Wedgerock Pty Ltd

ABN: 15 099 038 123

Karuah South Quarry

Noise and Vibration Impact Assessment

Prepared by

Spectrum Acoustics Pty Ltd

December 2018

Specialist Consultant Studies Compendium

Volume 1, Part 2

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Noise and Vibration Impact Assessment

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December 2018

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NOISE AND VIBRATION CONSULTANTS

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COMMONLY USED ACRONYMS

AHD	Australian Height Datum
ANZEC	Australian and New Zealand Environment and Council
ANZECC	Australian and New Zealand Environment and Conservation Council
DEC	Department of Environment and Conservation
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water
DPE	Department of Planning and Environment
DRG	Division of Resources and Geoscience
EIS	*Environmental Impact Statement*
ENM	Environmental Noise Model
EPA	Environment Protection Authority
OEH	Office of Environment and Heritage
MIC	Maximum Instantaneous Charge
MS	Morning Shoulder
NPI	*NSW Noise Policy for Industry*
OP	overpressure levels
PNTLs	project noise trigger levels
PPV	peak particle vibration
PVS	Peak Vector Sum
RBL	Rating Background Levels
RH	relative humidity
RMS	Roads and Maritime Services
RNP	*NSW Road Noise Policy*
RTA	Renzo Tonin Associates
SEARs	Secretary's Environmental Assessment Requirements
SPL	Sound Pressure Level
VLAMP	*Voluntary Land Acquisition and Mitigation Policy*

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EXECUTIVE SUMMARY

A noise and vibration impact assessment has been conducted for the proposed construction and operation of a quarry producing hard rock products at a Site located approximately 40km north of Newcastle and 4km northeast of Karuah, adjoining the northern side of the Pacific Highway. The proposed operating hours are as follows.

Proposed Hours of Operation

Activity	Monday to Friday	Saturdays	Sundays or Public Holidays
Site establishment and construction	7:00am to 6:00pm	7:00am to 1:00pm	Nil
Extraction operations	7:00am to 6:00pm	7:00am to 1:00pm	Nil
Blasting operations	10:00am to 4:00pm	Nil	Nil
Processing operations	7:00am to 6:00pm	7:00am to 1:00pm	Nil
Product despatch	5:00am to 6:00pm	5:00am to 1:00pm	Nil
Maintenance	24 hours / day	24 hours / day	Nil

Documents referred to in conducting the assessment include:

- *NSW Noise Policy* for *Industry* (NPI), EPA (2017);
- *NSW Road Noise Policy* (RNP), OEH (2011);
- *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration* (ANZEC)*;* and
- *Voluntary Land Acquisition and Mitigation Policy* (VLAMP), DPE (2014).

Ambient noise monitoring was conducted at one representative location (R21 / NM4) to establish noise trigger levels at the most potentially impacted receivers. Noise criteria for other assessed receivers were based on historical background noise measurements for existing quarries. The background noise and project noise trigger levels are as follows.

Location	RBL L_{A90}	Trigger levels/PNTLs $L_{Aeq(15minute)}$
R22	53	50^
R13, R15, R16, R17, R20, R21, R23	44	49
R7, R8, R19*	34	39
R12	30#	35

An assessment of available meteorological data found that winds of speeds up to 3 m/s occurred for less than 20% of the time during all seasons, implying that winds are not an assessable feature with regards to noise impact assessment.

Noise modelling was conducted to produce point to point calculations and noise contours for three operational scenarios to individual residential receivers surrounding the Site. Results are presented in tabular form.

Predicted operational noise levels were less than the noise assessment trigger levels at all non-project-related receivers. Noise impacts over privately owned land were also lower than acceptable amenity levels.

The Project would operate with the use of a noise barrier. The barrier would be a 4m high fence which would be erected along the southern side of the infrastructure area prior to the commencement of processing.

Ground vibration and overpressure levels from blasting are predicted to be below the criteria for all receivers.

Predicted cumulative noise levels from the proposed quarry and adjoining quarries at all receivers would be below the adopted cumulative noise trigger level.

The off-site traffic noise criterion of 55 dB(A),$L_{eq(15hour)}$ for arterial roads would be achieved for all receivers.

In summary, the assessment has found that the Project would be able to operate in compliance with the appropriate criteria for operational and road traffic noise emissions and for potential blast overpressure and vibration impacts.

1. INTRODUCTION

Spectrum Acoustics Pty Ltd has been commissioned by R.W. Corkery & Co. Pty Limited on behalf of Wedgerock Pty Ltd (the Applicant) to undertake an assessment of the Project to construct and operate a quarry producing hard rock products at a Site located approximately 40km north of Newcastle and 4km northeast of Karuah, adjoining the northern side of the Pacific Highway (see **Figure 1**).

This report provides:

- an overview of the acoustic environment around the Site, based upon recent and historical background noise measurements;
- an outline of the acoustic criteria relevant to the Project;
- an assessment of the predicted noise levels associated with the Project and as to the adverse impacts on the existing acoustic environment in vicinity of the proposed operations including traffic noise; and
- an outline of the required noise mitigation measures and monitoring.

This noise and vibration impact assessment has been prepared in accordance with the NSW Noise Policy for Industry (EPA, 2017), Road Noise Policy (OEH, 2011) and the Secretary's Environmental Assessment Requirements (SEARs) for the Project, issued on 2 November 2017 by the NSW Department of Planning and Environment (DPE). The requirements provided by DPE from the Environment Protection Authority (EPA) and the Division of Resources and Geoscience (DRG) have also been considered during the preparation of this report. **Appendix 1** records the coverage of the requirements from DPE, EPA and DRG within this report.

1.1 OVERVIEW OF THE PROJECT

The proposed extraction area, as shown on **Figure 2**, has been defined based upon the occurrence of the underlying hard rock resource. An estimated 10 million tonnes of fresh rock and 1.25 million tonnes of weathered rock have been identified within the proposed extraction area.

The Project would utilise conventional drill and blast, load and haul and processing methods to produce up to 600 000tpa of quarry products. These products would principally be used for road pavement products concrete and sealing aggregates, pre-coat products, gabion, armour rock, decorative gravel, crusher fines and select fill. Extraction would be undertaken in a staged manner, i.e. over two stages with each stage comprising three sub-stages. Production during the initial stages of extraction would be lower (up to 300 000tpa) with production gradually ramped up in the years following site establishment (to 600 000tpa). It is expected that extraction would continue for a period of approximately 25 years following Project commencement.

It is noted that both extraction and processing operations have been designed to optimise the recovery of resource whilst satisfying environmental and Site constraints.

Figure 2 displays the following principal components of the Project relevant to this assessment.

- Extraction Area - Stage 1
  The Stage 1 extraction area would cover approximately 4.9ha with its footprint typically between approximately 30m AHD and 75m AHD (to a floor with an elevation of 8m AHD).
- Extraction Area - Stage 2
  The Stage 2 extraction area would cover approximately 5.9ha with its footprint typically between 75m AHD and 120m AHD (to a sloping floor from an elevation of 8m to 12m AHD).
- Quarry infrastructure area
  The quarry infrastructure area would be located on the southern side of the extraction area and would incorporate the product stockpiling area, mobile processing plant and ancillary components area.
- Product stockpiling area
  The product stockpiling area would be located on the northern section of the Quarry infrastructure area during Stage 1. This area would be progressively expanded during Stage 2 to cover an area created through the backfilling of part of the Stage 2 extraction area. (see **Figure 2**).
- Mobile processing plant
  The mobile processing plant would incorporate a range of crushers and screens and would be located on the western section of the quarry infrastructure area during Stage 1. During Stage 2 (see **Figure 2**), the mobile processing plant would be relocated to the eastern section of the Quarry infrastructure area to minimise product haulage distances.
- Internal roads
  A network of roads to provide access for off-road haul trucks between the extraction and processing area.
- Quarry access road
  The inclined, sealed section of road extending from the Quarry entrance to the southern side of the Quarry infrastructure area.

The overall footprint of the operation would be kept as small as possible during all stages of operation, with vegetation and soil removed immediately prior to the progressive extension of operations. Progressive rehabilitation would be undertaken as soon as practicable following disturbance.

Quarry products would be despatched by road using the existing road network with access to the Site via a new entrance to Lot 11 DP 1024564 from Blue Rock Close. The location of the Quarry Entrance would be close to the existing entrance to the property and would be constructed to accommodate with quad-dog trailers and semi-trailers.

Figure 1 Locality Plan

Figure 2 Indicative site layout

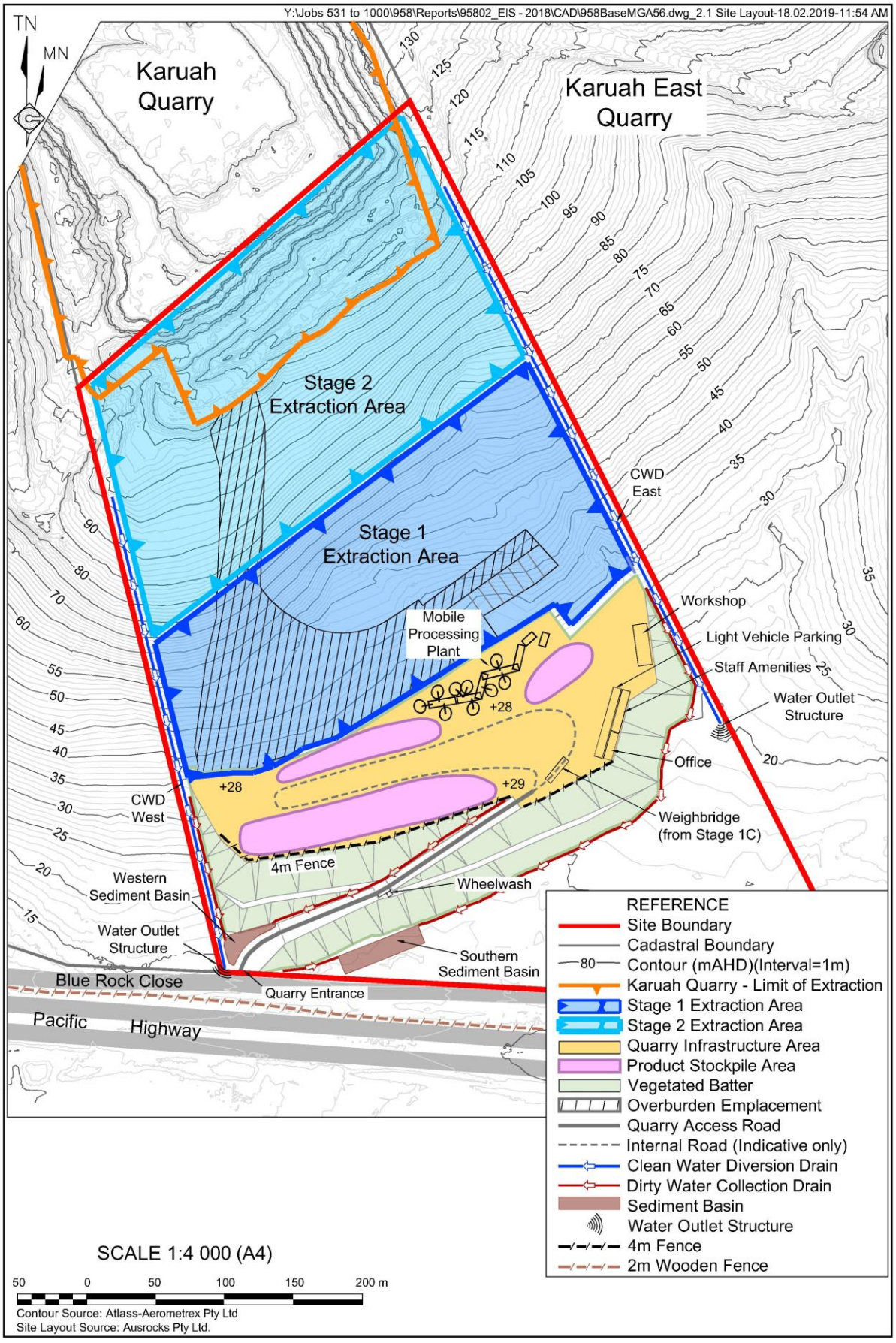


Table 1 lists the proposed hours of operation for a range of activities that would be undertaken at the Site throughout the life of the Project.

Table 1
Proposed Hours of Operation

Activity	Monday to Friday	Saturdays	Sundays or Public Holidays
Site establishment and construction	7:00am to 6:00pm	7:00am to 1:00pm	Nil
Extraction operations	7:00am to 6:00pm	7:00am to 1:00pm	Nil
Blasting operations	10:00am to 4:00pm	Nil	Nil
Processing operations	7:00am to 6:00pm	7:00am to 1:00pm	Nil
Product despatch	5:00am to 6:00pm	5:00am to 1:00pm	Nil
Maintenance	24 hours / day	24 hours / day	Nil

The hours nominated in **Table 1** are those that the Operator would operate within, not that they would be operating throughout the entire nominated periods. That is, the nominated hours would provide the flexibility needed to undertake all Project-related activities, when required. The flexibility achieved by the proposed operating hours would be important in order that the Operator can respond to large volume or urgent orders from its customers.

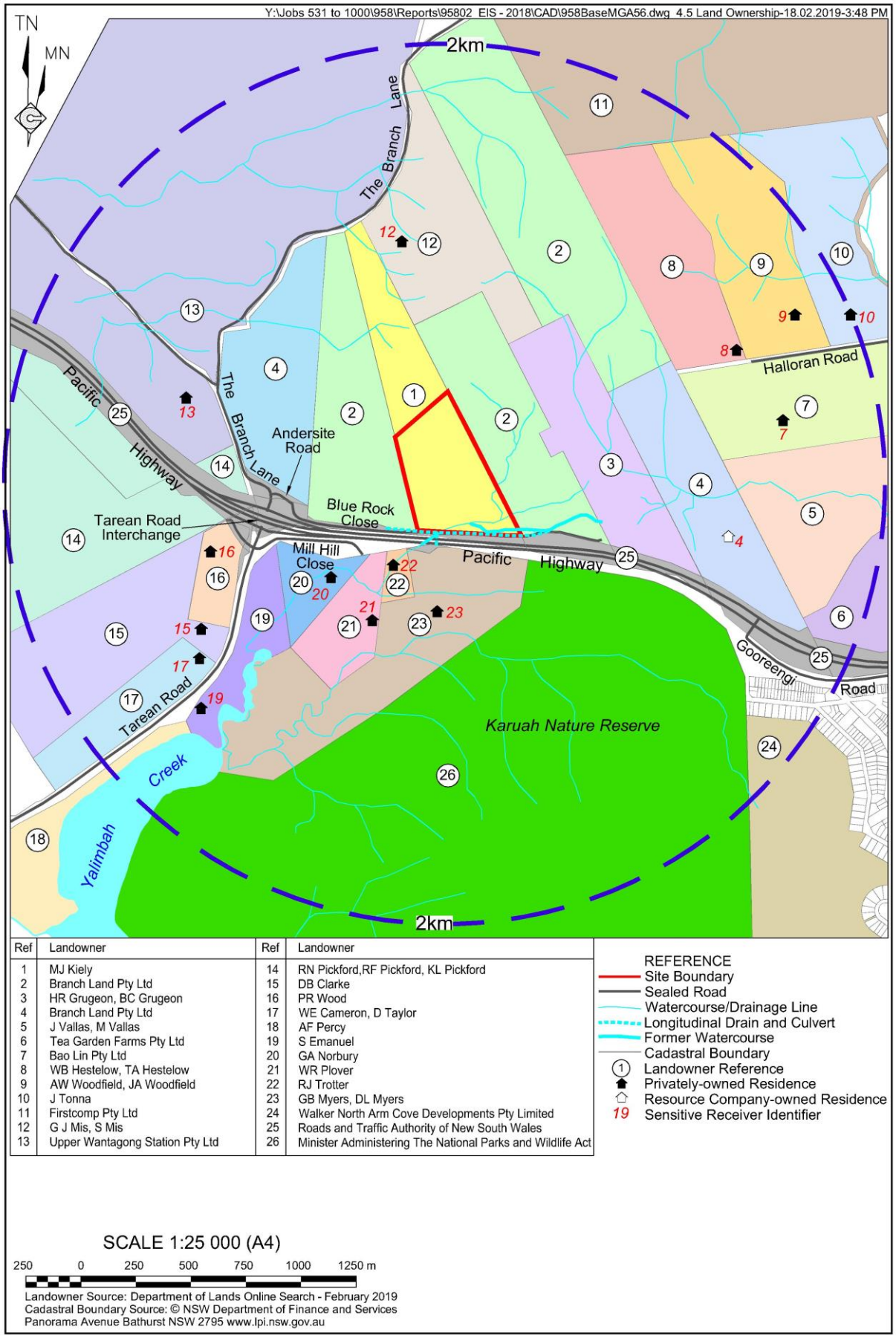
1.2 ASSESSED RECEIVERS

Privately-owned residential properties within approximately 2km of the Site were considered in this assessment and noise monitoring locations are shown in **Figure 3** and listed in **Table 2**. Additional residences are located at greater distance to the east and southeast of the proposed extraction area.

Table 2
Residential Receivers

Receiver	Landowner
R7	Bao Lin Pty Ltd
R8	WB Hestelow, TA Hestelow
R12	GJ Mis, S Mis
R13	Upper Wantalong Station Pty Ltd
R15	DB Clarke
R16	PR Wood
R17	WE Cameron, D Taylor
R19	S Emanuel
R20	GA Norbury
R21	WR Plover
R22	RJ Trotter
R23	GB Myers, DL Myers

Figure 3 Land Ownership and Assessment Locations



Ref	Landowner	Ref	Landowner
1	MJ Kiely	14	RN Pickford,RF Pickford, KL Pickford
2	Branch Land Pty Ltd	15	DB Clarke
3	HR Grugeon, BC Grugeon	16	PR Wood
4	Branch Land Pty Ltd	17	WE Cameron, D Taylor
5	J Vallas, M Vallas	18	AF Percy
6	Tea Garden Farms Pty Ltd	19	S Emanuel
7	Bao Lin Pty Ltd	20	GA Norbury
8	WB Hestelow, TA Hestelow	21	WR Plover
9	AW Woodfield, JA Woodfield	22	RJ Trotter
10	J Tonna	23	GB Myers, DL Myers
11	Firstcomp Pty Ltd	24	Walker North Arm Cove Developments Pty Limited
12	G J Mis, S Mis	25	Roads and Traffic Authority of New South Wales
13	Upper Wantagong Station Pty Ltd	26	Minister Administering The National Parks and Wildlife Act

REFERENCE
Site Boundary
Sealed Road
Watercourse/Drainage Line
Longitudinal Drain and Culvert
Former Watercourse
Cadastral Boundary
(1) Landowner Reference
Privately-owned Residence
Resource Company-owned Residence
19 Sensitive Receiver Identifier

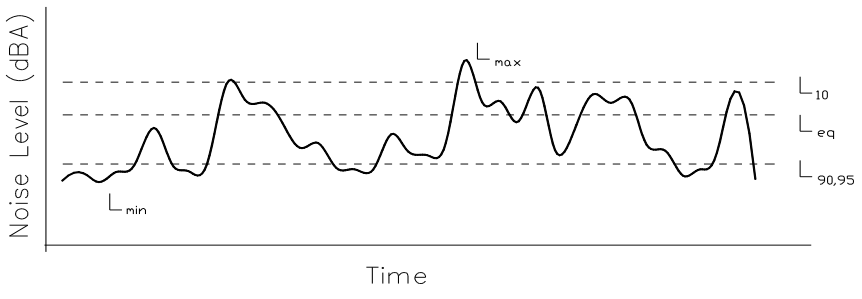
2. DESCRIPTION OF TERMS

Table 3 contains qualitative descriptions of commonly used acoustical terms and is presented as an aid to understanding this report.

Table 3
Definition of Acoustical Terms

Term	Definition
dB(A)	The quantitative measure of sound heard by the human ear, measured by the A-Scale Weighting Network of a sound level meter expressed in decibels (dB).
SPL	Sound Pressure Level. The incremental variation of sound pressure above and below atmospheric pressure and expressed in decibels. The human ear responds to pressure fluctuations, resulting in sound being heard.
STL	Sound Transmission Loss. The ability of a partition to attenuate sound, in dB.
Lw	Sound Power Level radiated by a noise source per unit time re 1pW.
Leq	Equivalent Continuous Noise Level - taking into account the fluctuations of noise over time. The time-varying level is computed to give an equivalent dB(A) level that is equal to the energy content and time period (for noise assessments this is typically 15 minutes).
Lmax	Maximum Noise Level – used to assess the potential for disturbance from impact noise at night time
L1	Average Peak Noise Level - the level exceeded for 1% of the monitoring period.
L10	Average Maximum Noise Level - the level exceeded for 10% of the monitoring period.
L90	Average Minimum Noise Level - the level exceeded for 90% of the monitoring period and recognised as the Background Noise Level. In this instance, the L90 percentile level is representative of the noise level generated by the surrounds of the residential area.

Significant Noise descriptors



3. EXISTING ENVIRONMENT AND CRITERIA

The existing meteorological and acoustical environments of the Site and its surrounds have been studied to determine prevailing conditions and to allow noise goals to be set.

3.1 METEOROLOGY

The atmospheric conditions most relevant to noise assessments are temperature inversions, gentle winds (indicative of possible wind shear) and relative humidity. The NSW Noise Policy for Industry (NPI) (EPA, 2017) states that wind effects need to be assessed where source to receiver winds (at 10m height) of 3m/s or below occur for 30% or more of the time in any season in any assessment period.

The meteorological data analysis conducted for the Project by Northstar Air Quality Pty Ltd was used to determine relevant meteorological conditions for this noise impact assessment. Data was analysed for the Nobbys (Newcastle), Williamtown RAAF and Paterson (Tocal) meteorological stations. The analysis found that winds up to 3m/s occurred less than 20% of the time during all seasons from all primary directions (+/- 45^0).

The following points are the most significant with respect to noise propagation and were adopted as parameters for noise modelling.

- Extremes of relative humidity (RH) are rarely experienced during daytime hours. A value of 70% RH was adopted.
- Noise modelling was carried out under the prevailing condition of neutral atmospheric conditions (20°C, no wind).

3.2 EXISTING ACOUSTIC ENVIRONMENT

In order to quantify the existing acoustic environment at the potentially most impacted receiver, a Rion NL-42 environmental noise logger was deployed from 10-16 September 2018 at location NM4 displayed on **Figure 3** as R21, and described in **Table 2**.

This location is approximately the same distance from the highway as the assessment point at R22 which is the closest receiver to the Pacific Highway. The noise monitoring was conducted to establish noise impact criteria specific to receiver R22, as previous studies for adjoining quarries did not conduct monitoring at this receiver. Noise criteria (project noise trigger levels) were established for all other receivers in previous assessments of adjoining quarry operations and these were retained for this assessment.

Whilst the operational status of the existing quarries was unknown at the time of noise monitoring, road noise from the Pacific Highway to the immediate north of the logger location audibly dominated the acoustic environment during deployment and retrieval of the logger with noise from the existing quarries inaudible.

Table 4 summarises the ambient LAeq and Rating Background Levels (RBL, L_{A90}) noise levels arising from the noise measurements according to procedures in the NSW NPI. Plots of the raw data are included in **Appendix 2**. Historical daytime noise monitoring results as summarised in the Noise and Blasting Impact assessment for the Karuah East Quarry (SLR,

2012) are shown in **Table 5** for the receiver numbering used in this report and the Noise Monitoring location numbering used in SLR (2012). The assignment of NM4 to the monitoring location, as proxy to the assessment point at R22, in this assessment continues to noise monitoring location numbering from previous assessments.

Table 4
Ambient LAeq and Rating Background Levels (RBLs) at NM4, dB(A)

Location	Leq(day)	Leq(eve)	Leq(night)	L90(day)	L90(eve)	L90(night)
Mill Hill Road (R21 / NM4)	58	57	54	53	52	44

Table 5
Historical Daytime Background Levels, dB(A) (SLR, 2012)

Location (Year)	L_{eq}	L_{90} (RBL)
R23 / NM2 (2003)	53	44
R8 / NM3 (2010)	51	34

Receivers most exposed to the Project are impacted by traffic noise from the Pacific Highway and relatively low percentage increases in traffic volumes, the data from 2012 are considered relevant to the project with regards to background noise levels and setting of project noise trigger levels.

3.3 PROJECT NOISE TRIGGER LEVELS

Project-generated noise within the Site is required to be assessed against the provisions of the NPI. In relation to the residences surrounding the Site, the NPI specifies two noise criteria: *intrusiveness and amenity criteria*.

The *Intrusiveness Criterion* limits Equivalent Continuous Noise Level (Leq) from the industrial source to a value of 'background plus 5dB'. That is, the Rating Background Level (RBL) for the time period, plus 5 dB(A). The RBL (L_{A90}) is defined as the overall single figure background level representing each assessment period.

The *Amenity Criterion* aims to protect against excessive noise levels where an area is becoming increasingly developed. Amenity criteria are dependent upon the nature of the receiver area and the existing level of industrial noise. There is existing industrial noise from quarries adjoining the Site and the residential area that is potentially affected by noise emissions from the Project is best described acoustically as an area dominated by road traffic noise.

Time periods for assessment as defined in the NPI are:

- Daytime – 7:00am (8:00am on Sundays) to 6:00pm;
- Evening – 6:00pm to 10:00pm; and
- Night – 10:00pm to 7:00am (8:00am on Sundays).

The project noise trigger levels for all residential receivers are derived from the lower of the existing intrusiveness criteria and the amenity criteria and the worst case or most conservative time period based on recorded background levels. If compliance is predicted during the worst case time period assessed, then compliance is assumed for the remaining time periods.

Table 6 defines the proposed operating periods relating to the hours of operation outlined in **Table 1**. With all extraction and processing operations to occur during daytime only, and with morning shoulder periods normally having higher background level than the daytime background level, the daytime trigger levels will be taken as worst case.

Table 6
Proposed Operational Time Periods

Activity	Monday to Friday	Saturday	Sunday
Site Establishment	Day	Day	NIL
Extraction Operations	Day	Day	NIL
Blasting Operations	Day	Day	NIL
Processing Operations	Day	Day	NIL
Product Despatch	MS[1](2), Day	MS[1](2), Day	NIL
Maintenance	24 hours / day	24 hours / day	NIL
1. Morning Shoulder (MS) period (number of hours prior to 7:00am)			

Table 7 lists the RBLs from historical noise monitoring summarised in **Table 5** and the project noise trigger levels (PNTLs) based on those background levels in SLR (2012). Trigger levels for the current assessment have been determined from site-specific noise monitoring as discussed in Section 3.2. Under Section 2.3 of the NPI, the daytime intrusiveness trigger level at R22 is "background + 5 dB" or 58 dB(A),$L_{eq(15minute)}$. The project amenity trigger level under Section 2.4 (**Table 2.2**) of the NPI is 50 dB(A),$L_{eq(day)}$.

Table 7
Rating Background Levels and PNTLs – dB(A)

Location	RBL L_{A90}	Trigger levels/PNTLs $L_{Aeq(15minute)}$
R22	53	50^
R13, R15, R16, R17, R20, R21, R23	44	49
R7, R8, R19*	34	39
R12	30#	35
^ Amenity noise level conservatively adopted as LAeq(15min) based on suburban classification. * Historical background measurement at R7 taken as representative of R8 and R19. # NPI default minimum trigger level adopted for receivers distant from the Pacific Highway.		

3.4 CUMULATIVE NOISE LEVELS

The recommended daytime amenity noise level for the **total** industrial noise from all sources (new and proposed) is 55 dB(A),$L_{eq(day)}$ from **Table 2.2** of the NPI.

The approach of deriving the project amenity noise level resulting from a new development on the basis of the recommended amenity noise level minus 5 dB is based on a receiver not being impacted by more than three to four individual industrial noise sources, which is the case for the receivers in the present study.

3.5 MAXIMUM NOISE LEVELS

The potential for sleep disturbance from maximum noise level events from the Project during the night-time period needs to be considered. Sleep disturbance is considered to be both awakenings and disturbance to sleep stages.

Where the subject development/premises night-time noise levels at a residential location exceed:

- $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,

Other factors that may be important in assessing the extent of impacts on sleep include:

- how often high noise events will occur
- the distribution of likely events across the night-time period and the existing ambient maximum events in the absence of the subject development
- whether there are times of day when there is a clear change in the noise environment (such as during early-morning shoulder periods)
- current scientific literature available at the time of the assessment regarding the impact of maximum noise level events at night.

Maximum noise level event assessments should be based on the L_{AFmax} descriptor on an event basis under 'fast' time response. The detailed assessment should consider all feasible and reasonable noise mitigation measures with a goal of achieving the above trigger levels. The maximum noise levels assessment levels, being the greater of 52 dB(A),L_{max} and the RBL + 15 dB, are only applicable to night-time noise emissions from product haulage trucks between 5am and 7am.

3.6 TRAFFIC NOISE

In NSW, noise from vehicle movements associated with an industrial source is assessed in terms of the NPI if the vehicles are not on a public road. If the vehicles are on a public road, the *NSW Road Noise Policy* (RNP) applies. Noise from the Project must, therefore, be assessed against the project noise trigger levels of the NPI and also the criteria in the RNP.

The RNP recommends various criteria based on the functional categories of roads applied by the NSW Roads and Maritime Services (RMS). The RMS differentiates roads based on a number of factors including traffic volume, heavy vehicle use, through or local traffic, vehicle speeds and applicable traffic management options. Vehicles accessing the Site will do so via the Pacific Highway which falls under the RMS definition of a freeway or arterial road.

Table 8 shows the noise criteria relevant to arterial roads extracted from **Table 3** of the RNP. For the assessment of traffic noise, the daytime period is from 7:00am to 10:00pm, whilst night is from 10:00pm to 7:00am.

Table 8
Road Traffic Noise Criteria

Situation	Recommended Criteria	
	Day (7:00am to 10:00pm)	Night (10:00pm to 7:00am)
Existing residences affected by additional traffic on existing freeway/ arterial/sub-arterial roads generated by land use developments	Leq (15-hour) 60	Leq (9-hour) 55

3.7 BLASTING AND VIBRATION

Blast overpressure and ground vibration criteria for human comfort and building damage are discussed below. The most stringent criteria will be adopted for the Project.

3.7.1 Human Comfort

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

- The recommended maximum overpressure level for blasting is 115 dB;
- The level of 115 dB may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 120 dB at any time;
- The recommended maximum vibration velocity for blasting is 5 mm/s Peak Vector Sum (PVS);
- The PVS level of 5 mm/s may be exceeded for up to 5% of the total number of blasts over a 12-month period, but should not exceed 10 mm/s at any time;
- Blasting should generally only be permitted during the hours of 9 am to 5 pm Monday to Saturday, and should not take place on Sundays and Public Holidays; and

Blasting should generally take place no more than once per day.

3.7.2 Building Damage Criteria

Building damage assessment criteria are nominated in AS 2187.2-1993 *"Explosives – Storage, Transport and Use. Part 2: Use of Explosives"* and summarised in **Table 9.**

Table 9
Building damage vibration criteria

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

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

4. ASSESSMENT METHODOLOGY

4.1 MODELLED SCENARIOS

A full description of the Project is given in Section 2 of the EIS. It was determined that the site establishment and construction stage and two operational noise scenarios represent worst case potential for noise impacts at the surrounding residential receivers. These scenarios are briefly described below and noise source locations indicated in **Figures 4-6**. Noise modelling using the Environmental Noise Model (ENM v3.06) was undertaken for the atmospheric conditions described in Section 3.1.

4.1.1 Scenario 1 – Site Establishment and Construction

Extraction of material at approximately 40m AHD and earthworks to form the base of the site infrastructure area at approximately 28m AHD.

4.1.2 Scenario 2 – Extraction Stage 1C

Extraction of material at approximately 40-70m AHD (natural surface) to a depth of up to approximately 55m. Site infrastructure area at approximately 30m AHD with mobile processing plant located in the southwestern corner of the area. A 4m high acoustic barrier (a fence) has been modelled along the southern side of the processing plant. Product haulage trucks using a ramp along the southern edge of the infrastructure area. Production rate 300 000 tonnes per annum.

4.1.3 Scenario 3 – Extraction Stage 2B

Extraction of material at approximately 40-120m AHD (natural surface) to a depth of up to approximately 110m. Site infrastructure area at approximately 30m AHD with mobile processing plant located in the northeastern corner of the area. Product stockpiles in **Figure 6** have been modelled at 4m high. Product haulage trucks using a ramp along the southern edge of the infrastructure area. Production rate 600 000 tonnes per annum.

Figure 4 Operational Scenario 1 – Site establishment and Construction

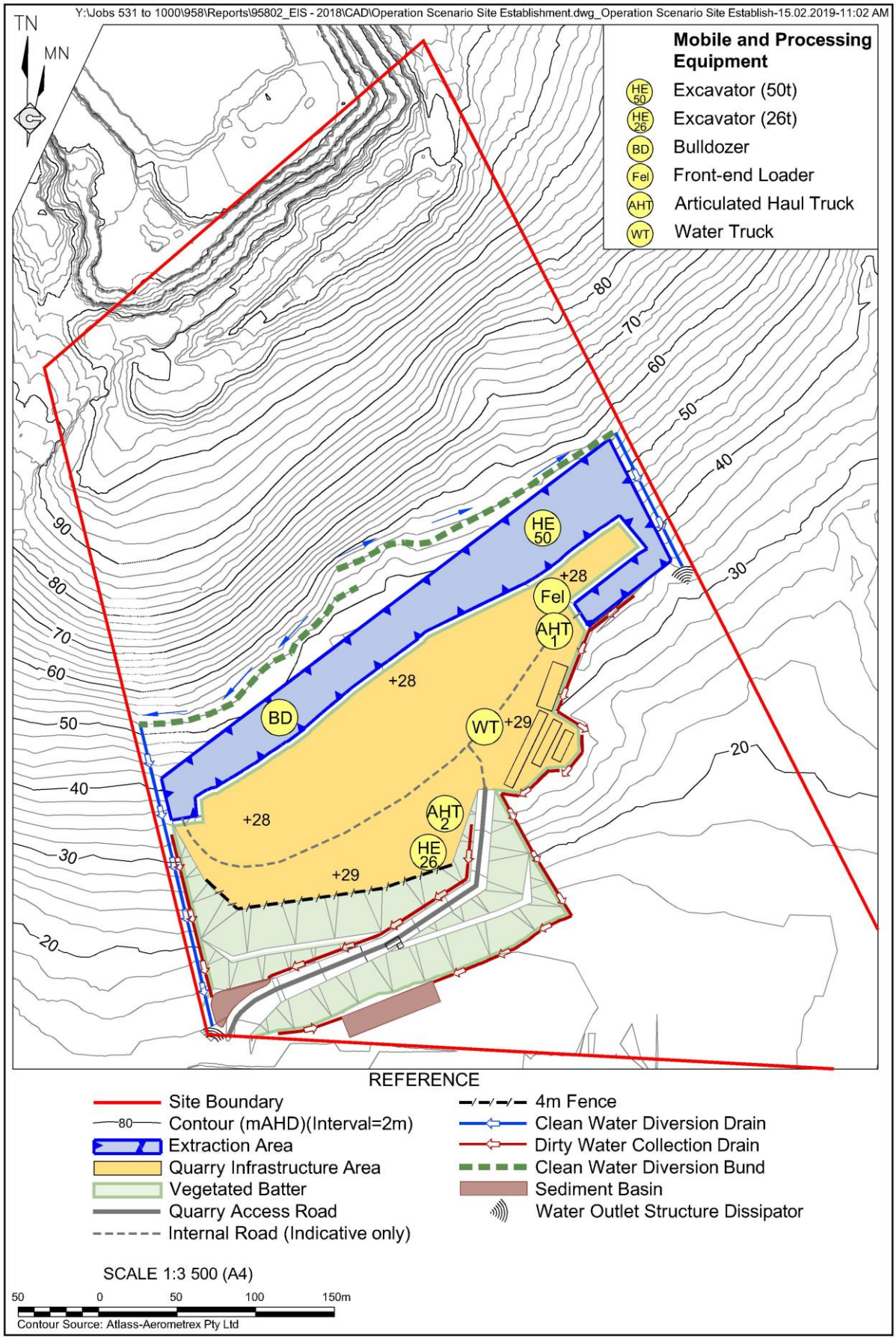


Figure 5 Operational Scenario 2 – Stage 1C

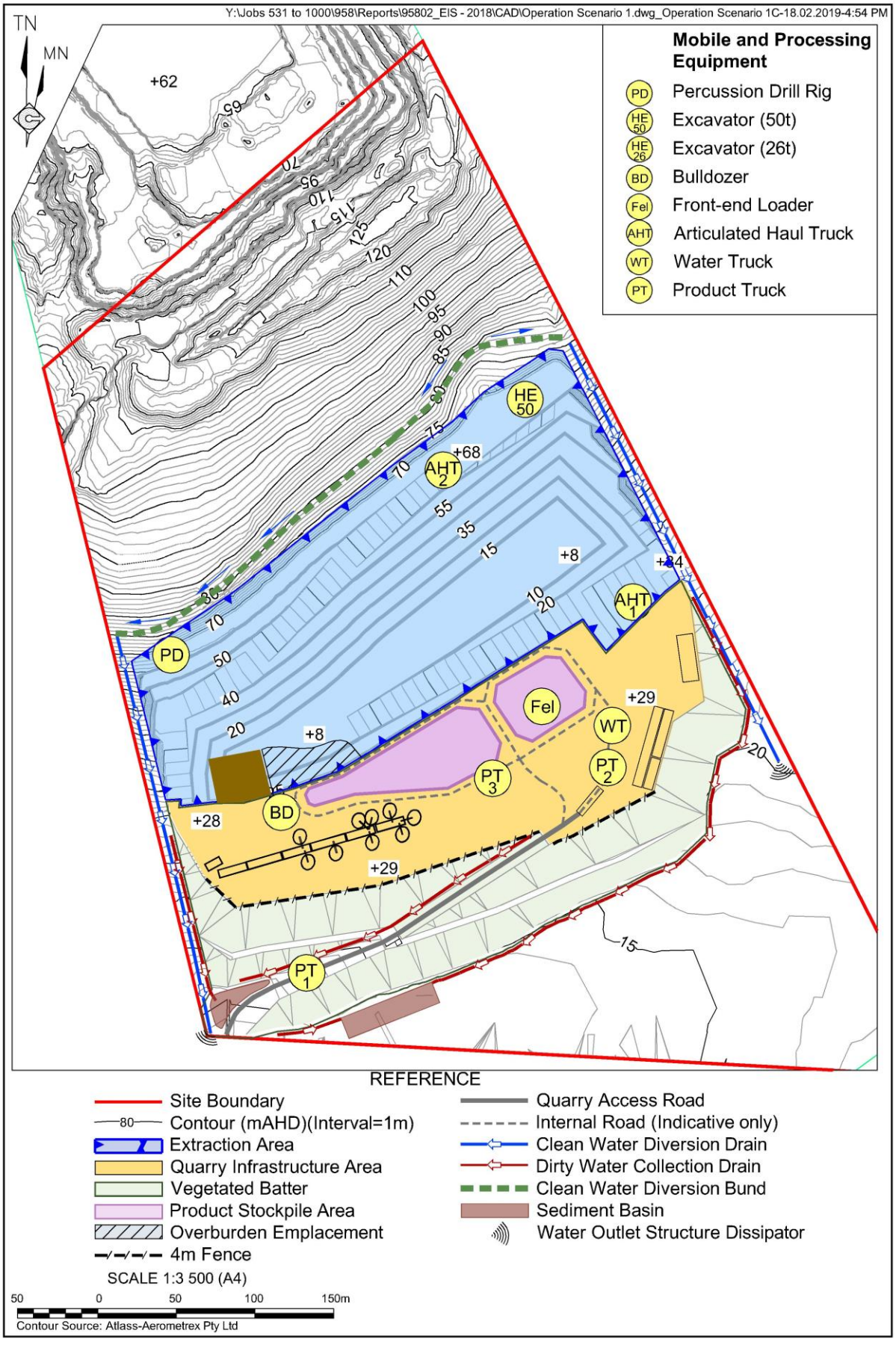
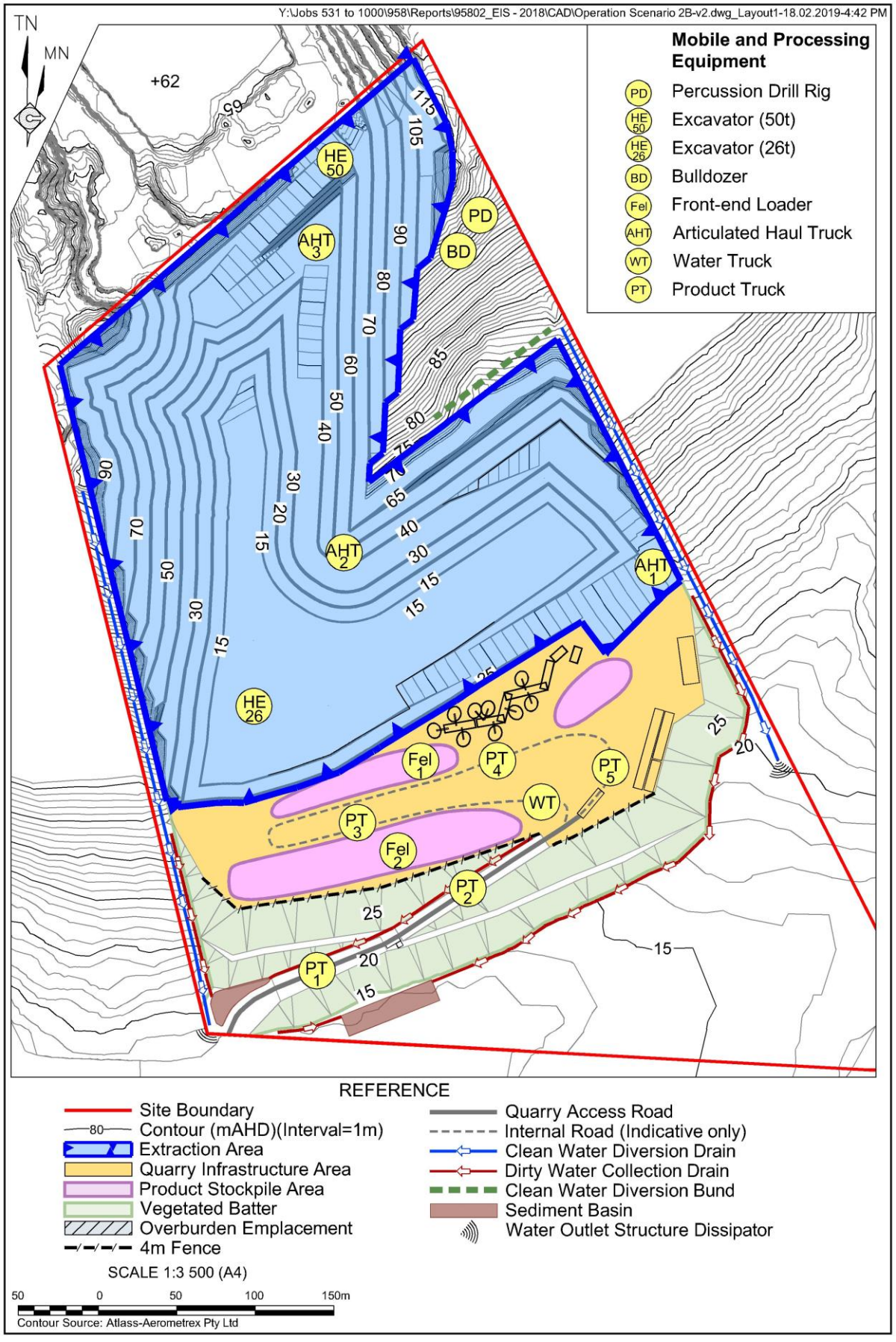


Figure 6 Operational Scenario 3 – Stage 2B



4.2 NOISE SOURCES

The sound power levels of the significant noise-generating equipment used in the modelling of each scenario are listed in **Table 10**.

Table 10
Noise Source Sound Power Levels

Equipment	Number		Use/Activity	Lw, dB(A)	
	300 ktpa	600 ktpa		Leq	Lmax
Percussion Drill Rig (Atlas Copco T40 or similar)	1	1	Drilling blast holes (typically used 2-3 days every month)	113	121
Hydraulic Excavator 50t (Caterpillar 349F or similar)	1	1	Resource extraction and haul truck loading.	108	112
Hydraulic Excavator 26t (Caterpillar 325F or similar)	1	1	Resource extraction and haul truck loading.	108	113
Bulldozer (Caterpillar D9T or similar)	1	1	Resource extraction (ripping/pushing), site works.	106	109
Front-end Loader (Caterpillar 980K or similar)	1	2	Haul truck and product truck loading, blending road pavement materials.	110	112
Articulated Haul Truck (Caterpillar 730C or similar)	1	3	Raw material haulage to processing area.	98	102
Water Truck (Minimum 12 000 L) (Caterpillar 720C or similar)	1	1	Dust suppression activities.	108	113
Primary crusher (e.g. Kleemann Mobicat MC125Z K008)	1	1	Primary crushing of raw material	119	125
Secondary crusher + screen (e.g. Mobicone MCO13 / MS18Z-AD)	1	1	Secondary crushing and screening of raw material	113	118
Tertiary crusher (e.g. Mobicone MCO13S)	1	1	Tertiary crushing of raw material	113	116
Triple deck screens (e.g. Mobiscreen MS20D)	1	2	Screening of product material	110	112
Product truck	3	5	Hauling product off-site to market	91	112[#]

* Typical number on-site at any given time.
[#] Impact from truck being loaded.
Source: Ausrocks Pty Ltd

4.3 CUMULATIVE NOISE

The worst case noise levels predicted in the current assessment and the predicted levels from assessments of existing quarries on the adjoining properties were tabulated and added together for comparison with the cumulative amenity noise level of 55 dB(A),$L_{eq(day)}$. This assessment draws on the cumulative noise assessment in SLR (2012) and common receivers considered in the current assessment.

4.4 MAXIMUM NOISE LEVELS

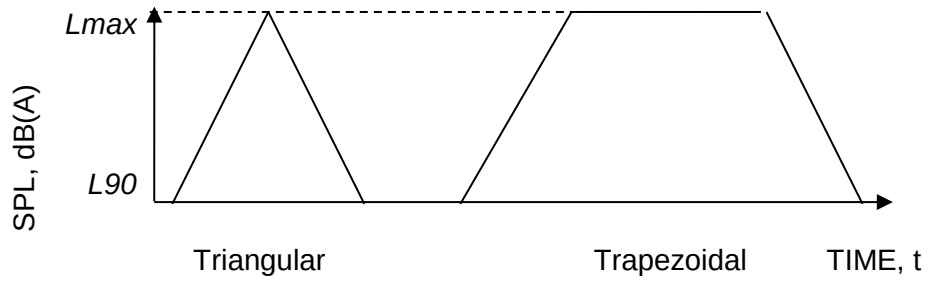
The only activity that would occur between 5:00am and 7:00am is product trucks being loaded and travelling on the Quarry Access Road. The Sound power levels of modelled L_{Amax} noise is shown in **Table 11**. Impact noise was modelled using the ENM program under neutral conditions.

4.5 TRAFFIC NOISE

Additional traffic noise generated by the Project at residential receivers adjacent to the Pacific Highway will be of a discrete rather than constant nature. There are many methods available for calculating the cumulative noise impact arising from discrete signals of various shapes. The methodology employed in this Section was sourced from the US Environmental Protection Agency document No. 550/9-74-004 *Information on Levels of Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety, March 1974*.

The document refers to *triangular* and *trapezoidal* time signals, which are illustrated in **Figure 7**. A triangular time signal rises from the background level to a peak noise level and then immediately begins to subside. A triangular time signal is a good approximation of the Sound Pressure Level (SPL) signal of a truck as it passes an observation point. A trapezoidal time signal rises from the background level to a maximum level and sustains that level for a period of time before subsiding. The trapezoidal time signal is a good approximation of the SPL signal of a train as it passes an observation point.

Figure 7 Triangular and trapezoidal noise signals



The value of $L_{eq,T}$ for a series of identical triangular time patterns having a maximum level of L_{max} is given by **Equation 1**.

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

Where

- L_b is background noise level, dB(A)
- L_{MAX} is vehicle noise, dB(A)
- T is the time for each group of vehicles (min)
- N is number of vehicle trips
- D is duration of noise of each vehicle (min)

For calculation purposes, L_{max} is the maximum vehicle noise at the assessment point(s), and has been based on numerous measurements of quarry truck pass-by noise taken by Spectrum Acoustics at receivers near other quarries in recent years. The background noise level is the level that existed prior to the introduction of the new noise, the L_{A90} level. The assessment period *T* corresponds to the stated criterion period, that is, 60 minutes.

For the purposes of the road traffic noise assessment, it has been assumed the closest residences to the Pacific Highway, at which the quarry-related truck noise is assessed, is R2 at 108m from the near edge of the highway.

4.6 BLASTING AND VIBRATION ASSESSMENT

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

4.6.1 Blast Overpressure

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

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

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

4.6.2 Blast Vibration

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

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

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

where *D* and *Q* are defined as in Equation 1. Equation 3 has been adopted to provide a conservative assessment as no specific site law has been established through trial blasting.

5. RESULTS AND DISCUSSION

5.1 PREDICTED OPERATIONAL NOISE LEVELS

Noise levels were modelled using Renzo Tonin Associates (RTA) *Environmental Noise Model* v3.06 (ENM) software. Point to point calculations were performed for all receivers in **Table 2**.

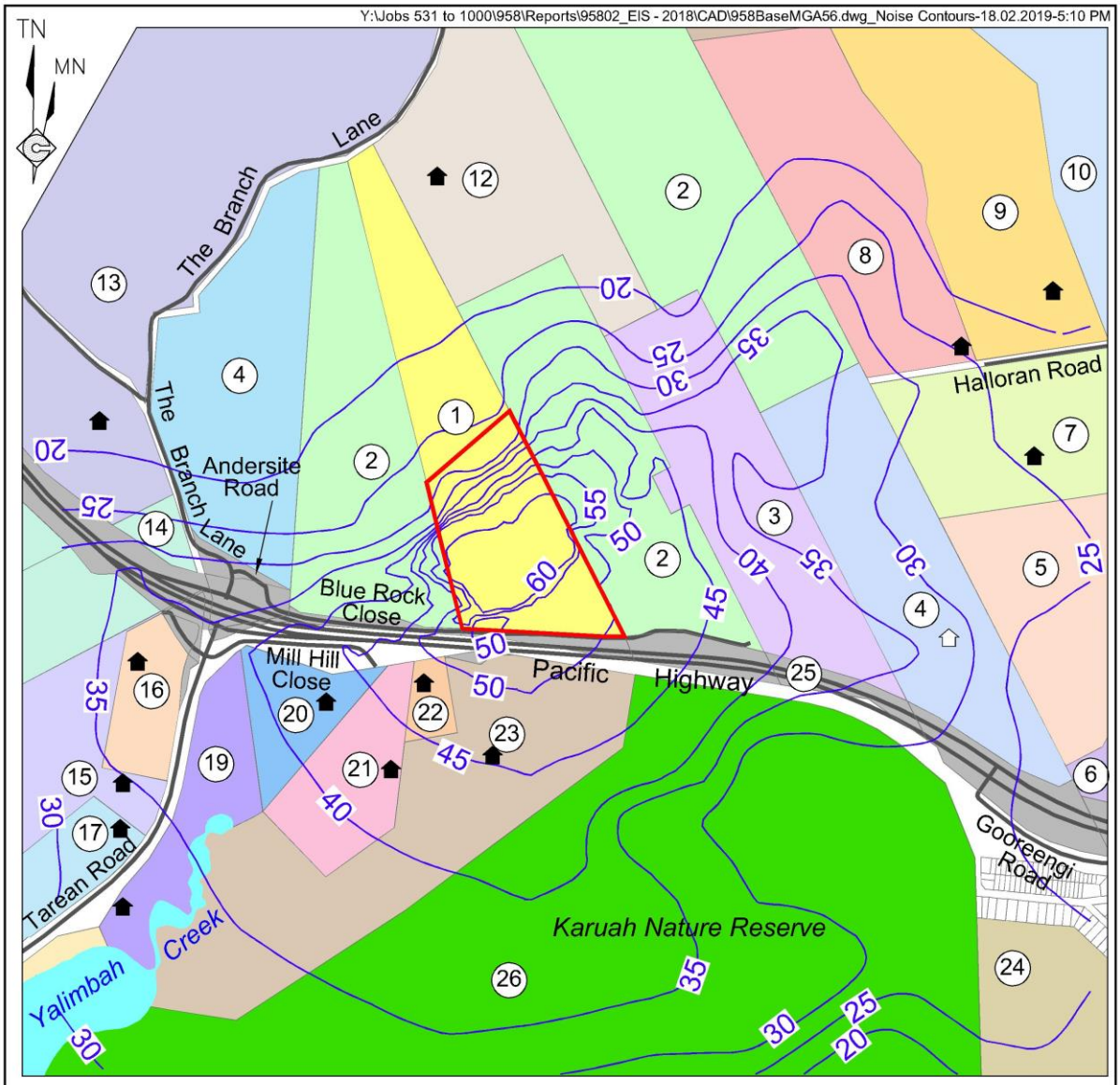
Predicted noise levels for the three modelled scenarios are summarised in **Tables 11** to **13**. Any exceedances of the noise trigger levels, if they occur, are highlighted in bold type. Criteria are taken from **Table 7**.

Noise contours are shown in **Figures 8** to **10.**

Table 11
Predicted noise levels, dB(A), $L_{eq(15min)}$ Scenario 1

Receiver*	Product Noise Trigger level	Meteorological condition
		Neutral
R7	39	25
R8	39	25
R12	35	<20
R13	49	<20
R15	49	35
R16	49	36
R17	49	34
R19	39	33
R20	49	43
R21	49	43
R22	50	47
R23	49	46
* See Figure 8.		

Figure 8 Noise Contours – Scenario 1 Site Establishment and Construction



Criteria	Project Noise Trigger Levels dB(A)
Noise Averaging Period	$L_{Aeq(15minute)}$
Receiver	
R22	50
R4, R13, R15, R16, R17, R20, R21, R23	49
R7, R8, R19	39
R12	35

Source: Spectrum Acoustics (2018)

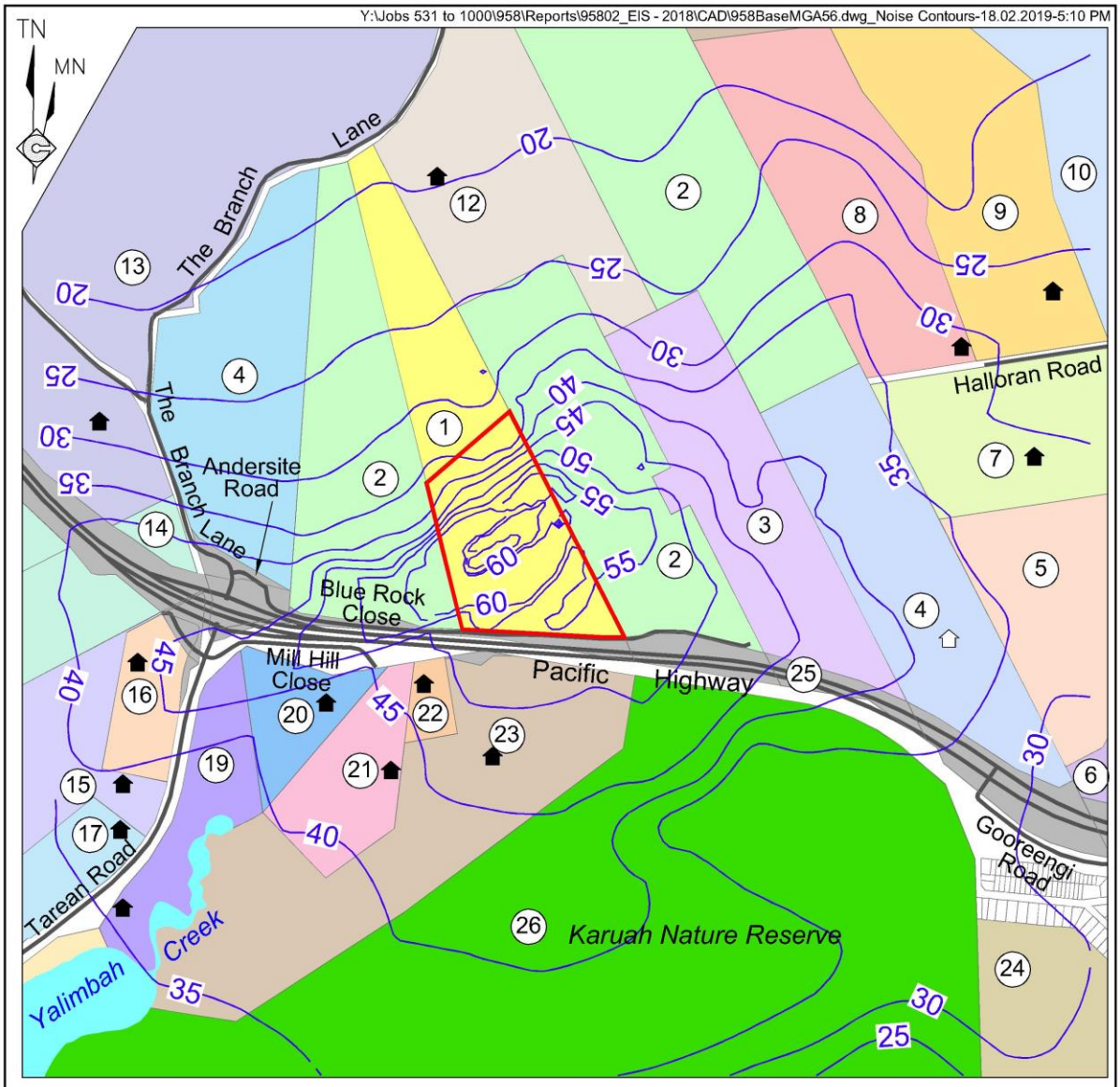
REFERENCE
Site Boundary
Sealed Road
Cadastral Boundary
Landowner Reference
Privately-owned Residence
Resource Company-owned Residence
Noise Contour dB(A)

SCALE 1:20 000 (A4)
200 0 200 400 600 800 1000 m
Landowner Source: Department of Lands Online Search - February 2019

Table 12
Predicted noise levels, dB(A), $L_{eq(15min)}$ Scenario 2

Receiver*	Product Noise Trigger level	Meteorological condition
		Neutral
R7	39	31
R8	39	30
R12	35	20
R13	49	23
R15	49	40
R16	49	44
R17	49	37
R19	39	36
R20	49	44
R21	49	44
R22	50	48
R23	49	48
* See Figure 9.		

Figure 9 Noise Contours – Scenario 2 Stage 1C



Criteria	Project Noise Trigger Levels dB(A)
Noise Averaging Period	$L_{Aeq(15minute)}$
Receiver	
R22	50
R4, R13, R15, R16, R17, R20, R21, R23	49
R7, R8, R19	39
R12	35

Source: Spectrum Acoustics (2018)

REFERENCE
Site Boundary
Sealed Road
Cadastral Boundary
(1) Landowner Reference
Privately-owned Residence
Resource Company-owned Residence
Noise Contour dB(A)

SCALE 1:20 000 (A4)

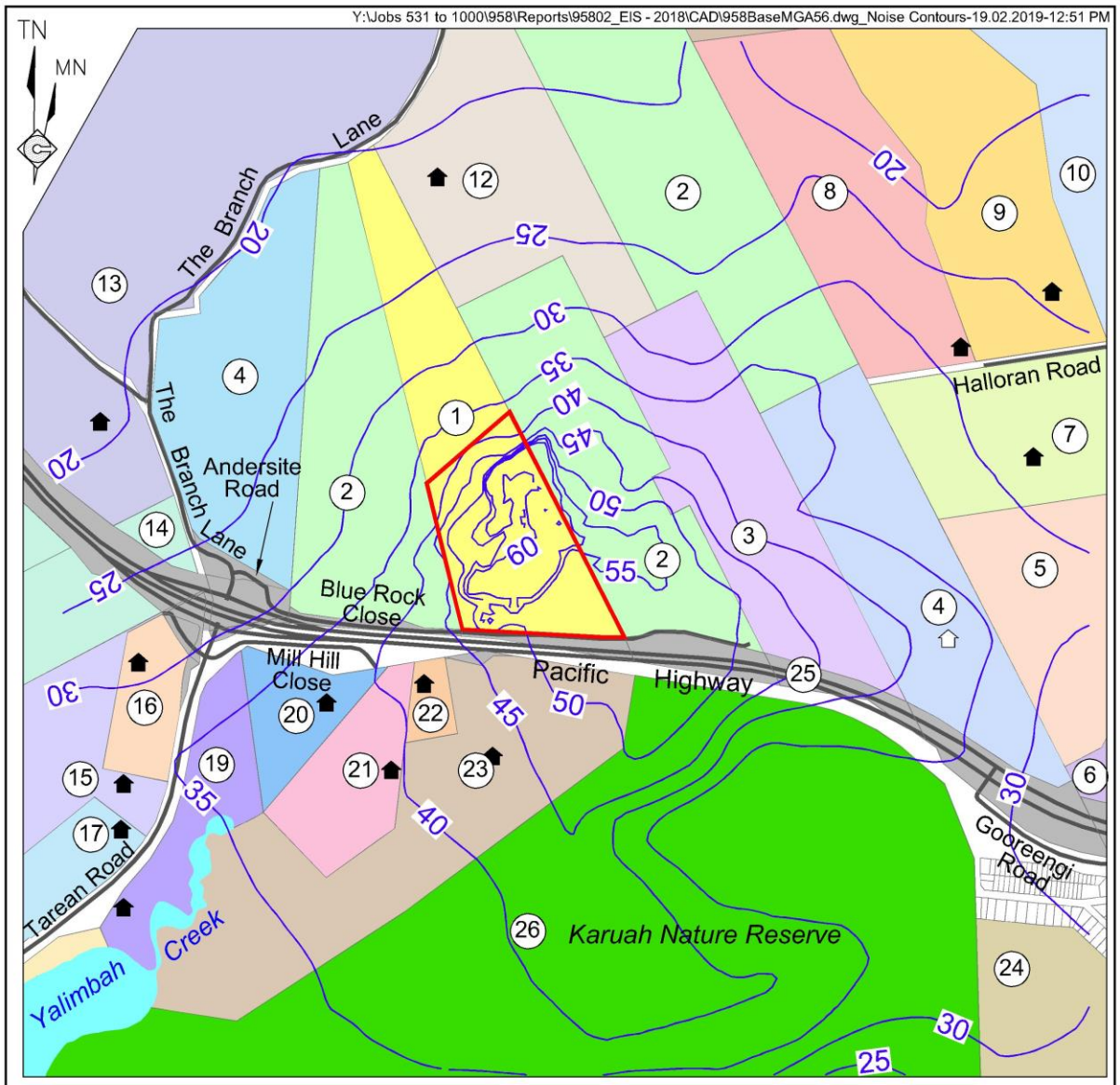
200 0 200 400 600 800 1000 m

Landowner Source: Department of Lands Online Search - February 2019

Table 13
Predicted noise levels, dB(A), $L_{eq(15min)}$ Scenario 3

Receiver*	Product Noise Trigger level	Meteorological condition
		Neutral
R7	39	34
R8	39	34
R12	35	22
R13	49	21
R15	49	33
R16	49	26
R17	49	33
R19	39	32
R20	49	38
R21	49	41
R22	50	45
R23	49	45
* See Figure 10.		

Figure 10 Noise Contours – Scenario 3 Stage 3B



Criteria	Project Noise Trigger Levels dB(A)
Noise Averaging Period	$L_{Aeq(15minute)}$
Receiver	
R22	50
R4, R13, R15, R16, R17, R20, R21, R23	49
R7, R8, R19	39
R12	35

Source: Spectrum Acoustics (2018)

REFERENCE
Site Boundary
Sealed Road
Cadastral Boundary
(1) Landowner Reference
Privately-owned Residence
Resource Company-owned Residence
Noise Contour dB(A)

SCALE 1:20 000 (A4)

200 0 200 400 600 800 1000 m

Landowner Source: Department of Lands Online Search - February 2019

The results in **Tables 11** to **13** predict noise levels below the project noise trigger level at all assessed receivers.

5.2 CUMULATIVE NOISE

Cumulative noise levels from the Project and existing quarries in the area are presented in **Table 14**. **Table 14** includes all receivers for which predicted noise levels from other projects are available. The results are absolute worst case and represent the greatest predicted noise level at each receiver from each project, regardless of whether the meteorological conditions or operational scenarios coincide. The resulting cumulative noise level is below the allowable cumulative amenity level.

Table 14
Predicted Cumulative Noise Levels, dB(A),$L_{eq(15min)}$

Receiver	Industrial Noise levels dB(A),Leq(15min) - Calm			Cumulative Level	Amenity Level
	Karuah Quarry	Karuah East Quarry	Karuah South Quarry		
R7	34	37	31	40	55
R13	48	19	23	48	55
R15	43	31	40	45	55
R16	44	30	44	47	55
R20	48	34	44	49	55
R22	42	37	48	49	55
R23	34	40	48	49	55

5.3 VLAMP ASSESSMENT

The DPE's *Voluntary Land Acquisition and Mitigation Policy for State Significant Mining, Petroleum and Extraction Industry Development* (VLAMP) lists five (5) different levels of noise impact and recommended actions. These impact levels and actions are shown in **Table 15**.

Table 15
VLAMP Noise Categories and Recommended Actions

Noise Category	Project Noise Levels	Recommended action
1. Negligible	0-2 dB(A) above PNTL	Not a discernible noise impact – no action required
2. Marginal	3-5 dB(A) above PNTL and project contributes less than 1 dB at residence	Mechanical ventilation and air conditioning
3. Moderate	3-5 dB(A) above PNTL and project contributes more than 1 dB at residence	Mechanical ventilation, air conditioning and facade upgrade
4. Significant	More than 5 dB(A) above PNTL at residence	Mechanical ventilation, air conditioning and facade upgrade, property acquisition
5. Significant	More than 5 dB(A) above amenity limit over 25% of land area	Property acquisition

The noise impact assessment in Section 5.1 found that none of the assessed receivers (residences) would be impacted under any noise category in **Table 15**. No privately-owned land would experience noise levels more than 5 dB above the project amenity level.

5.4 MAXIMUM NOISE LEVELS

Predicted maximum noise levels based on the Lmax value in **Table 11** for loading product trucks, as modelled using the ENM software, are shown in **Table 16**. Predicted maximum noise levels are well below the maximum noise level criterion at all receivers.

Table 16
Predicted Maximum Noise Levels, dB(A),L_{max}

Receiver	Criterion	Meteorological Condition
		Neutral
R7	52	<30
R8	52	<30
R12	52	<30
R13	52	<30
R15	52	<30
R16	52	<30
R17	52	<30
R19	52	<30
R20	52	30
R21	52	36
R22	52	38
R23	52	40

5.5 OFF-SITE ROAD TRAFFIC NOISE

5.5.1 Traffic Types and Levels

The bulk of the products would be despatched from the Site using truck and dog trailers of various configurations, i.e. with a capacity of between 32.5t and 37.5t, smaller quantities of products would be despatched by semi-trailers (27.5t to 30t capacity) or rigid trucks (12.5t to 18t capacity).

Traffic levels would vary substantially on a daily basis throughout the life of the Project. For the purposes of this assessment, daily loads despatched would vary from 12 to 72 and average 36 loads, i.e. when annual production is typically around 300 000tpa. When annual production levels of 600 000tpa are being achieved, the number of daily loads despatched would vary from approximately 20 to 120 and average approximately 72 loads. A worst case of 120 loads per day was considered in the assessment of potential noise impacts.

5.5.2 Product Transport Routes

All laden trucks departing the Site would travel westwards on Blue Rock Close from the Quarry Entrance. Blue Rock Close is a two-way, two-lane, sealed local road that runs east-west parallel to, and on the northern side of, the Pacific Highway. Laden trucks would then enter Andersite Road which connects Blue Rock Close to The Branch Lane at its western extent. The Branch Lane is a two-lane, two-way local road which provides access to the Pacific Highway interchange for all northbound laden trucks. Southbound laden trucks would continue onto Tarean Road prior to entering the southbound lanes of the Pacific Highway via the Pacific Highway interchange. On average, 95% of laden trucks would travel to the south towards the Sydney and Newcastle markets with fewer trucks destined for Taree to the north.

Unladen trucks travelling to the Site from Sydney and Newcastle would approach the Pacific Highway interchange from the south prior to entering The Branch Lane. Unladen trucks travelling from the north would approach the Pacific Highway interchange from the north prior to entering Tarean Road.

5.5.3 Traffic Noise impact Assessment

Based on the maximum annual product despatch rate of 600 000t, the Project would generate up to 240 movements per day, or 22 movements per hour, half as arriving empty trucks and half as departing full trucks. Since 95% of departing trucks would head south on the Pacific Highway, the potentially most impacted receiver is R16 at 185m south of the southbound interchange. Point calculation modelling resulted in a road traffic noise level of 43 dB(A),$L_{eq(1hour)}$ based on a nominal entry speed of 70km/h. This is significantly below the criterion of 55 dB(A),$L_{eq(9hour)}$ and is even below the background noise level previously measured at this receiver. Consequently, there is minimal potential for adverse traffic noise impacts from the Project.

5.6 BLASTING AND VIBRATION ASSESSMENT

Predicted blast overpressure and ground vibration levels at the nearest residential receivers in each direction from the Site are shown in **Table 17**. Calculations are based on charge weights (Maximum Instantaneous Charge weight, [MIC]) of a nominal 60kg and a likely maximum value of 80kg.

Table 17
Predicted Blast Impacts

Receiver	Distance (m)[a]	Criterion		MIC = 60 kg		MIC = 80 kg	
		PPV[b]	OP[c]	PPV	OP	PPV	OP
R22 (south)	315	5	115	2.1	114	2.1	115
R16 (west)	950	5	115	0.5	104	0.6	106
R12 (north)	720	5	115	0.8	107	1.0	108
R8 (east)	1260	5	115	0.3	100	0.4	101

[a] Distance from receiver to closest point of extraction area.
[b] Peak vertical ground vibration, mm/s.
[c] Blast overpressure, dB.

The results in **Table 17** confirm that blast vibration and overpressure levels will be not exceed the 5% exceedance criteria at the assessed residential receivers. A maximum of 5% of blasts per year can exceed these criteria as discussed in Section 3.7.1.

In addition to the residential receivers, blast vibration impacts on the Pacific Highway require assessment. The predicted PPV levels at a distance of 165m between the closest blast in Stage 1A to the highway is 4.7 mm/s for an 80 kg MIC blast. This is slightly below the 5% exceedance limit of 5 mm/s for human comfort and well below existing criteria imposed for various mining projects in NSW for damage to structures such as buildings (25 mm/s), road culverts (80 mm/s) and underground optic fibre cables (100 mm/s).

6. MONITORING

It is recommended that attended noise monitoring should be conducted on a quarterly basis for at least the first year of operation to determine compliance with the noise criteria and to inform any further noise mitigation works, should the need arise. Monitoring locations would include R22 and R7 to monitor operational noise from extraction and processing activities.

Each blast event would be monitored with monitoring protocols established in an approved Blast Management Plan.

Table 18
Coverage of SEARs and Additional Matters

Government Agency	Paraphrased Requirement	Relevant Section(s)
EPA	Construction noise – Interim Construction Noise Guideline (DECC, 2009)	N/A
	Vibration – Assessing Vibration: A Technical Guideline (DEC, 2006)	N/A
	Blast impacts – Australian and New Zealand Environment Council (ANZEC)	3.7, 4.6, 5.6
	Operations – NSW Noise Policy for Industry (NPI)	3.3, 4.1, 5.1
	Road traffic noise – NSW Road Noise Policy (DECCW, 2011)	3.6, 4.5, 5.5
	Detail monitoring to assess impacts of the proposal	6.0
DPE	Detailed assessment of construction noise (ICNG)	N/A
	Detailed assessment of operational noise (NPI)	3.3, 4.1, 5.1
	Detailed assessment of offsite transport noise (RNP)	3.6, 4.5, 5.5
	Consider Voluntary Land Acquisition and Management Policy (VLAMP)	5.3
	If claim for construction criteria, use ICNG	N/A
	Proposed blasting hours, frequency and methods	4.6
	Detailed blast assessment having regard to ANZEC guidelines	5.6
	Reasonable and feasible mitigation measures	4.1.2
	Monitoring and management measures	6.0

Annexure 1

Noise data charts

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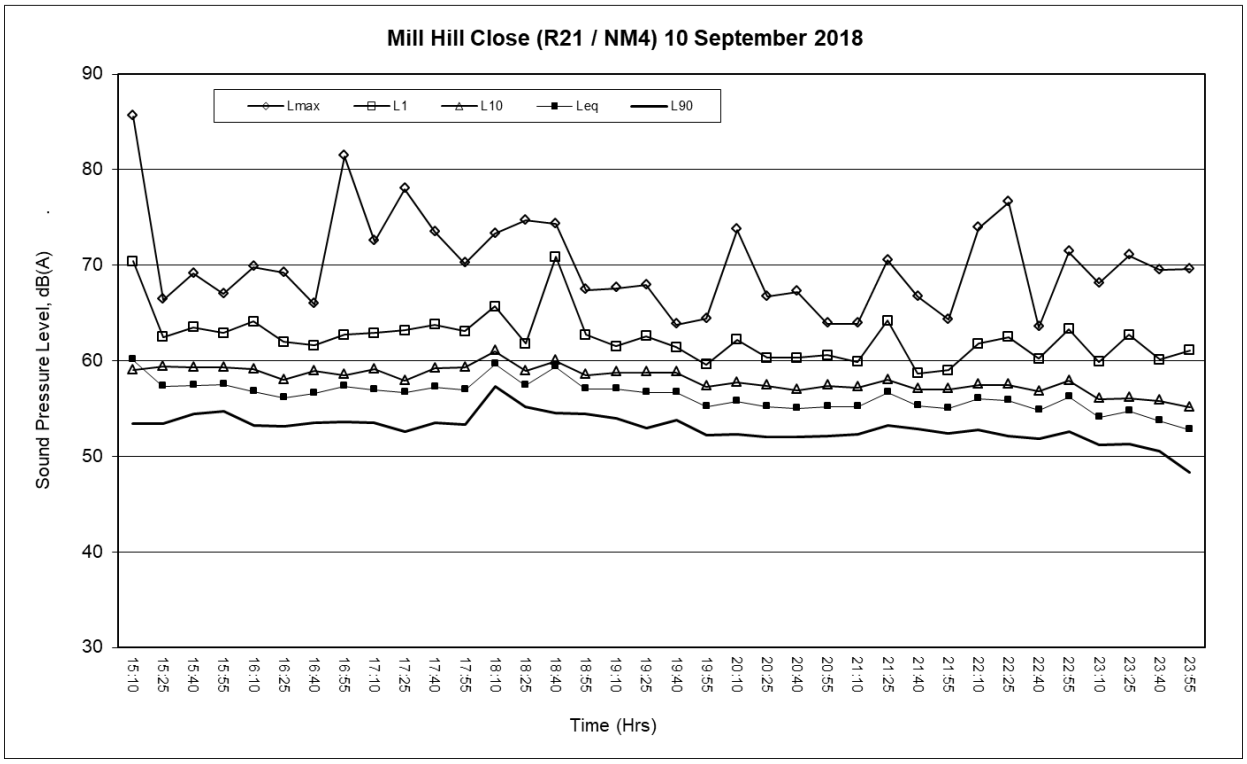
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Leq
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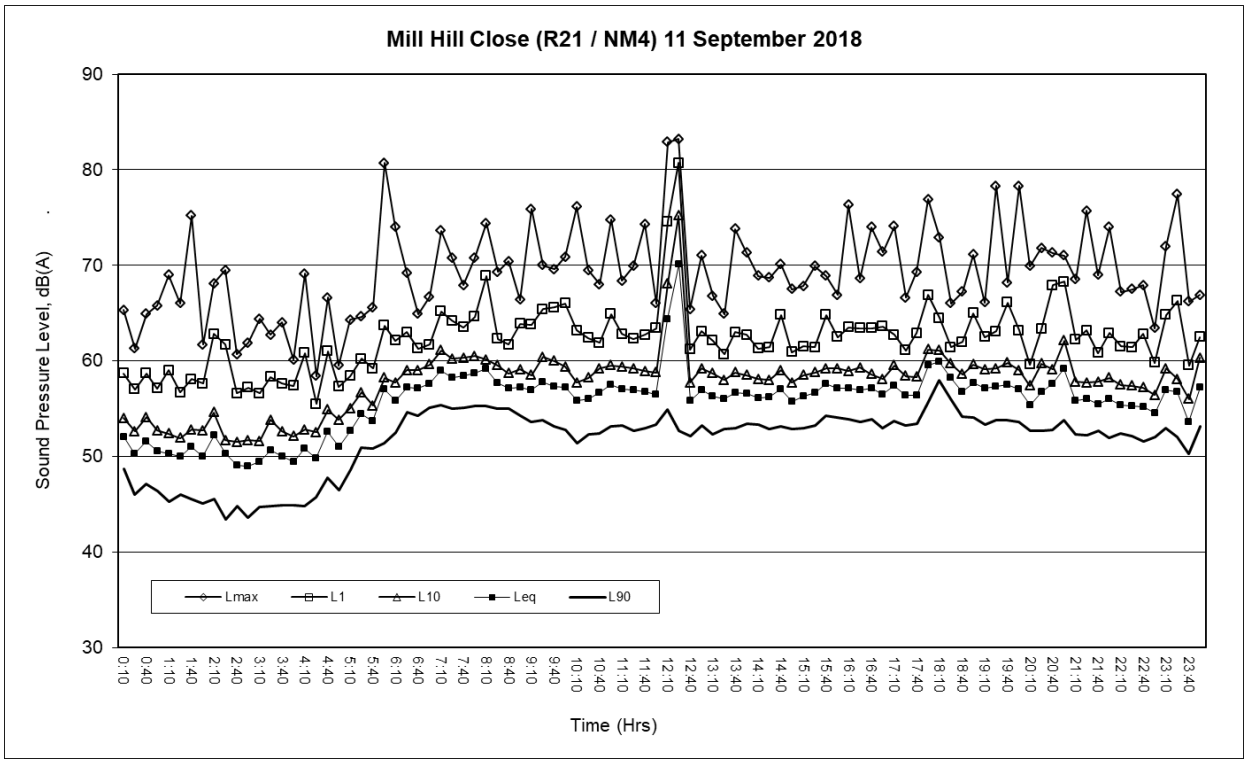
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L90
Sound Pressure Level, dB(A)
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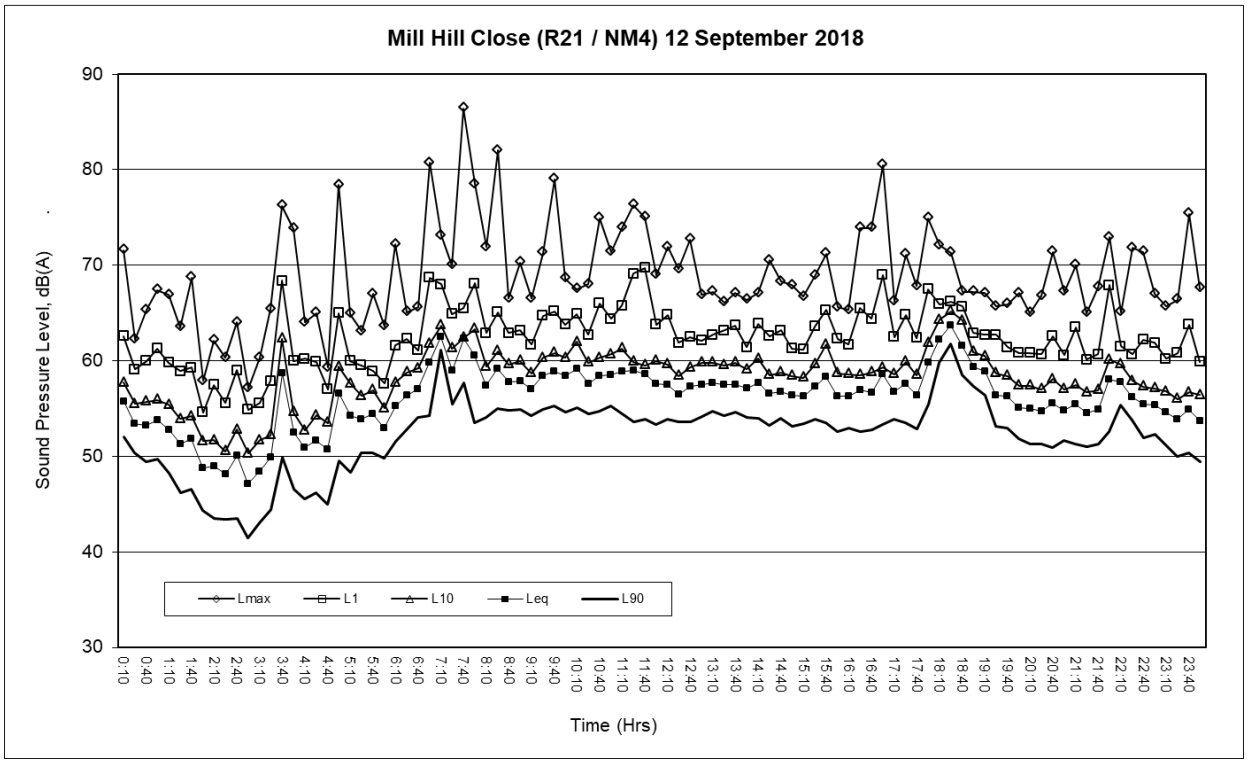
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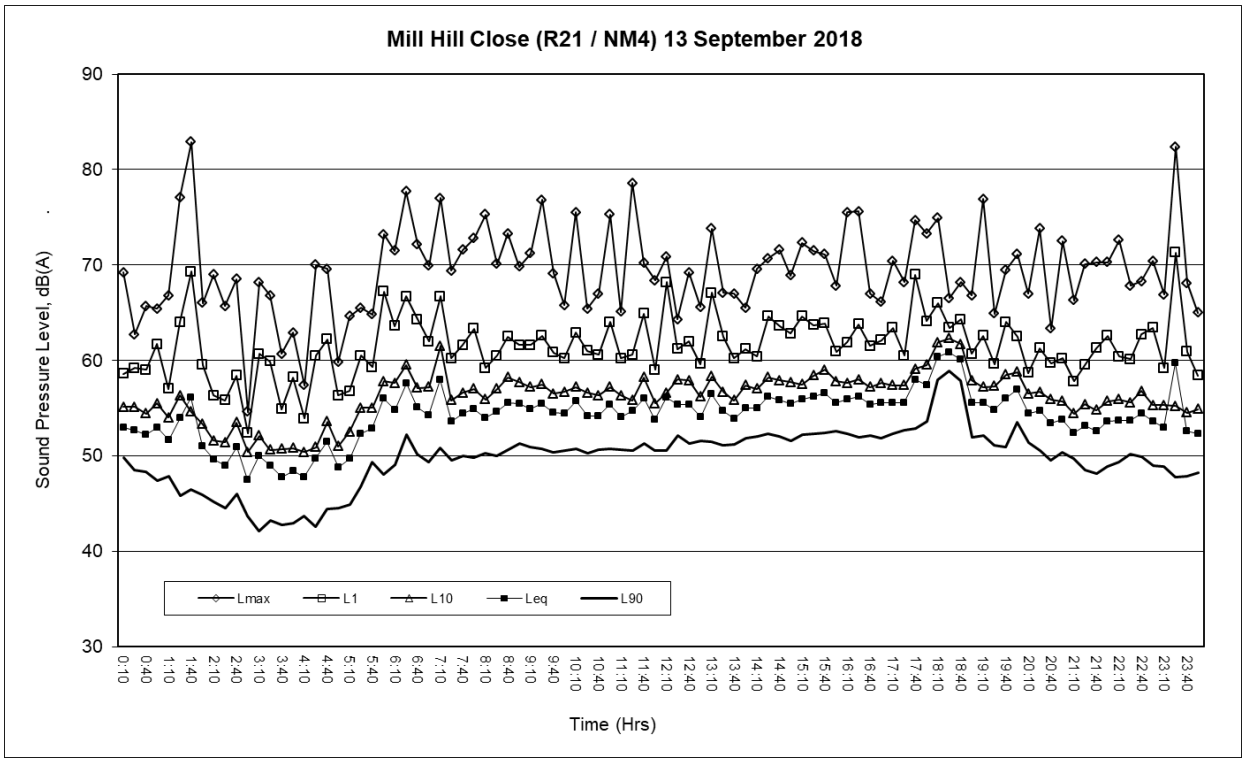
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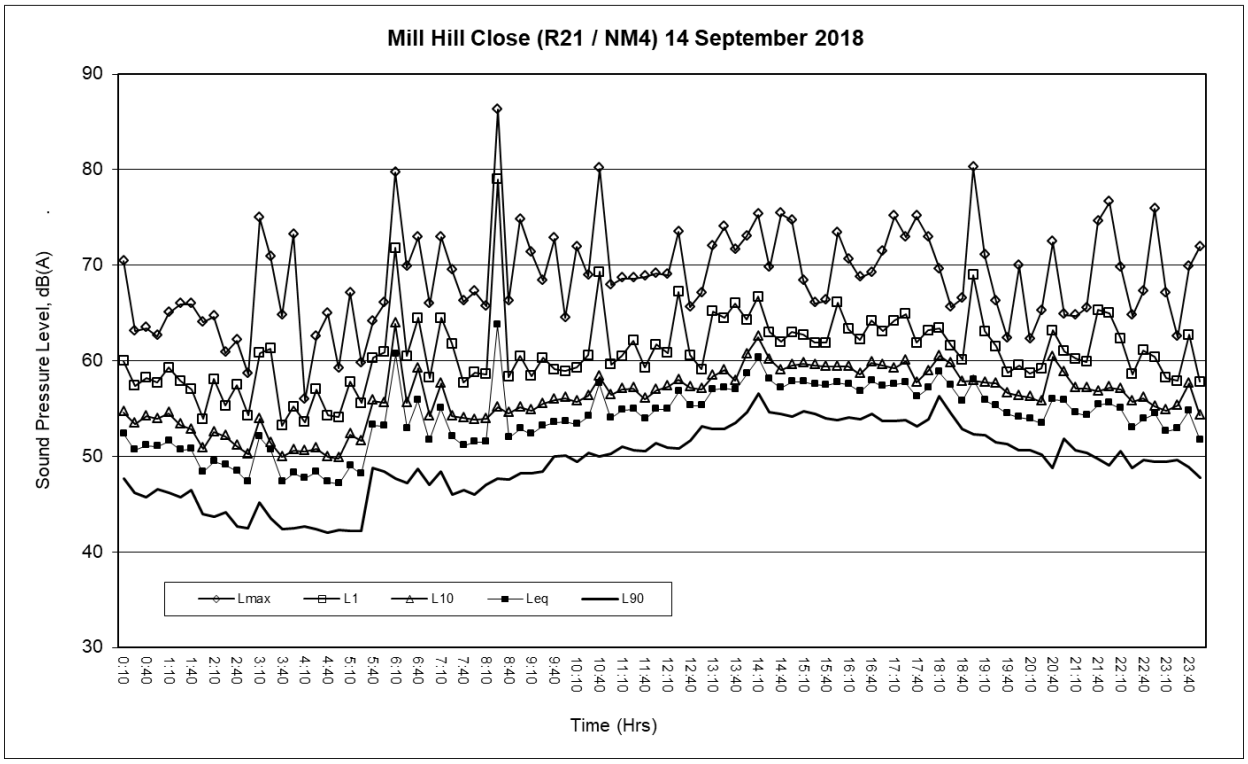
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Time (Hrs)
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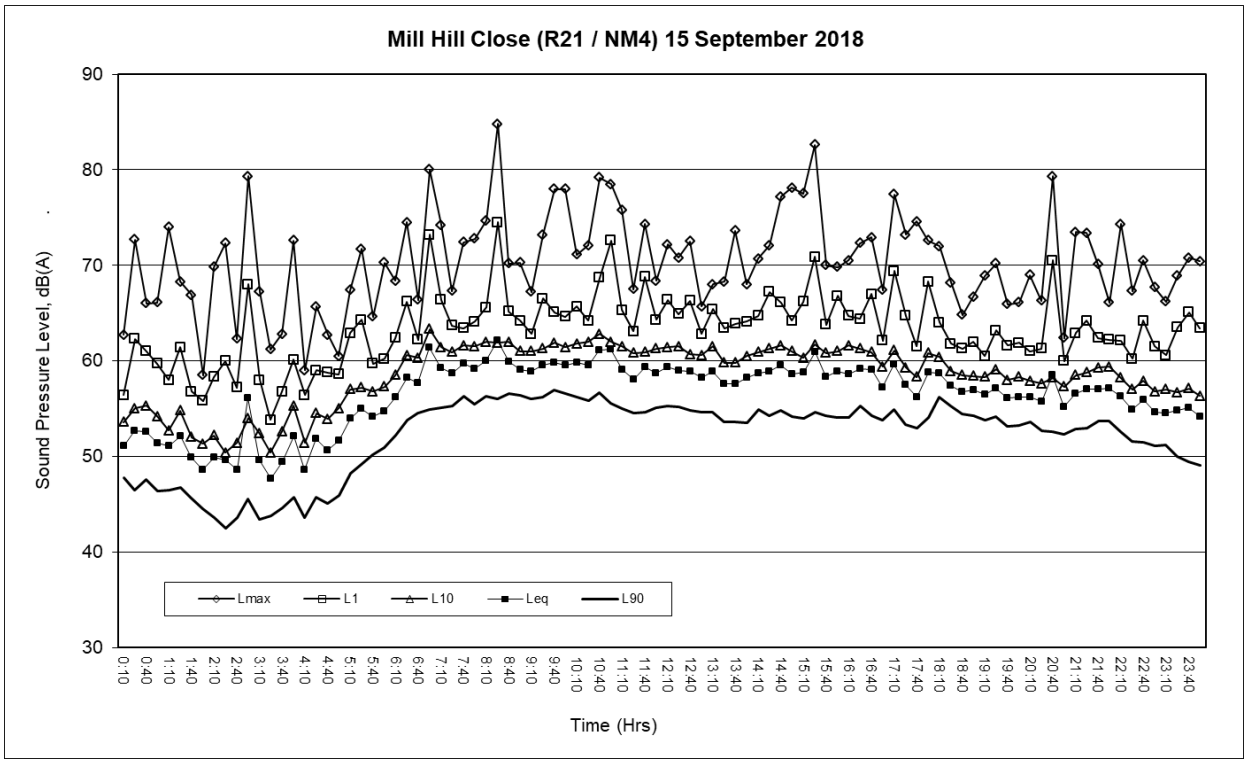
L10
Leq
L90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Sound Pressure Level, dB(A)
Time (Hrs)
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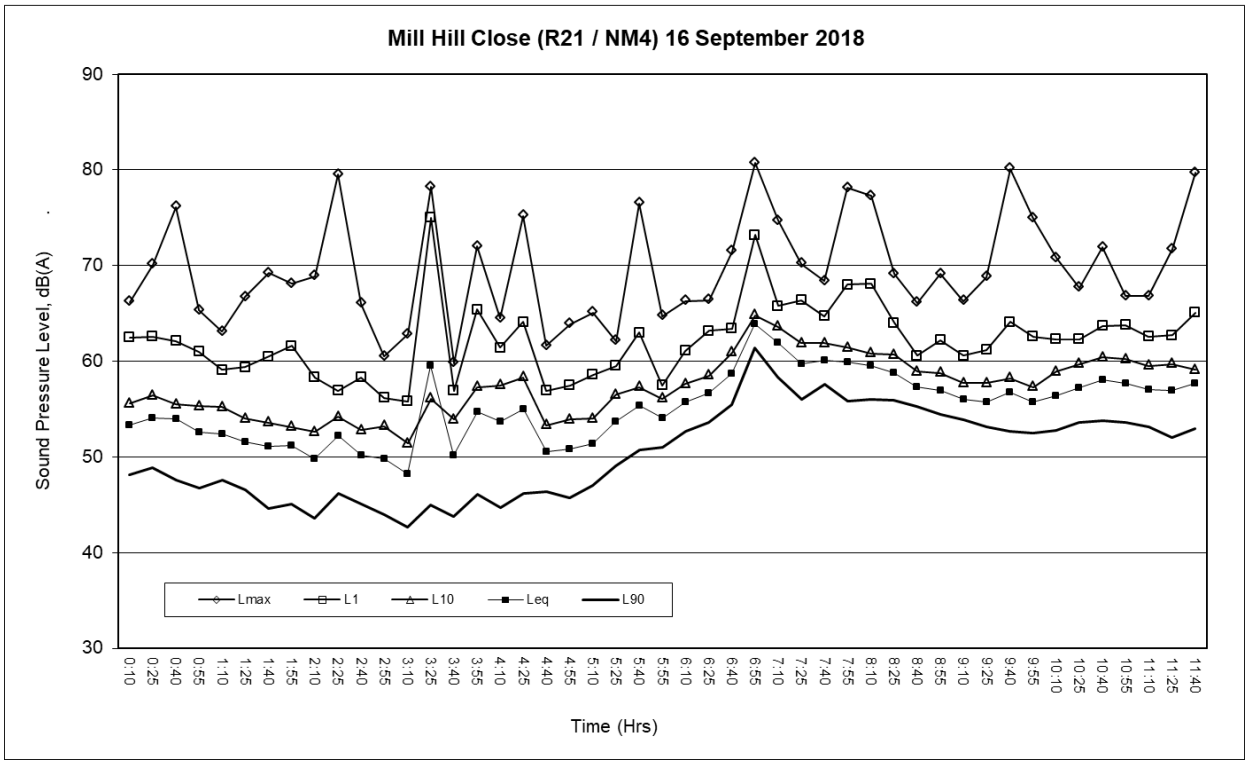
L10
Leq
L90


Mill Hill Close (R21 / NM4) 16 September 2018
Sound Pressure Level, dB(A)
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