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DANDY PREMIX QUARRIES PTY LTD
(T/A YARRA VALLEY QUARRIES PTY LTD)

BLASTING IMPACT ASSESSMENT FOR THE PROPOSED EXTENSION OF YARRA VALLEY QUARRIES, LAUNCHING PLACE (WA375)

May 2024

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1 INTRODUCTION

Terrock Consulting Engineers was engaged by Dandy Premix Quarries Pty. Ltd. (trading as Yarra Valley Quarries Pty. Ltd.) to assess the effects, risks and impacts of blasting from a proposed extension of the quarry at 130 McMahons Road, Launching Place, Victoria. It is proposed to expand the quarry's current approved extraction across an area to the northwest by widening and deepening the existing pit area.

This assessment has been undertaken to determine whether routine blasting operations in the proposed extension area can be undertaken in accordance with prescribed regulations, standards and guidelines for blasting at Victorian quarries, and assess blast impacts with respect to the surrounding environment and local amenity.

The primary topics addressed are:

- Ground vibration and airblast overpressure levels that would occur in the surrounding area, including levels at occupied residences.
- Flyrock risk and control.
- Risk of blast-induced damage to buildings and other structures
- The impact of blasting to local amenity.
- The impact of blasting to native species and domestic animals.

The subjects of dust, audible noise and geotechnical risk from whole quarry operations is referred to qualified consultants in these fields.

A site plan showing the existing and proposed extension area wherein blasting would occur, nearby roads and infrastructure, and the locations of dwellings within 1.5 km of the quarry is shown as **Appendix 1**.

2 BACKGROUND

Launching Place Quarry, known internally as 'YVQ', was established over 30 years ago within State Work Authority No. 375 (WA375). The site extracts high-quality hornfels rock that is processed on site to supply aggregate to Dandy Premix's concrete division and construction projects across Melbourne's eastern region. An extension of the quarry's original extraction area was approved in 2010 though the resource available within that area is nearing exhaustion.

Quarry management report that no significant concerns regarding current or historic blasting operations have been raised by community members including the nearest residents. The site's blast monitoring record show low levels of ground vibration and airblast occur in the area southwest of the quarry (McMahons Road) where the closest residences are located. The absence of complaints from residents indicates that blast vibration levels and impacts to amenity are low and generally imperceptible at locations around 1 kilometre from blast sites. An average of one blast per month is currently needed to meet production targets.

3 QUARRY LOCATION AND SURROUNDS

The quarry is situated in a gully at the southern flank of Mount Toolebewong, approximately 52 km east of Melbourne and 4.5 km north of Launching Place and Woori Yallock townships, and within the Yarra Ranges Council local government area. The Work Authority and proposed extension area is largely enclosed by dense bushland and steep hills on adjacent reserves and crown land. From the WA375 boundary, the neighbouring land areas are;

- Mount Toolebewong State Forest to the northwest
- Crown land to the north and northeast.
- Reserve land under management of Parks Victoria to the east and southeast
- Rural residential properties to the southwest
- Private property under ownership and management of YVQ to the west.

Boundaries of the land areas above can be seen in **Section 9.2.5**, **Figure 9**. Details of the current status and zoning of adjacent land areas can be found in reports prepared by Yarra Valley Quarries' environment and planning consultants.

3.1 Sensitive sites

Private properties in the surrounding area include mixed-use broadacre farmland, hobby farms and rural residential properties located among the foothills southwest of the quarry and north near the summit of Mount Toolebewong. Twenty-three properties with sensitive sites (occupied houses) are identified within 1.5 km of the proposed extension area as shown on the site plan **Appendix 1**. The closest house (on property not under ownership of YVQ) is 165 McMahons Road at a minimum distance of 660m from the proposed extraction limit. The closest four houses to the extension area are labelled 'Houses 1-4' on site plans and appendices.

Because the extraction area is proposed to be expanded in a northwest direction, the separation distances from houses to the southwest are similar to those from current operations. At houses along Moora Road to the north, the separation distance from the quarry would reduce by approximately 200m. This would result in a modest increase of ground vibration and airblast levels at sensitive sites from blasts near the northern extraction limit, though the separation distances are sufficient for levels to remain generally low.

3.2 Houses located on YVQ property

There are also two nearby houses under ownership of YVQ. One house is located on the Work Authority within the southwest area of the proposed extraction area and is anticipated to be demolished as part of early-stage development. Another house is located on YVQ property immediate west of the Work Authority, approximately 95m from the proposed extraction limit. Further information regarding the future status of these houses is provided in **Section 9.4**.

3.3 Infrastructure

There are no critical offsite infrastructure assets (high-voltage transmission lines, gas mains, etc.) located within 1 km of the existing quarry and proposed extension area. The closest section of public road reserve is McMahons Road that terminates immediately west of the quarry's plant and stockpile area approximately 400m from the proposed extraction limit.

4 SITE GEOLOGY

Hornfels formed by contact metamorphism of Humevale siltstone underlies the quarry and proposed extension area. The rock has contact zones with rhyodacite to the east, siltstone-sandstone to the south and west, and a granite intrusion to the north. The area's geology likely contributes to relatively low ground vibration levels from blasting as transmission of vibration waves is disrupted by rock jointing, localised faults and contact zones.

5 QUARRY STAGING AND EXTRACTION METHOD

Proposed future extraction would largely follow current practice with traditional drill and blast methods to liberate rock for onsite processing. Plans produced by BCA Consulting show four development stages summarised as:

- **Stage 1** – Blasting of upper-level benches to terminal profile immediately north of the existing pit. Wide benches established at lower levels across extension area.
- **Stage 2** – Upper-level blasting to terminal profile continues northwest. Lower-level benches further widened.
- **Stage 3** – Blasting to western and southern extraction limit, and across central area.
- **Stage 4** – Deepening of central pit area with blasts to terminal floor at RL 110m.

The precise locations upper-level blasts near the extraction limit cannot be determined at the planning stage. A substantial depth of overburden (soil, clay and highly weathered rock present in upper layers) is subject to mechanical excavation across the extension area to expose the top of the hard rock mass. Overburden depths up to ~20m are indicated in some areas and due to batters and berms formed from the extraction limit to upper-level rock, terminal blasts (the closest blasts to offsite receptors) would be at variable distances from the extraction limit. To provide a conservative approach for this assessment, the minimum separation distances between receptors and blasting are observed from the extraction limit, noting the closest blasts would likely be tens of metres further away.

The maximum face/bench height for production blasts in the proposed extension area is 10m resulting is relatively small-scale blasts compared to most other quarries. Short-face blasts (~5m height) would be required for terminal blasts above RL 210m to help form a stable terminal batter slope as part of site rehabilitation works. Processing plant upgrades are also proposed and the quarry's production rates would be increased with approximately 24 blasts per year (2 blasts per month) needed to meet future production targets.

6 ASSESSMENT CRITERIA

All blasting operations at Victorian quarries must be undertaken with observance to the following State and National codes, regulations, standards, guidelines, and conditions including;

- *Victorian Dangerous Goods (Explosives) Regulations 2022*
- *Mineral Resources (Sustainable Development) (Extractive Industries) Act 1990*
- *Environmental Protection Act 2017* (including the General Environmental Duty)
- *DEECA-ERR Guidelines and Codes of Practice; Ground Vibration and Airblast Limits for Blasting in Mines and Quarries*
- Australian Standard *AS2187.2-2006 Explosives Storage and Use: Part 2 – Use of Explosives*
- *Occupational Health and Safety Act 2004*
- *Australian Code for the Transport of Explosives by Roald and Rail - 3rd Edition*
- Site-specific Work Authority conditions that may apply as part of a quarry's approved Work Plan.

Key criteria relevant to this assessment are outlined in the following sections.

6.1 Blast vibration limits for Sensitive Sites

Ground vibration and airblast levels from quarry blasting are regulated by the Department of Energy, Environment and Climate Action (DEECA). The department's Earth Resources Regulator branch (ERR) provides guideline limits for ground vibration and airblast that typically become an operating condition for work authorities with blasting (as detailed in *ERR Guidelines and Codes of Practice; Ground Vibration and Airblast Limits for Blasting in Mines and Quarries).*

The limits apply at sensitive sites such as occupied dwellings and are:

Ground Vibration:	5 mm/s PPV (for 95% of blasts within a 12-month period) 10 mm/s PPV (all blasting)
Airblast:	115 dBL Linear peak (95% of all blasts within a 12-month period) 120 dBL Linear Peak (all blasting)

The upper limits (10 mm/s and 120 dBL) are provided as an allowance for the occasional, unexpected exceedance of the lower (95%) limits. However, compliance with the lower limits (5mm/s and 115 dBL) is considered by quarry operators as the performance target for all blasts. Compliance is assessed through the results of blast monitoring and exceedance of the limits may result in penalties for quarry operators.

The ERR limits are in consideration of human comfort and are set below levels at which blast vibration damage is known to occur to houses and other light-framed structures. Limits for commercial and industrial premises are not currently specified by the regulator though if required, consideration for such premises is usually given to damage criteria for which higher limits apply.

6.2 Blast vibration limits for infrastructure

Separate ground vibration limits may be ordered by owners of critical offsite infrastructure such as buried gas and water mains, and high-voltage transmission lines and pylons. The limits are higher than those for sensitive sites, typically 100 mm/s for electricity transmission poles and towers, and 20-50 mm/s for buried pipelines. Attention to the limits may only be required where blasting occurs within 100-200m of infrastructure assets. In such cases, blast designs may need to be modified to reduce ground vibration levels.

Aside from service lines and poles present in local road reserves and properties, there are no critical offsite assets located near YVQ and the proposed extension area. Due to separation distances of several hundred metres between blasts and the closest service lines, compliance with the typical 100mm/s limit is assured and no additional blasting controls are required.

6.3 Control of flyrock

It is the responsibility of shotfirers to ensure all rock fragments thrown from blast sites are fully contained within a quarry's work authority or title property boundaries. Excessive throw ('flyrock', where rock fragments are thrown well beyond normal distances) is prevented by appropriate blast design, blast hole and face surveying techniques, accurate hole loading practices and thorough record keeping. The residual risk of flyrock is mitigated by establishing wide clearance zones around blast sites at firing times.

While modern blasting techniques are highly effective to prevent flyrock and minimise the throw of rock fragments, excessive flyrock remains a possibility at all quarries and operators must ensure blasts are well designed, correctly loaded to the shotfirer's specifications and appropriate blast clearance zones are established and secured during every blast. The subject of flyrock risk and control at YVQ is addressed in **Section 9.2**.

6.4 Blast firing times

The quarry is currently permitted to fire blasts between 10am and 4pm from Monday to Friday. No blasts may be fired outside these times or during weekends and public holidays. These conditions are likely to remain in place should the extension be approved. Blasts at the quarry are usually fired between 11 am and 2 pm.

6.5 Blast notifications

Quarries are required to provide personal notifications of scheduled blasts at the request of individual residents and other stakeholders. Blast notifications are an effective method to help prevent startling and reduce annoyance to residents that can be caused by unexpected blast vibration. Notifications are typically provided by email, phone call or SMS and are available to all residents near YVQ.

7 BLAST DESIGN SPECIFICATIONS

The blast design shown in **Table 1** has been confirmed as standard specifications for future production blasting at YVQ. While smaller-scale blasts is anticipated in the upper layer and near extraction limits, the impacts of blasting from standard (maximum) 10m faces are the focus of this assessment because such blasts would result in the highest ground vibration and airblast levels.

Table 1 – Standard blast design specifications, WA375

Face height	10m (max.)
Sub-drill	0.5-0.8m
Blast hole length	10.8m (max.)
Blast hole diameter	89mm
Blast hole angle	10°
Front row (face) burden	3.0m
Inter-row burden	2.5-3.0m
Spacing	2.5-3.0m
Stemming height	3.0m
Explosive column length	7.8m (max.)
Linear Charge mass	7.5 kg/m*
Maximum charge/delay (MIC)	60-75 kg**

**based on average bulk explosives density of 1.2 sg*
***The quarry's shotfirer has advised that joints and cavities in the rock mass often result in higher MICs than calculated with the standard 7.5 kg/m linear charge mass for 89mm holes*

Design requirements for individual blasts may be modified by shotfirers to maintain compliance with blast vibration limits, mitigate the risk posed by flyrock or improve blast efficiency and general performance. Precise design requirements for individual blasts are guided by review of driller's logs, blast hole surveys, hole loading records, site inspections, and the results of ground vibration, airblast and flyrock monitoring.

8 BLAST IMPACT ASSESSMENT

8.1 Ground Vibration

When explosives detonate in the ground, the rock around each charge is fragmented and displaced, and residual energy is converted to ground vibration waves that radiate from the blast sites and reduce in magnitude with increasing distance. Beyond a few metres from each blast hole the wave motion is elastic and the ground returns to its original position after the wavefronts have passed. Blasts are designed so that each charge detonates at a separate moment in time to stagger the release of energy and minimise blast vibration levels.

Ground vibration from quarry blasting is typically perceptible to the occupants of buildings located within a kilometre or so of blast sites through structural and secondary responses such as a brief creak of structural members, small movement of loose items and fixtures, and associated audible effects such as rattling sounds. The effects may occur for 2-5 seconds per blast depending on the distance from the blast sites and the number of blast holes used.

Ground vibration from blasting is considered in terms of the Peak Particle Velocity (PPV) of the ground motion measured in units of millimetres per second (mm/s). PPV levels are commonly predicted using the following square root Site Law from Australian Standard AS2187.2-2006 Appendix J:

$$PPV = k_v \left(\frac{\sqrt{m}}{D}\right)^{-e} \quad [1]$$

Where:

PPV =	Peak Particle Velocity (mm/s)
m =	Charge mass per delay (kg)
D =	Distance from blast site (m)
k_v =	A site constant
e =	Attenuation rate (-1.6)

The model's site constant (k_v) reflects localised ground conditions that influence the transmission of ground vibration waves in specific directions from blast sites. Because conditions vary, site constants between individual blasts and locations also vary. AS2187.2-2006 recommends a k_v value of 1,140 for estimating PPV levels in "*average field conditions*".

Site constants are determined by transposing the Site Law model [1] using MIC, PPV and distance as inputs. This has been undertaken using a sample of recent and historic blast vibration measurements obtained southwest of YVQ near McMahons Rd (see monitoring location on **Appendix 1**). The monitoring results and site constants for the PPV measurements are shown in **Table 2**.

Table 2 - Sample of blast monitoring results, Yarra Valley Quarries

Date	PPV (mm/s)	Airblast (dBL)	Distance from blast (m)	k_v
31/01/2023	0.49	102.3	1,080	1,106
10/01/2023	0.34	99.9	1,235	951
24/11/2022	0.37	103.3	1,220	1,015
22/11/2022	0.29	104.6	1,240	816
22/05/2020	0.31	104.6	1,090	732
07/05/2020	0.37	101.3	995	710
12/12/2019	0.28	100.9	1,030	586

The monitoring results show low PPV and airblast levels in the McMahons Road area with a maximum k_v value of 1,106. However, due to uncertainties regarding ground conditions in other directions from the quarry and the normal variation of PPV levels between blasts, a conservative site constant of 1,200 is adopted for this assessment. This approach provides an allowance for some variability and PPV levels predicted with the model are considered the maximum levels that could ordinarily occur.

Observing the maximum charge mass of 75 kg per hole, the model for standard blasting adopted in this assessment is;

$$PPV = 1{,}200 \left(\frac{\sqrt{75}}{D}\right)^{1.6} \quad [2]$$

From the Site Law model [2], the distances to milestone PPV levels from standard blasts are shown in **Table 3.**

Table 3 – Distance to milestone PPV levels (MIC 75kg, k_v 1,200)

PPV (mm/s)	Dist. from blast (m)
10	172
5*	**266**
2	472
1	727
0.5	1,122

**ERR Ground Vibration Limit (95% of blasts)*

Ground vibration model contours are shown as **Figure 1**.

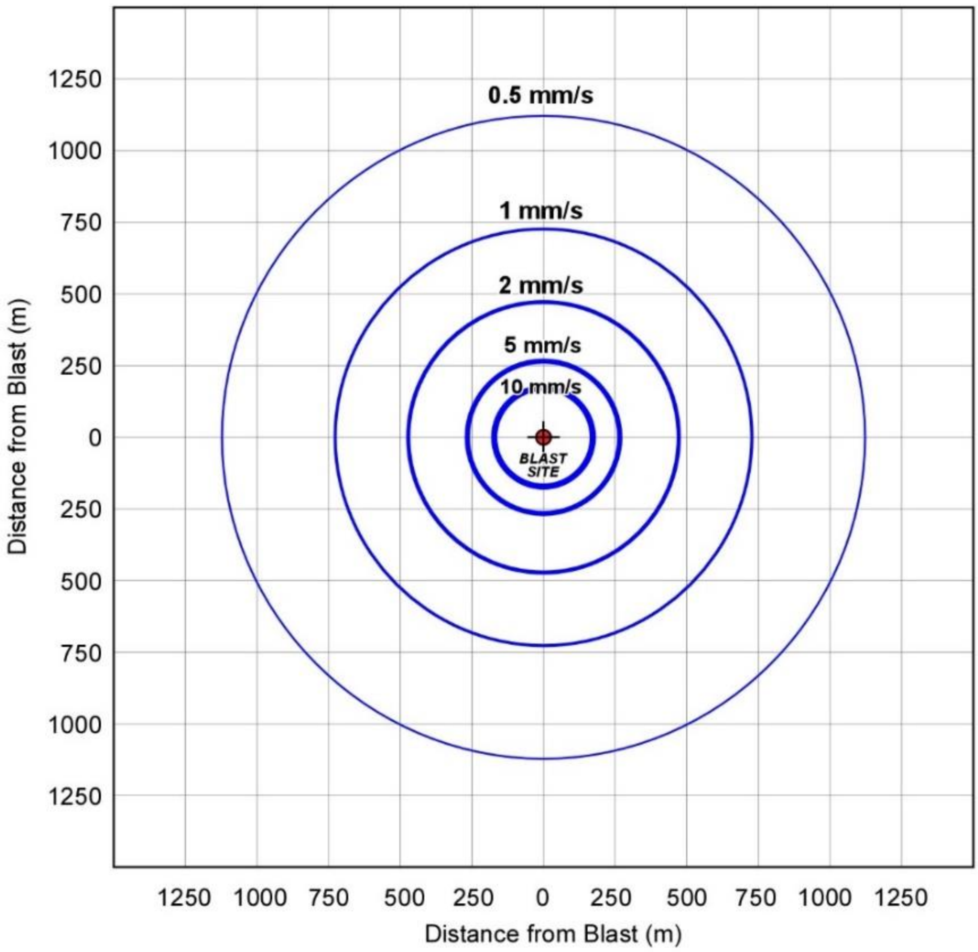

Figure 1 – Basic ground vibration contours, Yara Valley Quarries

The attenuation of maximum PPV levels over distance is presented graphically in the regression analysis (**Figure 2)**. The minimum distance to the closest sensitive (House 1, 165 McMahons Road) site is also shown.

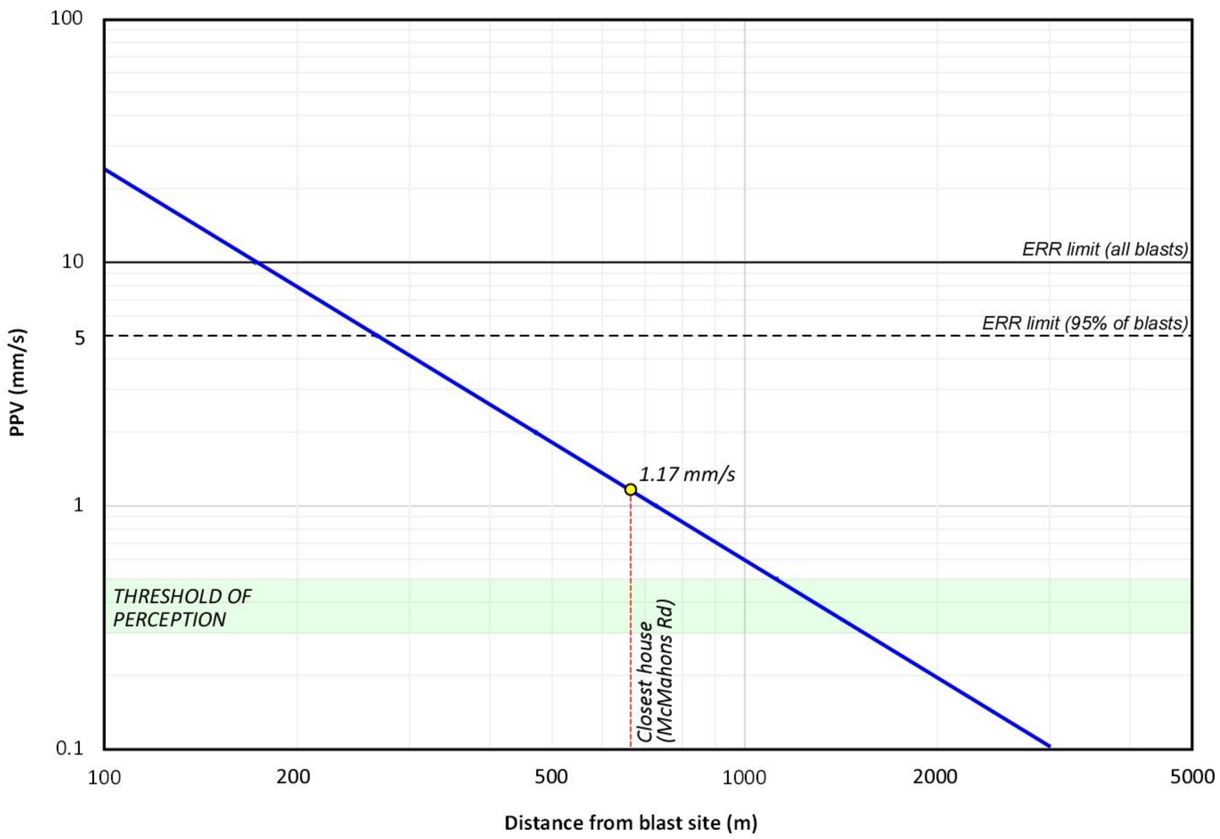

Figure 2 – Regression analysis showing reduction of maximum PPV levels over distance

PPV levels are shown to be below the ERR 5mm/s limit at locations beyond 266m from standard blasts. The threshold of human perception of ground vibration is regarded as 0.3-0.5mm/s and vibration effects from YVQ are likely to be imperceptible at sensitive sites beyond ~1 km from blast sites.

Observing the minimum separation distances between the proposed extraction limit and the closest houses, the maximum PPV levels at Houses 1-4 are shown in **Table 4**.

Table 4 – Maximum PPV levels at closest sensitive sites from the nearest blast(s)

	Distance to closest blast (m)	PPV (mm/s)
House 1 (165 McMahons Rd)	660	1.17
House 2 (45 Parrot Rd)	815	0.83
House 3 (155 McMahons Rd)	870	0.75
House 4 (9 Moora Rd)	880	0.73

Maximum PPVs would be limited to 10m face blasts at upper benches with reduced levels from the majority of blasts. PPV levels from short-face terminal blasts near the extraction limit would also be reduced due to the smaller charge masses required.

Maximum PPV levels in the surrounding area are presented visually by joining the circular ground vibration contours (**Figure 1**) around the proposed extraction limit and observing the locations of the 10, 5, 2, 1 and 0.5 mm/s levels (see **Appendix 2**). The contours do not represent levels from a single blast but show the maximum PPV level at any location from the closest 10m face blast to the extraction limit. The assessment shows standard production blasting in the proposed extension area would result in relatively low PPV levels and associated impacts, would be generally imperceptible at locations more than 1km from the quarry, and would achieve compliance with the ERR 5 mm/s limit at all sensitive sites.

From experience at other quarries, residents are more likely to raise concerns or complaints where PPV levels increase above 2 mm/s and become highly perceptible. The absence of complaints around YVQ indicates blast vibration levels from standard blasting are relatively low and this assessment demonstrates levels would remain low under the extension proposal.

8.2 Airblast

Airblast overpressure is a brief, low frequency (<20 Hz) fluctuation of air pressure that radiates from blast sites through the atmosphere at the speed of sound (~340 m/s) and reduces by approximately 9 decibels with doubling of distance. Airblast (measured as dBL) is sub-audible and may only be perceived by people inside buildings at blast times through structural and secondary audible responses, similar to the effects of a wind gust. The threshold of airblast perception for people inside buildings is regarded to be 100-105 dBL.

The higher frequency component of airblast (>20Hz) is perceived as audible blast noise as measured in the units dBA. If required, audible noise levels from blasting can be determined by overpressure readings (dBL) by reducing peak levels by 25 decibels. For example, an airblast reading of 115 dBL would measure 90 dBA on a sound level monitor for the same event (ref. AS2187.2-2006). Audible blast noise from quarries is not subject to monitoring or designated noise limits but is controlled by the overpressure limits that apply at sensitive sites.

Airblast levels are influenced by many factors including face direction, weather conditions at blast times, rock structure, and blast design specifications (face burden, stemming height and charge mass). Because YVQ is largely surrounded by steep hilly terrain, dBL levels would be reduced by varying degrees due to 'topographic shielding' where hills, ridges and upper benches form barriers to airblast transmission.

Approximate airblast levels can be predicted using the Terrock Airblast Model (Moore et al., 1993). This peer-reviewed model observes blast hole confinement provisions to determine the distance to the 115 dBL level ($D115_{dBL}$). The model is broadly conservative and is used to assess airblast impacts at numerous mines and quarries around Australia and overseas. The model adopted for the extension proposal has a site constant used for quarries with topographic shielding where reduced airblast levels occur in surrounding areas.

The Terrock airblast model and its inputs are:

$$D_{115} = \left(\frac{ka \times d}{B \text{ or } SH}\right)^{2.5} \cdot \sqrt[3]{m} \qquad [3]$$

Where:

D_{115} =	Distance to 115 dBL level (m)
d =	Blast Hole Diameter (mm)
m =	Max. Charge Mass/hole (kg)
B =	Front Row Burden (mm)
SH =	Stemming Height (mm)
Ka =	Site constant 250 (front of face) 190 (behind/side of blast)

Airblast levels are largely a function of the confinement of explosives charges (depth of burial) that is determined by stemming height and front row burden provisions. The highest dBL levels from blasts with a free face occur directly in front of the face and are controlled by front row burden provisions. Lower emissions occur to the rear and sides of blast sites as functions of stemming height and shielding provided by the new face formed behind the blast site.

Using the basic Terrock Airblast Model [3], the predicted distances to milestone airblast levels from standard blasts are shown in **Table 5**:

Table 5 – Milestone airblast levels at distance

Airblast (dBL)	Distance – Front of Face (m)	Distance – Behind/Side of Face (m)
120	436	219
115*	**632**	**318**
110	916	461
105	1,328	669
100	1,926	970

**ERR Airblast Limit (95% of blasts)*

Because airblast levels directly in front of a blast face are higher than behind and to the sides of the blast, the basic model contours have an ovoid form as shown in **Figure 3**.

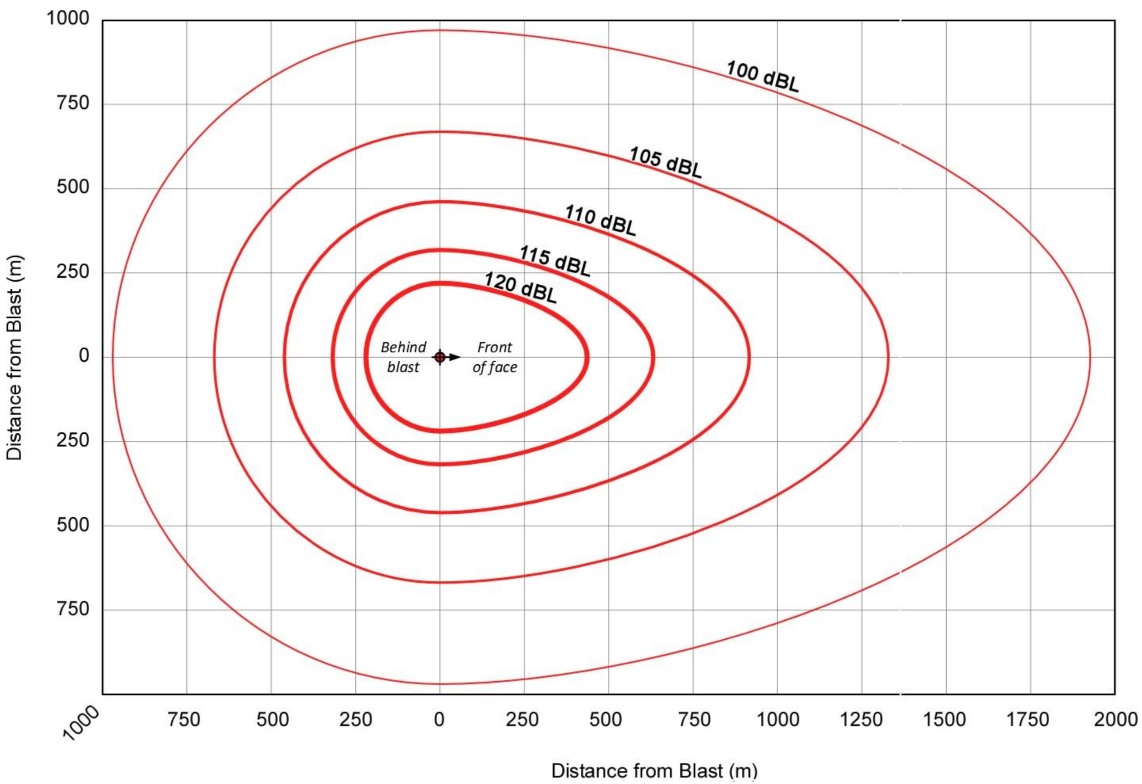

Figure 3 – Basic airblast contours, Yarra Valley Quarries

The reduction of airblast levels over distance (both in front and behind blast sites) is shown in the regression analysis **Figure 4**.

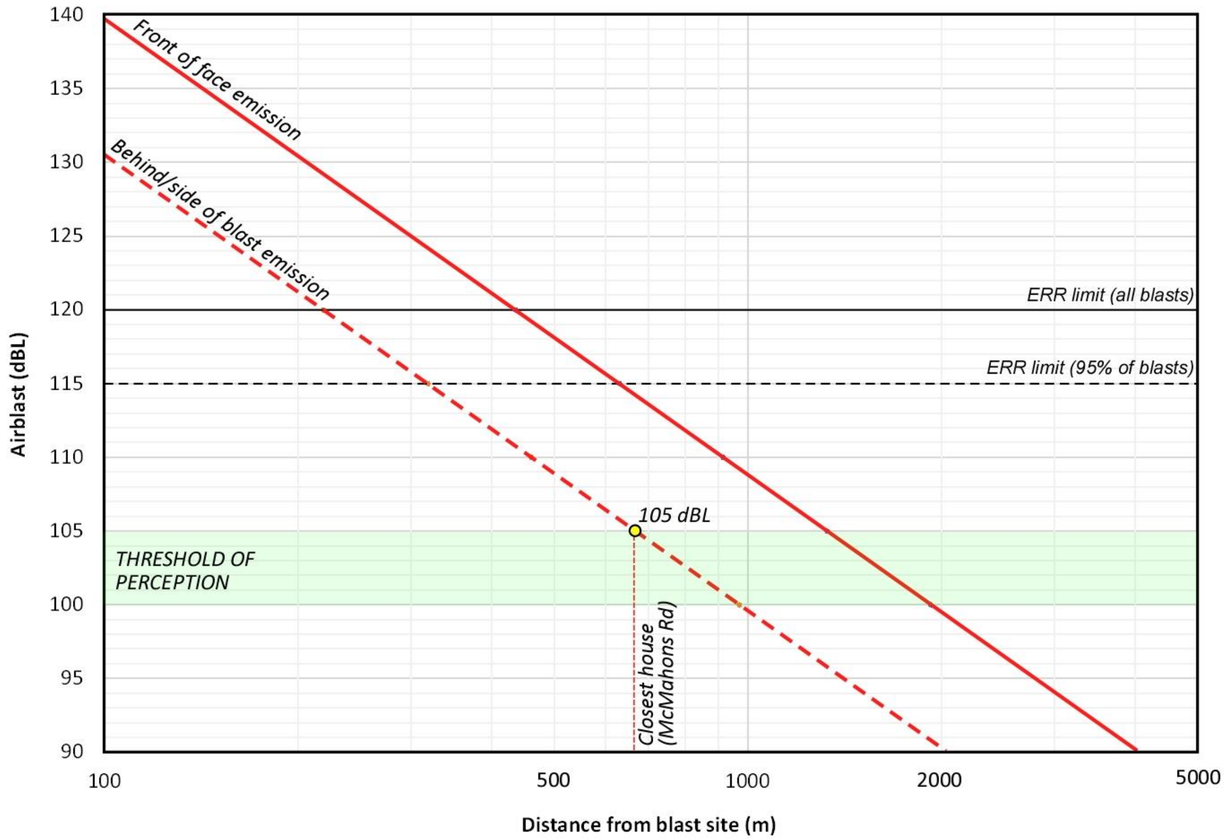

Figure 4 – Airblast Regression Analysis

The maximum airblast level at House 1 from the closest blast(s) is 105 dBL. Lower, behind-blast emissions apply in the southwest extension area because blasts face north or east and away from the closest houses. Airblast levels in limited areas could be somewhat increased for upper-level, southwest-facing blasts in the northern area of the extension during Stages 1 and 2. However, dBL levels would remain relatively low due to increased separation distance. At approximately 1,000m from the closest upper-level blasts in the northern area, the maximum airblast level at House 1 is 108.5 dBL.

This assessment demonstrates that airblast levels from proposed blasting would comply with the ERR 115 dBL limit at all sensitive sites. The predicted airblast levels are low compared to most other quarries and this is supported by the blast monitoring record with levels of 99.6 - 104.6 dBL recorded in the vicinity of the closest houses. However, careful attention to front row burden provisions must be maintained for southwest-facing, upper-level blasts to ensure airblast levels remain low and minimise impacts as far as can be practicably achieved.

Airblast levels from the closest blasts to the proposed extraction limit are presented visually by orienting single blast contours around the extraction limit and observing the locations of the 120, 115, 110, 105 and 100 dBL levels (see **Appendix 3**).

It is important to note the basic airblast model assumes flat, open terrain around blast sites. The dBL predictions in this assessment are therefore conservative because actual levels in surrounding areas are reduced by topographic shielding.

Influence of Topographic Shielding

The hills, gullies and ridgelines that surround most of the quarry provide a natural barrier to blast noise and overpressure with the effect of reducing airblast levels in the wider surrounds. The degree of shielding from individual blasts is a function of;

- the elevation of the barrier (e.g. a hill or upper benches of a quarry pit)
- the elevation of the blast site
- the elevation of the receptor
- the incident angle between the barrier and receptor.

The influencing factors and terminology of topographic shielding are shown in the following example diagram.

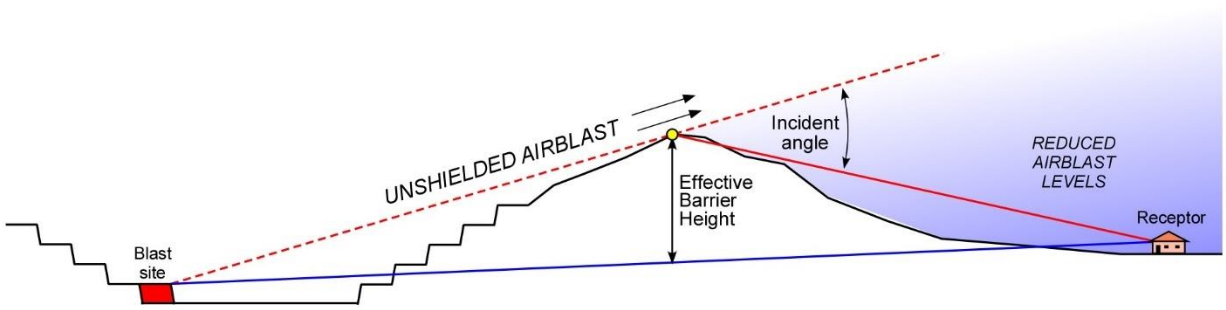

Figure 5a - Topographic shielding factors and terminology

Where the elevations and incident angle between a blast site and receptor are known, the approximate decibel reduction can be calculated using the following chart (**Figure 5b**).

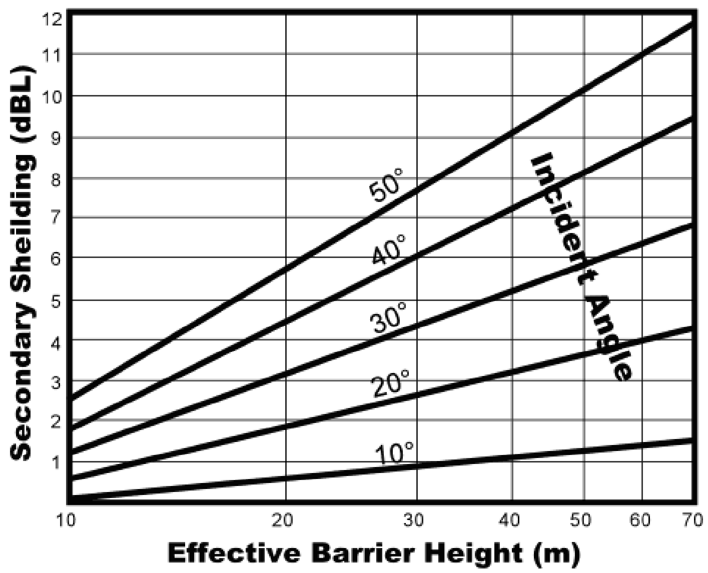

Figure 5b – Relationship between barrier height, incident angle and resulting dBL reduction

Blasts at lower benches of a quarry pit have greater incident angles and barrier heights, and therefore increased decibel reductions as shown on the following example.

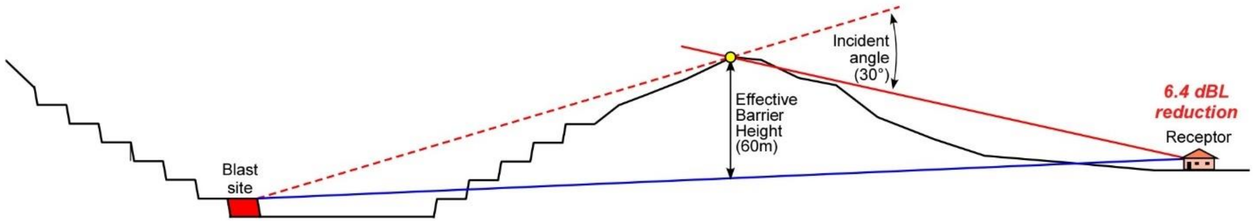

Figure 6a – Example of topographic shielding effect from a blast on a lower bench

Blasts on upper levels result in less shielding due to reduced barrier heights and incident angles. The effect of shielding may also be reduced at more distant receptors because the incident angle is typically flatter, though airblast levels at distant locations are low due to normal attenuation.

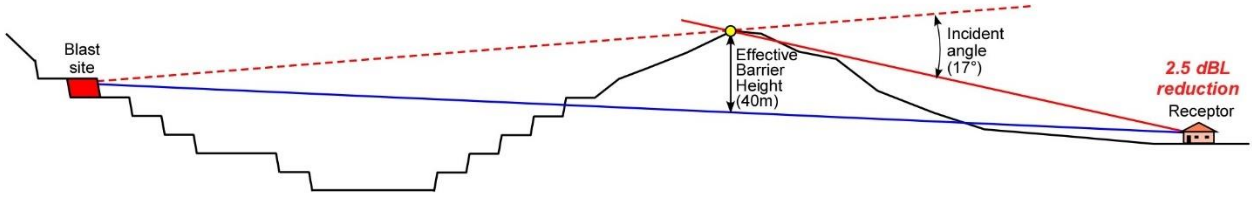

Figure 6b – Reduced topographic shielding from a blast on an upper bench

From separation distance alone, blasting in the proposed extension would comply with the ERR 115 dBL limit regardless of topographic shielding. In effect, the topography around the quarry would result in substantial dBL reductions for blasts at mid-lower benches of the pit, and reduced shielding for blasts at the upper few benches. For south-facing, upper-level blasts there would minimal or no shielding in limited areas immediately south of the quarry though dBL levels would be offset by separation distance.

For residents around the quarry, the perceptibility of airblast and blast noise would vary depending on face direction, blast site elevation and barrier hills and ridges between individual blast sites and receptors. In general, airblast levels would remain low (or very low) and the effects would be mostly imperceptible at sensitive sites.

8.3 Flyrock

The maximum throw of rock fragments under a blast's design specifications can be calculated using the Terrock Flyrock Model. The model was reviewed in 2007 by Dr. Peter Lilly (CSIRO Chief Officer of Exploration and Mining) who concluded, "*Terrock's flyrock model greatly simplifies what is dynamically a very complex in physics. However, the algorithm is likely to yield broadly conservative outcomes and is therefore considered to be appropriate by the writer*." The model is conservative by design and provides an allowance for some inconsistency of rock structure and minor errors that can occur during blast hole loading.

The maximum throw in front of a blast face ($Lmax_f$) is calculated with the formula:

$$Lmax_f = \frac{{k_f}^2}{G}\left(\frac{\sqrt{m}}{B}\right)^{2.6} \quad [4]$$

Where:

m =	Linear charge mass (kg/m)
B =	Front row burden (m)
$Lmax_f$ =	Maximum throw in front of face (m)
G =	Gravitational constant (9.8)
k_f =	a site constant

The maximum throw behind a blast site ($Lmax_r$) is calculated by:

$$Lmax_r = \frac{{k_f}^2}{G}\left(\frac{\sqrt{m}}{SH}\right)^{2.6} Sin\ (2\emptyset) \quad [5]$$

$Lmax_r$	maximum throw behind blast (m)
SH =	stemming height (m)
$\emptyset$ =	launch angle = hole angle from horizontal + a dispersal allowance of 10° (e.g. 10° hole angle + 10° dispersal = 70°)

Observations and measurements of throw distances at quarries show a site constant of 27 to be an appropriate default value for the model. Actual throw distances are normally well short of calculated throws though a cautious approach to flyrock and blast clearance is warranted due the serious consequence of rock fragments striking a person. If needed, the model can be calibrated to more accurately reflect the behaviour of local rock structure under blasting through a program of flyrock observation and measurement.

From the standard blast design specifications shown in **Table 1** the maximum throw distances are:

Front of Face	=	58.7m (**60m**)
Behind blast	=	37.7m (**40m**)

A cross section of throw trajectories is shown as **Figure 7a**.

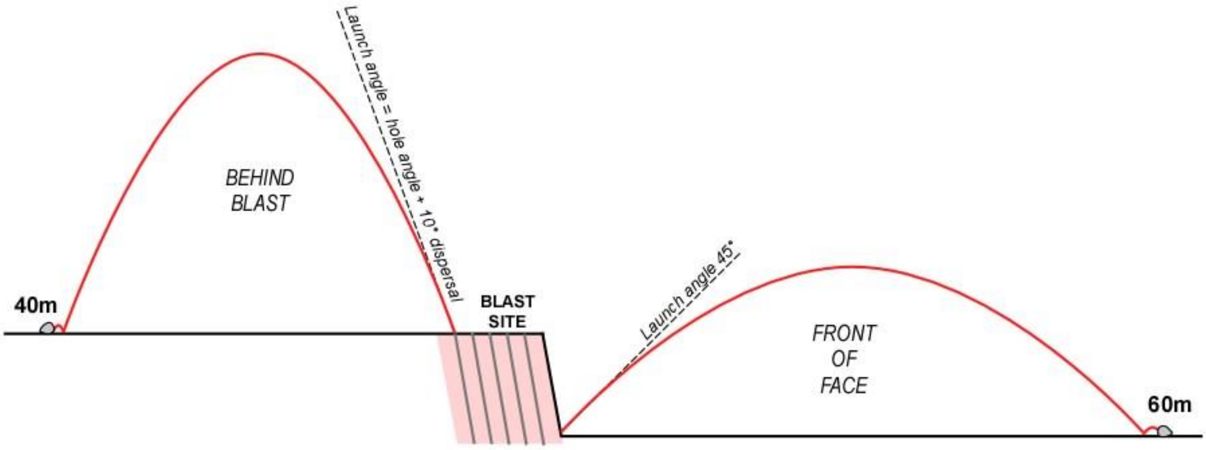

Figure 7a – Flyrock trajectories for standard blast specifications (conservative)

Because YVQ is a multiple bench quarry the difference in elevation between launch and landing sites may also need to be considered. If the area in front of a blast is at a lower elevation than the blast face, horizontal throw distance is increased roughly equal to the difference in elevation as shown in **Figure 7b**. Conversely, throw distance behind blasts can be reduced by barriers formed by upper benches or steep hills behind blast sites.

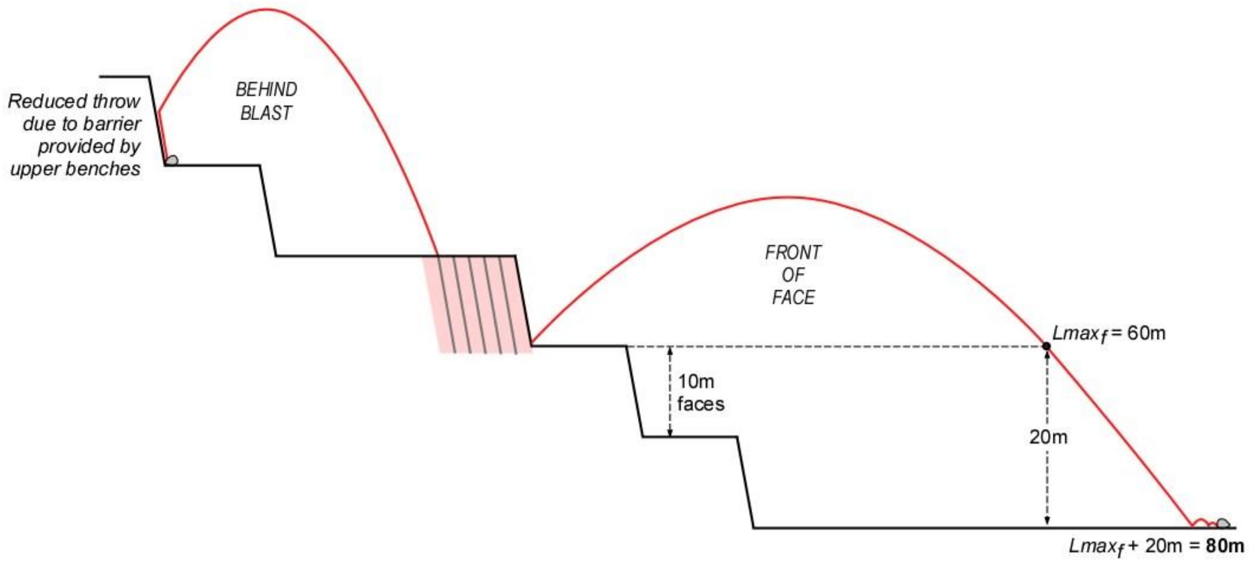

Figure 7b – Increased/decreased horizontal throw distance at multiple bench quarries (example)

The potential for increased horizontal throw distance in front of blasts does not present additional risk because the entire pit area is evacuated at blast times. Minimum blast clearance distances can be determined by applying Safety Factors to maximum throw calculations. The nature, causes and risk posed by flyrock, and approaches for determining blast clearance distances are discussed in **Section 9.2**.

9 RISKS AND IMPACTS OF BLASTING

Controlled blasting practices that adhere to existing standards and regulations present a low risk of harm to people, property and the surrounding environment. The residual risks and control measures required to mitigate them are discussed in the following sections.

9.1 Explosives Storage, Transport, Handling and Use

Blasting at Victorian quarries is undertaken by qualified personnel who are trained and licensed to use blasting explosives in the State of Victoria. Blasting is conducted in accordance with National and State regulations, standards and guidelines including:

- *Victorian Dangerous Goods (Explosives) Regulations 2022,*
- Earth Resources Regulation (ERR) guidelines for quarries
- *Australian Standard AS2187.2-2006*
- *Occupational Health and Safety Act 2004*
- *Australian Explosives Code 3rd Edition*
- Work Authority conditions, as well as any site-specific blasting conditions that may apply as part of a quarry's approved Work Plan.

Blasts at YVQ are designed, loaded and fired by a licenced contactor with assistance from quarry personnel and technicians from the explosive supply company. It is the responsibility of the shotfirer and all blast crew personnel to work to Victorian blasting regulations, relevant standards, site rules, and the procedures of the quarry's Blast Management Plan and Work Authority conditions. It is the responsibility of quarry management to ensure blasts are fired in accordance with prescribed regulations, maintain site safety and security, and coordinate the clearance procedure.

In line with current industry practice, no explosives are stored at YVQ. All explosives products are brought to site by a licenced explosives supplier on blast days and unused products are returned to the supplier's storage facility after each blast is loaded. Risk control measures for explosives transport, onsite handling and security procedures can be found in the quarry's Blast Management Plan, Risk Assessments, documents for individual blasts and Material Data Safety Sheets.

9.2 FLYROCK

The greatest blasting hazard to the safety of people and property is flyrock, where rock fragments from a blast are thrown well beyond anticipated distances. Flyrock events at quarries have become uncommon due to improvements of blasting practice and no flyrock injury has been reported from a Victorian quarry for several decades. However, flyrock remains a possibility at all quarries and its prevention and risk mitigation is a critical consideration for shotfirers and quarry managers.

9.2.1 The Nature of Flyrock

For blasts on benches with a free face the fragmented rock heaves forward and form a pile in front of the blast site from where it is hauled for processing. Sometimes fragments are thrown beyond the pile and land at more distance locations. The furthest potential throws occur within a 90° arc perpendicular to the face and consist of 100-200mm diameter fragments launched at a 45° angle. Smaller fragments have reduced throw due to wind resistance and the throw of larger blocks and boulders is limited by their mass.

The furthest throws behind blast sites typically consist of small fragments of stemming material or loose collar rock that are launched at the blast hole angle and may disperse a further 10°. If a blast hole is significantly under-stemmed, collar rock can break out at a 45° angle and be thrown further distances, an occurrence known as "cratering". Due to the smaller size of fragments, steep launch angles and lower velocities on landing, rock thrown behind blast sites generally presents a lower risk of serious injury than rock thrown in front of the face.

9.2.2 Causes of Flyrock

Flyrock is the result of human error, typically when insufficient face burden (under-burdening) is not identified prior to firing. Flyrock can also occur from stemming ejections where one or more blast holes are loaded with an insufficient quantity of stemming material. If under-stemming is significant, cratering may occur where fragments are thrown from the hole collar at 45° angles. Flyrock can also occur from unidentified structural weakness in face rock where cavities, seams, wide joints or pockets of naturally fragmented rock compromise the confinement of explosives energy. Cavities in the rock mass can also result in bulk explosive pumped into blast holes filling voids and resulting in overcharging that may compromise the effectiveness of design confinement provisions.

9.2.3 Preventing Flyrock

Under-burdening is identified by laser face profiling and Boretrak surveys that measure the true burden between the face and front row blast holes, and hole depth and deviation. If survey results show true burden to be less than design burden, affected blast holes are loaded in a manner that prevents explosives being placed in under-burdened sections. Treatment methods include loading the under-burdened section with stemming material or placing a quantity of broken rock against the toe of the face. Where under-burdening is significant, affected holes may left uncharged. Laser face profiling and Boretrak survey is a standard procedure at Yarra Valley Quarries and is undertaken prior to every blast.

Structural weaknesses in blast faces cannot be detected with laser profiling and are identified by thorough visual inspection of blast faces by experienced shotfirers familiar with the characteristics of a quarry's rock. Driller's logs, where the behaviour and progress of the drill bit is recorded by the drill rig operator, can also identify potential weaknesses and inconsistencies in the rock mass. These records are reviewed by shotfirers as part of the design process for every blast. Procedures for identifying and treating under-confined blast holes are detailed in the quarry's Blast Management Plan.

Flyrock behind a blast is prevented by ensuring a sufficient quantity of stemming material is loaded above the explosives column in every blast hole. Stemming material must be quality stone aggregate at least 1/10th the blast hole diameter. 10-14mm aggregate is the optimum grade for 89mm blast holes and is used for all blasts at YVQ.

Cratering is prevented by ensuring the height of the stemming column is at least 20 x the blast hole diameter. For 89mm holes, a minimum stemming height of 1.8m is required. The standard 3.0m stemming height used at the quarry is sufficient to prevent cratering.

Techniques for identifying under-burdening, structural weakness and overcharging, accurate hole loading practices and treatment of under-confined holes have greatly reduced the number of flyrock events from quarries. The residual risk is mitigated by establishing wide clearance zones around blast sites to account for the possibility of human error.

9.2.4 Blast Clearance Zones

Terrock recommends minimum clearance distances that observe safety factors applied to maximum throw calculations. This approach is adopted at numerous mines and quarries around Australia and has proven effective for protecting people and property at blast times. The minimum safety factors to have been accepted by operators and industry regulators are;

- Safety Factor 2 – Quarry Plant and Equipment
- Safety Factor 4 – Quarry Personnel and Public areas

Under this approach, the minimum clearance distances for standard blasts at YVQ are:

Table 6 – Safety factor clearance distances, YVQ

	Front of Face	***Behind Blast***
Maximum Throw	**60m**	**40m**
S.F. 2 – Plant & Equipment	120m	80m
S.F. 4 – Quarry Personnel & Public	240m	160m

Radial clearance areas in front and behind blasts are combined to form the shape of the clearance zone (**Figure 8**). The clearance distances are strictly minimum and in practice, site personnel and members of the public are evacuated to more distant areas.

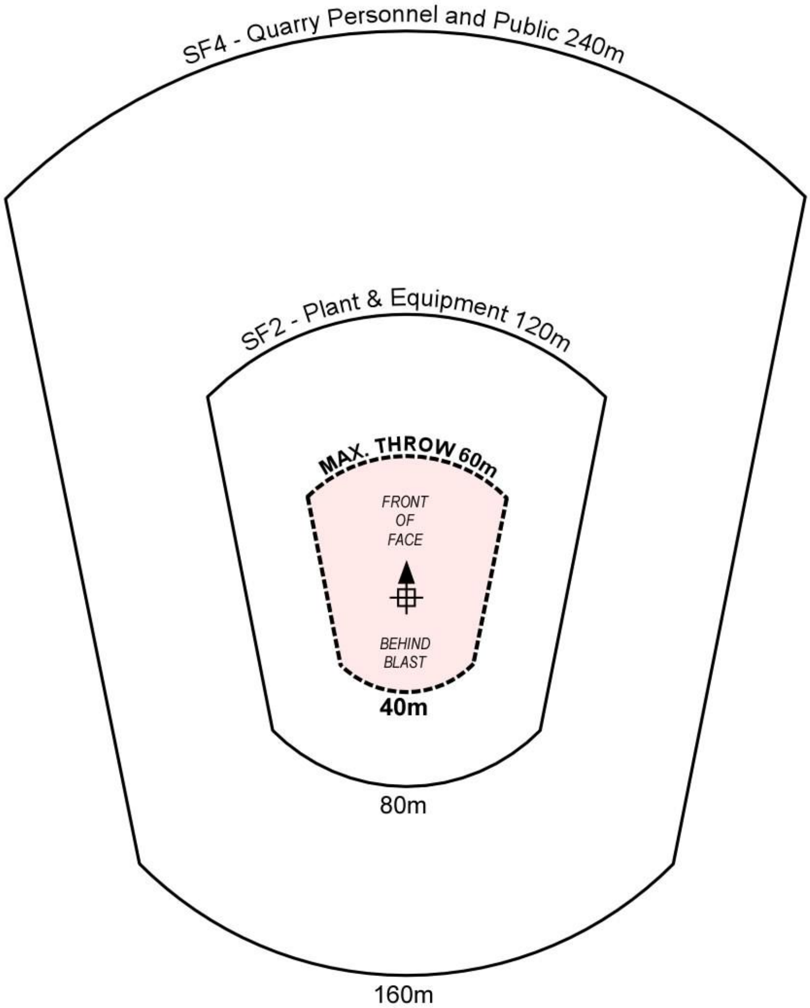

Figure 8 – Recommended minimum clearance zones (standard blasts), Yarra Valley Quarries

It is standard practice at YVQ and most other quarries to evacuate all site personnel from the pit and adjacent working areas to designated safe locations such as the quarry gate or weighbridge. As part of the clearance procedure the locations of all personnel is confirmed using the site's UHF channel, contractor management system, and communicating with area managers. A visual sweep of the pit area is also undertaken to ensure it is clear of people. Blast guards with UHF radios are positioned at access points to the pit and clearance area. No blast may be fired until the shotfirer receives confirmation that the clearance area remains free of people and it is safe to fire the blast. Details of the quarry's blast clearance and firing procedures are contained in the site's Blast Management Plan.

Providing adequate blast clearance is ultimately the responsibility of shotfirers and quarry managers. Clearance distances around individual blasts may be increased by the shotfirer at any time on consideration of a blast's design and location, modified hole loadings and previous observations. The adequacy of standard clearance provisions must be reviewed prior to every blast as part of a pre-blast risk assessment.

9.2.5 Blast Clearance outside the Quarry

Because blasts approaching extraction limits face inward toward the pit, the risk of flyrock thrown behind blast sites may need to be considered in limited areas outside the quarry. With a minimum distance of ~75m between the proposed extraction limit and neighbouring land areas (outside YVQ title properties) and maximum throw of 40m behind blasts, there are adequate buffers around the extension area to contain all rock fragments within the quarry.

For blasts less than 160m from public land areas, some clearance would need to be observed on small offsite areas for a limited number of blasts. Observing the overburden batters shown on development plans at the north and south extraction limit (where no blasting would occur) the maximum combined extent of clearance that could be needed outside the Work Authority is shown on the following site plan.

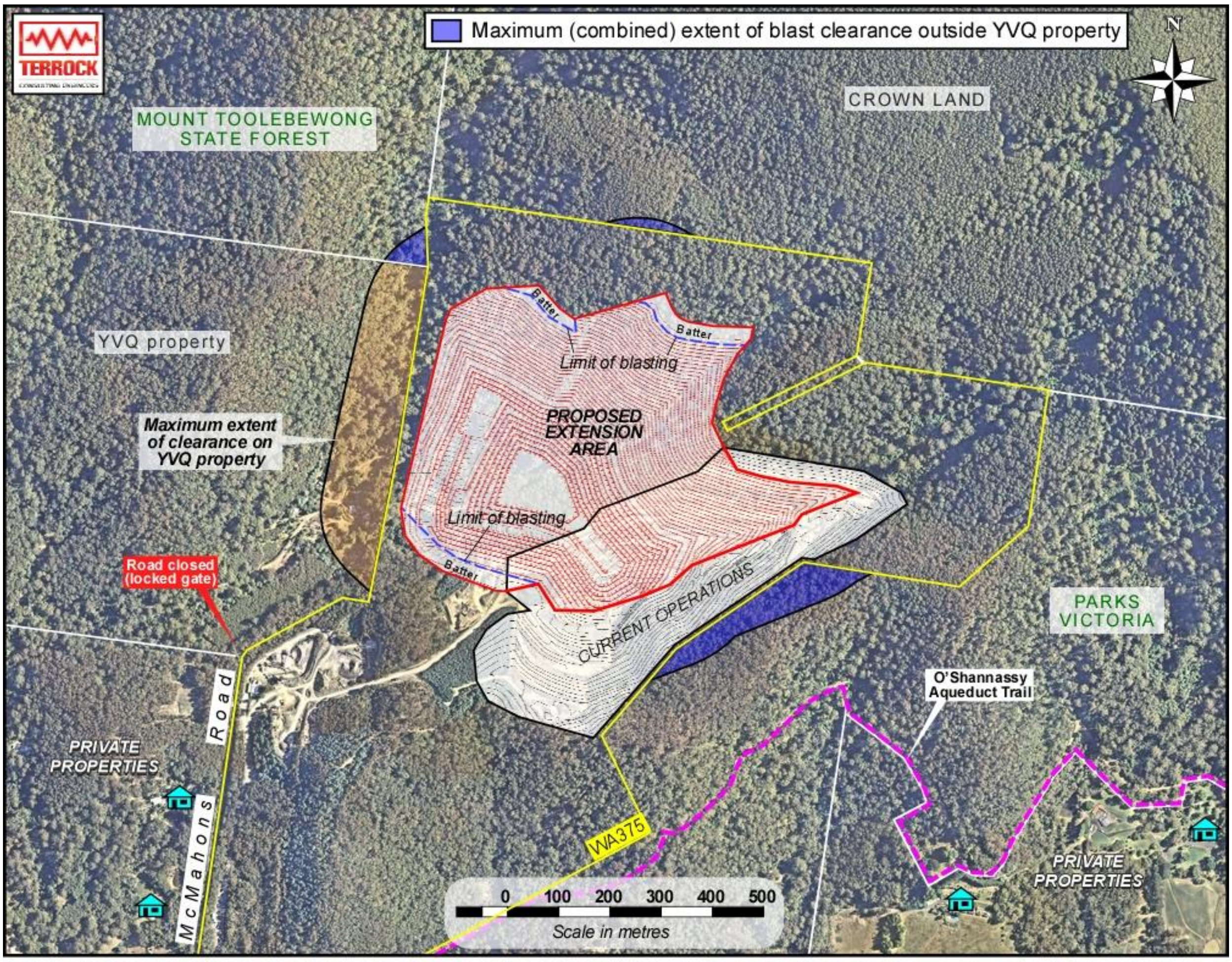

Figure 9 – Potential blast clearance areas (maximum combined extent) outside YVQ property

To inform flyrock risk in offsite areas, consideration is given to terrain behind blast sites where horizontal throw distances are reduced by benches and hill slope barriers. In addition, the steepness of the surrounding terrain and dense forest make most areas around the Work Authority boundary practically inaccessible to the public. Therefore, the likelihood of a person inadvertently entering the blast clearance zone at firing times is highly improbable.

The O'Shannassy Aqueduct Trail southeast of the quarry is the closest publicly accessible area on which people could be present at blast times. The nearest section of the trail is 325m from the southern extraction limit, a safe distance with a minimum flyrock safety factor of 8.1 for the closest potential blast.

If clearance is required within the offsite areas indicated, the clearance zone can be secured by positioning blast guards at the WA boundary (at a safe distance from the blast) with a view along the boundary line and adjacent land area. This may only be required for a small number of blasts located within 160m of the quarry boundary. In the highly unlikely event that a person approaches the boundary during the firing procedure, the guards would immediately notify the shotfirer and firing would be delayed until the person is confirmed to have left the area.

9.3 RISK OF BLAST-INDUCED DAMAGE TO BUILDINGS

Buildings can be damaged if exposed to very high levels of airblast and ground vibration. However, such damage is rare and the levels at which damage is known to occur to residential-type buildings are well above the human comfort limits that apply to blasting at Victorian quarries.

Australian Standard AS 2187.2 (2006) provides frequency-dependent criteria from overseas standards and guidelines (see **Appendix 4**) that can be used to establish PPV limits for preventing damage to buildings. From British Standard BS7385.2 (1993), at a typical blast frequency of around 10 Hz the recommended limit to prevent threshold/cosmetic damage is 18 mm/s above which there is "*an increasing possibility of damage*". The recommended limit to prevent major/structural damage is four times the cosmetic damage limit (i.e. 72mm/s). Australian and overseas research projects have shown PPV levels below 50-70mm/s to be non-damaging to various house types (ref. ACARP Study C9040).

The building element most sensitive to airblast are glass window panes. US military research has shown window breakage may occur when glass panes are exposed to levels above 140dBL (>200 Pa). Such levels represent an >18-fold increase of real air pressure from the ERR 115 dBL (11.2 Pa) limit.

Some people living near quarries believe blast vibration is the cause of cracks and other defects that appear in plasterboard, cornices and masonry over time. Cracking in houses is widespread around Victoria and is caused by common mechanisms including;

- Foundation soil movement, most commonly in areas where clay soils are subject to movement by seasonal expansion and shrinkage.
- Inadequate drainage provisions around a house that result in differential moisture levels and movement of foundation soils.
- Uplift of house footings or soil shrinkage from the roots of trees planted within 5-10m of houses.
- Poor house design, workmanship, inadequate compaction of foundation soils prior to construction and the use of low-quality or sub-standard construction materials.
- The normal settlement of house foundations, footings and structural members that may continue for many years after construction.
- Normal ageing and weathering processes where cracks and other defects develop over time due to loading from natural forces. Such defects are usually cosmetic, are within design tolerances for houses, and can be addressed by routine maintenance such as painting and filling every 10 or so years. More significant cracks (>5mm wide) may indicate underlying structural problems and should be assessed by an experienced engineer.

While the causal mechanisms of cracks and related defects in houses are well known to structural engineers and the construction industry, most quarry operators receive occasional informal damage claims from a few residents regardless of the PPV and airblast levels that occur. Such claims should be investigated by an experienced structural engineer on an as-needed basis.

9.4 FUTURE STATUS OF HOUSES ON YVQ PROPERTY

There is some uncertainty regarding the future status of the two houses under ownership of YVQ. If the houses are deemed to be sensitive sites (as per ERR definition) the standard blast vibration limits would apply at these locations. The controlling factors and critical distances for blasting risks and impacts identified in this assessment are;

> **Airblast** – 115 dBL limit is exceeded at locations less than 318m behind blasts.
>
> **Ground Vibration** – 5 mm/s PPV limit is exceeded at locations less than 266m from blasts.
>
> **Flyrock** – Blast clearance is required for areas less than 240m in front blasts and 160m behind blasts.

If the houses under YVQ ownership are 'sensitive' then they must be unoccupied when blasting occurs less than 318m of either house to comply with the ERR airblast limit. However, the house currently located within the proposed extraction area would be demolished as part of Stage 1 operations and it is likely this would be occur before blasting commences in the western area of the extension.

The house located on YVQ property west of the quarry is also subject to being unoccupied or demolished in the future. The precise timing of when this would be required and the occupancy status of the house over the next few decades cannot be known at this stage. Quarry management have confirmed that the houses will be unoccupied or demolished as needed to comply with regulatory criteria and Work Plan conditions.

9.5 RISK TO LOCAL AMENITY

The impact of blasting to the amenity of local surrounds is highly subjective and largely a matter of the sensitivities and attitudes of individuals. In general, most people exposed to perceptible blast effects within regulatory limits are tolerant of the occasional blast event and express little or no concern. However, a minority of people living near quarries express strong responses to perceptible blast vibration and may lodge formal complaints with quarry operators, regulatory authorities and local government representatives.

Concerns are typically raised by people who find blasting to be an annoyance, people who were startled due to a lack of blast notification, or those that believe blast vibration is the cause of normal cracks and other defects that develop in all houses over time. Some people object to blasting as part of broader objections to quarries, or from misconceptions about the risks of explosives. Due to various tolerances among individuals, blasting concerns and complaints are not a reliable indicator of high or excessive levels of blast vibration.

Anecdotally, concerns and complaints about blasting have increased over recent years driven by urban encroachment on quarry boundaries, increasing environmental awareness, sensationalist media reports and unsubstantiated claims made within social media groups.

While it is reported that no significant resident concerns about blasting at YVQ have emerged to date, it is possible that a small number of complaints could arise in the future because;

- some blast sites would be closer to houses north of the quarry (Moora Road) than recent operations, resulting in a modest increase of blast vibration levels during Stage 1 and 2.
- blast frequency would be increased from recent and historic operations.
- blasts at the upper-most levels of the northern area of the extension may result in airblast and noise levels that are somewhat above previous experience at houses south and southwest of the quarry due to minimal topographic shielding in this direction.

While the potential from adverse responses from individual residents cannot be discounted at any quarry, the overall impact of blasting on local amenity would remain low because;

- Ground vibration and airblast effects have short durations of 2-5 seconds per blast.
- Blast events would remain relatively infrequent (up to 2 blasts per month).
- Blasting is restricted to business hours and typically occurs around the middle of the day when people are less likely to be in their houses.
- Blasting effects cause no permanent change to the surrounding environment.
- Ground vibration and airblast levels at sensitive sites are predicted to be remain low, well below ERR limits for human comfort, and would be imperceptible at locations beyond 1 km from blast sites
- Recent and historic blasting at YVQ has not been a source of complaint, suggesting the impacts to amenity are low due to well controlled blasting practices, site topography, local geology and the attitudes of local residents.

Potential future community concerns can be alleviated by the quarry operator through existing formal and informal community engagement activities such as providing residents with personal blast notifications and updates and information on quarry activities including the results of blast monitoring.

Quarries must also maintain a register of complaints recording details of the complainant's name and address, and the nature of the complaint. Concerns should be addressed by management in a timely manner. If a complaint is escalated such as a formal damage claim, experienced consultants can be engaged to provide independent advice.

9.6 EFFECT OF BLASTING ON NATIVE FAUNA AND DOMESTIC ANIMALS

Located in the Southern Fall bioregion, YVQ is largely surrounded by damp forest bushland reserves including Mount Toolebewong State Forest to the northwest. The minimum buffer between the proposed extraction/blasting limit and the boundaries of reserves to the north is approximately 100m, and a minimum 75m to the aqueduct trail reserve to the southeast.

The effects of quarry blasting have low or negligible impacts to native wildlife in nearby habitat areas. This is indicated by the presence of native animals within active quarries, often very close to extraction and other work areas. Large mobs of kangaroos are resident within a quarry at Oaklands Junction, and Lysterfield Quarry that borders Churchill National Park. Koalas can be found browsing eucalypts within an active quarry in Dromana, the animals moving between the

Work Authority and neighbouring Arthurs Seat State Park. Wombats, echidnas and wallabies are regularly seen within an active quarry at Tynong North that borders Bunyip State Park. Snakes, goannas and other lizards are also a common sights at quarries with suitable habitat. Some operations attract waterbirds to dams and ponds at pit floors and raptors are a common sight at many quarries.

A survey of native flora and fauna species was recently conducted in forest habitat within an active work authority bordering Mount Samaria State Park. Numerous resident and transient fauna species were observed or inferred, including threatened species. The forest habitat area was found to be in good condition and there is no indication that nearby blasting or other quarry activities have an adverse impact to the habitat and the occurrence of species.

While there are no known formal studies into the effects of quarry-scale blasting on native fauna, the ongoing presence of native animals within active quarries and adjacent areas indicates that blasting is not a deterrence for habitation. Blasting is likely to cause a brief disturbance to animals located very close to blast sites at firing times, the same response as animals exposed to any sudden loud noise. The behaviour of birds close to blast sites is often observed with a typical response of taking flight before settling or returning to the area shortly after when the perceived threat has gone. However, quarry blasting occurs infrequently (once or twice per month) and the effects are limited to a few seconds per blast. It is also reasoned that animals have evolved to tolerate high levels and long durations of noise and overpressure during thunderstorms, and the impact of airblast to animals close to a blast site can be likened to that from a single thunderclap.

There is no evidence that blasting the proposed YVQ extension would be detrimental to the health and wellbeing of native species or their habitat, and it is reasonably concluded that current and proposed future blasting operations would have a negligible impact to wildlife in adjacent bushland areas.

The effects of blasting also have no known impact to domestic animals including livestock. The behaviour of horses and cattle close to blast sites is regularly observed, and the typical response of animals within 200m of a blast is to trot or walk a short distance away from the source of the disturbance before resuming grazing when the perceived threat has passed. The closest paddocks to YVQ are more than 700m from the proposed extraction area and blasting presents no risk of harm or disturbance to livestock on distant properties.

10 BLAST MANAGEMENT

10.1 Blast Management Plan

The control measures and onsite procedures required to mitigate blasting risks and impacts can be found in the quarry's Blast Management Plan (BMP) that accompanies the operation's approved Work Plan. A BMP details the procedures and controls that must be observed for all blasting to ensure blasts are well controlled, compliance with standards and thresholds set out in regulations and guidelines is achieved, and a high degree of safety is maintained for site personnel and the public at all times. Details within BMPs include (but are not limited to);

- Roles and responsibilities of all personnel involved with blasting operations.
- Details of relevant regulations and prescribed limits/conditions for blasting.
- Considerations that inform blast design, including the locations of sensitive sites and structures.

- Blast site access and security.
- Site communications systems and protocols.
- Blast hole loading procedures, including treatment methods for under-confined holes and weak rock structure.
- Details of Risk Assessment procedures and other documentation to be produced for every blast.
- Blast clearance requirements, and clearance and firing procedures.
- Emergency contacts and emergency assembly areas.
- Misfire procedures.
- Blast monitoring and reporting requirements.
- Blast notification requirements and details of nearby residents.

BMPs are working documents subject to periodic review and revision to reflect changes to blasting requirements and procedures over time. The findings of this assessment can be used to guide further development of the Launching Place Quarry BMP and operational procedures for blasting within the proposed extension.

10.2 Blast Monitoring

Blast monitoring requirements at quarries are largely driven by community sentiment with routine monitoring typically required at quarries that receive regular complaints. Blast vibration measurements at YVQ are currently obtained at a single location near the southwest corner of the Work Authority, the recorded levels reflecting those that occur at the closest houses on McMahons Road and Parrot Road. This monitoring location is appropriate for assessing impacts and compliance with ERR limits at the closest sensitive sites and should continue to be used for every blast.

If the extension gains regulatory approval, some additional monitoring is recommended at or near the closest sensitive sites on Moora Road to the north during early-stage operations to confirm the results of this assessment and help address resident concerns that could arise in the future. If a blast complaint from a more distant resident is made at some stage it is recommended that monitoring is undertaken at or near the receptor location for a few blasts to demonstrate compliance with ERR limits. If a complaint is escalated or becomes persistent, it may be in the operator’s best interest to undertake monitoring at the complainant’s location for every blast.

11 CONCLUSIONS

This assessment demonstrates that blasting can be conducted within the proposed extension area of Yarra Valley Quarries (WA375) with a high degree of safety, in compliance with prescribed regulatory criteria including ERR limits, and with low or negligible impacts to local amenity and the surrounding environment.

Ground vibration and airblast levels from the quarry would remain relatively low due to the scale of blasting proposed, wide separation distances, and local geology and topography of the surrounding area. From extrapolation of the quarry’s monitoring data, the maximum ground vibration level at the nearest sensitive site (house) is conservatively predicted to be 1.17 mm/s. The maximum airblast level from the closest blast to the nearest sensitive site is predicted to be 105 dBL, though levels could be slightly higher for a limited number of upper-levels blasts at the northern side of the extension area. Airblast levels from most blasts would be substantially reduced from the levels indicated in this assessment due to topographic shielding. Maximum ground vibration and airblast levels at all sensitive sites are shown to be well below the ERR limits of 5mm/s and 115 dBL.

Blasting operations at the quarry to date have resulted in minimal impacts to amenity. This conclusion is supported by the consistently low blast vibration levels recorded near the closest houses and the absence of resident complaints that are common at most other quarries. Blasting impacts from future operations would remain low because the proposed extension area is not substantially closer to sensitive sites. However, there is potential for a limited number of complaints to emerge over the longer term due to a modest increase of ground vibration levels north of the quarry, a modest increase of airblast levels southwest of the quarry, and because blasting would be more frequent with up to two blasts per month.

The maximum throw of rock fragments under standard blast design is calculated to be 60m in front of blast faces and 40m behind blast sites. Due to the wide buffers between the proposed extraction limit and Work Authority boundary, all rock from blasting would be contained within the Work Authority or adjacent YVQ property. A standard, minimum blast clearance zone of 240m (front of blasts) and 160m (behind blasts) is appropriate and workable for the scale of blasting proposed. Clearance areas for the vast majority of blasts would be entirely within the Work Authority. Depending on the requirement for blasting near the extraction limit, a small section of the clearance zone may extend beyond the quarry boundary to adjacent reserves for a few blasts. The areas indicated are effectively inaccessible to the public with dense forest and steep, rugged terrain. The small, offsite areas that may require clearance can be secured by a blast guard positioned onsite with a clear view of the boundary area and direct radio contact with the shotfirer.

Proposed blasting would result in negligible impacts to native fauna species in nearby forest habitat. Aside from a potential brief disturbance to animals located very close to a blast at firing time, ground vibration and airblast is not known to cause harm to the health and wellbeing of native animals or their habitat.

Further details of the quarry's site procedures and risk controls to ensure all blasting is conducted with a high degree of safety and low impacts to amenity and the environment can be found in the Yarra Valley Quarries Blast Management Plan.

James W Richards
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Terrock Pty Ltd

23 May 2024

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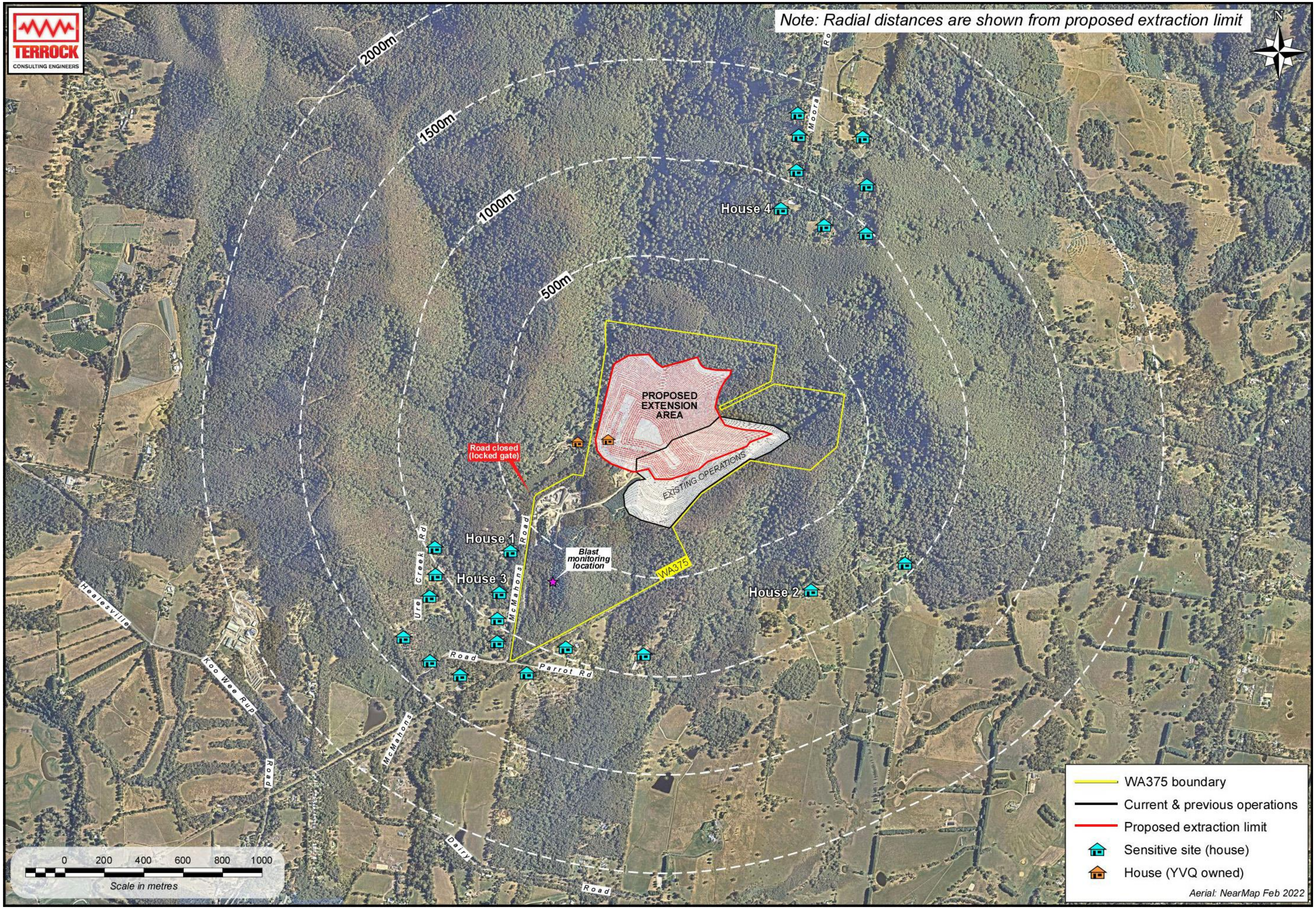
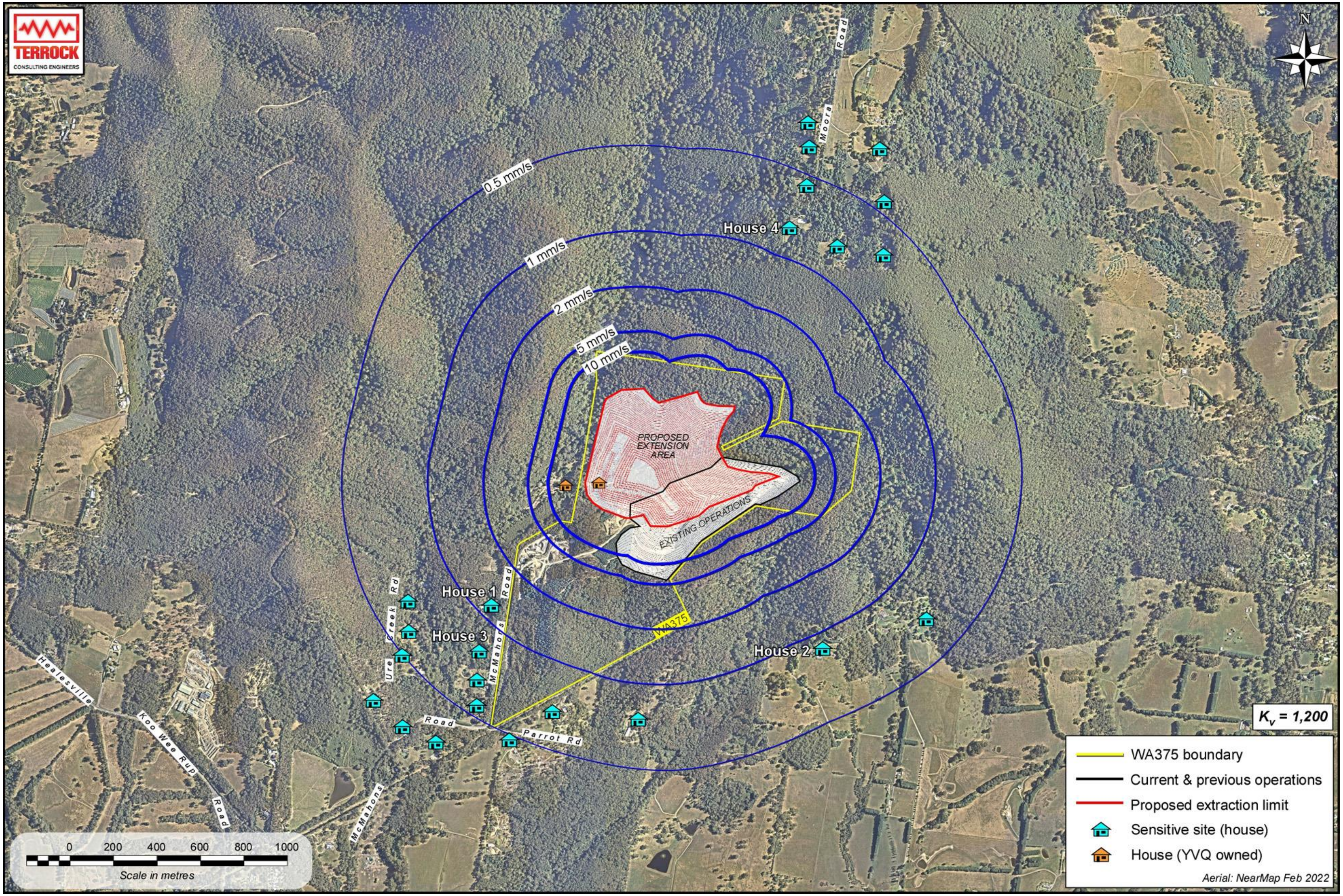
APPENDICES


Note: Radial distances are shown from proposed extraction limit
TERROCK
CONSULTING ENGINEERS
2000m
1500m
1000m
500m
PROPOSED EXTENSION AREA
EXISTING OPERATIONS
Road closed (locked gate)
Blast monitoring location
WA375
House 1
House 2
House 3
House 4
Moore Rd
McMahons Road
Ure Creek Rd
Parrot Rd
Healesville Koo Wee Rup Road
McMahons
Dairy Road
0 200 400 600 800 1000
Scale in metres
WA375 boundary
Current & previous operations
Proposed extraction limit
Sensitive site (house)
House (YVQ owned)
Aerial: NearMap Feb 2022


TERROCK
CONSULTING ENGINEERS
N
Moora Road
0.5 mm/s
1 mm/s
2 mm/s
5 mm/s
10 mm/s
House 4
PROPOSED
EXTENSION
AREA
EXISTING OPERATIONS
House 1
House 3
House 2
WA375
Ure Creek Rd
McMahons Road
Healesville
Koo Wee Rup
Road
Parrot Rd
McMahons
0 200 400 600 800 1000
Scale in metres
K_v = 1,200
WA375 boundary
Current & previous operations
Proposed extraction limit
Sensitive site (house)
House (YVQ owned)
Aerial: NearMap Feb 2022

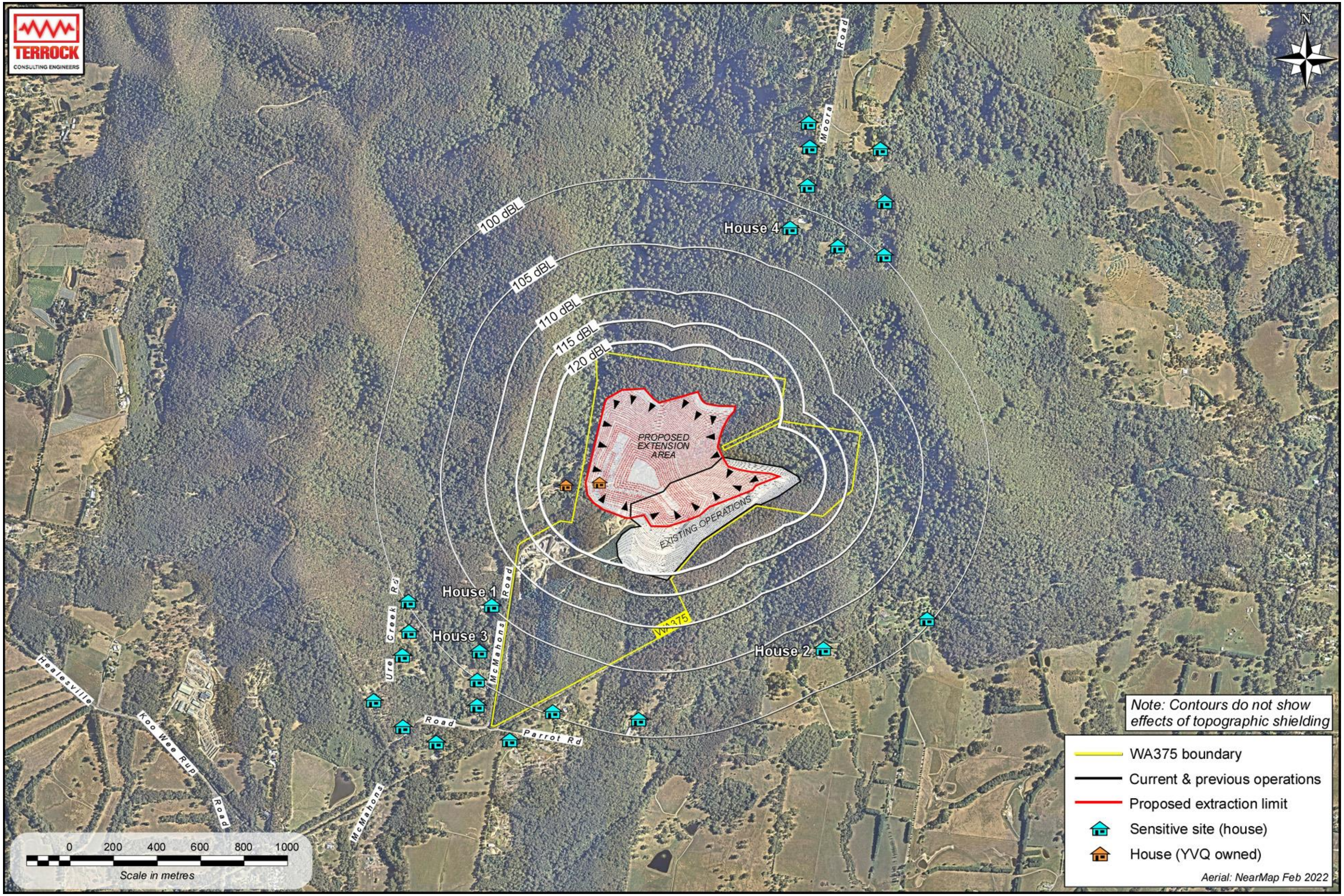

TERROCK
CONSULTING ENGINEERS
100 dBL
105 dBL
110 dBL
115 dBL
120 dBL
PROPOSED EXTENSION AREA
EXISTING OPERATIONS
WA375
House 1
House 2
House 3
House 4
Moore Road
McMahons Road
Ure Creek Rd
Healesville Koo Wee Rup Road
Parrot Rd
Road
McMahons
Note: Contours do not show effects of topographic shielding
WA375 boundary
Current & previous operations
Proposed extraction limit
Sensitive site (house)
House (YVQ owned)
Aerial: NearMap Feb 2022
0 200 400 600 800 1000
Scale in metres
N

TABLE J4.4.2.1

TRANSIENT VIBRATION GUIDE VALUES FOR COSMETIC DAMAGE (BS 7385-2)

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures. Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structure. Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

NOTES:

1 Values referred to are at the base of the building.

2 For line 2, at frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded.

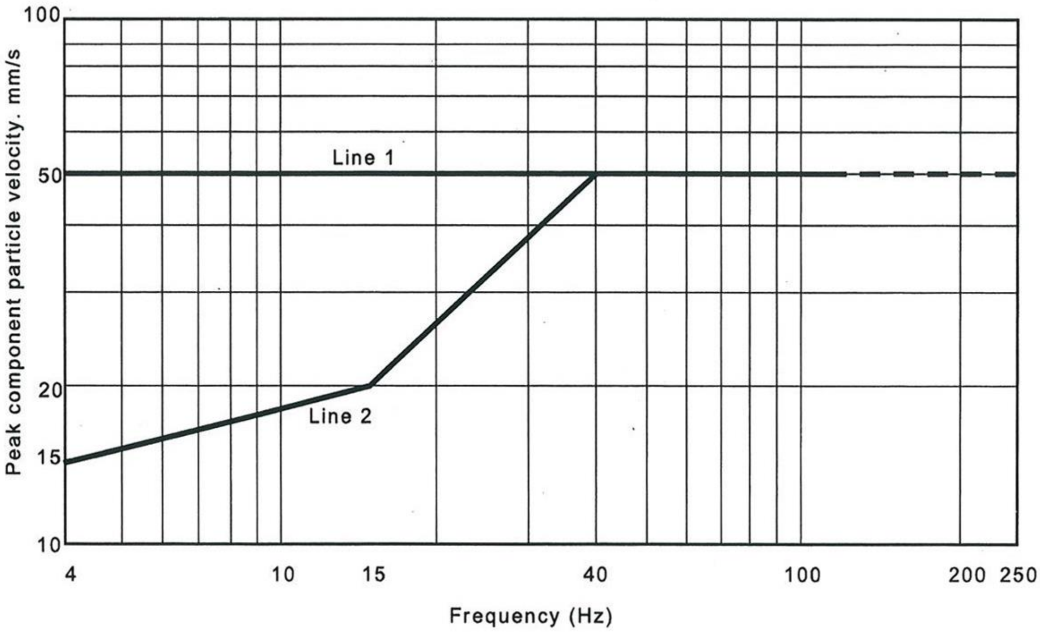


FIGURE J4.4.2.1 TRANSIENT VIBRATION GUIDE VALUES FOR COSMETIC DAMAGE (BS 7385-2)

TABLE J4.4.2.2

BS 7385-1:1990—DAMAGE CLASSIFICATION

Damage classification	Description
Cosmetic	The formation of hairline cracks on drywall surfaces or the growth of existing cracks in plaster or drywall surfaces; in addition, the formation of hairline cracks in the mortar joints of brick/concrete block construction
Minor	The formation of cracks or loosening and falling of plaster or drywall surfaces, or cracks through bricks/concrete blocks
Major	Damage to structural elements of the building, cracks in support columns, loosening of joints, splaying of masonry cracks etc.

The frequency dependent alternative blasting criteria for low-rise residential buildings given in (USBM) RI 8507 are shown in Figure J4.4.2.2 and Table J4.4.2.3.

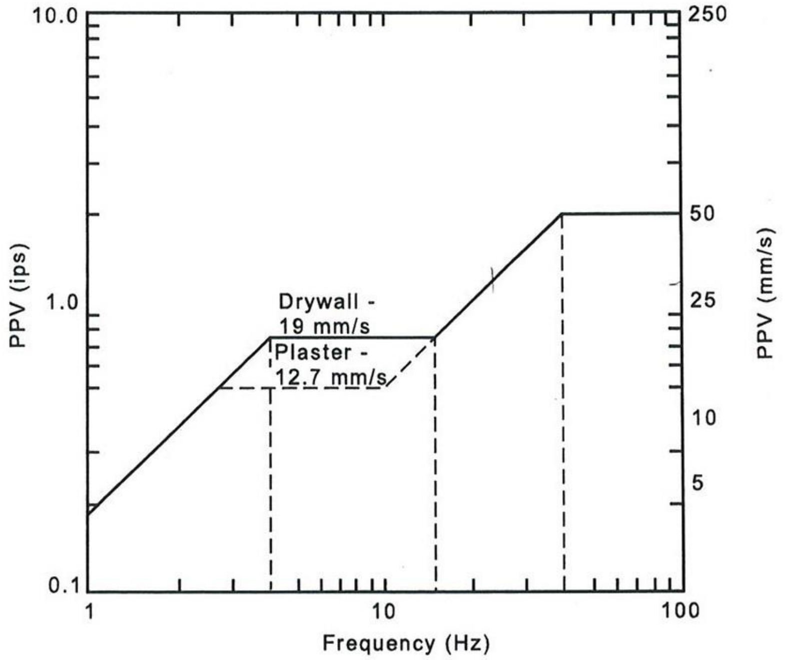


FIGURE J4.4.2.2 USBM 'SAFE' BLASTING VIBRATION LEVEL CRITERIA

USBM damage classifications are shown in Table J4.4.2.3.

TABLE J5.4(B)

RECOMMENDED AIRBLAST LIMITS FOR DAMAGE CONTROL (see Note)

Category	Type of blasting operations	Peak sound pressure level (dBL)
Damage control limits		
Structures that include masonry, plaster and plasterboard in their construction and also unoccupied structures of reinforced concrete or steel construction	All blasting	133 dBL maximum unless agreement is reached with the owner that a higher limit may apply
Service structures, such as pipelines, powerlines and cables located above the ground	All blasting	Limit to be determined by structural design methodology

NOTE: Tables J5.4(A) and J5.4(B) are intended to be informative and do not override statutory requirements, particularly with respect to human comfort limits set by various authorities. They should be read in conjunction with any such statutory requirements and with regard to their respective jurisdictions.