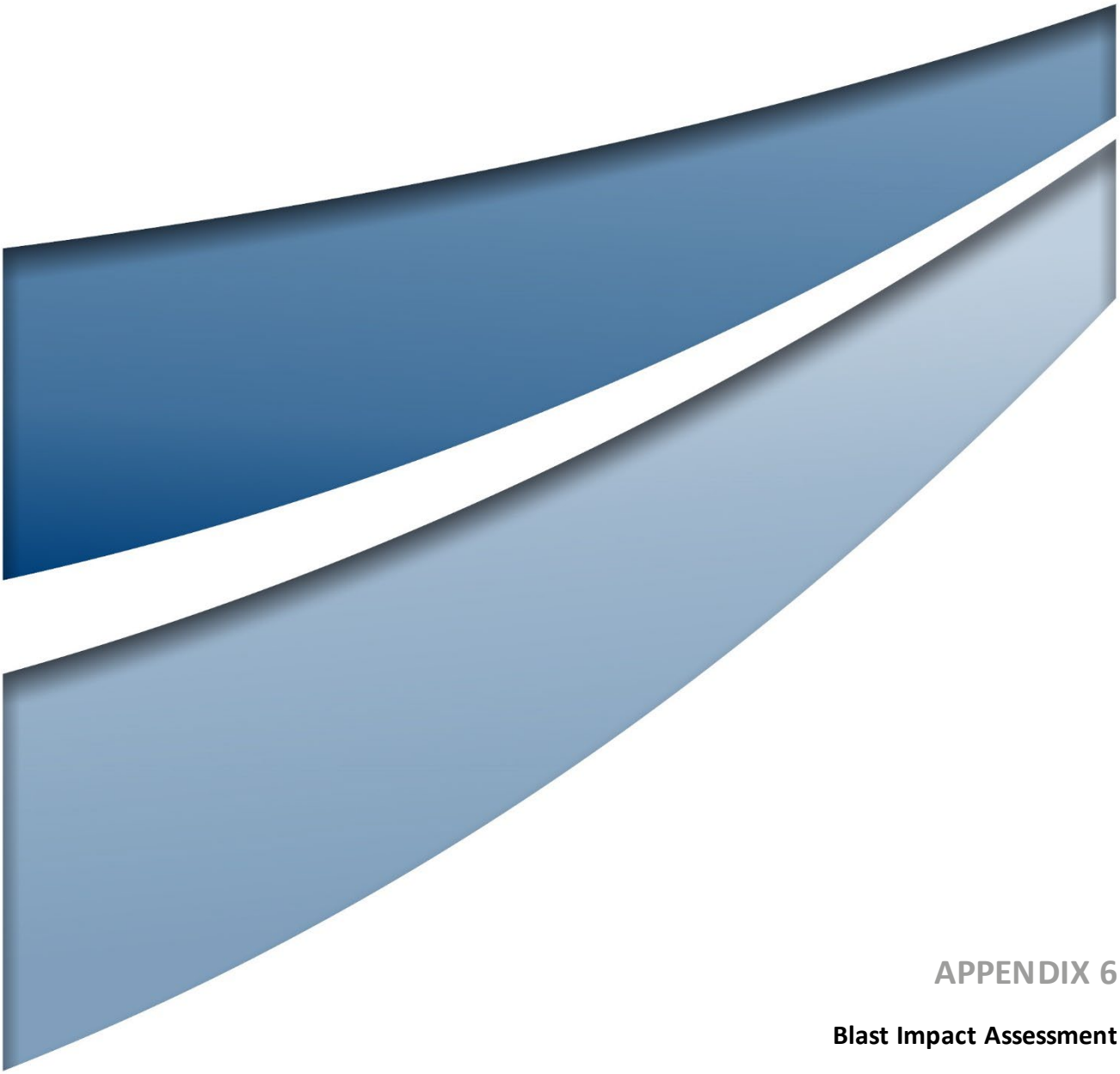

APPENDIX 6

Blast Impact Assessment

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STONE RIDGE QUARRY - BLASTING IMPACT ASSESSMENT

Report prepared for Umwelt (Australia) Pty Ltd on behalf of Australian Resource Development Group Pty Ltd

Report No. UM-2210-250523 FINAL

Thomas Lewandowski
25th May 2023

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Table of Contents

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1.0 INTRODUCTION

Enviro Strata Consulting Pty Limited (ESC) was engaged by Umwelt (Australia) Pty Limited (Umwelt) to undertake a Blasting Impact Assessment (BIA) for the proposed Stone Ridge Quarry on behalf of Australian Resource Development Group Pty Limited (ARDG).

ARDG is seeking to develop a new hard rock quarry, known as Stone Ridge Quarry (the Project), located within Wallaroo State Forest at Balickera NSW, approximately 25 kilometres (km) north of Newcastle within the Port Stephens Local Government Area (LGA).

The proposed development of a new quarry operation will include drill and blast operations. These will be conducted in the area nearby to Boral's Seaham quarry. The proposed Project will extract a high quality hard rock resource for further processing (including crushing and screening), re-sale, and distribution within the construction industry.

This BIA is based on ground vibration and airblast overpressure modelling, utilising parameters representative for the area. The assessment findings are presented in the context of the relevant ground vibration, airblast overpressure and flyrock limit criteria for the assessed items.

2.0 PROJECT DETAILS

The Project is seeking to access a high quality, hard rock resource suitable for producing a wide range of quarry products for the Lower Hunter, Central Coast and northern Sydney construction material markets. The Project proposes to produce up to 1.5 million tonnes per annum (Mtpa) of saleable quarry product with approval sought for an initial 30-year quarrying period.

The Project is located on land managed by Forestry Corporation of New South Wales (FCNSW).

The construction phase of the Project consists of earthworks and clearing of vegetation for site preparation to enable access to target resources and development of the quarry extraction area. Construction of a weighbridge and associated administrative buildings combined with the installation of on-site processing plant and associated equipment are also required to facilitate the Project. A site access point off Italia Road would also need to be constructed. A summary of the of key project aspects is provided in **Table 2.1**.

The Project is a State significant development (SSD) under the State Environmental Planning Policy (Planning Systems) 2021 (Planning Systems SEPP) as proposed extraction will exceed 500,000 tonnes per year. A development application (DA) for the Project, supported by an environmental impact statement (EIS) is required to be submitted under Part 4 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This BIA has been prepared as part of the EIS.

Table 2.1: Summary of Key Project Aspects

Aspect	Proposed for the Project
Project life	30 years
Limits of production	Up to 1.5 Mtpa of quarry product/sales per year
Project Area	Approximately 139 ha (including extraction, processing and stockpiling area and buffers), with a disturbance area of approximately 79 ha
Extraction method	Drill, blast and haul
Material processing	Mobile and modular/fixed crushing, screening, and blending plant, pre-coat plant
Overburden management	Overburden will be minimal and any topsoil and overburden will be stockpiled on site for use in rehabilitation
Product	Concrete, asphalt and sealing aggregates, gabion and crushed rock, armourstone and roadbase
Product transport	Road transport of up to 1.5 Mtpa of product via the Pacific Highway
Site access	Single access point on Italia Road. No trucks will turn right out of the site onto Italia Road towards East Seaham. No trucks will turn right out of Italia Road onto the Pacific Highway.
Employment	Construction: 10 to 15 full time employees Operation: Up to 10 full time employees, 3 to 5 part-time employees
Hours of operation	Construction: • 7.00 am to 6.00 pm Monday to Friday • 8.00 am to 1.00 pm Saturday • No work on Sunday or public holidays Operation: • Quarrying and processing - 7.00 am to 6.00 pm Monday to Friday, and 7.00 am to 3.00 pm Saturdays • Truck loading, product transport and maintenance - 6.00 am to 10.00 pm Monday to Friday, and 7.00 am to 3.00 pm Saturdays No operation on Sundays or Public Holidays apart from maintenance activities as required
Rehabilitation and final landform	Rehabilitation will be undertaken progressively where appropriate in the context of further resources remaining available in the Project Area at the end of the planned 30-year approval life. A conceptual final landform will be prepared for the Project.

The proposed disturbance boundary for the Project is highlighted in **Figure 2.1**. The section marked in green represents the extraction area of the Project.

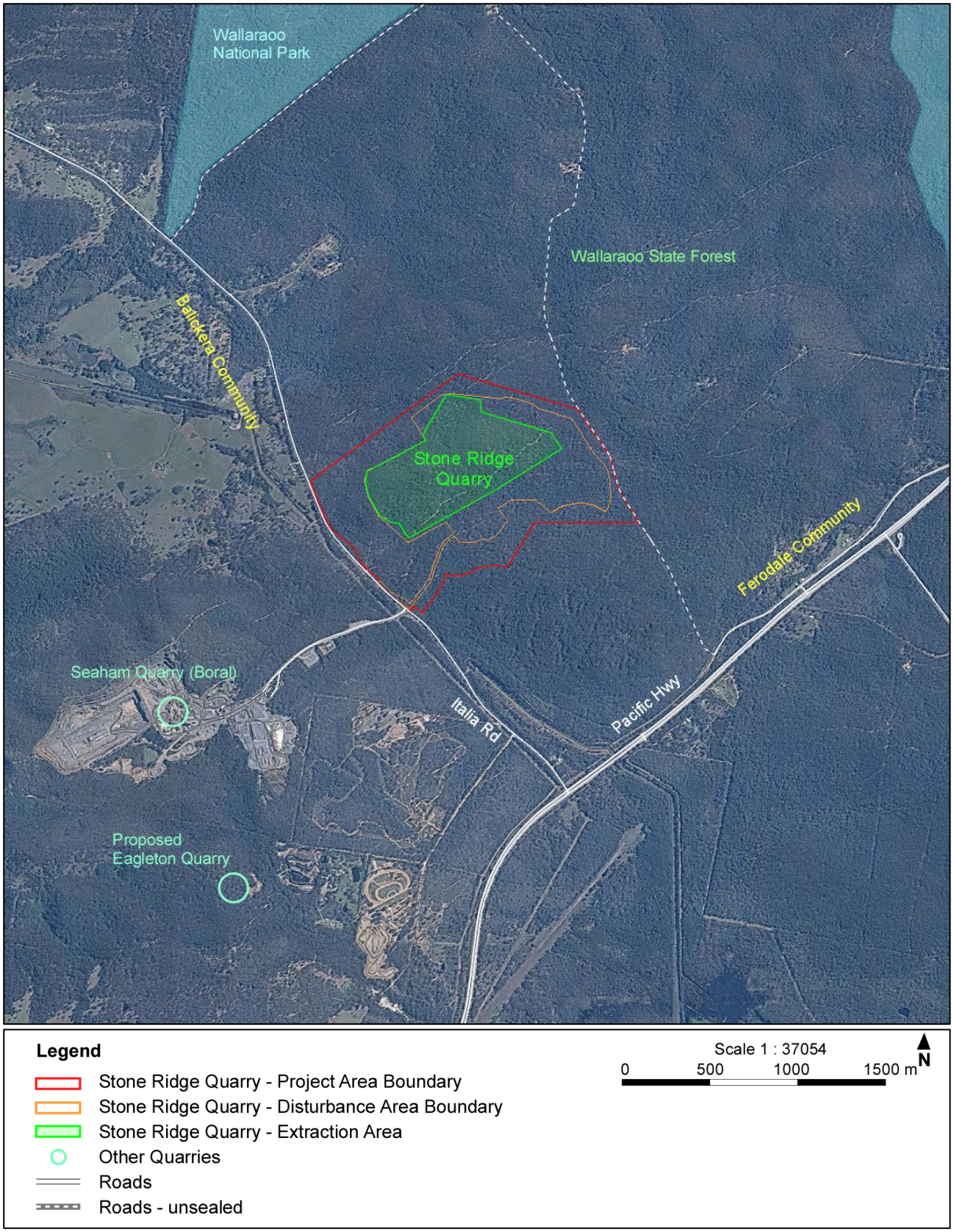


Figure 2.1 – Location of Stone Ridge Quarry in the Context of Local Area

2.1 ASSESSMENT REQUIREMENTS AND STUDY AREA

This Blasting Impact Assessment (BIA) has been prepared by Enviro Strata Consulting Pty Ltd (ESC) on behalf of Umwelt to inform the Environmental Impact Statement (EIS) for the Project.

The BIA has been undertaken in accordance with the requirements of the NSW Department of Planning and Environment (DPE), as set out in the Planning Secretary's Environmental Assessment Requirements (SEARs) for the Project, issued on 1st June 2020. The BIA follows the guidelines presented in the Australian and New Zealand Environment Council guideline 'Technical Basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration' (ANZECC, 1990) and Australian Standard (AS 2187.2-2006).

Assessed

This BIA represents a detailed assessment of the likely blasting impacts of the Project including ground vibrations, airblast overpressure, and flyrock on the following:

- people
- animals
- buildings/structures
- infrastructure, and
- significant natural features

The blasting impacts of the Project related to fumes/odour and visual effects on the surrounding environment are addressed in the EIS (EIS 2022).

Not Assessed

This BIA has not assessed potential blast impacts on the Project-owned mining and associated assets. These will be managed by Stone Ridge Quarry to maintain safe working practices.

3.0 EXISTING ENVIRONMENT AND IDENTIFIED RECEPTORS

The BIA has evaluated the impact of blasting associated with quarrying operations within the Project's extraction area on identified sensitive receptors, including private residences, buildings/structures (including heritage sites), infrastructure, animals and significant natural features. The assessment covers a 2 km radius of impact.

The impact of blasting has been undertaken in accordance with the existing criteria as specified in the ANZECC guideline (1990) or the Australian Standard (AS 2187.2-2006) or other relevant norms. The criteria are discussed in detail in Section 5.2. This section introduces the identified sensitive receptors, their location and distance relative to the Project (refer to **Figure 3.1** and **3.2**).

3.1 PRIVATE RESIDENTIAL RECEPTORS

The locations of residential receptors with respect to the Project's extraction boundary are shown in **Figure 3.1.** The residential receptors are all privately-owned.

The main points to note are as follows:

- There are two community clusters (Balickera and Ferodale) neighbouring the proposed Project.
- The closest cluster of residential receptors (Balickera) is located within approximately a 420 - 1,760 m range to the north-west and west of the Project. Most residences are located along Italia Road.
- The second cluster of residential receptors is located adjacent to the Pacific Highway along Nine Mile Road at Ferodale. It is located within a 1,270 - 1,540 m range to the south-east of the Project area.
- There is also a single isolated residence to the South of the Project close to the intersection of Italia Road and Pacific Highway, located within a 1,510 m range.

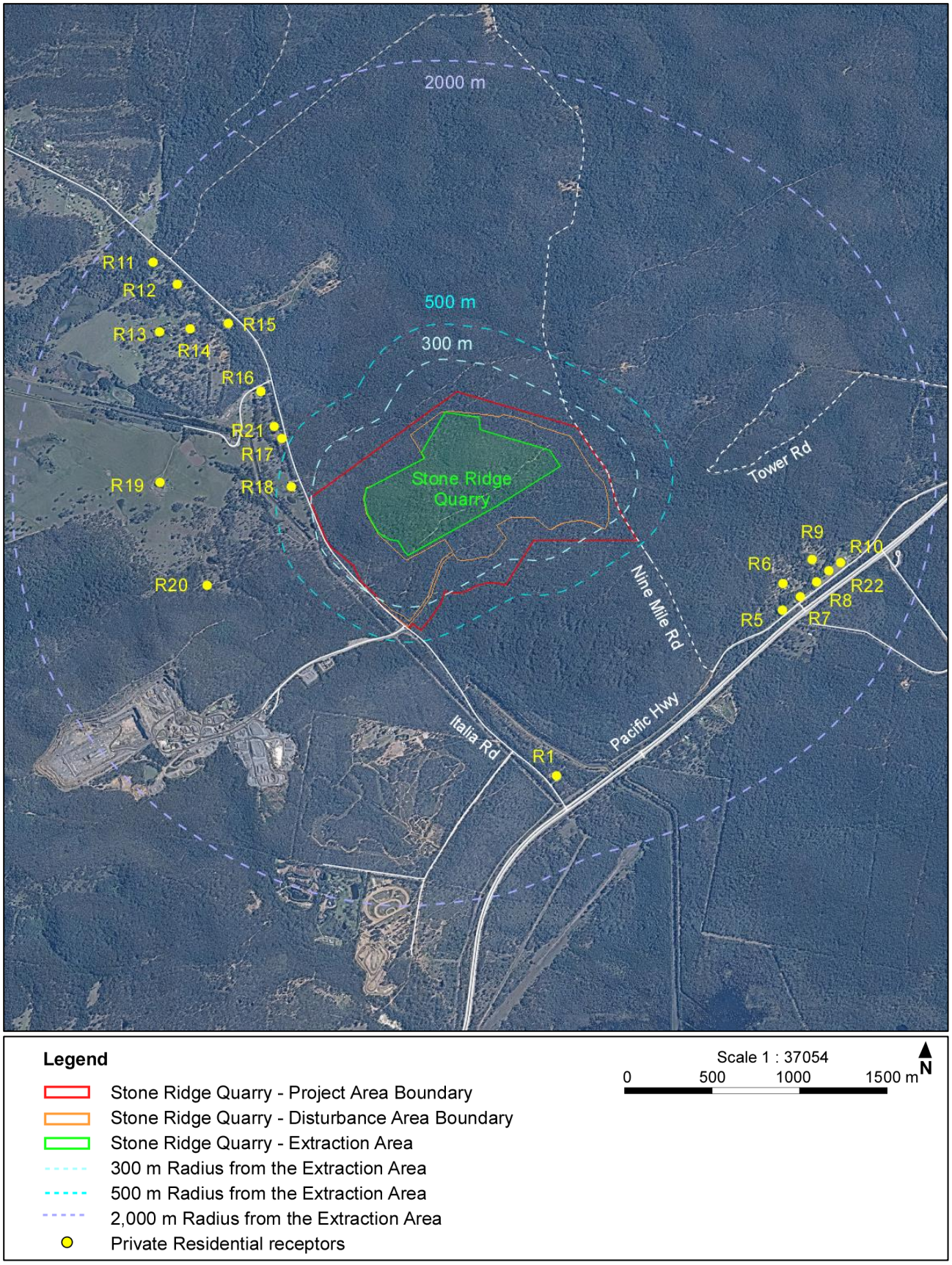


Figure 3.1 - Locations of Residential Receptors within a 2 km Radius

3.2 INFRASTRUCTURE AND HERITAGE SITES

A number of public and private infrastructure receivers were identified in the vicinity of the Project, ranging within 270 and 2,280 m from the proposed extraction area; individual distances to each facility are presented in **Table 6.3,** in Section 6.2.2. The locations of the infrastructure with respect to the Project's extraction boundary are shown in **Figure 3.2.**

The following public and private infrastructure facilities, and heritage sites were assessed in this BIA:

Public Infrastructure:

- Public roads: Italia Road, Pacific Highway and a Nine Mile Road dirt track within the Wallaroo Forest
- Bridges: four bridges on the public roads (Italia Road, Pacific Highway and Nine Mile Road)

Private infrastructure:

- Hunter Water Corporation (Hunter Water) infrastructure located at Balickera used to pump raw water from the Williams River at Seaham Weir through the Balickera Channel, then to raise the flow approximately 15m at the Balickera Pump Station and finally to direct the flow through the Balickera Channel and Tunnel into the northern end of Grahamstown Dam; the infrastructure includes:
    - Balickera Tunnel
    - Balickera Channel
    - Pumping Station
    - Bridge
    - Pipelines
    - Electrical Sub-station
    - 33 kV powerlines
- Telecommunication: underground lines along Italia Road and various operators' telecommunication towers located within Wallaroo Forest;
- Adjacent quarries including:
    - The existing Boral's Seaham Quarry
    - The proposed Eagleton Quarry
- Other private enterprises including:
    - Port Stephens Gardenland - landscaping supplies
    - Port Stephens Boarding Kennels – dog boarding facility
    - Ringwood Park Motor Complex – an outdoor motor sport complex with racing tracks
    - Circuit Italia – outdoor motor sport complex (under construction)
    - Hunter Valley Paintball – an outdoor paintball venue
    - Kids Amusements - party equipment rental service

Heritage sites:

- Balikera House – is a European heritage site located at 303 Italia Road (locally listed heritage item ID I3 in the Port Stephens Local Environmental Plan 2013). It is a former farmhouse built using convict labour circa 1830. Currently forms a part of private residential buildings.

3.3 SIGNIFICANT NATURAL FEATURES

Wallaroo National Park has been identified as a significant natural feature within proximity of the Project; it is located 1,730 m from the Project's blasting boundary. The location of Wallaroo National Park with respect to the Project is shown in **Figure 3.2.**

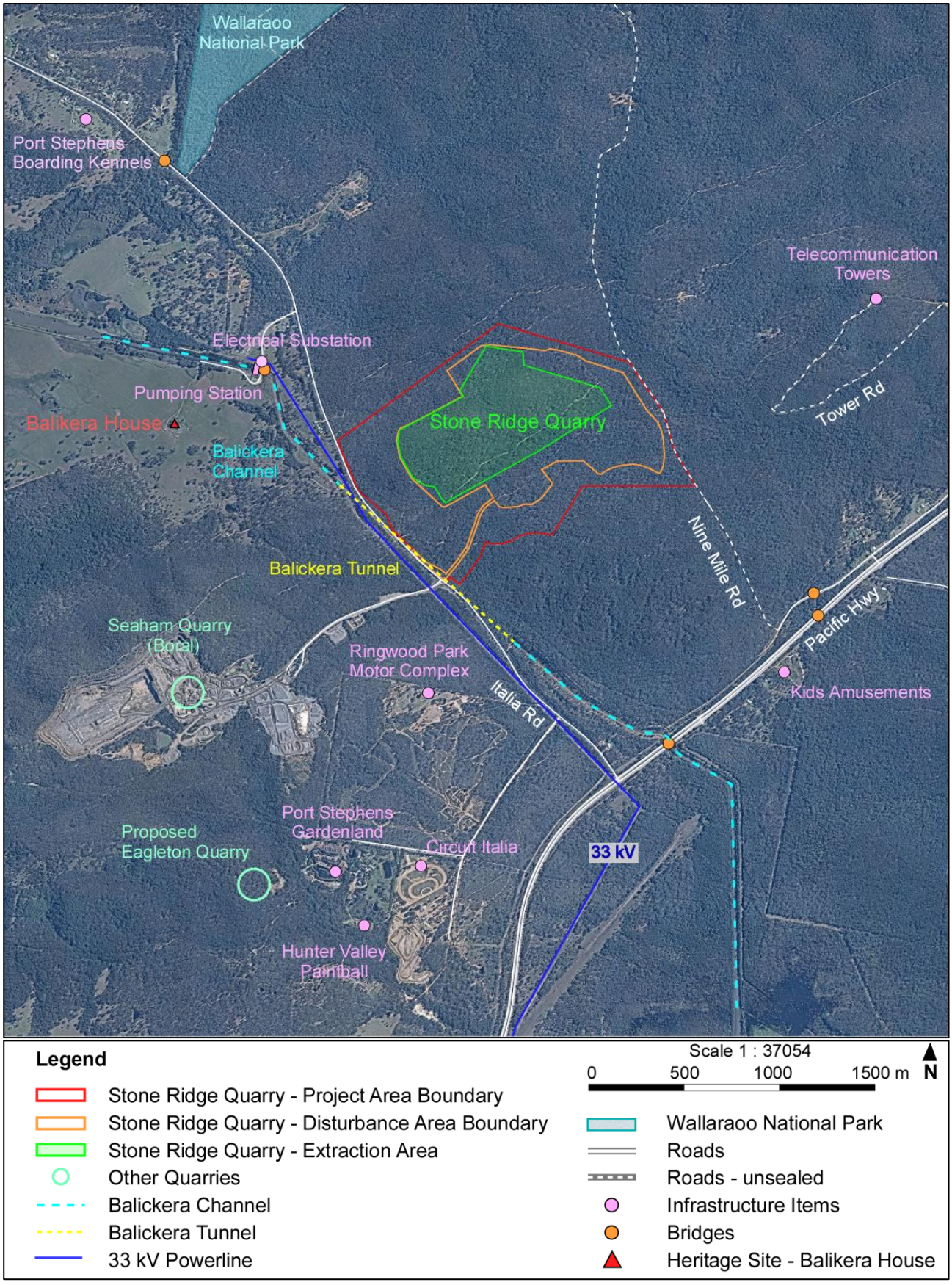


Figure 3.2 - Locations of Public and Private Infrastructure, Heritage Sites and Significant Natural Features

4.0 CONCEPTUAL BLAST DESIGN

Typical Blast

The extraction method to be employed for the Project will involve drilling and blasting operations.

Typically, the blasting operation sequence commences with a bench survey and bench drilling using a drill rig. A typical bench is rectangular in shape with approximately 100 holes and a uniform drilling pattern. The holes are loaded with explosive material (i.e., emulsion or water gel type) and then the top of the holes is filled with a gravel material (i.e., stemming) to contain the energy release and to ensure a low airblast emission is achieved minimising environmental impact. The loaded explosives are then initiated through a NONEL shock tube connected to each hole. This delivers a signal to the primer and/or booster placed within each hole and the primer and/or booster then initiates the explosives.

A delay system, which is incorporated on the surface of the blast area allows for single hole initiation and it allows for a small delay between each blasted hole. This particular system controls the ground and air vibration impacts allowing lower environmental impact.

Following the blast firing, the blasted and fractured rock strata will be removed for further processing (including crushing and screening) in the quarry's processing facility.

Geology and Project Stages

Geology of the area has been confirmed using detailed surface mapping, surface and downhole geophysics and diamond drilling program undertaken by ARDG between the years 2016 and 2019 (ARDG 2020). The dominant rock formations from a quarrying perspective targeted by the Project are rhyodacite and dacite. The geological assessment model concluded bench sizes in the order of 15 m with steeply designed highwalls.

The Project will extend for approximately 30 years and a total of 9 operational stages have been identified for the duration of the Project. The extraction will take place in two quarry pits, the Main Quarry Pit and a much smaller pit located to the north - Northwest Quarry Pit.

The conceptual Project extraction stage plans (i.e., Stages 1, 2, 6, 8 and 9) were identified and selected as the most representative stages of the Project for assessment purposes. The selected stages are considered to be representative of the key features of the proposed extraction activities and quarry progression in view of blasting impacts as outlined below:

- During the initial stages (Stages 1 – 2) the Project commences (in the Main Pit and Northwest pit) in the eastern section of the extraction area and advances to the south-west towards Italia Road and Balickera community.
- During Stage 6, the Main Pit of the Project advances further towards Italia Road and Balickera community (i.e., increased blasting impact on the Balickera community is to be expected).
- During Stages 8 – 9 the Project will further expand towards Italia Road and Balickera community reaching its final extent and maximum blasting impact on the Balickera community. The main quarrying activity will however take place in the central and eastern part of the Main Pit reaching into deeper sections of the rock strata. As the pit advances into deeper layers, it is expected that some topographical shielding will take place. This will assist with airblast overpressure impact management on the local community.
- The final proposed layout of the Project, the final pit boundary and the above-referenced Stages 1, 2, 6, 8 and 9 are shown in **Figure 4.1**.

Based on the plans provided, the Project will extract 50 Mt of material, the Project will progress with bench by bench blasting and subsequent extraction. The final pit void will be extracted to approximately 17 m below the surface level, mining up 100 m of material in the highest section of the terrain. An example of a representative cross-section through the extraction area in the North-West - South-East direction is presented in **Figure 4.2** (refer to the blue colour line corresponding to the 50 Mt extraction plans).

Blast Details

Based on the parameters assessed, it is anticipated that maximum 15 m benches will be targeted, which corresponds to a maximum instantaneous charge (MIC) mass for blasting in the order of 122 kg. Three different sizes of blast hole diameters will be available to provide a range of charge masses for different site requirements. The proposed blast hole diameters are 76, 89 and 102 mm; these give raise to charges masses in the order of 75, 98.4 and 122 kg respectively. In addition, the use of deck charges can expand the MIC range and increase flexibility. The following charge masses were utilised for modelling of blast impacts 37.5, 75, 98.4 and 122 kg.

Blasting activities at quarry site will use emulsion or water gel products (which are usually used for wet conditions).

All these details together with other parameters (summarised in **Table 4.1)** were considered in the undertaken blasting impact study.

Table 4.1: Typical Drilling and Blasting Design Details for the Project.

Parameter	Value
Drilling Capacity	2 drill rigs i.e., Epiroc T40 or Sandvik DX900 (or equivalent)
Blast Hole Diameter (mm)	76, 98 and 102
Number of Holes per Blast	110 (typically)
Drill Pattern	3 rows (typically)
Burden (m)	2.4, 2.7 and 3 (respectively)
Spacing (m)	3.0, 3.5 and 3.7 (respectively)
Bench Height (m)	15 m
Stemming (m)	2.5, 2.7 and 2.8 (respectively)
Blasting Product	Bulk emulsion or water gel products
Blasting Product Density (t/m^3)	1.2
MIC (kg)	Up to 122 kg
Rock Density (g/cm^3)	2.6
Powder Factor (kg/m^3)	0.7 nominal
Blast Size (kt)	60 – 70 kt fired once/fortnight or 30 – 35 fired once/week
Operational Period	48 weeks / year
Blasting Frequency	Variable between 1 or 2 blast per fortnight

Times and Frequency of Blasting

Blasting will be undertaken Monday to Friday (between 9am and 5pm); drilling activities will be undertaken Monday to Friday (between 6am and 6pm), and on Saturdays (from 7am to 3pm). The Project will be undertaken in such a manner as to ensure the imposed consent conditions are met. It is anticipated to fire one to two blasts per fortnight.

To avoid any combined impacts of blasting on the adjacent community, no simultaneous blasting with the neighbouring quarries will be undertaken.

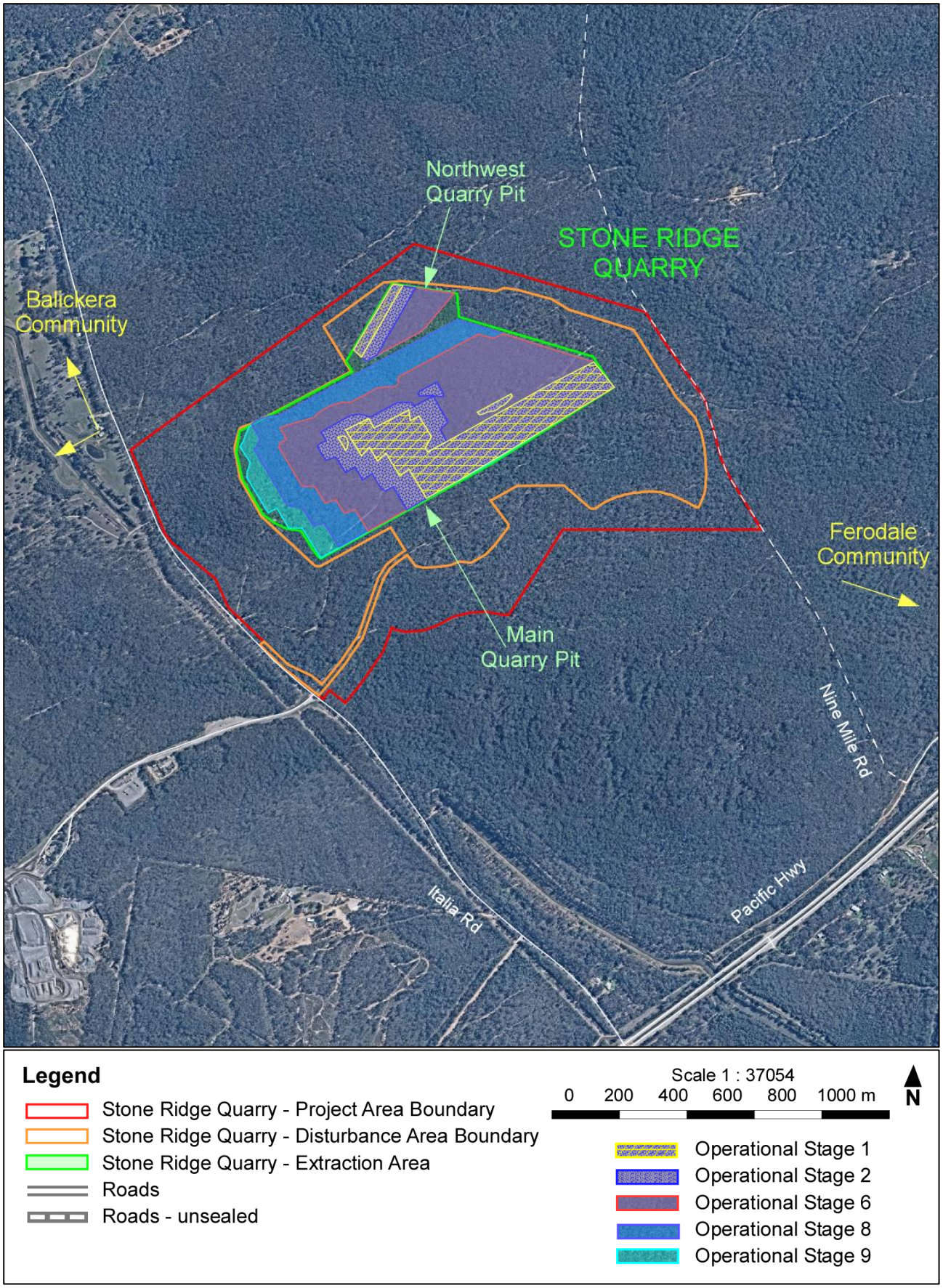


Figure 4.1– Proposed Extraction Area – various stages (1, 2, 6, 8 and 9) – selected to show most relevant pit progression stages in view of blasting impacts on critical receptors.

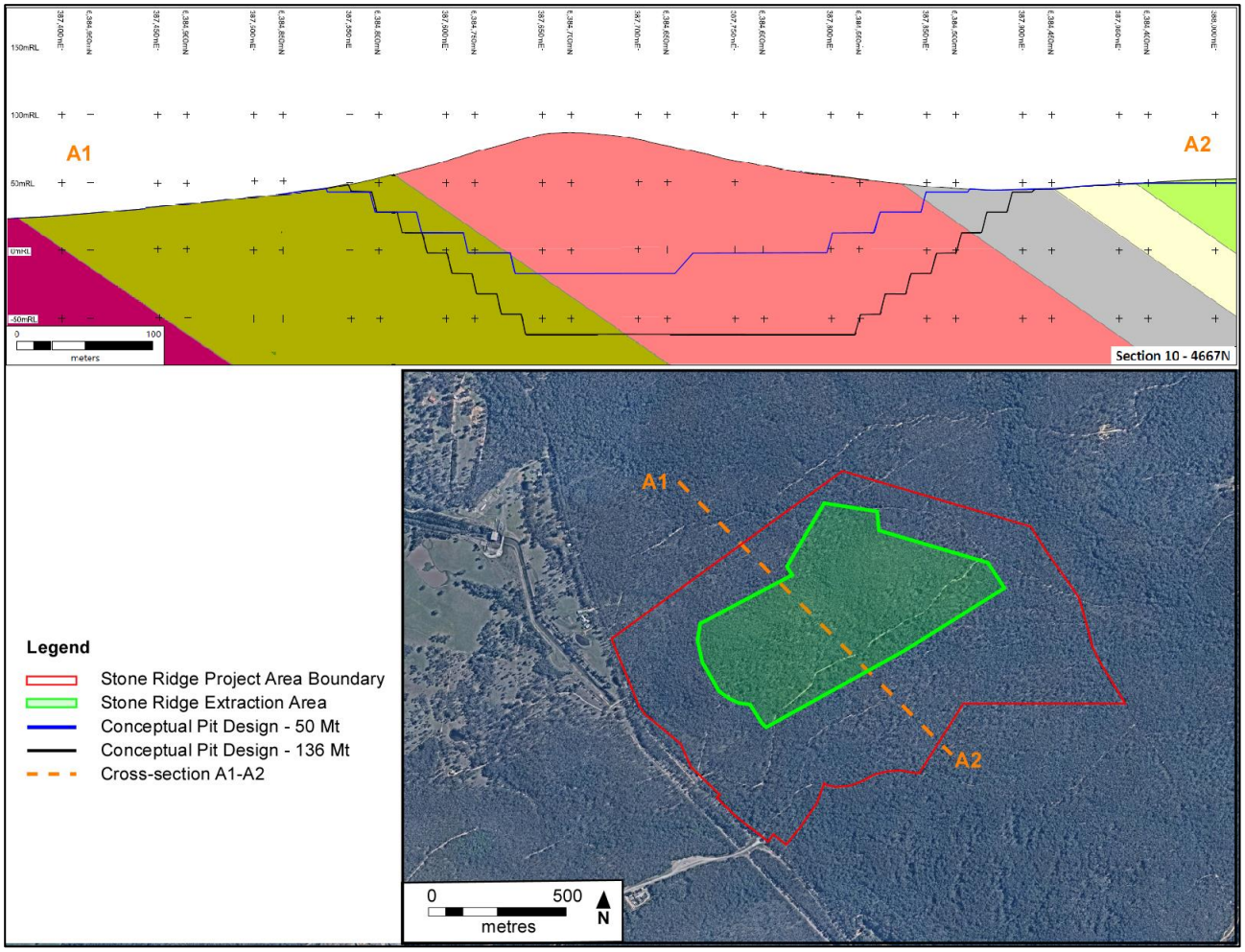


Figure 4.2 – Cross-section through the Extraction Area in the North-West - South-East direction

5.0 PREDICTIVE MODELS AND BLAST EMISSION CRITERIA

5.1 PREDICTIVE MODELS

5.1.1 Ground Vibration Predictive Model for Balickera Area

For ground vibration study a site law formula is to be developed to provide indicative potential vibration levels for a given point of concern, which includes residential receptors, infrastructure, and heritage items. The site law formula, which is recommended by the Australian Standard (AS 2187.2-2006), is accepted by relevant NSW Government agencies as appropriate for mining and quarrying blast assessments.

The site law formula equation is specified as follows:

$$PPV = k\left(\frac{D}{\sqrt{m}}\right)^{a}$$

where:	***PPV***	=	Ground vibration as vector Peak Particle Velocity (mm/s)
	D	=	Distance between charge and point of measurement (m)
	m	=	Maximum Instantaneous Charge (MIC), effective charge Mass per delay (kg)
	a	=	Site exponent
	k	=	Site constant

For assessment purposes, a ground vibration predictive model was used. The model was originally developed in 2020 when a series of single hole test blasts were conducted (ESC (2020A)). The single hole study was undertaken in the area designated for the Project and relied on controlled explosion of variable charge masses using explosives in pre-drilled holes. The method mimics (simulates) the future blasting practice in the area, although larger charge masses will be used. The blast induced ground vibrations were recorded using a number of vibration monitors. The data collected was utilised to develop a ground vibration predictive model (i.e., site law model) representative of the proposed quarry area.

The site law analysis is presented using a standard log and/or log scale, where Peak Vector Sum Values (PPV) monitored are plotted against the scaled distance (see **Figure 5.1)**.

Again, for the purpose of assessment, two lines had been drawn for. The first line represents a median line (i.e., 50% level line), which indicates that 50% of vibration responses are located above the line and 50% are below the line.

The second line is a 95% level line where 95% of vibration responses are located below this line. The 95% level, advocated by the Australian and New Zealand Environment and Conservation Council (ANZECC) Guidelines (1990), allows for an inherent variation in emission levels. It allows for 5% exceedance of the general blast criterion.

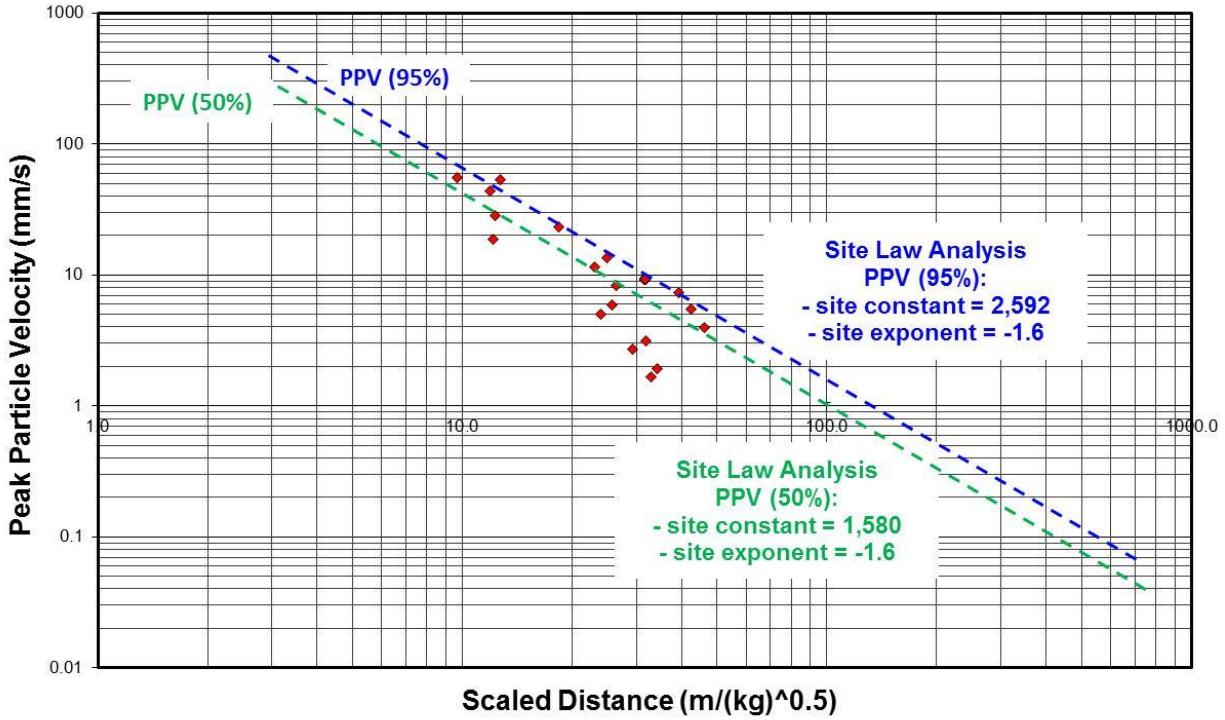


Figure 5.1 – Site Law Analysis for Balickera Area

The parameters governing ground vibration behaviour for the Balickera area are derived through the site law analysis (corresponding to the 95% level) and specified as follows:

- site exponent a = -1.6
- site constant k = 2,592

Therefore, the formula for the Balickera area vibration modelling is:

$$\boldsymbol{PPV} = 2{,}592 \left(\frac{D}{\sqrt{m}} \right)^{-1.6}$$

Where: ***PPV*** = Ground vibration as vector Peak Particle Velocity (mm/s)
D = Distance between charge and point of measurement (m)
m = Maximum Instantaneous Charge (MIC), effective charge mass per delay (kg)

For completeness, the site law parameters representative of a 50% level are specified as follows:

- site exponent a = -1.6
- site constant k = 1,580

5.1.2 Airblast Overpressure Predictive Model

The impact of generated airblast levels from the blast source is generally guided by the sonic decay law recommended in the Australian Standard (AS 2187.2-2006). It highlights that the cube-root scaled distance (detailed in AS 2187.2-2006) is more appropriate for an airblast impact assessment as opposed to the square root used for ground vibration. The sonic decay formula is specified as follows:

$$\boldsymbol{P} = \boldsymbol{k} \left(\frac{D}{\sqrt[3]{m}} \right)^{a}$$

Where: ***P*** = Peak Pressure (kPa)
D = Distance between charge and point of measurement (m)
m = Maximum Instantaneous Charge (MIC), effective charge mass per delay (kg)
a = Site exponent
k = Site constant

The airblast overpressure model for Stone Ridge Quarry conditions has not been developed yet. A model from a mine comparable to the proposed quarry has been utilised as an interim measure.

This model was originally developed in one of the smaller coal mines. The mine used similar blasting parameters to that proposed by the Project i.e., the mine used charge masses in the order of 42 – 225 kg.

The analysed sample of data covered various blasts including overburden, and interburden blasts. Multiple vibration readings were collected for each blast from various stations, producing a sample of approximately 50 monitoring results. The results were collected from monitoring stations positioned within 70 to 1,100 m distance from the blasting area i.e., presenting comparable distance

range to Balickera residences. The airblast overpressure monitoring results were plotted and together with other parameters and gave rise to the airblast predictive model shown in **Figure 5.2.**

The sonic decay law analysis features presented two lines corresponding to the median of the measured data set (marked as Sound Pressure Level (SPL) 50%) and SPL 95% corresponding to 95% of the total population of data.

Note: 95% criterion is utilised following ANZECC guideline (1990), which allow for an inherent variation in emission levels by allowing 5% exceedance of general criterion.

To facilitate accuracy of the assessment, the forced exponent of -1.45 has been used. This corresponds to an attenuation rate of 8.6 dBL with a doubling of distance as specified in Australian Standard, Explosives – Storage and use, Part 2 – Use of explosives (AS 2187.2-2006).

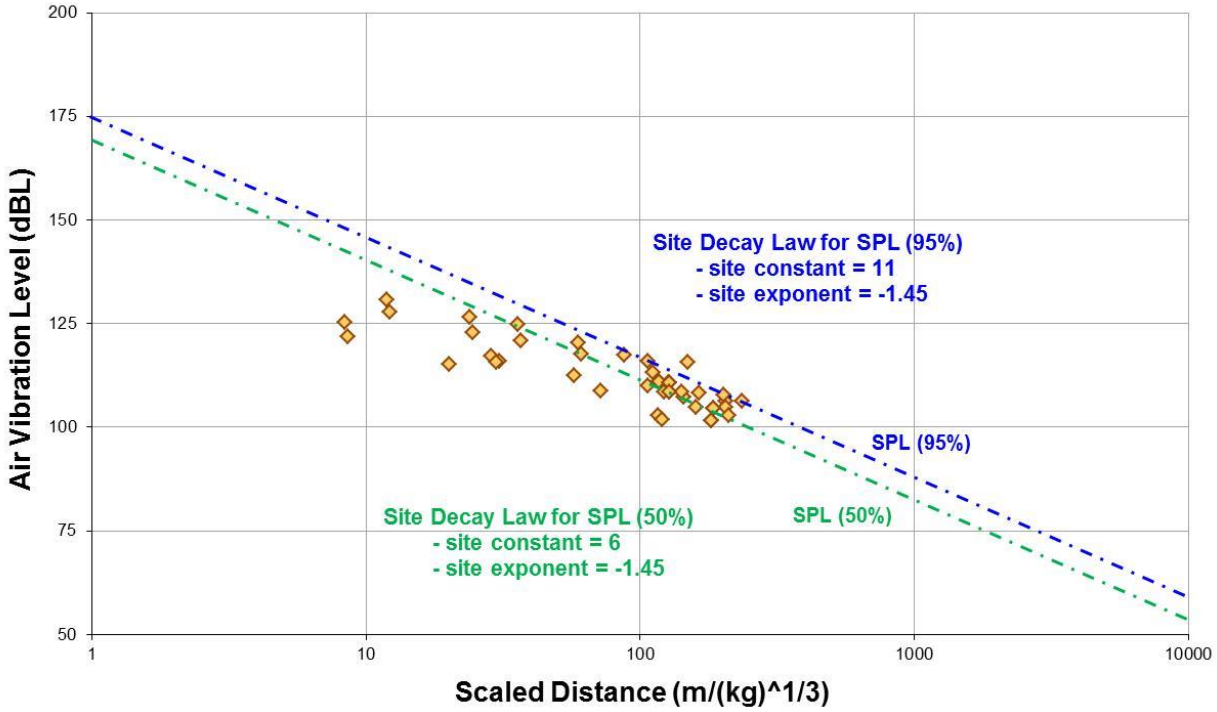


Figure 5.2 – Representative Sonic Decay Law Model

Therefore, based on the assessment above (using the 95% confidence level), the estimated sonic decay parameters for Balickera area are as follows:

- site exponent a = -1.45
- site constant k = 11

The formula used for modelling purposes is therefore:

$$P = 11\left(\frac{D}{\sqrt[3]{m}}\right)^{-1.45}$$

Where:

P	=	Peak Pressure (kPa)
D	=	Distance between charge and point of measurement (m)
m	=	Maximum Instantaneous Charge (MIC), effective charge mass per delay (kg)

5.2 BLAST EMISSION CRITERIA

5.2.1 Criteria for Private Residential Receptors

Blast Emission Criteria for Human Comfort

To minimise the impact on residential receptors, the Office of Environment and Heritage (OEH) adopts the ANZECC guidelines, "Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration" (1990). These guidelines indicate the following:

- The general criterion for ground vibration is 5 mm/s, Peak Particle Velocity (PPV).
- The PPV of 5 mm/s may be exceeded up to 5% of the total number of blasts over a 12-month period. The upper PPV level of 10 mm/s should not be exceeded at any time.
- The general airblast criterion is 115 dBL (decibel Linear).
- The level of 115 dBL may be exceeded up to 5% of the total number of blasts over a 12-month period. The airblast level should not exceed 120 dBL at any time.

The same criteria are specified for the proposed Project. Therefore, the impacts of the Project have been assessed against these same conditions.

Blast Damage Criteria – Ground Vibration

For blast damage criteria of residential structures/houses, the Australian Standard AS 2187-2:2006, refers to other available standards, such as British Standard BS 7385-2:1993 and American (USBM) RI8507.

The blast damage criteria are frequency-dependent; based on the British Standard BS 7385-2:1993 these range from 15 mm/s for low frequencies up to 50 mm/s for high frequencies, see **Appendix 1A**.

Note: The lowest transient vibration value for cosmetic damage is estimated as 15 mm/s at 4 Hz. The cited range is well above the blast emission criteria for human comfort (i.e., 5 mm/s and 10 mm/s) as discussed above. It therefore follows that when vibration limits for human comfort are imposed, compliance with blast damage criteria for residential structures will also be achieved.

Blast Damage Criteria – Airblast Overpressure

The Australian Standard AS 2187-2:2006 specifies a conservative limit of 133 dBL as a safe level, which implies no damage to the structure. AS 2187-2:2006 also specifies that the damage to windows (regarded as the most fragile / sensitive material) is considered improbable for airblast level exposures below 140 dBL.

Therefore, when vibration limits for human comfort are imposed as stated above (i.e., 115 and 120 dBL), by default, the possibility of structural damage for the surrounding residential structures/houses is eliminated.

5.2.2 Criteria for Infrastructure and Heritage Sites

The existing and proposed ground vibration and airblast emission criteria for identified infrastructure and relevant historical sites are presented below and summarised in **Table 5.1**.

Bridges and Public Roads

Australian Standard AS2187.2-2006 provides a recommendation regarding vibration exposure for concrete bridges. In addition, a comprehensive overview of the existing allowable vibration limits for various infrastructure (including public roads and related facilities) was presented in the ACARP Report No. C14057. Vibration levels for public roads and/or concrete bridges were specified as follows:

- Public roads – 100 mm/s
- Concrete bridges – 100 mm/s (referenced in AS2187.2-2006)

These vibration limits are used as assessment criteria for the Project.

Various Infrastructure Facilities

There are a range of Hunter Water and Boral's quarry infrastructure facilities in the vicinity of the Project including a pumping station, offices, pipelines, and others.

Guidelines on vibration limits for infrastructure are provided in Australian Standard AS 2187.2-2006 "Explosives – Storage and Use – Part 2: Use of Explosives". Also, the ACARP Report No. C14057 presented a comprehensive overview of existing allowable vibration limits for various infrastructure including buried communication cables and pipelines. Therefore, the relevant vibration limits include:

- **25 mm/s** – for occupied, non-sensitive sites such as factories and commercial premises,
- **100 mm/s** – for unoccupied structures of reinforced concrete or steel construction,
- **100 mm/s** – for buried communication cables and pipelines,
- **133 dBL** – recommended airblast limit for damage control; this limit is recommended as a safe level that will prevent structural and/or architectural damage from blasting.

These vibration limits are used as the assessment criteria for the Project.

Power Transmission Lines and Electrical Substation

The neighbouring powerlines and transmission power poles are owned by Hunter Water. One of the major electricity suppliers in NSW, Ausgrid, generally uses a vibration limit of 100 mm/s for timber power poles. Therefore, the relevant vibration limits include:

- 100 mm/s for timber power poles
- 25 mm for electrical substation.

These vibration limits are used as the assessment criteria for the Project.

Balickera Tunnel and Balickera Channel (Hunter Water Infrastructure)

A detailed assessment was conducted in a separate report (ESC (2022)) on the impact of blasting on Balickera Tunnel and Balickera Channel. The infrastructure conditions and material exposed were discussed in detail including concrete and variable hard rock strata materials exposed throughout the channel and the tunnel. The allowable vibration limits for these infrastructure facilities are in the order of few hundred mm/s (i.e., in excess of 200 mm/). The relevant vibration limits include:

- > 200 mm/s for concrete material,
- > 200 mm/s for Balickera Tunnel.

These vibration limits are used as the assessment criteria for the Project.

European Heritage Site

There is a locally listed heritage item (the Balikera House, ID I3) in the Port Stephens Local Environmental Plan 2013 in the vicinity of the Project.

The applicable vibration limits for heritage structures are 5 mm/s and 133 dBL. The recommended levels are in line with the ACARP Report (No. C14057) findings for Heritage Sites, which recommends 'safe' vibration limits such as those used by the British Standard BS7385 (i.e., the lowest transient vibration value for cosmetic damage is estimated as 15 mm/s at 4 Hz (British Standard BS7385**)**.

A summary of blast emission criteria used in the assessment is presented in **Table 5.1.**

Table 5.1: Summary of Blast Emission Criteria

Item	Vibration Criteria (mm/s)	Airblast Criteria (dBL)
Private residences (1)	5 / 10	115 / 120
European Heritage Site	5	133
Balickera Tunnel and Balickera Channel	>200	n/a
Occupied Infrastructure (2)	25	125
Unoccupied infrastructure including: Public roads and bridges Timber power poles Buried communication cables Telecommunication towers	100	n/a
Electrical Substation	25	n/a

1 – applies to buildings and sheds only (after ANZECC (1990))

2 – occupied non-sensitive sites such as factories and commercial premises (after AS2187.2-2006)

6.0 BLASTING IMPACT ASSESSMENT

The assessments presented below address potential blasting impacts from the Project on the surrounding area. The assessments are based on ground vibration and airblast overpressure modelling using the models presented in Section 5.1. The generated ground vibration and airblast overpressure estimates have been evaluated in the context of relevant limits and/or criteria, as stated in Section 5.2. This allowed identifying potential risks related to blasting at the proposed extraction area.

The modelling involved a set of four simulations, incorporating a range of charge masses, i.e., 37.5, 75, 98.4 and 122 kg. The charge masses were derived from the blasting parameters proposed to be employed by the quarry.

The modelling accounts for the worst-case scenario, i.e., blasting from the edge of the proposed extraction area, which corresponds to the minimum distance between the blasting area and the receptors. The compiled result tables therefore highlight the maximum ground vibration and airblast overpressure levels that will be generated at these receptors over the lifetime of the Project.

6.1 COMMUNITY

The private residential receptors were introduced and described in Section 3.1, and shown on **Figure 3.1**.

This assessment addresses the potential impact of blasting on the area surrounding the Project and specifically, the private residential receptors. The assessment identifies potential ground vibrations, airblast overpressure and flyrock exposure generated when undertaking blasting within the proposed extraction area.

The modelling evaluates ground vibration and airblast overpressure levels for private residential receptors located within a 2 km radius of the Project, see **Figure 3.1.** Residences located in excess of 2 km are not assessed in this analysis as given the maximum charge mass of 122 kg, beyond this distance significant impact of ground vibrations and airblast overpressure is considered highly unlikely. Receptors located beyond 2 km should generally be exposed to ground vibration less than 0.6 mm/s and airblast overpressure less than 99 dBL, levels, which are difficult to detect for most of the population.

The derived estimates highlight the maximum impacts for private residential receptors that will be generated over the lifetime of the Project. The distances stated in the tables represent the minimum distances between the residences and the extraction area boundary.

6.1.1 Assessments Results

6.1.1.1 Ground vibration

The results of the ground vibration modelling with the focus on the maximum vibration estimate for a particular MIC, for residential receptors located within a 2 km radius are summarised in **Table 6.1**.

Table 6.1: Results of Ground Vibration Modelling for Residential Receptors – Maximum Vibration Estimates (worst-case scenario)

Residential Receptor ID	Min. Distance [1] (m)	Direction from Blasting Area	Estimated Max. Ground Vibration (mm/s)			
	Hole diameter (mm)		76	76	89	102
			MIC (kg)			
			37.5 [2]	75	98.4	122
R1	1,510	S	0.4	0.7	0.8	1.0
R5	1,510	SE	0.4	0.7	0.8	1.0
R6	1,430	SE	0.4	0.7	0.9	1.1
R7	1,560	SE	0.4	0.6	0.8	0.9
R8	1,600	SE	0.4	0.6	0.8	0.9
R9	1,530	SE	0.4	0.7	0.8	1.0
R10	1,690	SE	0.3	0.6	0.7	0.8
R11	1,760	NW	0.3	0.5	0.7	0.8
R12	1,570	NW	0.4	0.6	0.8	0.9
R13	1,470	NW	0.4	0.7	0.9	1.0
R14	1,340	NW	0.5	0.8	1.0	1.2
R15	1,210	NW	0.6	1.0	1.2	1.4
R16	800	NW	1.1	1.9	2.3	2.7
R17	560	NW	1.9	3.3	4.1	4.8
R18	420	W	3.0	5.2	6.5	7.7
R19	1,160	W	0.6	1.0	1.3	1.5
R20	980	W	0.8	1.3	1.7	2.0
R21	620	NW	1.6	2.8	3.5	4.1
R22	1,640	SE	0.3	0.6	0.7	0.9

1 – minimum distance over the lifetime of the Project, i.e., from the edge of the blasting boundary

2 – the MIC corresponds to a single deck when deck charges used

grey cells – vibration estimate exceeding the applicable limit (5 mm/s for 95% of blasts); however, compliance is achievable at all residences through the application of reduced charge masses

The results of ground vibration modelling are summarised as follows:

- The potential ground vibration exposure for various modelling scenarios was estimated to be in the range of 0.3 to 4.1 mm/s for all receptors except for two receptors R17 and R18; these vibrations are below the applicable limits specified as 5 mm/s (for 95% of blasts) and 10 mm/s (not to be exceeded).
- The predicted maximum exposure for receptors R17 and R18 is 5.0 and 7.7 mm/s respectively when blasting with the maximum charge mass of 122 kg. However, compliance with the vibration criteria at these receptors can be achieved with the introduction of some limited blast management measures via the application of reduced charge masses. This will apply to blasting within 600 m of these receptors. For example, blasting at the minimum distance of 420 m (an overall worst-case scenario) using a deck charge of 37.5 kg will generate vibrations in the order of 3.0 mm/s which is below the applicable limits of 5 mm/s (for 95% of blasts) and 10 mm/s (not to be exceeded).

- The restriction on charge masses applies to only a limited area in the north-western corner of the quarry pit. This restriction will only be relevant to Stages 6 to 9.

6.1.1.2 Airblast Overpressure

The results of the airblast overpressure modelling with the focus on the maximum air vibration estimate for a particular MIC, for residential receptors located within a 2 km radius are presented in **Table 6.2**.

Table 6.2: Results of Airblast Overpressure Modelling for Residential Receptors – Maximum Airblast Estimates (worst-case scenario)

Residential Receptor ID	Min. Distance [1] (m)	Direction from Blasting Area	Estimated Max. Airblast Overpressure (dBL)			
	Hole diameter (mm)		76	76	89	102
			MIC (kg)			
			37.5 [2]	75	98.4	122
R1	1,510	S	97.8	100.7	101.9	102.8
R5	1,510	SE	97.8	100.7	101.9	102.8
R6	1,430	SE	98.5	101.4	102.6	103.5
R7	1,560	SE	97.4	100.3	101.5	102.4
R8	1,600	SE	97.1	100.0	101.2	102.1
R9	1,530	SE	97.7	100.6	101.7	102.6
R10	1,690	SE	96.4	99.3	100.5	101.4
R11	1,760	NW	95.9	98.8	100.0	100.9
R12	1,570	NW	97.3	100.5	101.4	102.3
R13	1,470	NW	98.2	101.1	102.2	103.1
R14	1,340	NW	99.3	102.2	103.4	104.3
R15	1,210	NW	100.6	103.5	104.7	105.6
R16	800	NW	105.8	108.7	109.9	110.8
R17	550	NW	110.6	113.5	114.6	115.5
R18	420	W	113.9	116.9	118.0	118.9
R19	1,160	W	101.2	104.1	105.2	106.1
R20	980	W	103.3	106.2	107.3	108.2
R21	620	NW	109.0	112.0	113.1	114.0
R22	1,640	SE	96.8	99.7	100.8	101.7

1 – minimum distance over the lifetime of the Project, i.e., from the edge of the blasting boundary

2 – the MIC corresponds to a single deck when deck charges used

grey cells – airblast overpressure estimate exceeding the applicable limit (115 dBL for 95% of blasts); however, compliance is achievable at all residences through the application of reduced charge masses

The results of the airblast overpressure modelling are summarised as follows:

- The potential airblast overpressure exposure for various modelling scenarios was estimated to be in the range of 96 to 114 dBL for all receptors except for two receptors R17 and R18; these estimates are below the applicable limits specified as 115 dBL (for 95% of blasts) and 120 dBL (not to be exceeded).
- The predicted maximum exposure for receptors R17 and R18 is in the order of 116 and 119 dBL respectively when blasting with the maximum charge mass of 122 kg. However, compliance with the airblast overpressure criteria at these receptors can be achieved with the introduction of some limited management measures via the application of reduced charge masses. This will apply to blasting within 600 m of these receptors. For example, blasting at the minimum distance of 420 m (an overall worst-case scenario) using a deck charge of 37.5 kg will generate airblast overpressure in the order of 114 dBL which is below the applicable limits of 115 dBL (for 95% of blasts) and 120 dBL (not to be exceeded).
- The restriction on charge masses applies to only a limited area in the north-western corner of the quarry pit. This restriction will only be relevant to Stages 6 to 9.
- As the proposed Project reaches greater depths, some topographical shielding will emerge due to the change in the contours of the area. This will assist with impacts associated with airblast overpressure and lessen the impacts on the surrounding community.

6.1.1.3 Flyrock

The proposed quarry will operate using an appropriate exclusion zone. As an exclusion zone will be used for each blast, the issue of flyrock impact on adjacent residences is therefore considered to be fully managed and potential risks will be mitigated. The closest private receptors R18, R17 and R21, in the later stages of the Project will be located at approximately 420, 550 and 620 m distances from the proposed extraction area. Any residences located within the exclusion zone (i.e., 500 m unless otherwise determined by a qualified specialist) will need to be addressed i.e., the residents will need to be notified and evacuated for the duration of the blast. This however will be limited to only a few blasts over the lifetime of the Project. Landowners will also be notified where any areas of relevant private land will fall within 500 m of the blast location to ensure an exclusion zone is applied.

It is also to be noted that, flyrock management for these residences will coincide with flyrock impact management on Italia Road (public road) under the umbrella of the Road Closure Management Plan which will require exclusion zone of 500 m and associated road/area closure for the duration of the blast. Therefore, it is concluded that the flyrock risks for residential receptors will be managed adequately.

6.2 INFRASTRUCTURE AND HERITAGE SITES

The infrastructure and heritage items were introduced and described in Section 3.2; the identified items are located at variable distances with respect to the extraction boundary of the proposed Project ranging from 270 to 2,250 m. The assessed items are shown on **Figure 3.2**.
The study focuses on the infrastructure located within an approximate 2 km radius. In general, vibration assessment criteria for infrastructure refer to higher vibration limits (25 mm/s or above), therefore the 2 km distance from blasting when using a maximum of 122 kg charge mass is sufficient to identify any significant blasting impacts.

6.2.2 Assessments Results

6.2.2.1 Ground Vibration

The results of the modelling, with the focus on the maximum ground vibration to be generated for a particular MIC, are summarised in **Table 6.3.**

The analysis of ground vibration impacts is summarised as follows:

- **Infrastructure**
  - **Public roads and bridges** - the maximum estimated vibration exposure is 15 mm/s, this is below the specified vibration limit of 100 mm/s.
  - **Hunter Water infrastructure** - Subsequent to SEAR's recommendations (SEAR's 2020), the blasting impacts on Hunter Water infrastructure (including Balickera Tunnel, Balickera Channel, and related infrastructure) were addressed in detail in a separate report (ESC (2022)), which described the assessed items along with their current state and condition. The ground vibration assessment concluded impacts below the applicable vibration limit and hence no risk of damage from blasting for Hunter water infrastructure (as stated in the ESC report).
  - **Power lines** (33 kV) - the maximum estimated vibration exposure is 13 mm/s, this is below the applicable vibration limit of 100 mm/s.
  - **Telecommunication infrastructure** - the maximum estimated vibration exposure for underground lines is 15 mm/s and 1.1 mm/s for telecommunication towers, this is below the specified vibration limit of 100 mm/s.
  - **Other private enterprises and related infrastructure (buildings/sheds)** - the maximum estimated vibration exposure is 3 mm/s, this is below the applicable limits ranging from 5 to 25 mm/s (depending on the item i.e., classed as either private houses or occupied non-sensitive sites) for any of these items.

- **Heritage Sites**
  - Balikera House - vibration exposure is predicted to be no higher than 1.5 mm/s, which is below the applicable criteria of 5 mm/s.

In summary, the assessment concluded that no additional blast control measures are required to comply with the ground vibration criteria for infrastructure and heritage sites.

Table 6.3: Results of Ground Vibration Modelling for Infrastructure and Historical Sites Maximum Vibration Estimates (worst-case scenario)

Receptor	Min. Distance[1] (m)	Estimated Max. Ground Vibration (mm/s)				Applicable Vibration Criteria (mm/s)
	Hole diameter (mm)	76	76	89	102	
		MIC (kg)				
		37.5 [2]	75	98.4	122	
PUBLIC / PRIVATE INFRASTRUCTURE						
Roads & Bridges						
Italia Road	270	6.1	11	13	16	100
Pacific Hwy (F3)	1,390	0.4	0.8	1.0	1.1	
Pacific Hwy Bridge over Balickera Canal	1,570	0.4	0.6	0.8	0.9	
Pacific Hwy Bridge over Nine Mile Creek	1,400	0.4	0.8	0.9	1.1	
Bridge on Nine Mile Rd	1,300	0.5	0.9	1.1	1.3	
Bridge on Italia Rd	1,850	0.3	0.5	0.6	0.7	
Hunter Water Infrastructure						
Balickera Tunnel	270	6.1	11	13	16	>200
Balickera Channel	340	4.2	7.3	9.1	11	
Pumping Station	800	1.1	1.9	2.3	2.7	25
Bridge	770	1.1	2.0	2.5	2.9	100
Pipelines	780	1.1	1.9	2.4	2.9	
Electrical Sub-station	800	1.1	1.9	2.3	2.7	25
Powerlines						
33 kV Power poles (Hunter Water)	300	5.1	9.0	11	13	100
Telecommunication						
Telecommunication underground lines (along Italia Road)	270	6.1	11	13	16	100
Telecommunication towers	1,380	0.4	0.8	1.0	1.1	
Other Private Infrastructure						
Seaham Quarry (Boral)	750	1.2	2.0	2.6	3.0	25
Proposed Eagleton Quarry	2,100	0.2	0.4	0.5	0.6	
Port Stephens Gardenland (landscape supplies)	2,000	0.2	0.4	0.5	0.5	
Ringwood Park Motor Complex	1,000	0.7	1.3	1.6	1.9	
Circuit Italia	1,900	0.3	0.5	0.6	0.7	
Port Stephens Boarding Kennels [3]	2,280	0.2	0.4	0.4	0.6	5/10
Hunter Valley Paintball [3]	2,250	0.2	0.4	0.4	0.5	
Kids Amusements [3]	1,530	0.4	0.7	0.8	1.0	
HERITAGE SITES						
Balikera House (adjacent to R19)	1,170	0.6	1.0	1.3	1.5	5

1 – minimum distance over the lifetime of the Project, i.e., from the edge of the blasting boundary

2 – the MIC corresponds to a single deck when deck charges used

3 – assessed applying private residence criteria

6.2.2.2 Airblast Overpressure

Generally, unoccupied infrastructure facilities are not assessed in terms of airblast overpressure exposure as the levels required to inflict damage are not applicable and/or not reached (as stated above in Blast Damage Criteria for airblast overpressure, Section 5.2). In the case of occupied infrastructure airblast overpressure limits apply and as such they need to be assessed. The results of the modelling for the relevant items, with the focus on the maximum airblast overpressure to be generated for a particular MIC, are summarised in **Table 6.4.** The results show that the impact of airblast overpressure on the potentially occupied infrastructure using maximum charge mass is in the range of 98 – 112 dBL, which is below the applicable limit of 125 dBL.

The airblast overpressure exposure for the identified heritage site does not exceed 106 dBL, which is below the applicable criteria of 133 dBL.

In summary, the assessment concluded that no additional blast control measures are required to comply with the airblast overpressure criteria for the applicable infrastructure and heritage sites.

Table 6.4: Results of Airblast Overpressure Modelling for Infrastructure and Heritage Sites Maximum Vibration Estimates (worst-case scenario)

Receptor		Estimated Max. Airblast Overpressure (dBL)				Applicable Vibration Criteria (mm/s)
	Hole diameter (mm)	76	76	89	102	
	Min. Distance[1] (m)	MIC (kg)				
		37.5 [2]	75	98.4	122	
PRIVATE INFRASTRUCTURE						
Seaham Quarry (Boral)	750	107	110	111	112	125[3]
Proposed Eagleton Quarry	2,100	94	97	98	99	
Port Stephens Gardenland	2,000	94	97	98	99	
Port Stephens Boarding Kennels	2,280	93	96	97	98	
Ringwood Park Motor Complex	1,000	103	106	107	108	
Circuit Italia	1,900	95	98	99.0	100	
Hunter Valley Paintball	2,250	93	96	97	98	
Kids Amusements	1,530	98	101	102	103	
HERITAGE SITES						
Balikera House (adjacent to R19)	1,170	101	104	105	106	133

1 – minimum distance over the lifetime of the Project, i.e., from the edge of the blasting boundary

2 – the MIC corresponds to a single deck when deck charges used

3 – based on AS2187.2-2006 criteria for occupied non-sensitive sites, such as factories and commercial premises

6.2.2.3 Flyrock

As indicated above, the Project will operate using an appropriate exclusion zone for managing flyrock risk.

The closest infrastructure facilities susceptible to flyrock include Italia Road, Nine Mile Road (a dirt track) and powerlines; these will be located within 200 - 300 m distance from the proposed extraction area. This will occur over various stages of the Project. To manage blast impacts the quarry will develop a Road Closure Management Plan. This is to manage flyrock and other risks.

For other infrastructure (due to sufficient distances), the flyrock impact is considered to be fully managed and potential risks are considered low and/or negligible. Also, the impact of flyrock for underground infrastructure (i.e., Balickera Tunnel, telecommunication lines) is not applicable.

The closest heritage site, Balikera House, will be located approximately 1,170 m from the proposed extraction area; therefore, the flyrock risk is negligible.

6.3 ANIMALS

There are no known major farms with cattle or other breeding animals in the area (i.e., within a 2 km radius of the Project). Also, there are no known major grazing land areas. However, it should be noted that some cattle grazing had been observed within property R19. The estimated ground vibration and airblast overpressure impacts for the R19 receptor are no higher than 1.5 mm/s and 106 dBL respectively (i.e., below the ANZECC guideline limits).

Also, as there are a number of private rural residences in the area, it is natural to expect the presence of pet animals on the premises. As indicated before, the ANZECC guideline limits which apply to private residences are to protect human comfort and as such, it can be inferred that blasting impacts will be fully managed in relation to people as well as cattle and pets/animals within these properties.

6.4 SIGNIFICANT NATURAL FEATURES

Wallaroo National Park has been identified as a significant natural feature within proximity of the Project; it is located 1,730 metres from the Project's blasting boundary.

At this distance, the maximum estimated ground vibration and airblast overpressure levels for the worst-case scenario are no higher than 0.8 mm/s and 101 dBL, respectively. These levels are well below the ANZECC guideline limits and generally below human perception levels. Therefore, it can be inferred that animals or any features of the Wallaroo National Park will not be negatively impacted by blast vibrations. Also, the risk of flyrock at this distance is considered negligible. Therefore, no risks have been identified for significant natural features located in the area.

7.0 VIBRATION IMPACT FROM PASSING TRAFFIC

Another potential risk considered, with respect to impacts on Hunter Water infrastructure, was the impact of vibrations from traffic passing over Balickera Tunnel. Such impact could arise as a result of increased traffic due to transport of rock material from the proposed quarry. To assess the impact

a vibration monitoring study of ground vibrations generated from passing traffic was undertaken in the vicinity of the Balickera Tunnel in 2020 (ESC 2020B). The monitoring site was located on Italia Road above Balickera Tunnel and captured vibrations due to passing traffic including heavy transport vehicles servicing Seaham Quarry (operated by Boral).

The study confirmed low vibration impact from the passing traffic (including heavy vehicles) on the surrounding environment and Hunter Water infrastructure. The range of vibrations recorded varied from 0.1 to 2.5 mm/s. The vibrations correspond to a distance of 3 to 5 m. The level of vibrations generated is well below the assessment limits for Hunter Water and other adjacent infrastructure.

In summary, based on this study, it is concluded that there will be no damage or deterioration of Balickera Tunnel or other adjacent infrastructure due to passing of heavy vehicles.

8.0 MANAGEMENT AND MITIGATION MEASURES

There are a number of various blast control measures and technologies available, which can minimise blasting impacts (including ground vibration, airblast overpressure and flyrock impacts) on the surrounding environment and enable blasts to be designed to conform to relevant criteria and/or constraints.

The recommended blast emission control measures for the Project are specified as follows:

Control measures for ground vibration:

- Use of a ground vibration predictive model to estimate potential ground vibration levels for the critical receptors;
- Use of appropriate charge mass design and avoid overcharging holes;
- Use of an appropriate initiation sequence to minimise the possibility of holes interactions, i.e., ideally aiming for single hole initiation.

Control measures for airblast:

- Use of an airblast predictive model to estimate potential overpressure levels for the critical receptors;
- Use of appropriate charge mass design and avoid overcharging holes; Use of an appropriate initiation sequence to minimise the possibility of holes interaction i.e., ideally aiming for single hole initiation.
- Apply appropriate quality stemming material and stemming height to enable correct confinement of explosive charges and therefore, minimise airblast overpressure emission;
- Maintain appropriate burden specification for the front row holes (to avoid face burst);

Control measures for flyrock:

- Maintain appropriate burden specifications for the front row holes (to avoid face bursts and related flyrock incidents),
- Ensure appropriate quality of stemming material and stemming height to facilitate explosives confinement to minimise the possibility of stemming ejection and/or flyrock incidents.

Other mitigation and management measures include the following:

Blast Monitoring System

The assessment identified the exact locations of various private residences. These residences are considered to be widely spread in three main directions i.e., north-west (and west), south-east and south.

It is therefore recommended that the monitoring system for private residences should consist of three (3) monitoring stations to capture ground vibration and airblast overpressure impacts from blasting at the Project site.

One of the stations is to be located to the west of the operation near residence R18. This will be representative for private residences located in the Balickera area near Italia Road. This station will also provide coverage for Hunter Water infrastructure in this area, and further located heritage site of Balickera House.

Another station is to be located to the south-east of the operation to provide coverage for the scattered Ferodale residences located along Nine Mile Road.

The third station is to be located to the South of the operation in the vicinity of the single residence R1.

Pre-Blast Assessment Protocol

A pre-blast assessment protocol plays an effective role in managing blast impacts. The Project will draw an appropriate protocol (including weather impacts) to manage blasting and to minimise the impacts on the surrounding area. The protocol will also need to be reviewed on a regular basis to address the physical changes in the quarrying activities.

Weather data will be obtained from the nearby Williamtown BOM station to assist with the assessment of environmental conditions prior to blasting and utilised in the pre-blast assessment protocol.

Road Closure Management Plan

Blasting activities for the Project will be undertaken within proximity to public roads including Italia Road and an unsealed section of Nine Mile Road (located within the forest). Depending on the operational stage, the roads will be located within 0.5 km from the extraction area. This will require the development of a Road Closure Management Plan in consultation with the relevant road authorities and the local council.

Public Notification

Due to close distances to some of the private residences the quarry is to develop blast notification system of the scheduled blasts. This is to inform public of the date and time of the blast. Various formats of public notifications are available and can be tailored for optimal local requirements.

Interaction with the Adjacent Quarries

Blasting activities within the Project may overlap with the blasting time of the adjacent quarries (i.e., Boral's Seaham quarry and potential new Eagleton's quarry (when it becomes operation).

To avoid any potential issues due to blast impact interaction and to minimise impact on the local community, Stone Ridge Quarry will liaise with neighbouring quarries to prevent concurrent blasting times.

9.0 CONCLUSIONS AND RECOMMENDATIONS

The BIA report presents an assessment of blasting impacts associated with the Project on the surrounding environment, inclusive of people, houses, public and private infrastructure, heritage sites, animals and significant natural features.

The assessment outcomes are summarised as follows:

- Blasting parameters were derived based on the geological model of the area and quarry production projections. The nominal blasting benches will be in the order of 15 m. Three drill rig sizes will be utilised to provide a range of working charge masses.
- For the purpose of assessing blasting impacts, ground vibration and airblast overpressure models (representative for the area and blasting conditions) were utilised.
- The blast emission and damage criteria for assessed items are specified in Section 5.2 of this report. The assessment covers items within a 2 km radius of the proposed blasting boundary.

The assessment outcomes are summarised as follows:

- **Impact on Residential Receptors**:
  - The impact of ground vibration and airblast overpressure on the Balickera and Ferodale communities can be managed effectively below the recommended ANZECC guideline limits within the specified blasting parameters at all private receptors. However, the modelling identified the need for control of charge masses when blasting in the north-western section in the later stages of the Project (Stages 6 to 9) to manage vibrations and overpressure impacts on the community.
  - The quarry will operate using an adequate exclusion zone to manage flyrock impacts. The potential flyrock risks are considered low or negligible or will be managed adequately in the later stages of the Project (Stages 6 - 9) via implementation of a 500 m flyrock exclusion zone applicable to residents.

- **Impact on Public and Private Infrastructure**:
  - The modelling for Hunter Water infrastructure facilities, concluded no significant blast vibration impacts (i.e., well below assessment criteria). The details were presented in a separate ESC report (2022), which provided a detailed evaluation for each infrastructure facility. This report concluded that the risk of damage from blast vibration exposure is classified as low for the considered infrastructure items i.e., no damage or deterioration is expected due to blasting. The risk of damage from airblast and flyrock is considered low and/or negligible or not applicable.
  - Ground vibration and airblast overpressure modelling (wherever applicable) identified that the predicted vibrations for infrastructure including: public roads, bridges, powerlines, telecommunication infrastructure, and other private infrastructure will be below the applicable limit criteria and/or damage levels.
  - The impact of flyrock on the closest infrastructure including Italia Road, Nine Mile Road and powerlines can be managed effectively by the implementation of the Road Closure Management Plan. Because of short distances to Italia Road (i.e., 270 m) and Nine Mile Road (i.e., 200 m), the quarry will develop Road Closure Management Plan to manage flyrock impacts and to minimise potential risks. For other infrastructure, the flyrock impact is considered to be fully managed and potential risks are considered low and/or negligible.

- Vibration impact from traffic passing over Balickera Tunnel, associated with quarry activities will cause no damage or deterioration of Balickera Tunnel or other adjacent infrastructure.

- **Impact on the Heritage Site**:
  - The blast vibration and airblast overpressure modelling confirmed blasting impacts on the heritage site (i.e., Balikera House) will be below the assessed criteria levels.
  - The impact of flyrock is considered to be low and/or negligible risk.

- **Impact on Animals:**
  - The assessment concluded no significant concerns for the wellbeing of livestock or pet animals located at Balickera.
  - The ground vibration and airblast overpressure modelling confirmed predicted blasting exposures below the assessment limits.

- **Impact on Significant Natural Features:**
  - The assessment did not identify any blasting risks or issues related to blasting impacts on the Wallaroo National Park or its fauna.

RECOMMENDATIONS

- Various recommendations regarding blast design and its execution were provided in Section 8 with the aim of minimising blast impacts on the adjacent environment.
- A vibration monitoring program is to be implemented to ensure the quarry complies with vibration and overpressure limits. Detailed recommendations regarding the number and location of monitoring stations were provided in Section 8.
- A pre-blast assessment system that incorporates weather monitoring data is to be implemented.
- A Road Closure Management Plan is to be developed and implemented to manage the impacts on public roads/infrastructure and flyrock risks.
- A public notification system is to be developed to inform the public of scheduled blasts.
- Blasting activities associated with the Project may overlap with the adjacent Boral's Seaham Quarry and proposed Eagleton's Quarry. It is recommended that ongoing liaison and interaction between quarries is developed to avoid the possibility of concurrent blasts.

Thomas Lewandowski
25th May 2023
ESC

REFERENCES

1. ACARP Report Reference No. C14057 ‘Effect of Blasting on Infrastructure’ Alan Richards, Adrian Moore, 2008

2. ARDG (2020), ‘Scoping Report - Proposed Stone Ridge Quarry Project (Wallaroo State Forest No. 781)’, prepared by Australian Resource Development Group Pty Ltd. February 2020.

3. Australian & New Zealand Environment and Conservation Council (ANZECC) (1990). ‘Guidelines Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration’ September 1990.

4. Australian Standard AS 2187.2:2006, Explosives – Storage and use, Part 2 – Use of explosives (AS 2187 Part 2).

5. British Standard BS 7385-2:1993, “Evaluation and measurement for Vibration in Buildings – Part 2: Guide to Damage Levels from Ground Borne Vibration”.

6. EIS (2022). “Environmental Impact Statement for Stone Ridge Quarry Project”. Prepared by Umwelt for ARDG.

7. ESC (2020A), “Single Hole Study and Site Law Development for the Proposed Stone Ridge Quarry Area”. Report no. SR-2007-090620

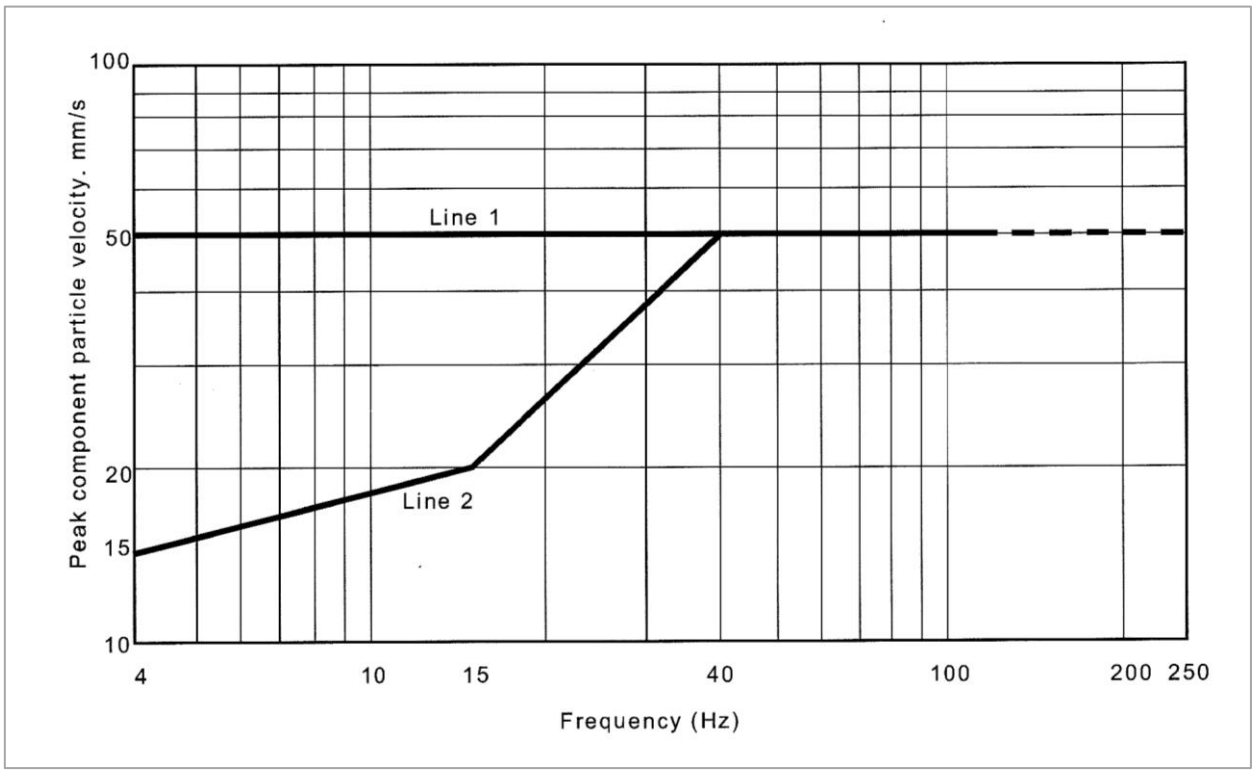
8. ESC (2020B), “Monitoring of Ground Vibrations from Passing Traffic above Balickera Tunnel, Italia Road, Balickera”. Report no. SR-2005-030420.

9. Port Stephens Local Environmental Plan (2013).

10. SEARs (2020), “Planning Secretary’s Environmental Assessment Requirements (Application Number SSD-10432)”. Date issued 01.06.20.

11. US Bureau of Mines, USBM RI8507.

Appendix 1A – Transient Vibration Guide Values for Cosmetic Damage - British Standard (BS 7385-2:1993)



Appendix 1B – Safe Level Ground Vibration Blasting Criteria from USBM RI8507