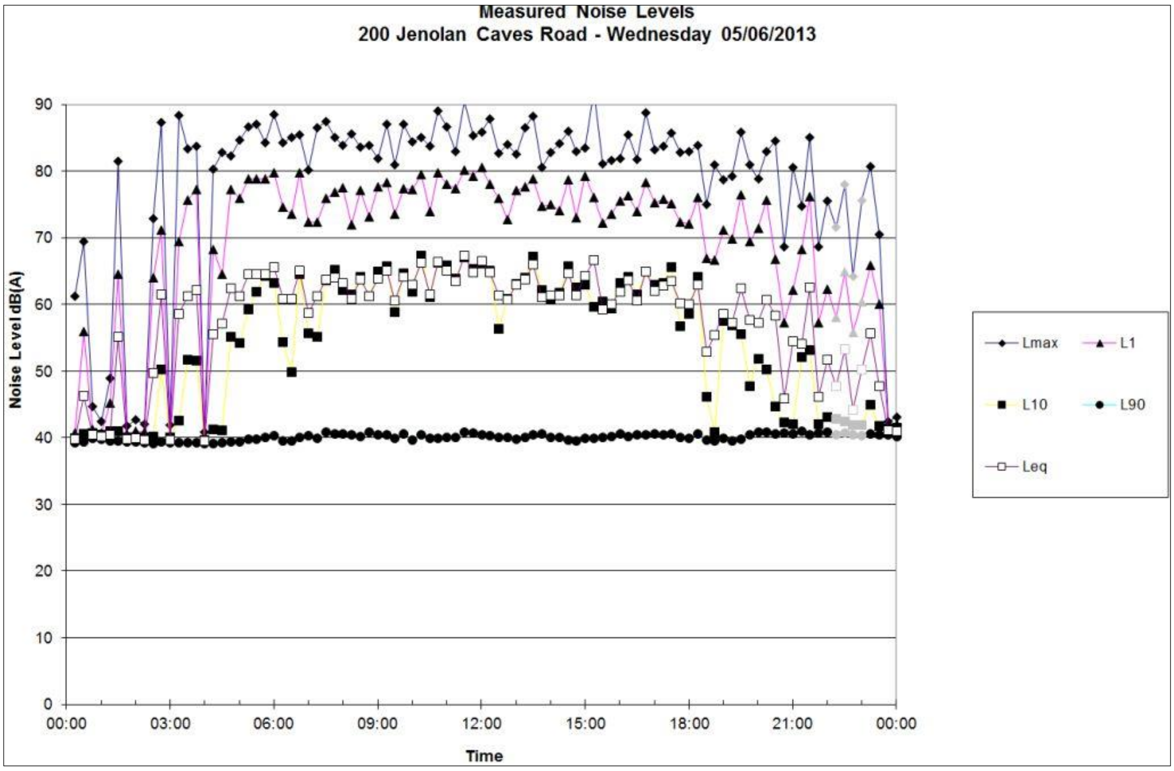
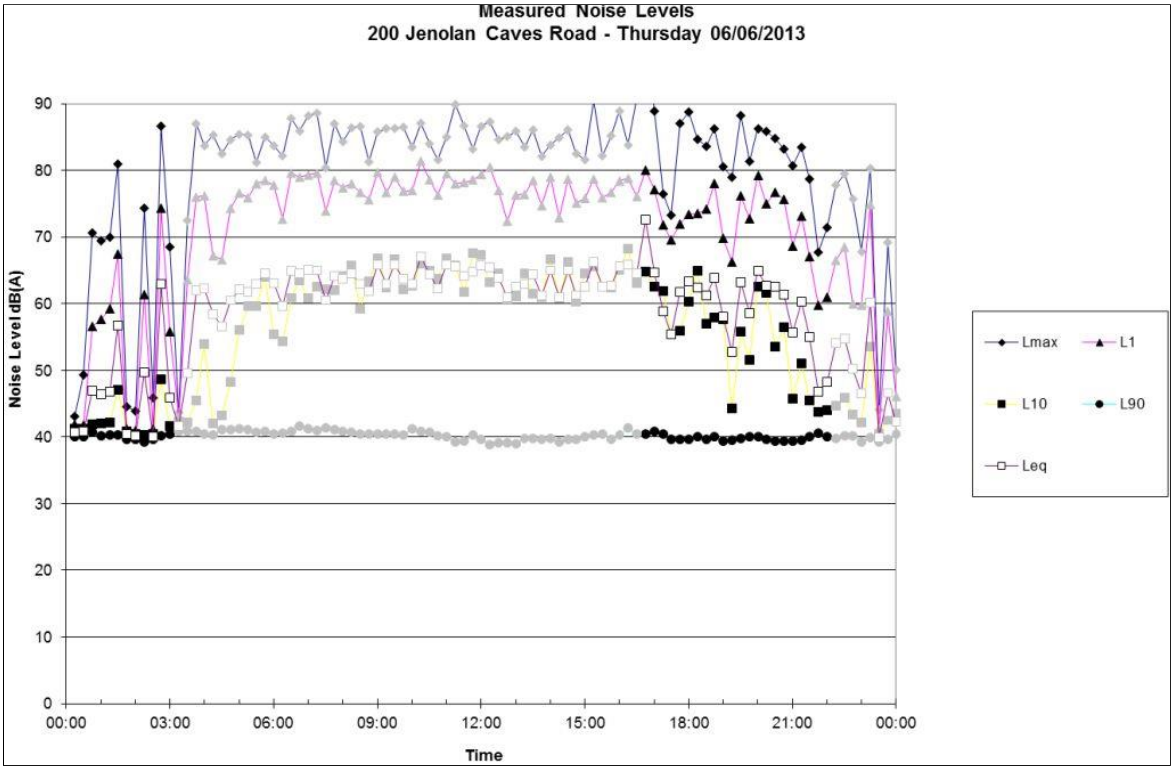
Lmax
L1
L10
L90
Leq

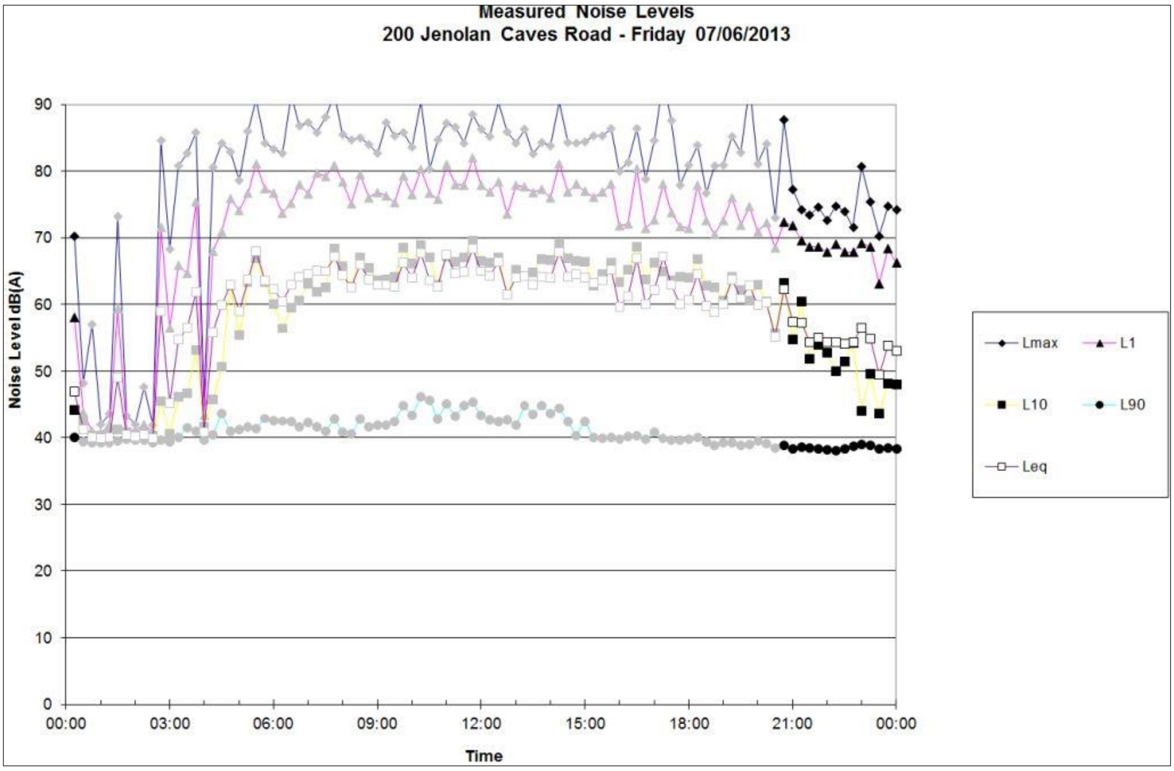

Measured Noise Levels
770 Jenolan Caves Road - Tuesday 04/06/2013
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq

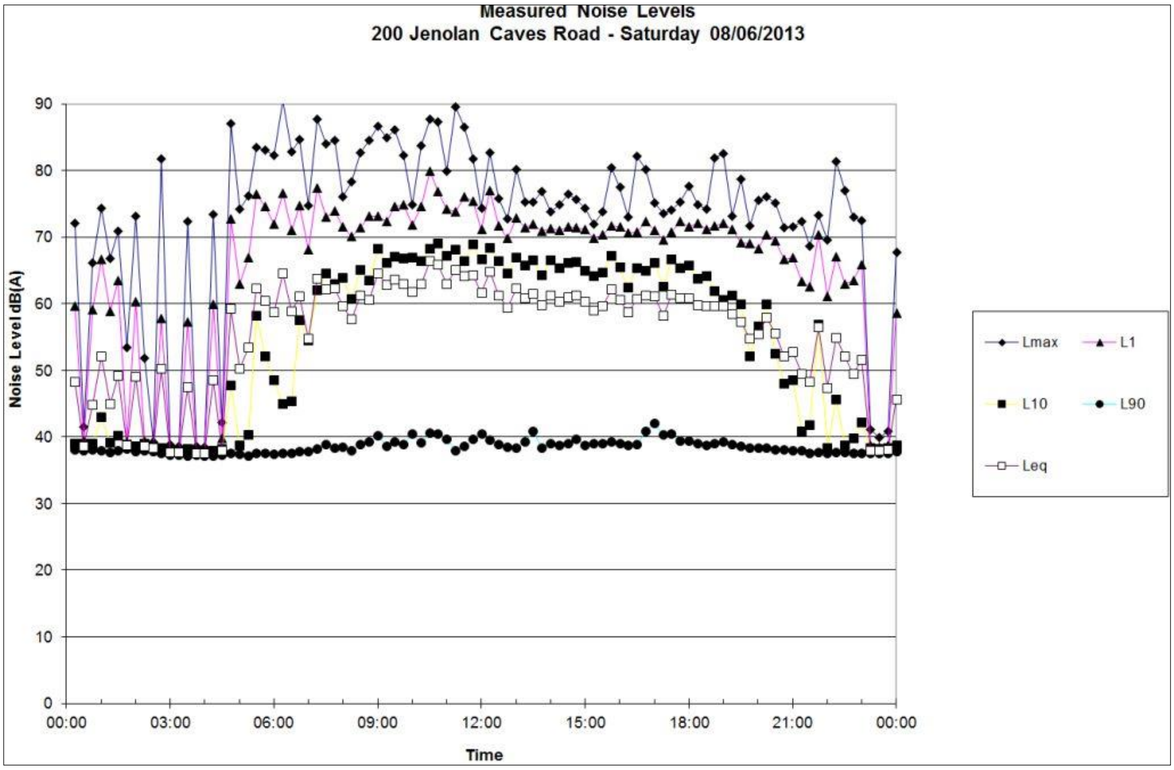
200 Jenolan Caves Road

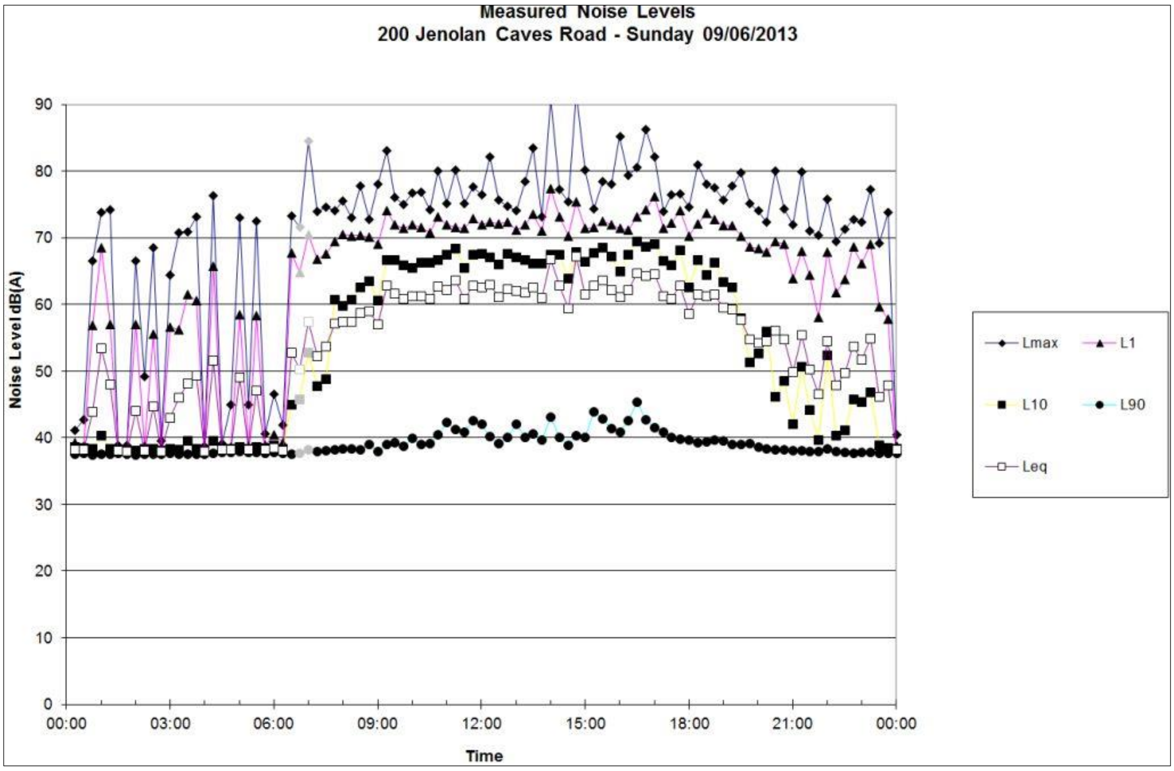


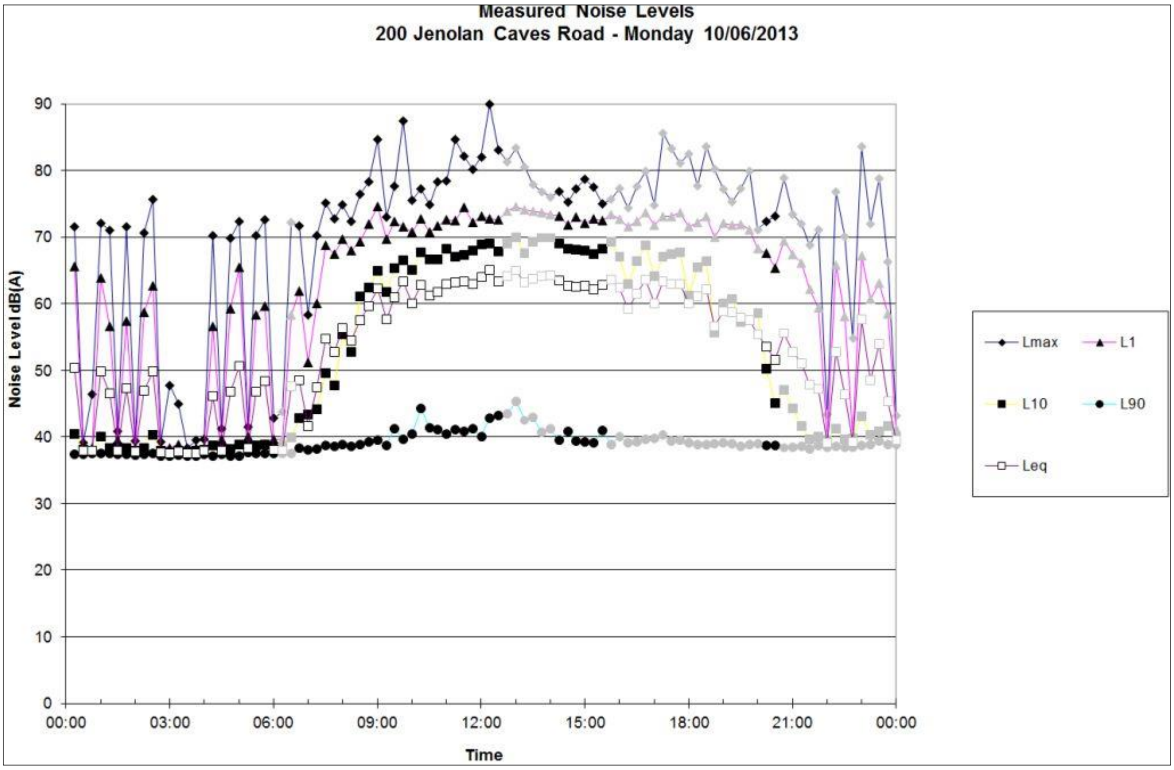


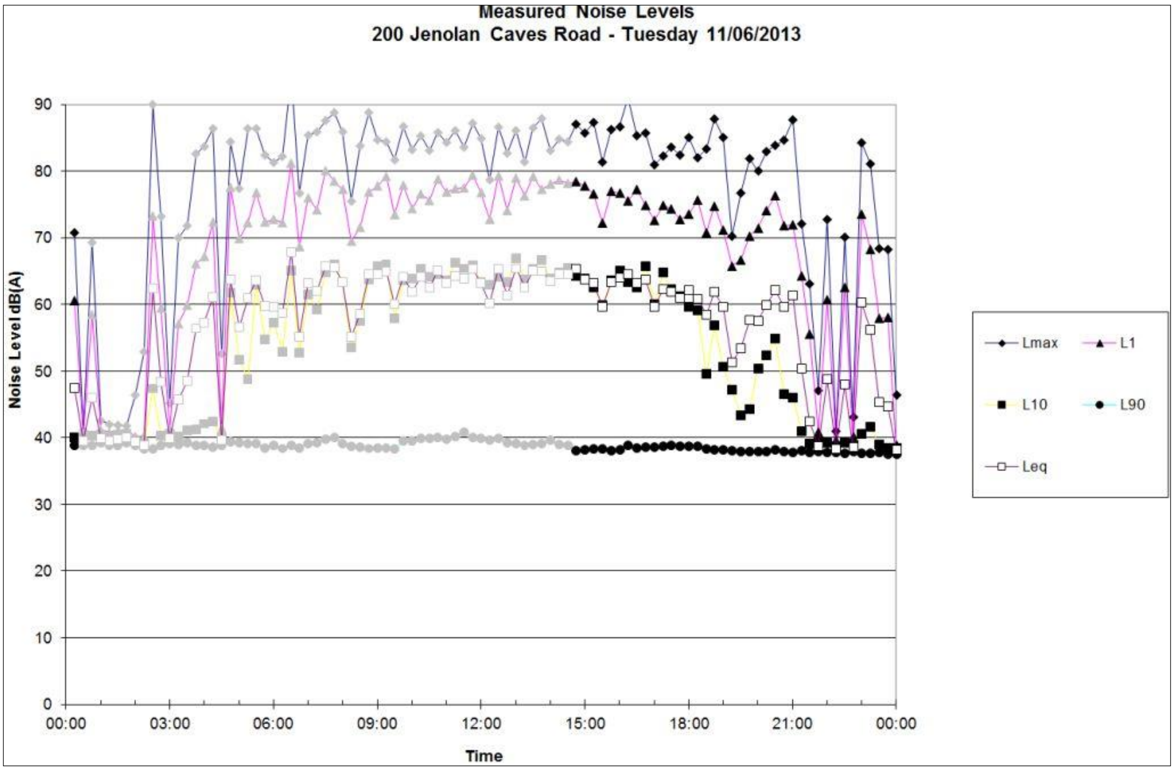

Measured Noise Levels
200 Jenolan Caves Road - Thursday 06/06/2013
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq

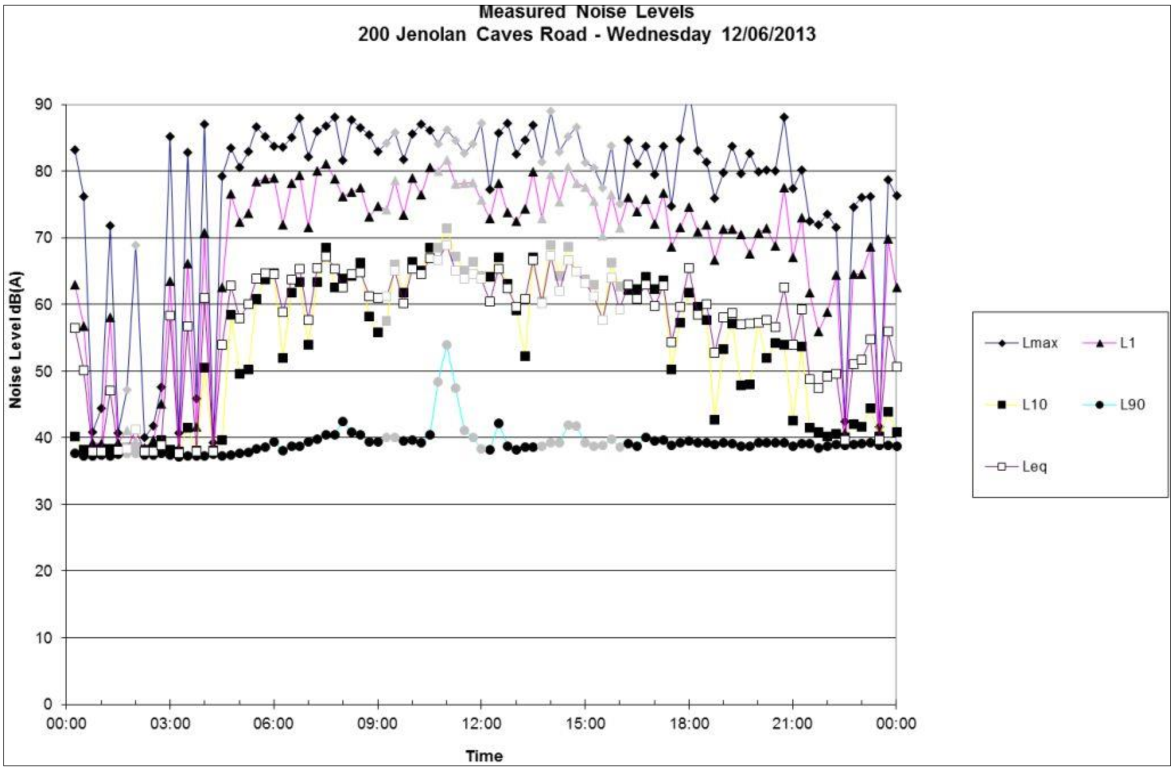

Measured Noise Levels
200 Jenolan Caves Road - Friday 07/06/2013
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq

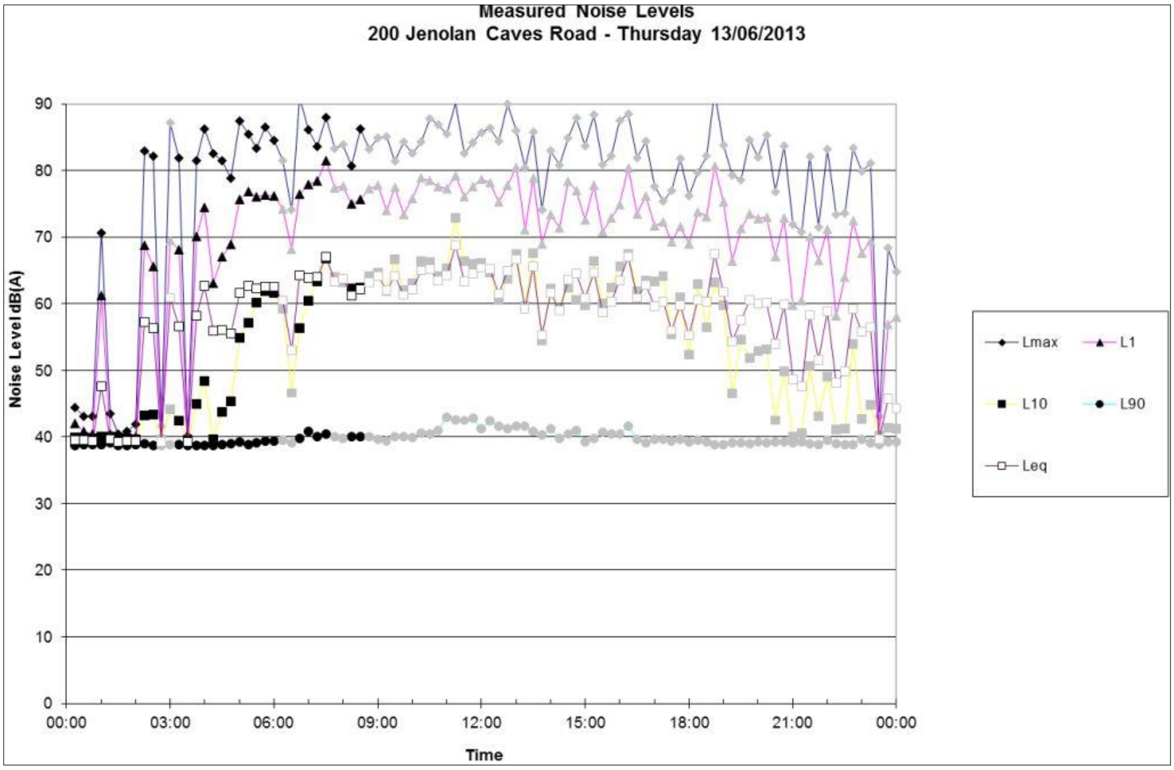

Measured Noise Levels
200 Jenolan Caves Road - Saturday 08/06/2013
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq

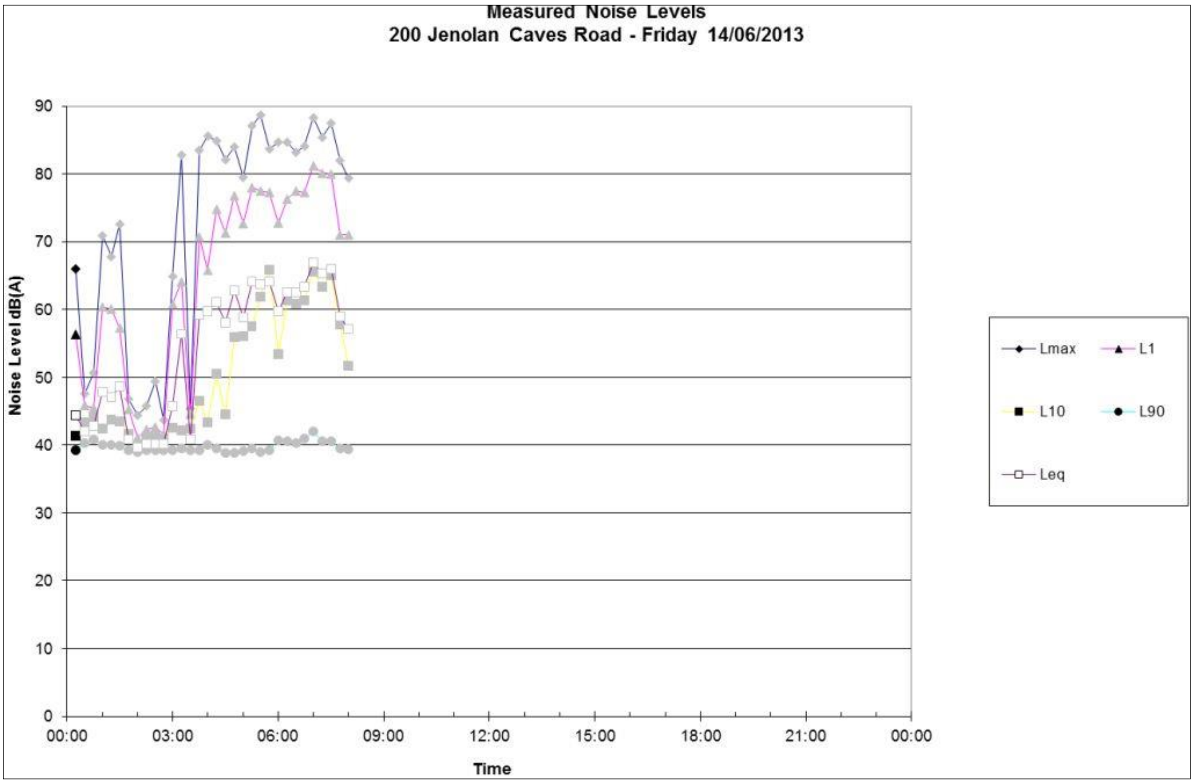

Measured Noise Levels
200 Jenolan Caves Road - Sunday 09/06/2013
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq

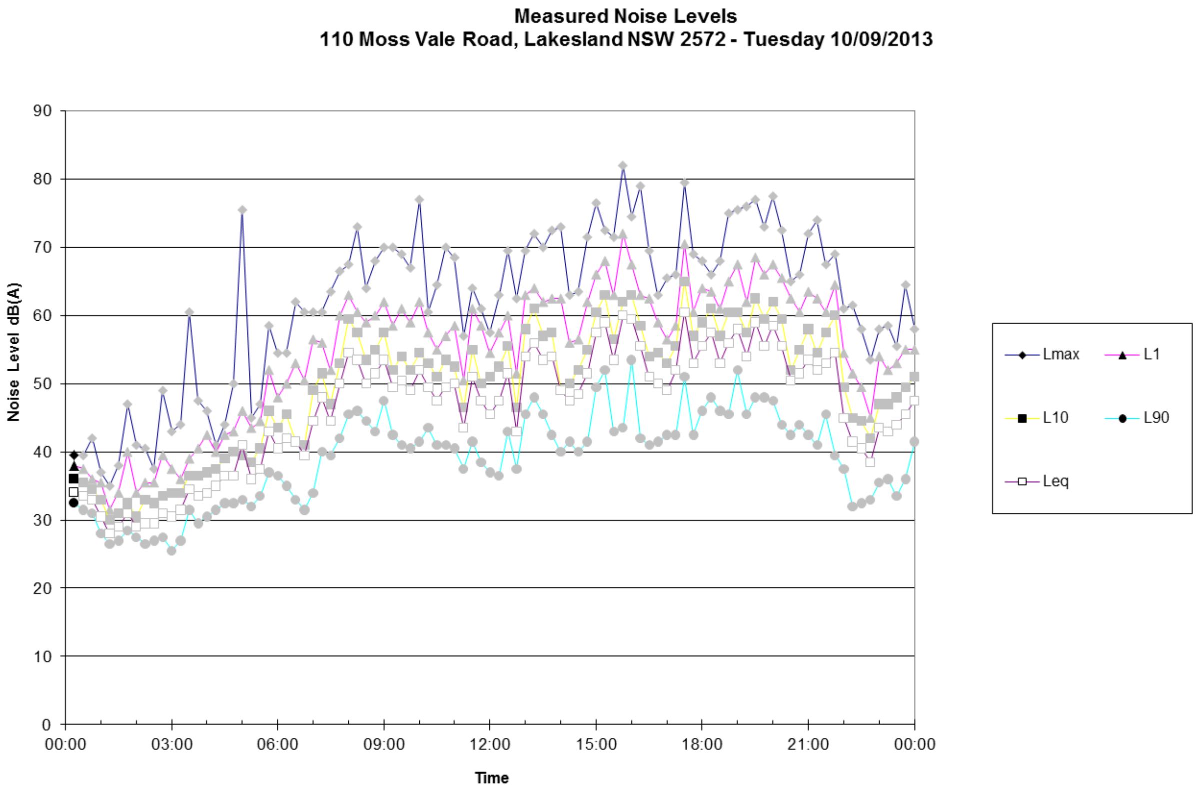

Measured Noise Levels
200 Jenolan Caves Road - Monday 10/06/2013
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
200 Jenolan Caves Road - Tuesday 11/06/2013
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq

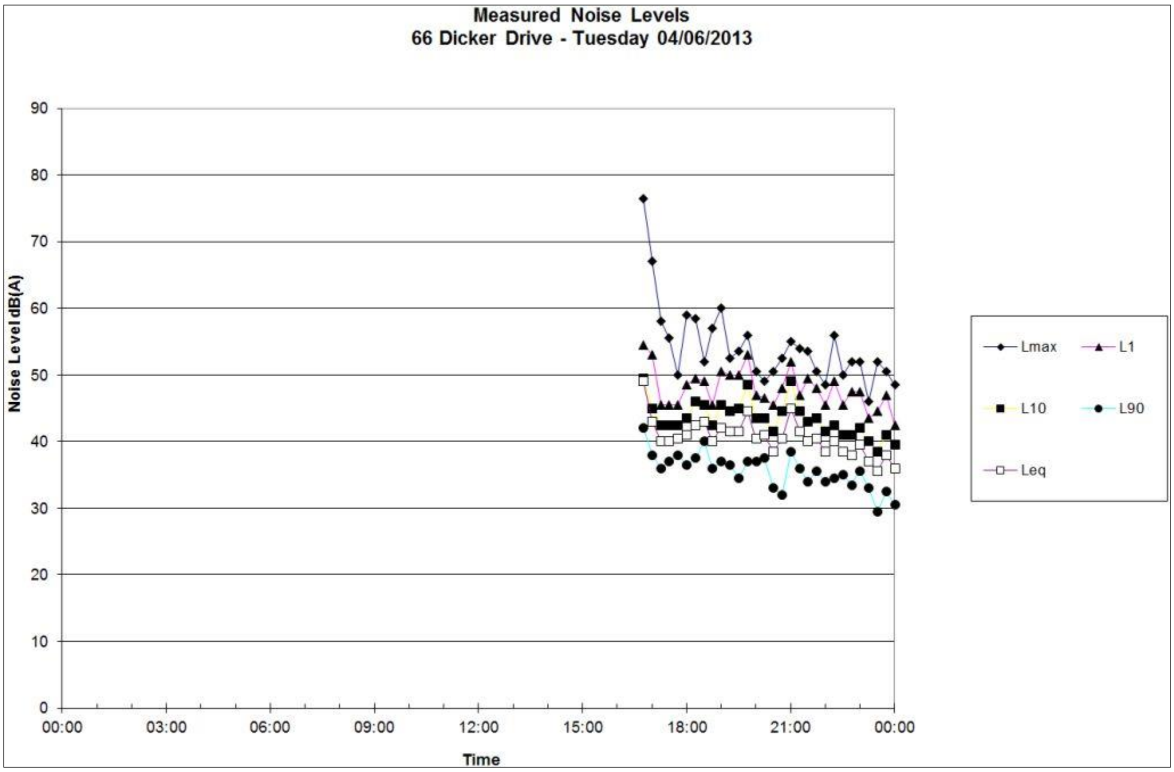

Measured Noise Levels
200 Jenolan Caves Road - Wednesday 12/06/2013
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq

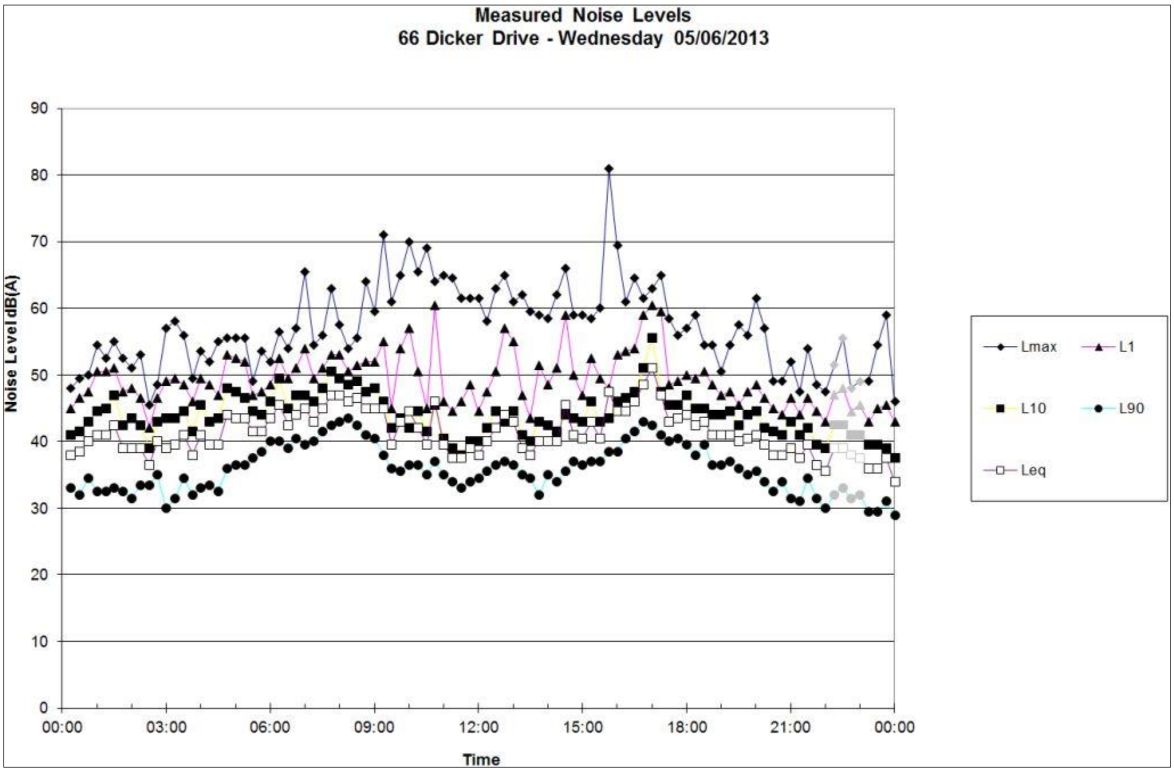

Measured Noise Levels
200 Jenolan Caves Road - Thursday 13/06/2013
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq

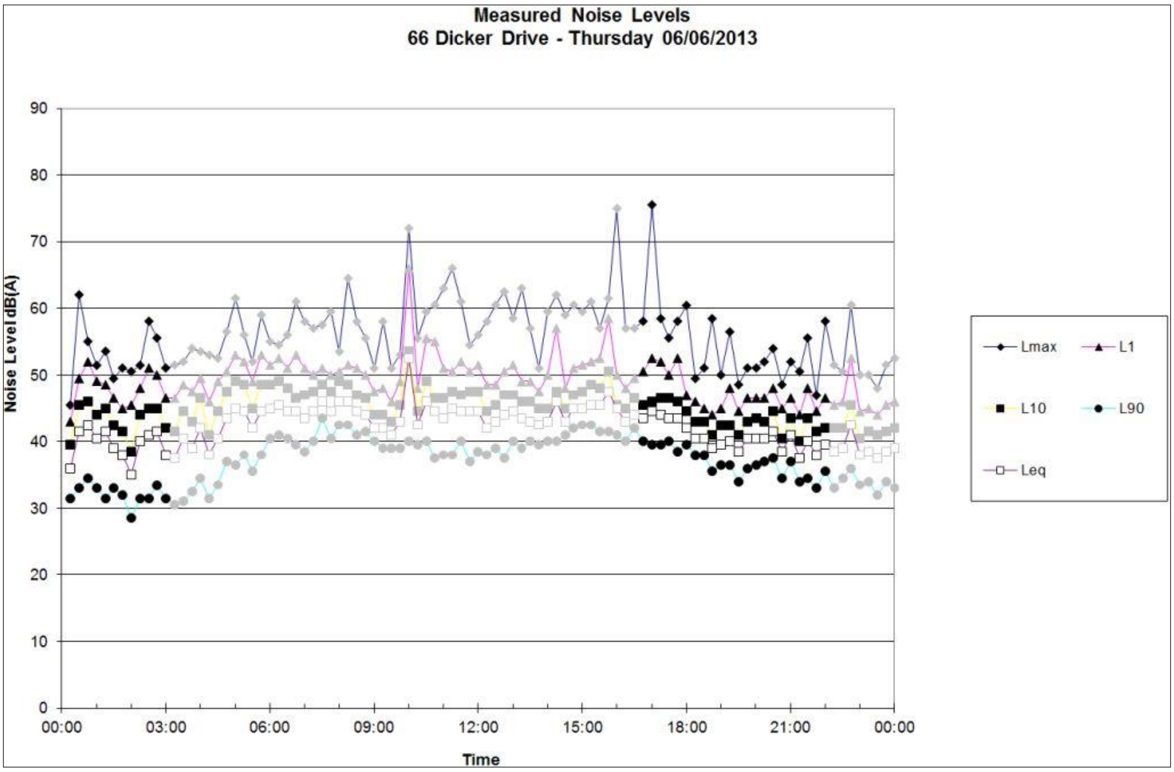

Measured Noise Levels
200 Jenolan Caves Road - Friday 14/06/2013
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq

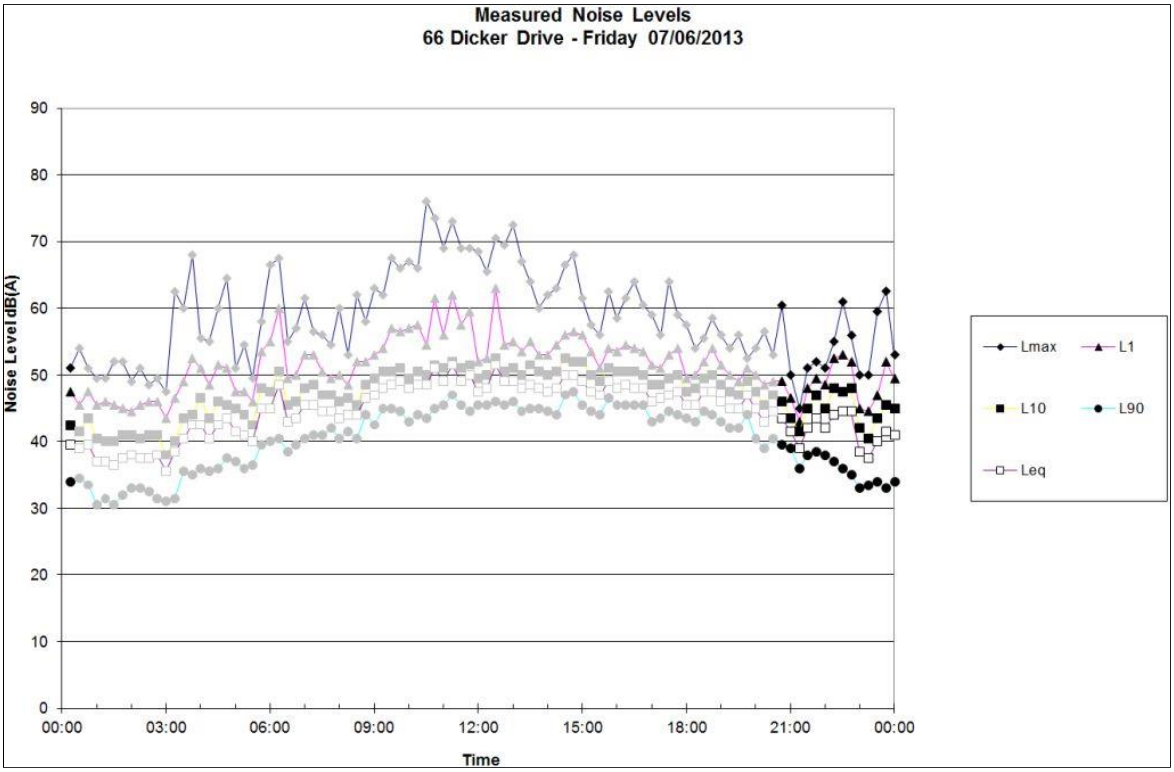

Measured Noise Levels
110 Moss Vale Road, Lakesland NSW 2572 - Tuesday 10/09/2013
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq

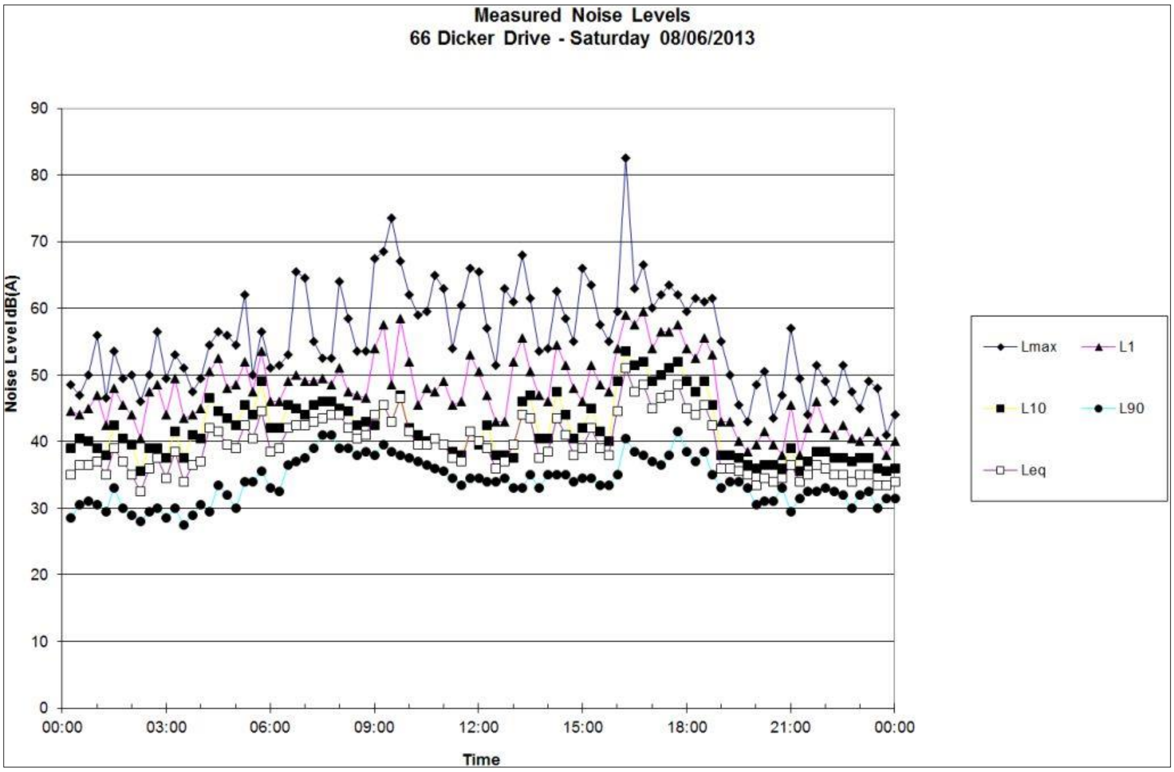
66 Dicker Drive

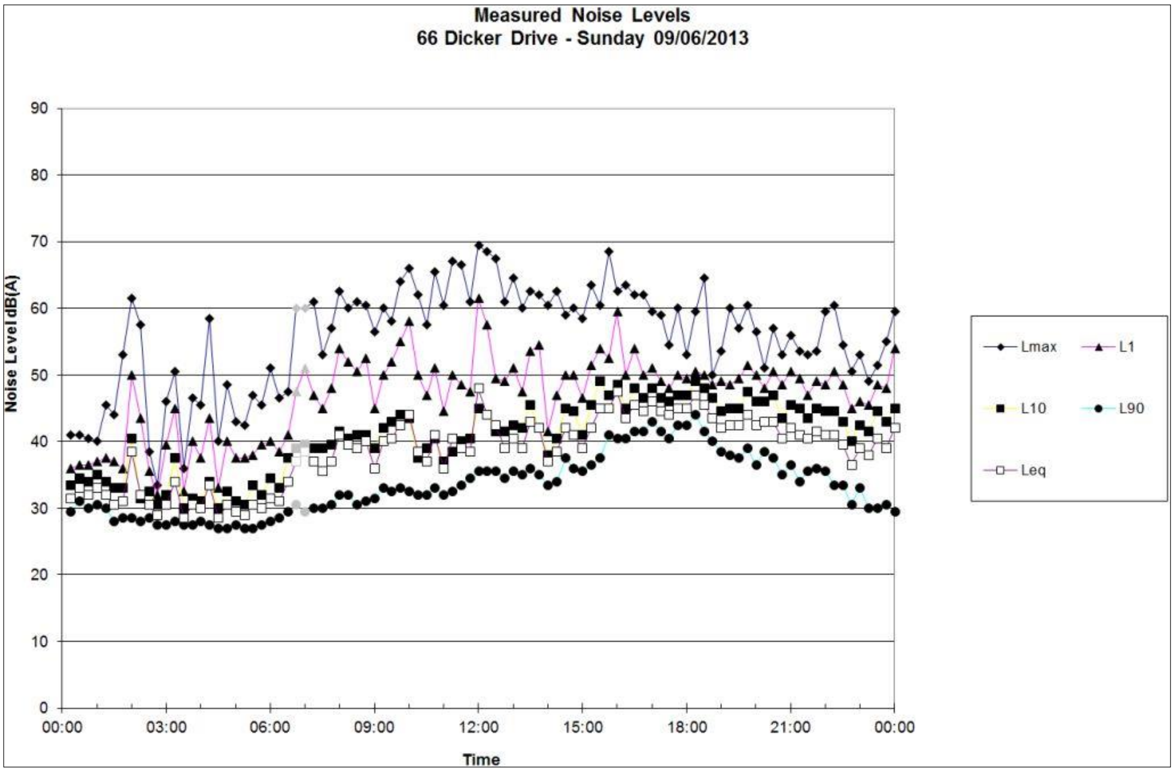





Measured Noise Levels
66 Dicker Drive - Thursday 06/06/2013
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
66 Dicker Drive - Friday 07/06/2013
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq


Measured Noise Levels
66 Dicker Drive - Saturday 08/06/2013
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq
0
10
20
30
40
50
60
70
80
90
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00


Measured Noise Levels
66 Dicker Drive - Sunday 09/06/2013
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq
0
10
20
30
40
50
60
70
80
90
00:00
03:00
06:00
09:00
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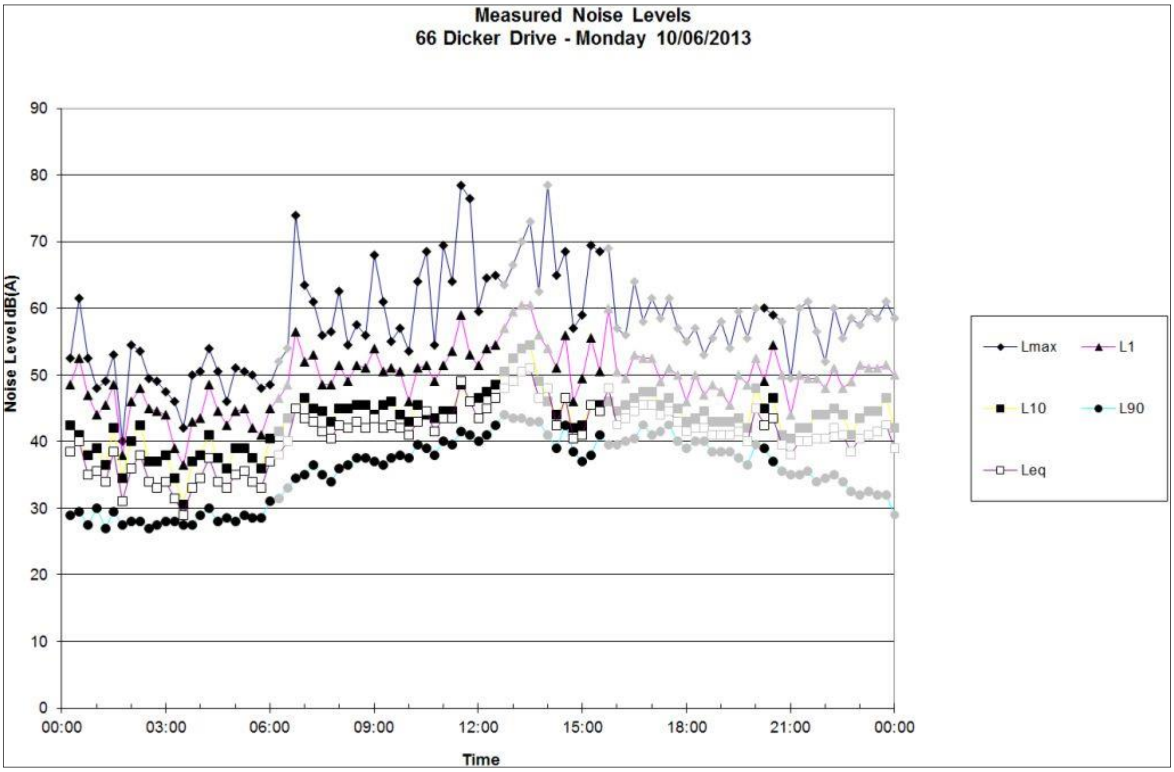
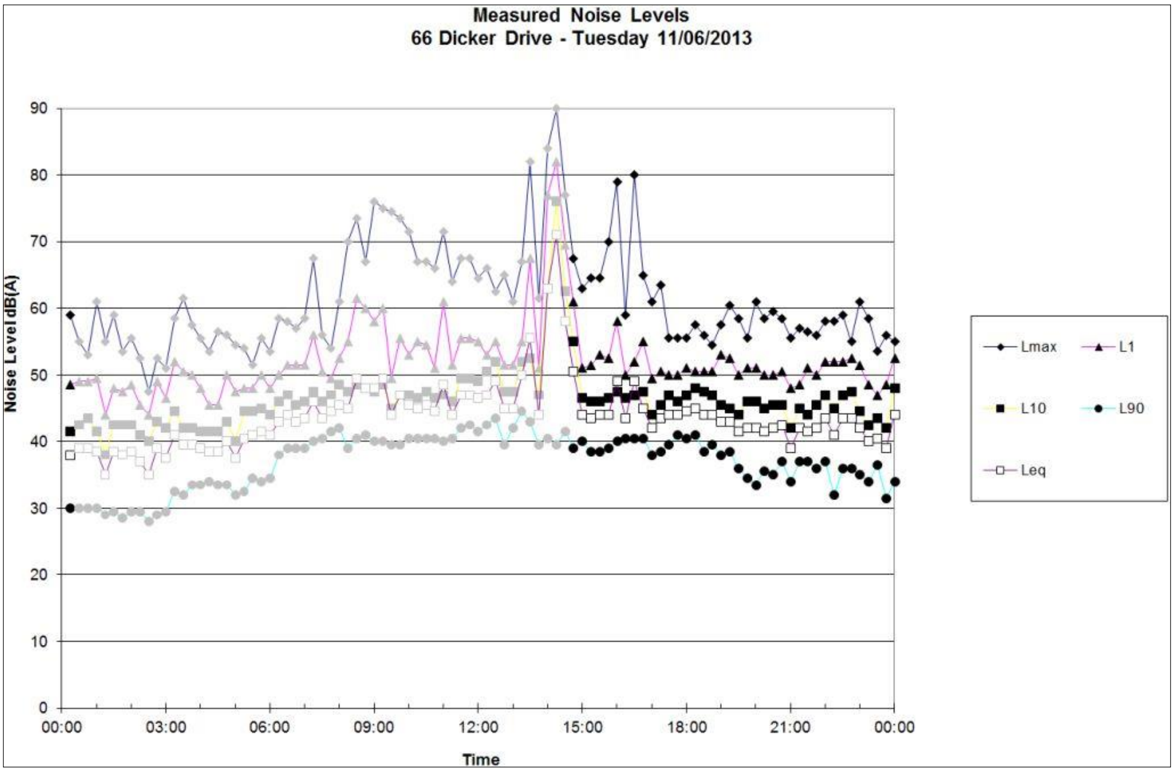
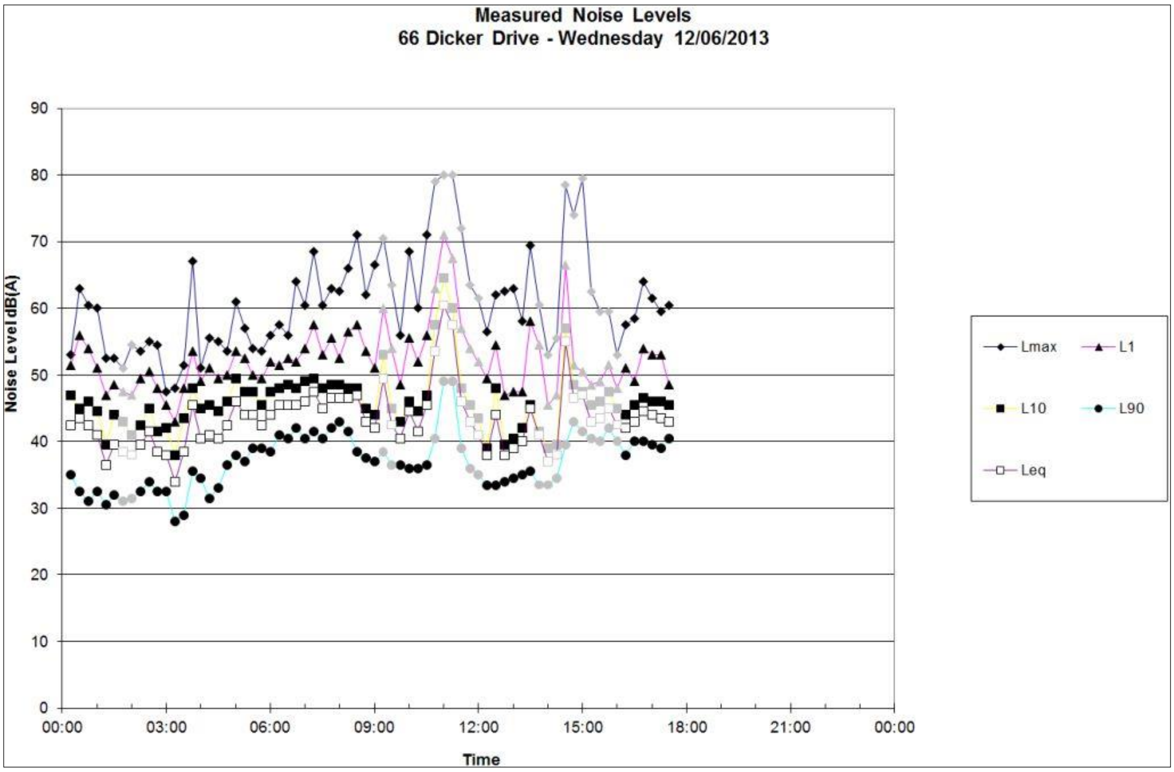
18:00
21:00
00:00


Measured Noise Levels
66 Dicker Drive - Monday 10/06/2013
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00


Measured Noise Levels
66 Dicker Drive - Tuesday 11/06/2013
Noise Level dB(A)
Time
Lmax
L1
L10
L90
Leq
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00


Measured Noise Levels
66 Dicker Drive - Wednesday 12/06/2013
Noise Level dB(A)
90
80
70
60
50
40
30
20
10
0
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Time
Lmax
L1
L10
L90
Leq

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Attachment 5: Maximum Instantaneous Charge Data

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Shot Number	MIC
37	204kg
38	256kg
39	324kg
40	210kg
41	346kg
42	289kg
42a	106kg
43	393kg
44	372kg
45	311kg
46	307kg
47	399kg
48	224kg
49	443kg
50	138kg
51	470kg
52	52kg
53	409kg
54	220kg
55	23kg

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