

Report to

Karuah East Quarry Pty Limited



**Karuah Pit Consolidation Project:
Blast Impact Assessment**

**Karuah East Quarry
MP09_0175 MOD 11**

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1. INTRODUCTION

Karuah East Quarry Pty Limited (KEQPL) owns and operates the Karuah East Quarry (KEQ), and together with Hunter Quarries Pty Ltd (HQPL) who owns and operates the Karuah Hard Rock Quarry (KHRQ), forms the Karuah Quarry Complex located approximately 5 kilometres (km) northeast of Karuah at Blue Rock Close / Andersite Road, Karuah.

The KEQ and KHRQ sites produce a high quality andesite resource which is supplied to construction, infrastructure, and other development projects across Greater Newcastle, the Hunter Valley and Mid-North Coast regions.

KEQPL and HQPL, who are affiliated companies, are proposing to modify the State Significant Development (SSD) approvals for the Karuah East Quarry (Project Approval MP09_0175) and the Hard Rock Quarry (DA 265-10-2004) under the provisions of Section 4.55(2) of the Environmental Planning and Assessment Act 1979 (EP&A Act). The applications are being referred to as the Karuah Pit Consolidation Project and will consist of two concurrent modification applications to the SSD approval for each quarry, that will be known as KEQ MOD 11 and KHRQ MOD 2.

HQPL has recently acquired Lot 11 DP 1024564 (Lot 11), enabling HQPL and KEQPL to control all landholdings within the Karuah Quarry Complex. This acquisition now allows HQPL and KEQPL to readily extract previously sterilised resource from the remnant dividing highwall between the KEQ and KHRQ extraction pits forming a Consolidated Extraction Area (CEA). The purpose of the modification is to primarily enable the extraction of the previously sterilised andesite resource from the remnant dividing highwall as well as within other cleared areas from the KEQ and KHRQ sites in a coordinated approach.

Heilig & Partners Pty Ltd has been engaged by KEQPL to prepare a Blast Impact Assessment (BIA) for the Karuah Pit Consolidation Project, with this report considering the KEQ (MOD 11) component of the overall project, which should be read in conjunction with the concurrent KHRQ (MOD 2) BIA.

2. OBJECTIVES OF BLAST IMPACT ASSESSMENT

This BIA is prepared to provide a framework for the procedures to maintain best practice controls to manage potential environmental impacts during the drilling and blasting activities associated with the extraction of material from KEQ, inclusive of the proposed MOD 11 development.

The objective of this document describes how KEQPL will manage blasting activities and the related environmental impacts such as ground vibration, airblast overpressure and flyrock. It sets out the anticipated performance requirements and procedures to ensure that the possible environmental impacts associated with blasting activities are adequately identified and controlled for the project.

This document is applicable to all the drilling and blasting activities during the establishment phase of the proposal, as well as the ongoing production phases of the KEQ.

This document has been prepared to address the Assessment Requirements for MOD 11 issued by the NSW Department of Planning, Housing & Infrastructure dated 1 October 2025 which requires the Modification Application to consider blasting.

This BIA will also be used to update site's established Blast Management Plan (BMP) (version 4A, dated March 2025) required under the Project Approval (MP09_0175) and Environment Protection Licence (EPL 20611), as well as the site's Blast Control Plan developed to the satisfaction of the NSW Resources Regulator.

2.1. Performance Criteria

The environmental controls on blasting activity required as part of the license conditions will address:

- Minimising the impact of vibration and airblast overpressure associated with blasting activities to acceptable amenity levels.

- Preventing damage to adjacent public utilities, structures and other buildings resulting from vibration and air overpressure effects.

In addition to the above-mentioned environmental objectives and performance criteria, all drilling and blasting activities will necessarily meet the following objectives:

- Control of flyrock and safety of all personnel.
- Compliance with the requirements of the quarry and Explosives Inspectorates.
- Fragmentation and diggability requirements commensurate with excavating equipment.

The current Project Approval (MP09 0175) and EPL (EPL 20611) impose blasting criteria that is reproduced in Table 1.

Table 1 – Environmental criteria relevant to blasting activities, as per MP09 09175 and EPL20611

	Ground vibration and air overpressure measured at a sensitive place	
	Monday to Friday 9am to 4pm	Other times and public holidays
Ground Vibration (peak particle velocity)	Exceed 5 mm/s for more than 5% of the total number blasts during the reporting period No blasting > 10mm/s	No blasting to occur, unless special approvals sought.
Airblast overpressure level (dB linear peak)	Exceed 115 dBL for more than 5% of the total number of blasts during the reporting period No blasting > 120dBL	No blasting to occur, unless special approvals sought.

The permissible limits given in Table 1 are generally consistent with those of other recently reviewed quarry approval and other license conditions. The noted variations however relate to the percentile compliance conditions of 95% of blasts over a 12-month period.

These Table 1 criteria are protective of personal amenity and quality of life for existing residents around the KEQ as well as necessarily ensuring that the integrity of infrastructure, including houses, sheds, water tanks, pools, and in-ground services, are not impacted upon by the quarry blasting.

There is no indication that more restrictive criteria than those given in Table 1 are required to be applied to the current or proposed MOD 11 activities at the KEQ.

3. KARUAH EAST QUARRY DESCRIPTION

The operation of KEQ (and KHRQ) contribute towards satisfying significant and ongoing market demand associated with various State Significant Infrastructure (SSI) projects in the Newcastle, Hunter Valley and Mid-North Coast regions. These projects are critical to deliver improved connectivity of the Mid North Coast to Newcastle, the Hunter Valley and Sydney and include the Newcastle Inner-city Bypass (SSI-6888), Pacific Highway widening at Hexham Straight, Singleton Bypass, and the M1 Pacific Motorway extension to Raymond Terrace (SSI-7319).

KEQPL supplies high quality quarry products to a large and rapidly emerging customer base that includes Transport for NSW, a number of local Councils, the Port of Newcastle, Ausgrid, Newcastle Airport, Tier 1 infrastructure providers as well as the general construction, development and infrastructure industries within greater Newcastle, Hunter Valley and the Mid North Coast Regions. KEQPL also supplies and supports downstream businesses, including the Tea Gardens Hunter Ready mix Concrete Plant, which in turn contributes to the local construction industry.

Project Approval (PA) MP09_0175 was granted for the KEQ on 17 June 2014 under the provisions of Section 75J of the EP&A Act 1979. Key features of the PA MP09_0175 are summarised as follows:

- Quarrying operation is permitted on the site until 31 December 2034;
- Establishment and use of quarry plant and associated infrastructure;
- The extraction (excluding overburden), processing, stockpiling and transport of quarry products is limited to 1.5 million tonnes (Mt) in any calendar year;
- Roadworks to secure access to the site including upgrade and extension of Blue Rock Close, realignment of the Andersite Road and Blue Rock Close intersection and adjust road markings at Branch Lane and Andersite Road intersection;
- A total permitted disturbance area of 40.18ha;
- Establishment of a land based biodiversity offset on Part Lot 13 DP 1024564, Lot 14 DP 1024564, Lot 5 DP 838128 and part Lot 201 DP 1042537;
- Conditions apply to manage / mitigate potential impacts associated with a range of environmental conditions including noise; blasting; air quality; soil and water; transport; biodiversity; heritage; emergency and hazards management and waste; and
- Progressive rehabilitation of the subject site.
- Approved operating hours for the quarry activities are as follows:
 - o 7.00am to 9.00pm, Monday to Friday.
 - o 7.00am to 10.00pm, Monday to Friday, on 50 calendar days per year.
 - o 7.00am to 6.00pm, Saturday.
 - o No drilling 6.00pm to 10.00pm Monday to Friday or 1.00pm to 6.00pm Saturday.
 - o No quarrying operations on Sundays or Public Holidays.
- Approved operating hours for product loading and dispatch are as follows:
 - o 5.00am to 9.00pm, Monday to Friday.
 - o 5.00am to 10.00pm, Monday to Friday, on 50 calendar days per year.
 - o 6.00am to 6.00pm, Saturday.
 - o No product loading and dispatch on Sundays or Public Holidays.
- Approved blasting hours are as follows:
 - o 9.00am to 4.00pm, Monday to Friday.
 - o No blasting Saturdays, Sunday and Public Holidays.
- Up to two (2) blasts can be carried out per week.

4. PROPOSED MOD 11 DEVELOPMENT

The proposal seeks to enable the extraction of previously sterilised andesite resource from the remnant dividing highwall and all disturbed areas at the KEQ (MOD 11 to MP 09_0175) and KHRQ (MOD 2 to DA 265-10-2004) in a coordinated approach. The proposal does not seek to increase the approved annual throughputs at either quarry (1.5 Mtpa at KEQ and 500,000 tpa at KHRQ). There will be no intensification of annual quarry operations.

Details of the proposed KEQ MOD 11 development are provided below, and the proposed KEQ site plan is provided in **Appendix 1**:

- Concurrently modify both the KEQ and KHRQ consents to extract the known resource contained within already disturbed areas of Lot 12, Lot 13 and Lot 11 including the

dividing highwall, within the currently approved excavation depths of RL45 at KEQ and RL65 at KHRQ.

- Formalise a total life of quarry extraction at KEQ of 28.33Mt (a nominal reduction from the 29 million tonnes anticipated in the original KEQ Project Approval documentation).
- Minor extension and overlap of extraction boundary of both KEQ (into Lot 11) and KHRQ (into Lot 12) extraction areas to holistically encompass the highwall structure, inclusive of appropriate safety offsets.
- Extension of the KEQ extraction area to the west (highwall removal) and to the east.
- Material sourced from the overlapping area of the CEA will be transported by internal haul road to either the KEQ or KHRQ for processing, stockpiling, sale and transport to market within currently approved throughput rates.
- A minor extension of 4,690m² to the KEQ disturbance area. This area is located at the north-eastern boundary of the approved KEQ and is highly degraded and comprised entirely of exotic grasses and disturbed vegetation that has been historically cleared and managed to support a now redundant powerline corridor (infrastructure has been previously removed). This area is proposed to form a minor extension of the approved disturbance area and is incorporated into the consolidated extraction area. With the inclusion of this area, the total site disturbance area of KEQ will increase nominally from 40.18 Ha to approximately 40.65 Ha.
- Changes to approved blasting activity as follows:
 - o Reduction in blasting frequency to limit the number of blasts to a maximum of two (2) blasts per week in total between KEQ and KHRQ.
 - o Approved blasting hours at KEQ are proposed to be extended by one (1) hour to occur between the hours of 9am and 5pm (Monday to Friday) to provide improved flexibility during blasting of the dividing highwall and align with proposed arrangements at KHRQ.
- Revised final landform resulting in a free-draining landscape of the current extraction area, reduced geotechnical risks over the long-term and a landform with greater consistency with the existing surrounding environment.
- Reviewing and modernising established Management Plans as required.
- No change is necessary to the Project Approval as it relates to annual extraction, processing and transport rates (capped at 1.5 Mtpa).

The following coordinated extraction sequence between the KEQ and the KHRQ will be generally undertaken to complete the Karuah Pit Consolidation Project (inclusive of remnant highwall removal):

- Stage 1: Extract the current top benches of the remnant highwall (RL135 m) down to RL90 m (currently lowest KEQ bench at the time of writing (February 2025)), forming a single extraction level/area on Lot 12. This approach is needed to safely remove peak of the dividing highwall and make the extraction area level with the current KEQ extraction area.
- Stage 2: Extract Lot 12 from RL90 m (currently lowest KEQ bench at the time of writing (February 2025)), down to RL65 m in line with KHRQ pit floor and KEQ boot-bin levels, forming a single extraction level/area over the entire Consolidated Extraction Area.
- Stage 3: Extract final benches at KEQ (Lots 12 & 13) from RL65 m down to RL45 m. The KHRQ pit floor is to remain at RL65 m.

5. KARUAH EAST QUARRY LOCATION

The KEQ extents are bounded by bushland to the north and east, the KHRQ to the west (with bushland further west), and the Pacific Highway to the south. Bushland dominates the areas surrounding the quarry with the closest residential properties being approximately 650 metres from the south-western bounds of the KEQ pit, and approximately 660 metres to the east.

In general, the area is very low density with not more than 7 properties within a 1000-metre radius around the pit footprint. A separation distance of approximately 620 metres exists between the existing KEQ pit and Pacific Highway (and approximately 570 metres between the Pacific Highway and the edge of the proposed extended KEQ pit) which links Brisbane and Sydney. The location of the Karuah East Quarry pit and the adjacent sensitive receivers are shown in Figure 1 and Table 2 shows the title details of each identified receiver.



Figure 1 – Plan of the area (Google Earth) showing the maximum extents of the Karuah East Quarry Pit area as a green shaded zone. Adjacent rural residential properties are also shown.

Table 2 – Nearby sensitive receiver ID and property ID

Receiver ID	Property ID
A	Lot 100 DP785172
B	Lot 3 DP785172
C	Lot 2 DP785172
D	Lot 22 DP1024341
E	Lot 250 DP1092111
F	Lot 50 DP1036893
G	Lot 1 DP1032636
H	Lot 10 DP1032636
I	Lot 11 DP1032636
J	Lot 13 DP1032636
K	Lot 12 DP1032636

The potential effect of blasting is assessed based on the assumption that blast activities are undertaken at the perimeter of the proposed extraction footprint in order to test conservative minimum separation distances to sensitive receivers. This necessarily produces an assessment skewed to the conservative evaluation; however, it ensures that the assessment remains valid should there be any changes to the overall quarry and pit benching design.

6. EXISTING CONDITIONS

The existing conditions in the area of the KEQ are typical of a semi-rural area with minimal sources of external ground vibration, beyond heavy vehicles.

Any instances of perceptible vibration would result only from a combination of heavy vehicle movement coupled with uneven road pavement surfaces. Only under these combined conditions would measurable vibration occur. Even then, it would however be limited to areas immediately around the road and not measurable at the property given the setback distance of the property to the road. A review of the Pacific Highway shows the surface pavement is generally in good condition; however, is frequently used by heavy transport.

Although no long-term background measurements of vibration were collected as part of this BIA, some short interval vibration measurements at other locations where there is heavy transport showed levels of vibration less than 0.1mm/s at distances of within 10 metres from the road. These distances are significantly less than the minimum distance between the road and the dwelling.

There are no identified locations around the KEQ where elevated vibration levels already occur.

7. ADJACENT PROPERTIES

A review of the neighbouring properties to the extended KEQ extraction area, identifies a small number of various types of dwellings and sheds within approximately 650 to 1500 metres.

Most of these properties are timber or brick-veneer construction style dwellings, with no instances of blast induced vibration damages being reported to KEQPL due to operations to-date.

It should be noted that the setback of properties along Mill Hill Close make it difficult to identify the type and age of the property with accuracy, but it would be assumed that these fit with the described above.

There is no indication that they would require a vibration criterion that is more stringent than that commonly applied for standard residential properties.

It is noted that around the planned blast area:

- The nearest residential property is located to the south and is approximately 650 metres from the closest location of possible blasting in the quarry.
- Towards the south-west there are several properties along Mill Hill Close and Tarean Road with the closest being approximately 650 metres from the closest point of blasting.
- There are no residential properties directly to the west of the KEQ.
- East of the proposed KEQ extended area of extraction are two properties along Halloran Road with the closest being further than 660 metres from blasting.
- The property density in the area is low with less than 10 individual buildings/sheds within 1500 metres of the consolidated quarry crest.

Examples of the building types adjacent to the proposed quarry are shown in Figure 2. Infrastructure is generalised according to residential and industrial sheds. No other significant infrastructure has been identified in the general vicinity of the quarry. Building specific vibration criteria is not proposed nor

considered relevant. There are no buildings that would preclude the generic building categories and associated vibration criterion given in Table 1.



827 Tarean Road, Karuah

2 Halloran Road, North Arm Cove

Figure 2 – Typical example of properties that exist around the KEQ along Halloran Road, North Arm Cove (east of site) and Tarean Road, Karuah (south of site).

8. OTHER PROPOSED QUARRY OPERATIONS

The proposed Karuah South Quarry (KSQ) (State Significant Development (SSD) SSD-8795) application at Lot 11 DP 1024564 is located to the west of KEQ and the south of the existing KHRQ extraction area. The KSQ proposal seeks to extract the remaining resource south (of KHRQ) and west (of KEQ) of the existing quarry's limit of extraction. The quarry is proposed to be a conventional drill and blast operation with rock collected and processed onsite. Processed product is proposed to be stockpiled onsite with a loader used to load trucks for transport off-site when required. The proposed hours of operation are 5:00 am to 6:00 pm Monday to Friday and 5:00 am to 1:00 pm Saturday with only product loading and transport activity to occur between 5:00 am and 7:00 am. The proposed annual production limit is 600,000 tonnes.

Following acquisition of Lot 11 DP 1024564, KEQPL (and affiliated companies) is also the proponent for the proposed KSQ. In relation to the consideration of cumulative impacts, the following is noted:

- If approved, KSQ will not commence operations until after operations at KHRQ have ceased;
- The applicant is currently reviewing the business case for the proposed KSQ; and
- Any future revision or amendment to the proposed KSQ project will be supported by an updated BIA that accounts for the proposed Karuah Pit Consolidation Project.

9. DRILLING AND BLASTING METHOD

Extraction within the KEQ will continue using a combination of drilling and blasting techniques, together with a small amount of free digging and hydraulic hammering where any oversize material is encountered, which is consistent with current operations. Some material may be removed using medium size excavators without any requirement for blasting.

Previous blasting on site has identified the required powder factor to achieve appropriate breakage and diggability as around 0.75 kg/m³ (Precision Drill & Blast, 2026). No information is available on the quantity of oversize that is likely; however, it is expected to be minimal, possibly around a few percent. It is also expected that the explosives supply and delivery will be sub-contracted to a specialised blasting supplier. The same level of quality assurance that has been applied to all previous aspects of the blasting processes will continue.

The scale of blasting will be controlled by the benching strategy for the site rather than a restricted scale of blasting as a requirement to comply with both vibration and air overpressure levels. The blast design is therefore based upon:

- A blasthole diameter of between 89 and 102mm, drilled using conventional and modern hydraulic drilling rig equipment.
- A nominal bench height up to 15 metres depending upon the geometry of the benches. Shorter bench heights may be initially required to establish the benching plan. Once established, any bench face exceeding 15 metres would be unlikely. The proposed pit geometry is based around 15 metre benches.
- A nominal blasthole pattern with a burden and spacing of around 2.5 and 2.8 metres respectively depending upon the competency of the rock mass (and the blasthole diameter).
- A single explosive charge per blasthole, independently sequenced to restrict the maximum explosive quantity per delay to a value permitting compliance at the nearest property.
- The powder factor is expected to vary to provide fragmentation and diggability commensurate with the excavation techniques with very limited use of hydraulic hammers. Advice from KEQPL's blasting contractor provides that the current power factor lies in the current region of 0.6 to 0.75 kg/m³ (Precision Drill & Blast, 2026).

Once the extension to the KEQ extraction area has been established, blasting is planned to continue with 15 metre bench heights. The shallower bench heights will only be used during the initial phase of establishing the bench faces.

The KEQ site plan (refer to Plate A) shows a bench height of 15 metres with multiple benches planned. Based upon a 15 metres bench height, the explosive weight will vary to around 100 kilograms per blasthole for an 89 mm diameter blasthole loaded with an emulsion explosive type explosive. Lesser explosive weights may be used during the development of the quarry in the initial stages until regular bench heights are established.

10. DRILLING AND BLASTING IMPACTS

The effects associated with blasting activities will be controlled to ensure safe working procedures for all personnel, safety of adjacent equipment and infrastructure (including houses and public utilities) and a minimum disturbance to persons located around the quarry area.

The environmental impacts from blasting will be controlled to the established performance criteria provided in Section 1 of this BIA.

As noted in Section 4, blasting hours are proposed to be extended to align with standard quarry hours between the hours of 9:00 am to 5:00 pm Monday to Friday, excluding public holidays. In the event that additional blasting is required beyond the proposed blasting hours, written approval from both the NSW EPA and the NSW Planning Secretary would be sought in the first instance.

As also noted in Section 4, blasting frequency will be cumulatively reduced from an approved three blasts per week (two blasts at KEQ and one blast at KHRQ) to a cumulative two blasts per week.

Blasting is typically undertaken during the middle of the day and only when fine weather conditions prevail. Blasting outside these hours will only be undertaken in unforeseen circumstances (e.g. safety issue with explosives) or the event a misfire or other emergency.

The tonnage yield per blasthole will vary according to the available quarry area, product forecast and blast design, including the bench height, drill pattern dimensions, and the number of blastholes. A

typical blast yields up to approximately 60,000 tonnes although blasts of more than 60,00 tonnes are completed from time to time.

10.1. Drill and Blast Vibration

Production blasting has been undertaken on site as part of the current KEQ. A site specific relationship has been developed between vibration level, distance and explosive quantity using measured vibration data from previous production blasting.

The primary factors known to influence the level of ground vibration from blasting include:

- The weight of explosive per delay;
- The distance between the blastholes and the point of measurement; and
- The local geological conditions and the influence of geology and topography on vibration attenuation.

Consistent with the recommendations of the Australian Standard¹, the most common form of the vibration equation to predict the amplitude of ground vibration from blasting at any distance from the blasthole and is given as:

$$PPV = K \left(\frac{d}{\sqrt{w}} \right)^{-\beta}$$

where d is the distance between the blastholes and the point of measurement;
w is the maximum instantaneous charge weight per delay;
K and β are site specific constants.

Based on the above equation, the expected level of ground vibration can be determined for a given distance and maximum charge weight.

A relationship between the level of vibration, the quantity of explosive and the distance from the blast has been derived vibration measurements from a regression of the vibration recorded from the existing blasting activities at the same site. An equation consistent with the format described above has been developed from these data. and used to estimate the level of ground vibration.

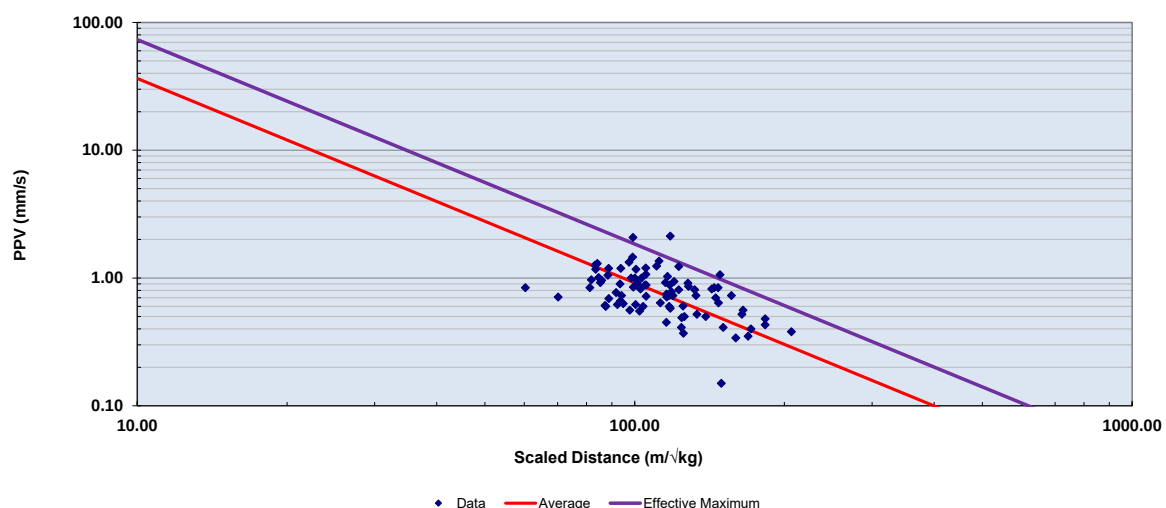


Figure 3: Regressed vibration data measured from the current blasting activities at the Karuah Hard Rock Quarry and the Karuah East Quarry

¹ AS2187.2-2006, "Explosives – Storage, transport and use Part 2: Use of explosives"

To account for the variability in explosive performance and ground characteristics, it is accepted industry practice to design blast patterns using an equation that predicts the 95-percentile level (i.e. a level which will exceed 95% of all measured values) and continually update and review practices according to the measured levels. If measured levels routinely exceed, or fall below, the predicted value, the equation is adjusted to reflect the different site conditions. The vibration relationship for the 95th percentile that has been regressed from the existing Karuah Quarry is as follows:

$$PPV = 2780 \left(\frac{d}{\sqrt{w}} \right)^{-1.60}$$

Figure 3 shows vibration level as a function of distance from the blasthole for varying quantities of explosive. Because of the sufficient separation distance between the proposed extraction areas of KEQ the nearest properties, the explosive quantities per blasthole will be generally consistent with that used at conventional medium to large scale quarrying operations.

Figure 4 shows the explosive quantities per blasthole ranging up to 130 kilograms. As a function of distance for compliance with a 5mm/s criterion. Explosive weights per blasthole will necessarily vary according to the blasthole depth with greater variation in explosive quantities expected during the initial stages of the quarry development phases until consistent bench heights have been established.

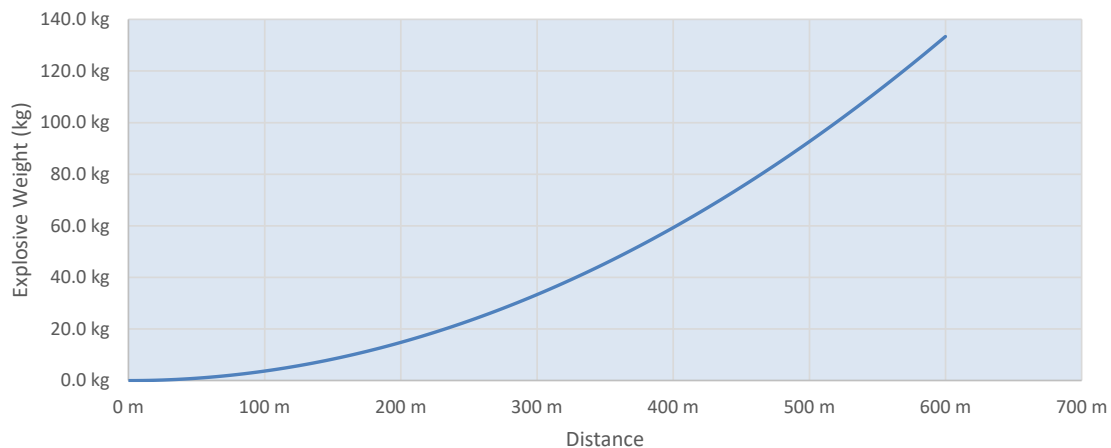


Figure 4: Vibration level as a function of distance from varying explosive quantities per delay for compliance with 5mm/s

10.2. Air Overpressure

Like the vibration analyses, site data has been collected by HQPL and KEPQL from all recent blasting operations to determine the overpressure level as a function of distance and explosive weight. The assessment is therefore based upon information presented in the peer reviewed international literature.

The United States Bureau of Mines (USBM)² have undertaken perhaps the most extensive review of overpressure and its effects and have proposed the form of the relationship showing the expected level of overpressure as a function of distance and explosive quantity. Using this form of this equation, a reference equation for estimating the overpressure is shown below:

$$dBL = 164 - 24 \times \log \left(\frac{d}{\sqrt[3]{w}} \right)$$

² Siskind, D.E., Stachura, V.J., and Stagg, M.S., 1980. "Structure Response and Damage Produced by Airblast from Surface Mining", United States Bureau of Mines, Report of Investigations No 8485.

where dBL is the level of overpressure and d and w are as per the vibration relationship.

Unlike ground vibration, geology has a negligible impact on the levels of air overpressure. The overpressure level is affected by blast design, in particular the proximity of the explosive charges to the free surface. Also, unlike ground vibration, overpressure level is significantly affected by local conditions including:

- Topography and vegetation with treed areas or other elevated features aiding in affecting the measured level of overpressure. Properties on the leeward side of the hill will commonly measure overpressure up to 5dBL less than those of the windward side.
- Atmospheric conditions with wind direction, humidity and temperature inversions combining to affect overpressure levels by as much as 10dBL for upwind versus downwind areas of the blast.
- Orientation of blast with measurements point in front of the blast receiving levels up to 5dBL greater than those points directly behind the blast.

10.3. Blast Modelling of Explosive Quantities

The regressed vibration and air overpressure relationships can be used to assess the effects of the planned scale of blasting for the KEQ and confirm any restrictions that may be necessary to ensure compliance with the existing environmental performance criteria summarised by Table 1 at the existing properties.

It should be noted that the maximum permissible explosive weights used by KEQPL will be maintained and only increased in the event that the closest sensitive receivers where either acquired or detailed in an agreement with the current property owner to exceed the environmental performance criteria (in accordance with MP 09-0175).

The analyses given in Plate B shows the expected explosive quantities that can be used in the total footprint of the quarry consolidation based upon compliance with 5 mm/s at the nearest properties. The entire footprint of the consolidated extraction area has been considered in the analyses to ensure flexibility of the design. The scale of blasting material and corresponding bench heights are therefore modelled to be based upon the predicted quantities in Plate B and the permissible explosive quantities referenced to Figure 4.

Plate B also shows the expected location of vibration contours for blasting with explosive quantities modelled to comply at the nearest sensitive receivers with a 5 mm/s vibration limit. Those locations lying nearer to the blast than say the 2 mm/s contour will on occasions receive vibration levels exceeding 2mm/s, but predicted to be not more than 5 mm/s. Those further from blast than the same 2 mm/s contour are predicted to receive vibration less than 2 mm/s. The contours show the maximum extent of the vibration and not that which would be produced from all blasts. When blasting in north-western section of the KEQ, the level of vibration at properties on the eastern sides of the quarry near to Halloran Road will fall to low and most likely immeasurable vibration values. Only when blasting in the east and south-eastern side of the KEQ will the level of vibration potentially reach the maximum expected value for those properties on Halloran Road. Plate B also indicates:

- The scale of blasting in the KEQ will be consistent with the current maximum 15 metres benches over the majority of the quarry. There are no areas of the proposed extended extraction area where the explosive weight will need to be reduced in order to comply at the closest properties along Halloran Road or Mill Hill Close.
- The residential properties along Halloran Road, Mill Hill Close or Tarean Road do not affect the scale of blasting although may receive perceptible levels of vibration at some stages when blasting occurs at the nearer extents of the consolidated quarry footprint.

- The entirety of the KEQ extraction area will not require any adjustment to the scale of blasting. Explosive quantities per blasthole of 130 kilograms are considered feasible. The current benching design for the KEQ indicates that explosive quantities will be around 130 kilograms per blasthole.

Plate D shows the modelled location of the varying air overpressure contours based upon compliance with 115 dBL at the adjacent properties. The information shown on Plate C indicates that the blast design with the maximum explosive weight will comply with the 115 dBL limit and like the ground vibration impacts will require no adjustment to achieve compliance with the environmental performance criteria.

Plate D indicates:

- Similar to vibration, there is no adjustment to the scale of blasting required to comply with the 115 dBL criterion at the adjacent residential properties along Halloran Road, Mill Hill Close or Tarean Road.
- Explosive quantities per blasthole of 130 kilograms are considered feasible to achieve compliance with the existing environmental performance criteria.
- The quarry can be blasted with the maximum 15 metre bench height and achieve compliance with the existing environmental performance criteria.

11. FLYROCK MODELLING

There are two potential sources of flyrock from blasthole patterns:

- Vertical face; and
- Horizontal surface.

High velocity rock movement from the vertical face can occur if blastholes are drilled too close to the vertical face, enabling the high-pressure gases to easily burst free. Best practices suggest that orientation of the vertical face and the blasthole orientation should be reviewed prior to the blast to identify any instances where the distance to a free face may be insufficient to prevent flyrock. Where possible, the preferred direction of any movement of blasted material should also be towards the center of the pit and away from sensitive receivers. The planned pit arrangement for the proposal complies with this objective.

11.1. Flyrock Modelling

An engineered flyrock model combining all the relevant aspects of projectile motion based upon rock ejection velocities has been developed and applied to the KEQ. The model incorporates the results of more than ten different documented research projects specifically aimed at estimating flyrock ejection velocities, flyrock ranges and/or safety exclusion zones. These models account for both blast designs, in particular the proximity of the explosive column to the free face, and fluid dynamics code addressing projectile motion and air resistance (drag) of the ejected blast fragments. The models incorporate specific derived code to best estimate flyrock ranges and corresponding safe exclusion zones. The presented results are based on probabilistic analyses and estimate the likely landing position of possible ejected rock fragments based upon their equivalent diameter.

The uncontrolled movement of rock from the horizontal surface (i.e. ejection of rock around the collar) and vertical free face represent the possible sources of flyrock. Confined blasting (i.e. without a free face) virtually eliminates the possibility of flyrock from the vertical face, although the propensity for flyrock from the collar region increases and necessitates an increased uncharged collar to better control rock movement from around the collar. There is no intent to undertake routine confined blasting as part of the current proposed blasting activities.

Blasting in built up areas where control of flyrock is critical commonly employs an uncharged collar length equivalent to between 25 and 30 times the blasthole diameter, or for an 89mm diameter blasthole, 2.3 to 2.7 metres. These ratios are as per the Australian Standard AS2187.2 for the control of flyrock from blasting.

Figure 5 shows the results of the flyrock outcomes for a 15-metre bench height blasthole loaded with approximately 130 kilograms of explosive. The modeled landing positions for flyrock are based upon the calculated trajectories and a probabilistic component accounting for the fragment size, direction and velocity. The probabilistic component of the model estimates flyrock ranges based upon a combination of operating conditions and therefore predicts the outermost envelope of flyrock landing points.

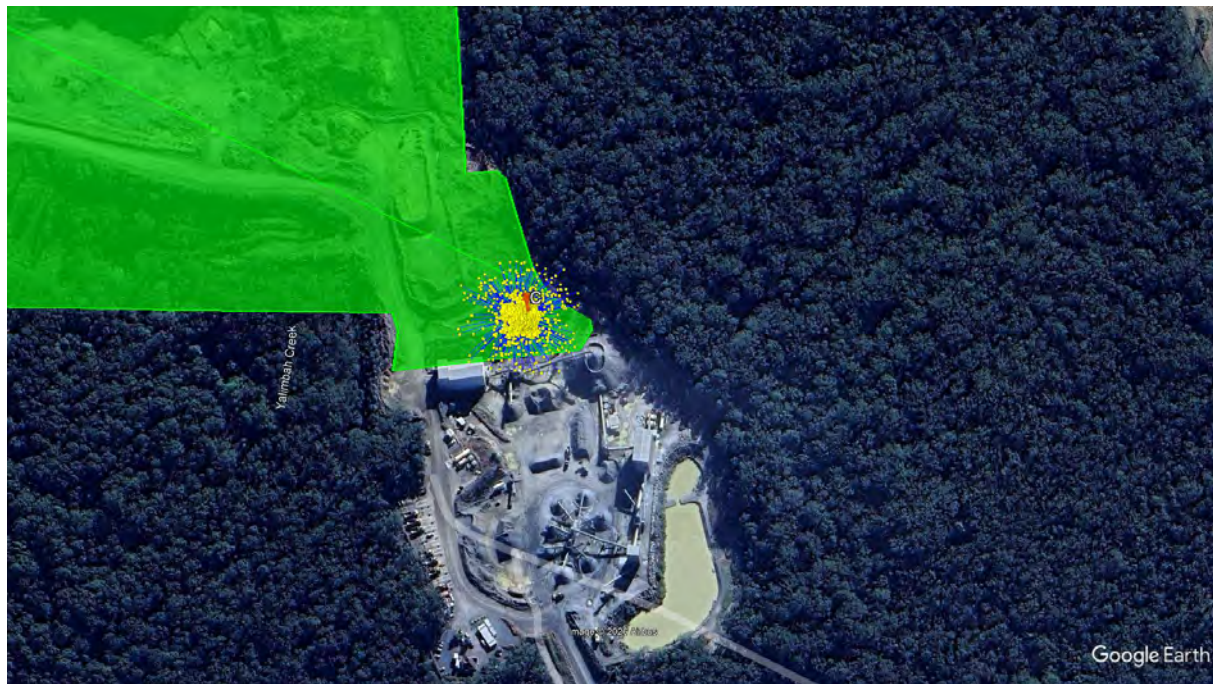


Figure 5 – Predicted flyrock locations from blasting with a 102mm diameter blast-hole and 15 metre bench. The predicted locations are shown as the yellow markers.

The representative locations correspond to the closest point that blasting with a 15-metre bench could occur to Halloran Road. The modeling predicts that any blast generated flyrock is constrained to within a zone of approximately 50 metres around the perimeter of the blast zone, compared to 660 metre separation to Halloran Road, approximately 540 metres to Blue Rock Close and approximately 570 metres to the Pacific Highway.

The flyrock modeling indicates that for a 15-metre bench with an uncharged collar of 2.5 metres and an explosive weight per blasthole of approximately 130 kilograms, flyrock is controlled to within approximately 80 metres of the blasthole collar. For other bench heights and with a corresponding increase in the weight of the explosive to around 125 kilograms, the extent of flyrock increases slightly because of the increased explosive weight.

The predicted flyrock ranges are based upon a detailed flyrock model that considers flyrock distances based upon ejection velocities, particle size and sphericity and whether collar or front row origin. Whilst best engineering procedures would clearly dictate that site data should continue to be used to supplement the model and verify the predicted results, the model is considered to produce appropriate preliminary expectations of flyrock ranges for varying particle sizes. The probabilistic component of the model estimates flyrock ranges based upon a combination of operating conditions and therefore predicts the outermost envelope of flyrock landing points.

The modelling predicts that flyrock related issues are extremely unlikely for the proposed expansion of blasting areas within the KEQ, particularly given the very controlled nature of the blasting activities in the existing quarry area.

12. ENVIRONMENTAL MITIGATION MEASURES

Environmental mitigation measures will be incorporated into each blast to minimise the impact of the following effects:

- Vibration,
- Airblast overpressure, and
- Flyrock.

12.1. Vibration

Mitigation measures to reduce vibration effects during blast activities are not required based upon the modelling results and the large separation distances from any sensitive receivers. If circumstances change and control measures are required, they could include:

- Ensuring all relevant areas associated with blast activities have been properly analysed to determine scale of blasting required.
- Ensuring only exact quantity of explosives is used for each hole.
- Condition surveys by KEQPL for adjacent structures whose risk assessment has highlighted that vibration from blasting may be elevated or where the owner has expressed concern in relation to the possibility of damage, will be undertaken.
- Regular vibration monitoring to confirm that vibrations being induced by the blasting activities are at or below the established environmental performance criteria specified in Section 1.

12.2. Airblast Overpressure

Mitigation measures to reduce overpressure effects during blast activities are not required based upon the modelling results and the large separation distances from any sensitive receivers. If circumstances change and control measures are required, they could include:

- Ensure all relevant areas associated with blast activities have been properly analysed to determine scale of blasting required.
- Engagement with the nearest residents (as identified in Figure 1) as to the effect of the blasting activities.
- Ensure only exact quantity of explosives is used for each hole.
- Regular airblast overpressure monitoring to confirm that vibrations being induced by the blasting activities are at or below the established environmental performance criteria specified in Section 1.
- All blasts designed with a minimum uncharged collar length.
- Where uneven or irregular vertical faces are encountered, ensure that a minimum front row burden is maintained by undertaking face profiling and borehole tracking.

12.3. Flyrock

Mitigation measures to reduce flyrock during blast activities are not required based upon the modelling results and the large separation distances from any sensitive receivers. If circumstances change and control measures are required, they could include:

- An increased minimum uncharged collar lengths (beyond that recommended in the Australian Standard AS2187.2) is applied to all blastholes.
- Ensuring that all design criteria are very accurately measured, documented and adhered to prior to any blasting activity proceeding.

Controlling flyrock is paramount to the design. It is recommended that all blast patterns are recorded by video (drone footage) to determine the appropriateness of the uncharged collar lengths and overall blast design parameters. Where stemming ejection occurs, or face bursting is observed, the blast design should be reviewed as part of best practices.

13. PERCEPTIBILITY

The following table shows the human perception as a function of vibration levels, as given in the International literature linking human response and vibration.

Table 3 –perceptibility of vibration (Wiss, 1984)

Perceptible Effects	Vibration Range	
	Lower Bound	Upper Bound
Imperceptible	-	0.4mm/s
Slightly Perceptible	0.4 mm/s	1 mm/s
Distinctly Perceptible	1 mm/s	2.5 mm/s
Strongly Perceptible	2.5 mm/s	10 mm/s
Disturbing	10 mm/s	-

The performance criteria specified in Section 1 of this plan limit vibration levels at some properties to those classed as “strongly perceptible”, however given the larger separation distance, the vibration is significantly lower and would more likely “slightly perceptible”.

14. BLASTING MANAGEMENT

As per the Australian Standard AS2187.2 recommendations, all blasts will be planned and designed to achieve the required outcome with minimum impact on the surrounding environment, below, on or above the soil or water surface. Records that detail the results of each blasting operation will be taken and maintained. This information assists in the planning and implementation of further blasts and provides documentation in case of incident or complaint.

For the KEQ, blast management documentation is divided between the Blast Management Plan (latest version 4A, March 2025), which was established in consultation with the EPA) and approved by the NSW Planning Secretary; and the Blast Control Plan that is developed and implemented to the satisfaction of the NSW Resources Regulator.

The Blast Management Plan governs how blasting activities will be undertaken to ensure compliance with environmental performance criteria, other management obligations provided by the Project Approval (MP09_0175) and EPL (20611) and any potential impacts to external stakeholders.

The Blast Control Plan governs how blasting activities will be undertaken to ensure compliance with relevant Australian Standards and industry best practices, and any potential impacts to internal stakeholders.

Both documents will be reviewed and updated as necessary prior to commencing blasting activities in the extended extraction areas within KEQ.

14.1. Blast Management Plan Contents

The established Blast Management Plan (latest version 4A, March 2025) includes the following details to ensure compliance with the Project Approval (MP09_0175) and EPL (EPL 20611).

- Regulatory requirements.
- Blasting mitigation and management measures including:
 - o Operating controls;
 - o Design and operational controls;
 - o Community notifications;
 - o Continuous improvement and best practice management; and
 - o Staff training.
- Blasting limits including:
 - o Baseline data;
 - o Identification of sensitive receivers; and
 - o Operational blasting criteria.
- Blasting monitoring program, including:
 - o Locations and frequency;
 - o Record keeping and performance monitoring; and
 - o Meteorological monitoring.
- Blast fume management, including:
 - o Blast fume mitigation and management measures;
 - o Blast fume identification and record keeping;
 - o Blast fume event management; and
 - o Blast fume event investigation
- Monitoring and Reporting including:
 - o Public reporting;
 - o Periodic management plan reviews;
 - o Complaints handling and incident response;
 - o Independent review; and
 - o Notification of landowners.
- Community Consultation and Improvement, including:
 - o Ongoing consultation via the established KEQ Community Consultative Committee;
 - o Performance monitoring; and
 - o Continual improvement.
- Roles and responsibilities.

This document will be reviewed as necessary to include the MOD 11 proposal.

14.2. Blast Control Plan Contents

The Blast Control Plan will include the following elements in accordance with Australian Standard AS2187.2:

- Location of the proposed blasting.
- Description of the proposed blasting.
- Permits/licences required for the project.
- Identification and position of the person responsible for the project including project safety and security.
- Identification and position of person who has given approval to use explosives on the project.
- Key appointments and responsibilities.
- Shotfirer's details.
- Details of the risk management assessment.
- Details of adjacent structures or services that influence the blast design.
- Details of reports, drawings and records consulted.
- Layout plan of the blast including drilling pattern and hole depths.
- Detonation sequence/effective charge mass per delay (MIC)/powder factor.

- Type of explosive to be used and quantity required.
- Method of initiation.
- Type of firing equipment and procedures.
- Drilling procedures.
- Explosive loading and charging procedures.
- Explosive storage and handling procedures.
- Security procedures for the site and the blast, including explosives.
- Environmental considerations for airblast overpressure, ground vibration
- Details of communication systems.
- Warning procedures.
- Traffic management plan.
- Proposed dates and times of blasting.
- Details of the exclusion zone.
- Method of notification to owners and occupiers of structures, and providers of services adjacent to the blast.
- Influence of weather.
- Loading in poor light conditions or reduced visibility.
- Cessation of explosive-related activities during electrical storms.
- Misfire management system.
- Post blast assessment and inspection procedures.
- Provision for post-blast comments.
- Signature spaces for the plan author, shotfirer and person who approves the plan.

14.3. Records

Details of the blast will be taken and maintained, including:

- Environmental conditions at the time of the blast.
- Monitoring equipment including type, serial number and location.
- Details of measurements recorded during the blast.
- Details of flyrock or fly.
- Details of incidents and complaints.
- Comment on the results of the blast.
- Proposed modification to the blast plan for future shots.

14.4. Community Consultation

KEQPL has a well-established community engagement process in place, as is outlined within the established Blast Management Plan (ver 4A, March 2025) which will continue as part of the proposed MOD 11 development including prior to the commencement of blasting in any new areas within the KEQ. The following is noted:

- A Blast Notification Register is established. Information describing the nature and likely timing of a scheduled blast is conveyed to those on the established Blast Notification Register (which includes all residences identified within Figure 1).
- KEQ has an established Community Call Line for any enquiries or complaints and procedures to respond to any enquiries or complaints in line with the KEQ Environmental Management Strategy.
- KEQ has an established Community Consultative Committee (CCC). Results of environmental performance (including compliance with blasting criteria) is reported to the CCC.
- Monthly environmental monitoring results (including compliance with blasting criteria) is published on HQPL website.

It is also noted that public exhibition for the KEQ was undertaken during NSW Planning's assessment of the original KEQ application prior to determination. Public exhibition of the proposed MOD 11 will also occur in line with the provisions of the NSW Environmental Planning & Assessment Act, 1979.

14.5. Reconciliations and Reporting

For each blast, the following records are maintained:

- A pre-blast sheet confirming that the expected level of vibration at each of the nearest sensitive receivers complies with the vibration limits.
- A completed drilling sheet prepared by the shotfirer showing the measured depth of each blasthole. The sheet will identify and clearly mark any "short" blastholes.
- A blast loading plan showing the depth of each blasthole, quantity of explosive in each blasthole and the uncharged stemming length. The initiation sequence will also be shown. Reconciled explosive quantities used versus the designed quantity will also be shown and any variations accounted for.
- A signed blast summary sheet showing that each of these forms been received and no variations between the intended and implemented design exist.

These requests are in accordance with the specifications listed in the Australian Standards AS2187.2 document.

15. MONITORING OF BLASTING ACTIVITIES

A monitoring program for both vibration and air overpressure levels is established as part of the Blast Management Plan for the KEQ and will be continued for the MOD 11 proposal in line with MP 09_0175 and EPL 20611.

The Monitoring Program has been developed with reference to the procedures described in AS 2187.2-2006, "Explosives - Storage, Transport and Use" and with reference to the ANZECC's "Technical Basis for Guidelines to Minimise Annoyance due to Blasting Overpressure and Ground Vibration", September 1990.

A monitoring site has been established (in consultation with the EPA) and is representative of the nearest privately owned residential dwellings and other sensitive infrastructure. The site (EPL 20611 Monitoring Point 11) is located on Mill Hill Close as illustrated by Figure 6 below and monitors air blast overpressure and ground vibration for all blasts.

This location is sufficient to accommodate the proposed MOD 11 development, and the establishment of new locations is not necessary.

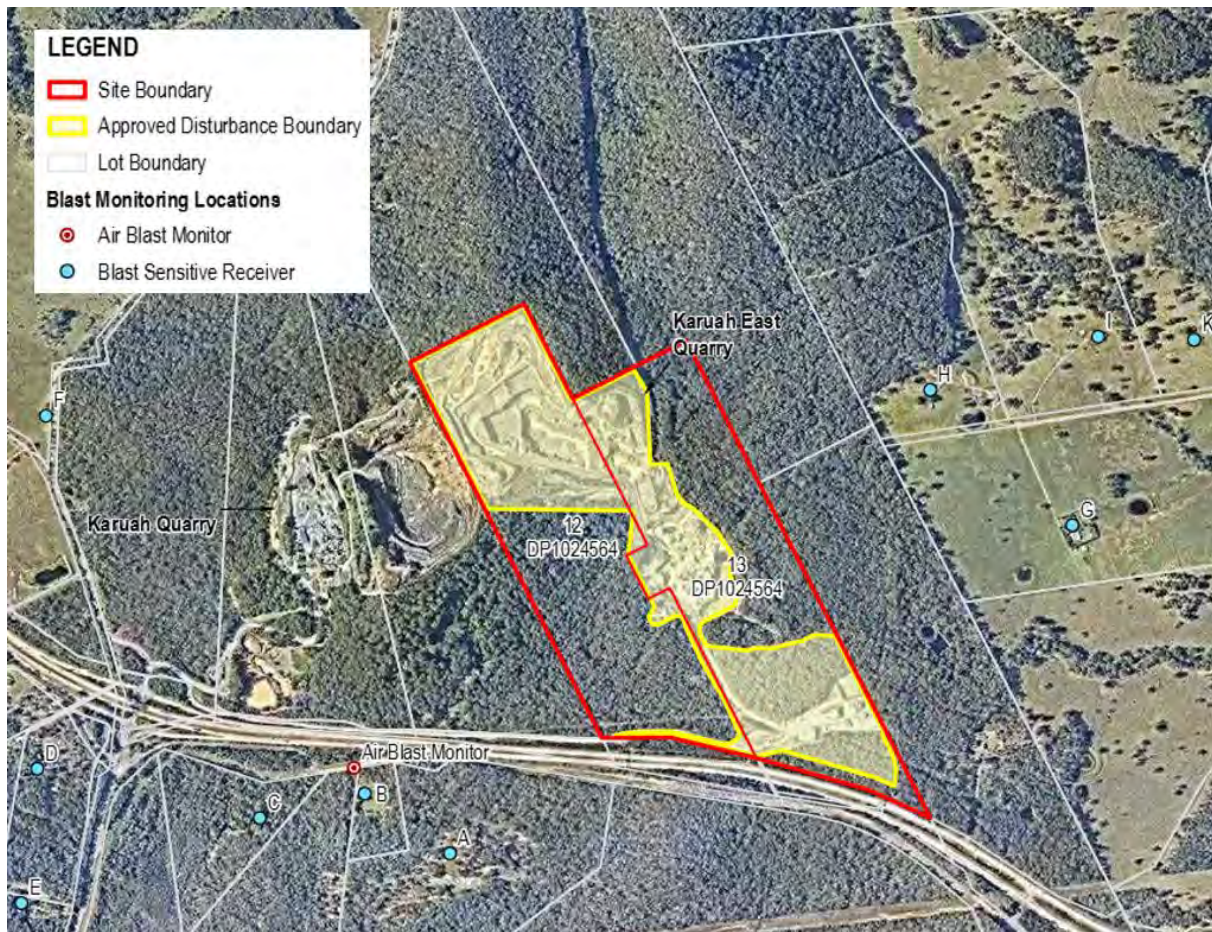


Figure 6 – Location of Air Blast Monitor

In the event that community feedback is received that warrants investigation at an additional location surrounding the KEQ, monitoring will be undertaken and continue until such time that sufficient data is available to allow a satisfactory assessment of both vibration and overpressure values from the blast design. If deemed necessary, amended blast design would be considered to ensure compliance with blasting criteria is achieved.

The vibration monitoring system will consist of an individual vibration and air blast monitor which will be positioned at EPL 20611 Monitoring Point 11 on Mill Hill Close. The vibration monitor will have four recording channels. An external geophone (transducer) will monitor ground vibration in three directions (transverse, vertical and longitudinal particle velocities) and report the level in mm/s. An external microphone will measure the level of overpressure, reporting the data in units of dBL. The monitor will be configured with a vibration threshold trigger to record blast events which exceed a minimum value, typically around 0.5mm/s. The recording duration will be set to exceed the duration of the blast.

Vibration and air overpressure monitoring will be undertaken by persons with appropriate experience. Monitoring equipment will meet the specifications of the Australian Standards AS2187.2. Section J.

16. CONCLUSION

This BIA provides an assessment of how KEQPL will manage blasting activities for the proposed Karuah Pit Consolidation Project, which primarily seeks to enable the extraction of the previously sterilised andesite resource from the remnant dividing highwall as well as within other cleared areas from the KEQ and KHRQ sites in a coordinated approach. This report has been prepared to specifically accompany the MOD 11 application to the KEQ (MP 09_0175).

This BIA has provided a framework for the KEQ to maintain best practice controls to manage potential environmental impacts during the drilling and blasting activities associated with the extraction of material from KEQ associated with the proposed Karuah Pit Consolidation Project.

This BIA describes how KEQPL will manage blasting activities and the related environmental impacts such as ground vibration, airblast overpressure and flyrock and has sets out the performance requirements and procedures to ensure that the possible environmental impacts associated with blasting activities are adequately identified and controlled for the project.

The following conclusions are made:

- Based on modelling completed, compliance with established blasting criteria (airblast overpressure and vibration) within MP 09_0175 and EPL 20611 will continue to be achieved. No amendments to established criteria are necessary.
- No additional mitigation measures (to those already incorporated into the Blast Management Plan and Blast Control Plan) to reduce vibration, overpressure effects and flyrock during blast activities are required based upon the modelling results and the large separation distances from any sensitive receivers.
- The proposed blasting arrangements including extension of hours from 9.00am to 5.00pm (weekdays and excluding public holidays) as well as the reduction of cumulative blasts between the KEQ and adjoining KHRQ from 3 per week to two per week is acceptable.
- Modelling completed predicts that flyrock related issues are extremely unlikely for the proposed development and there will be no impact on the closest sensitive receivers and public roads.
- The established Blast Management Plan (ver 2A, March 2025) and Blast Control Plan can be readily updated to include the proposed MOD 11 development.
- The established monitoring program for both vibration and air overpressure levels is satisfactory to accommodate the proposed MOD 11 development.
- Established community engagement and reporting processes are satisfactory to accommodate the proposed development.

The proposed development is acceptable in terms of blasting considerations and can be supported.

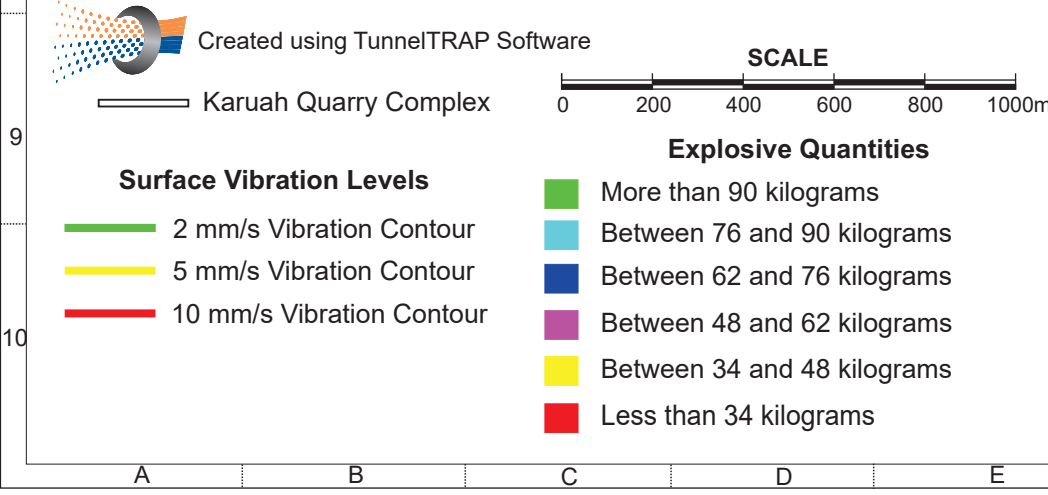
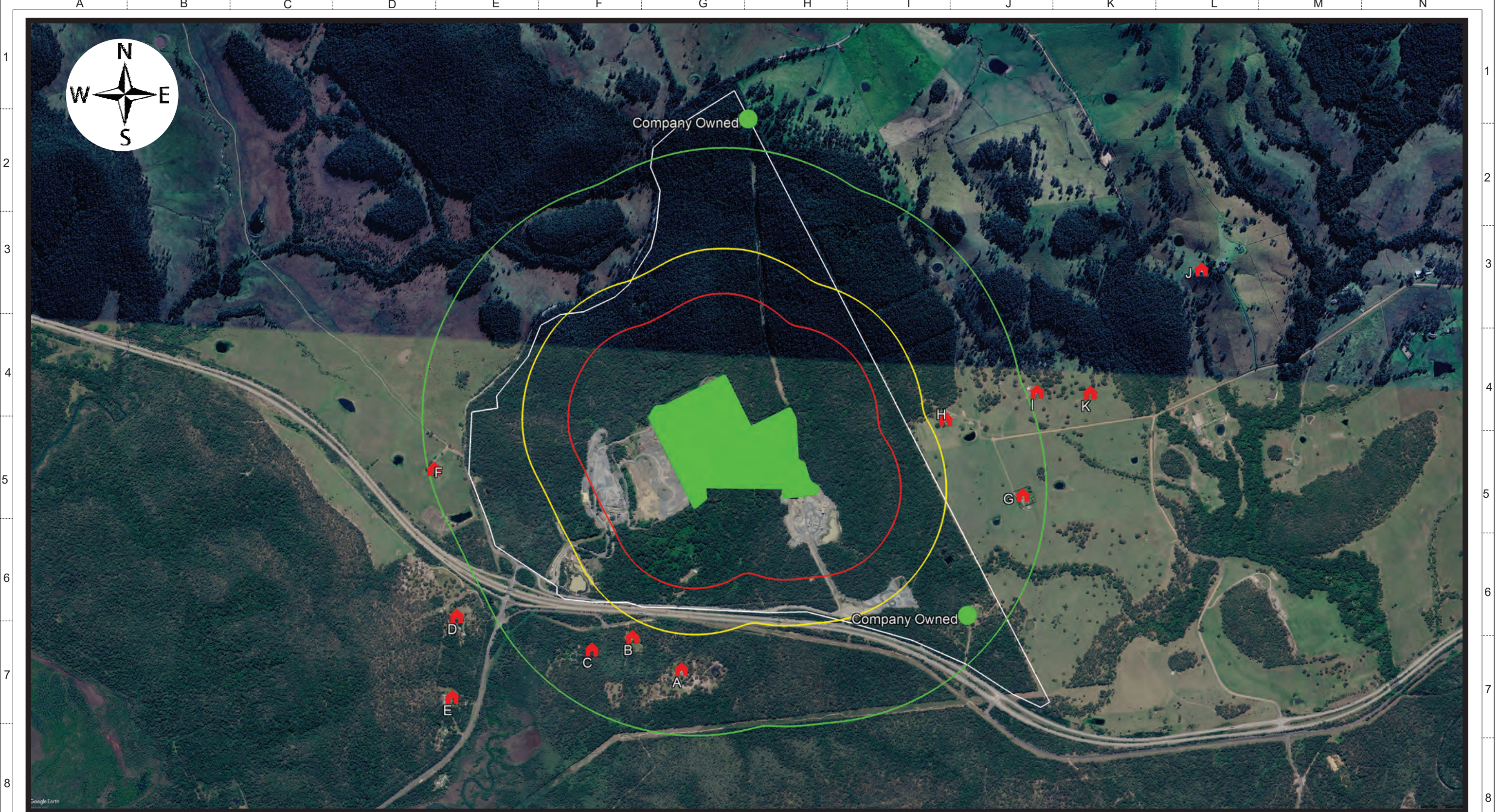
17. STATEMENT

The above BIA has been prepared by John Heilig (RPEQ 6304) of Heilig & Partners consulting engineers. In preparing this assessment, Heilig & Partners have made certain assumptions. We have assumed that all information and documents provided to us by KEQPL or because of a specific request were complete, accurate and up to date. Where we have obtained information from a Government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware why any of the assumptions are incorrect.



John Heilig (RPEQ6304)

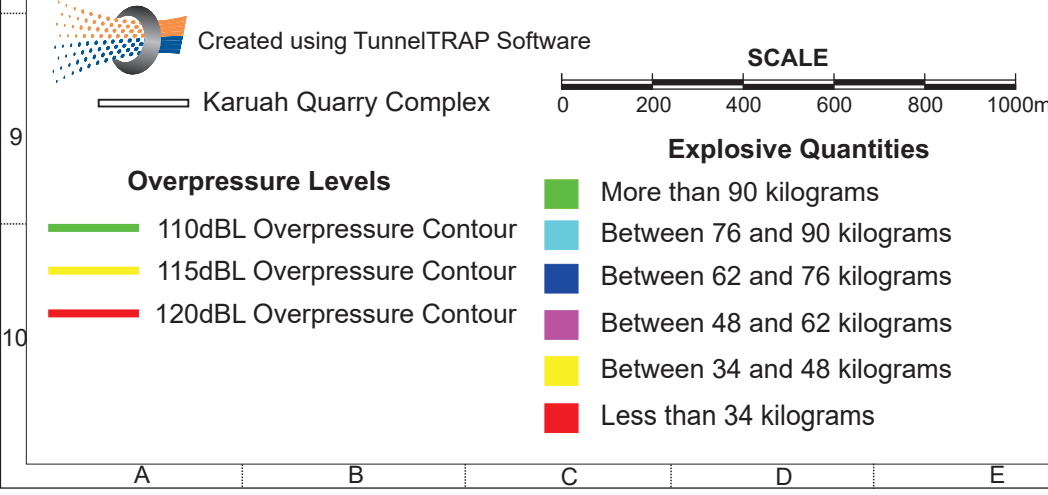
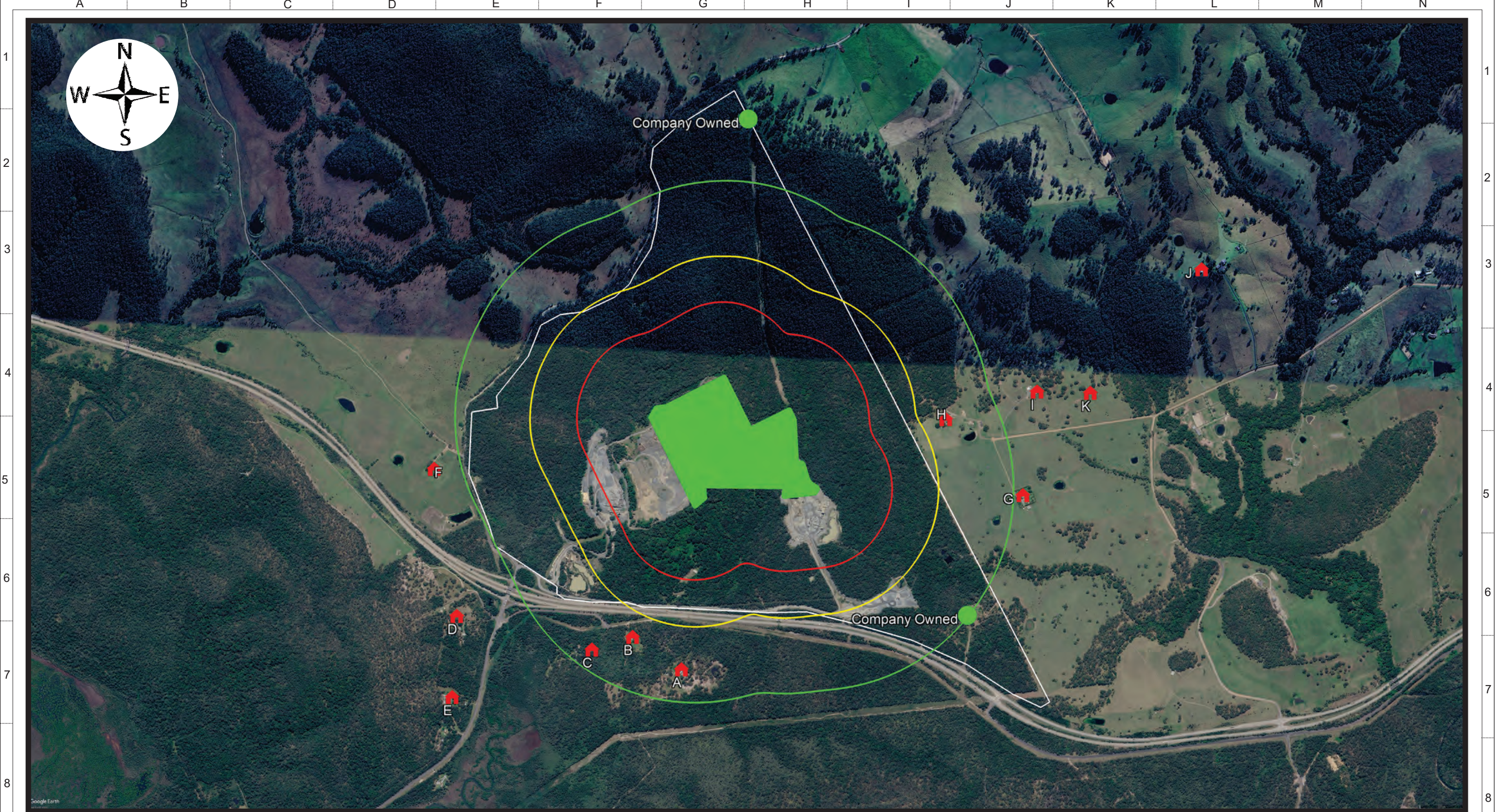
18. MODELLING RESULTS



PROJECT DESCRIPTION Hunter Quarries - Karuah East Quarry - Back calculated explosive weights and associated vibration contours from blasting to comply with a vibration criterion of 5mm/s at the adjacent residential receivers. Vibration contours are shown at surface level and represent maximum expected values from blasting.

 HEILIG & PARTNERS Engineered Excellence Telephone +61 7 3715 7599 P.O. Box 1176 Mobile 0419 196 369 Mt. Ommaney Facsimile +61 7 3715 7588 QLD. 4074. Australia Email john@heiligandpartners.com.au		Plate No. A	Date Drawn: 9 March 2026
		Revision History R1: Original	Ref No: Pit Consolidation Project Karuah East Quarry
		Job No: HP2511-2	

In preparing this drawing, HP have made certain assumptions. We have assumed that all information and documents provided to us by the Client or as a result of a specific request were complete, accurate and up to date. Where we have obtained information from a Government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware why any of the assumptions are incorrect.

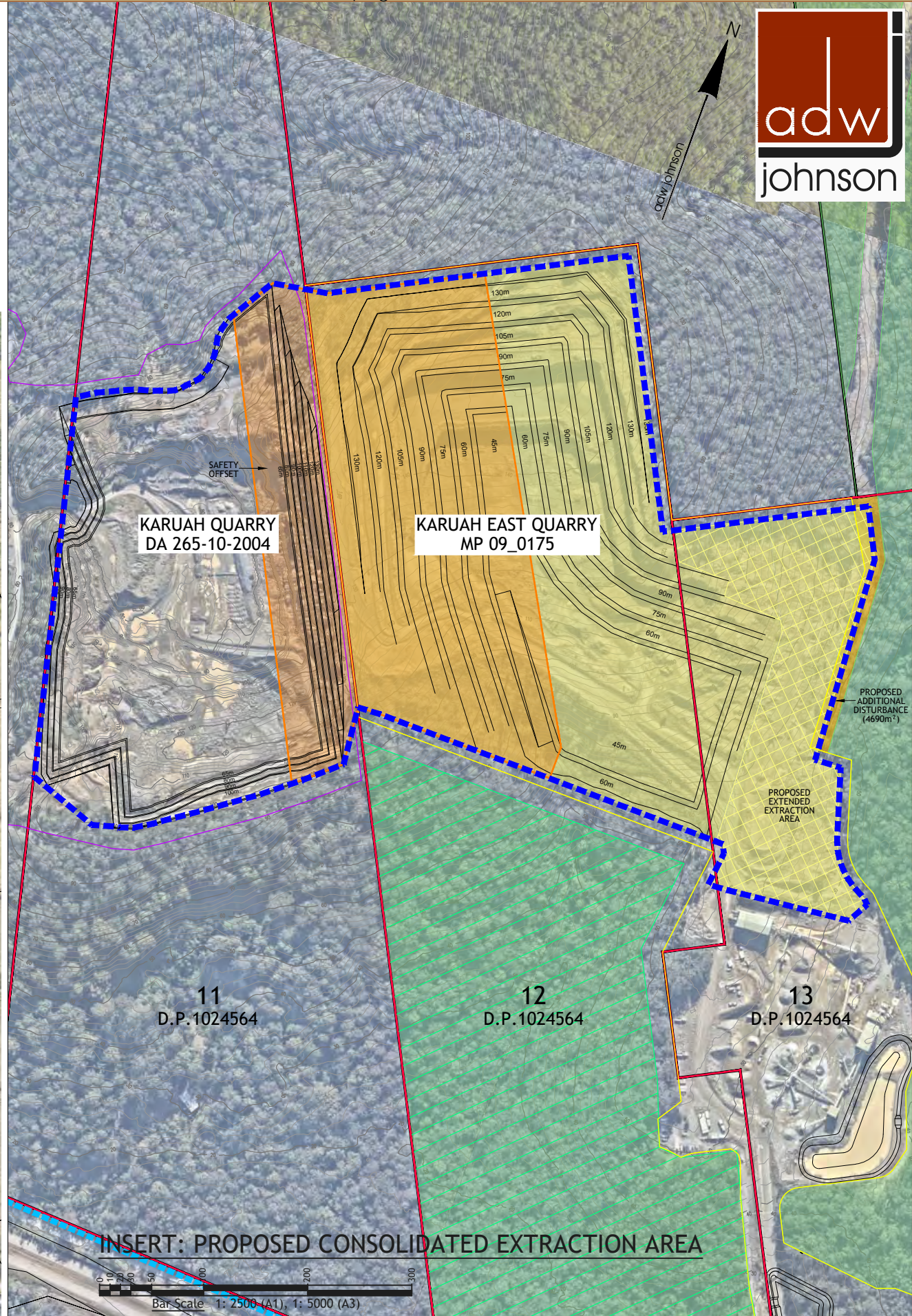
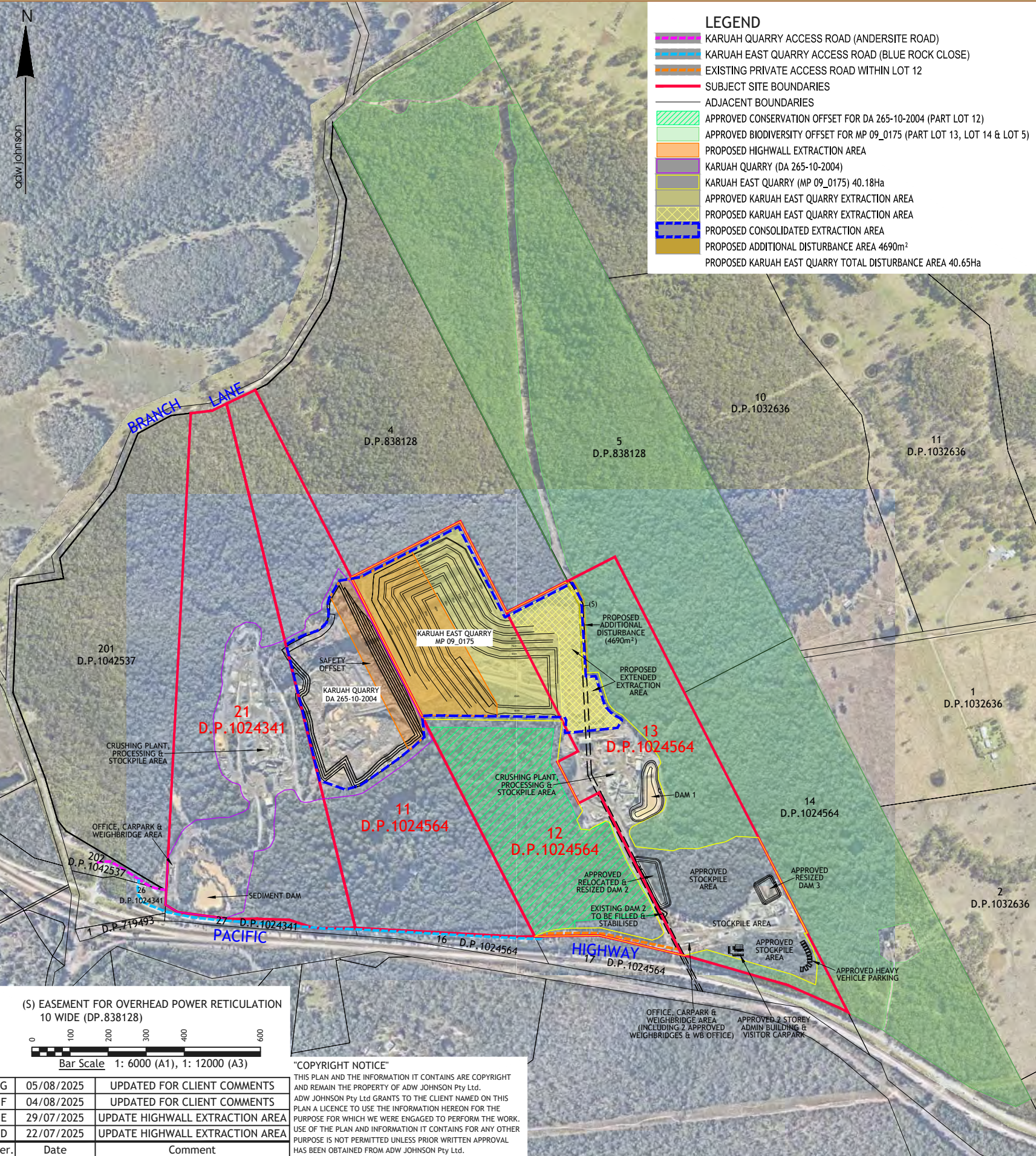


PROJECT DESCRIPTION Hunter Quarries - Karuah East Quarry - Back calculated explosive weights and associated overpressure contours from blasting to comply with an overpressure criterion of 115dBL at the adjacent residential receivers. Overpressure contours represent maximum expected values from blasting.

 HEILIG & PARTNERS Engineered Excellence Telephone +61 7 3715 7599 P.O. Box 1176 Mobile 0419 196 369 Mt.Ommaney Facsimile +61 7 3715 7588 QLD. 4074. Australia Email john@heiligandpartners.com.au		Plate No. B	Date Drawn: 9 March 2026
		Revision History R1: Original	Ref No: Pit Consolidation Project Karuah East Quarry
		Job No: HP2511-2	

In preparing this drawing, HP have made certain assumptions. We have assumed that all information and documents provided to us by the Client or as a result of a specific request were complete, accurate and up to date. Where we have obtained information from a Government register or database, we have assumed that the information is accurate. Where an assumption has been made, we have not made any independent investigations with respect to the matters the subject of that assumption. We are not aware why any of the assumptions are incorrect.

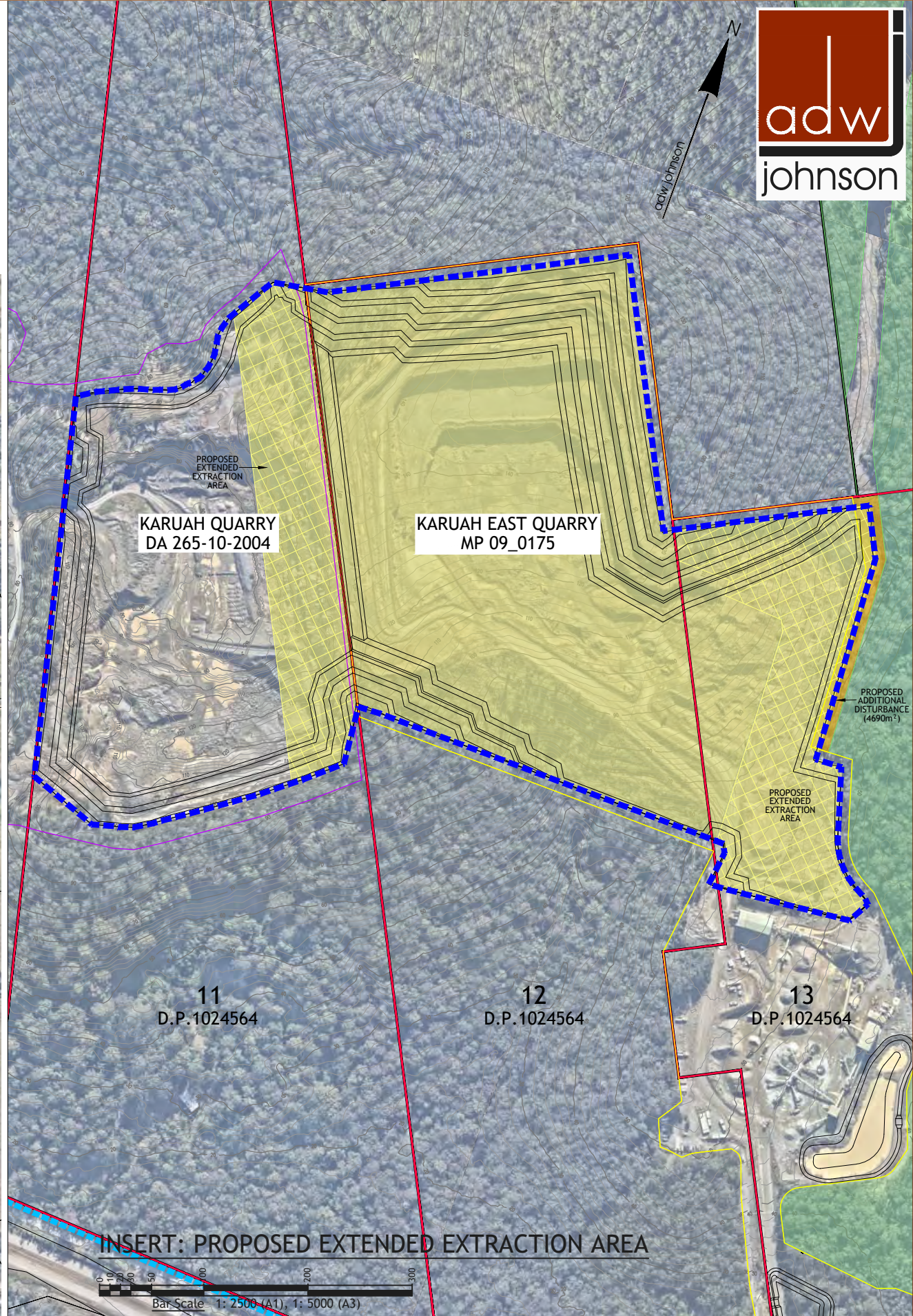
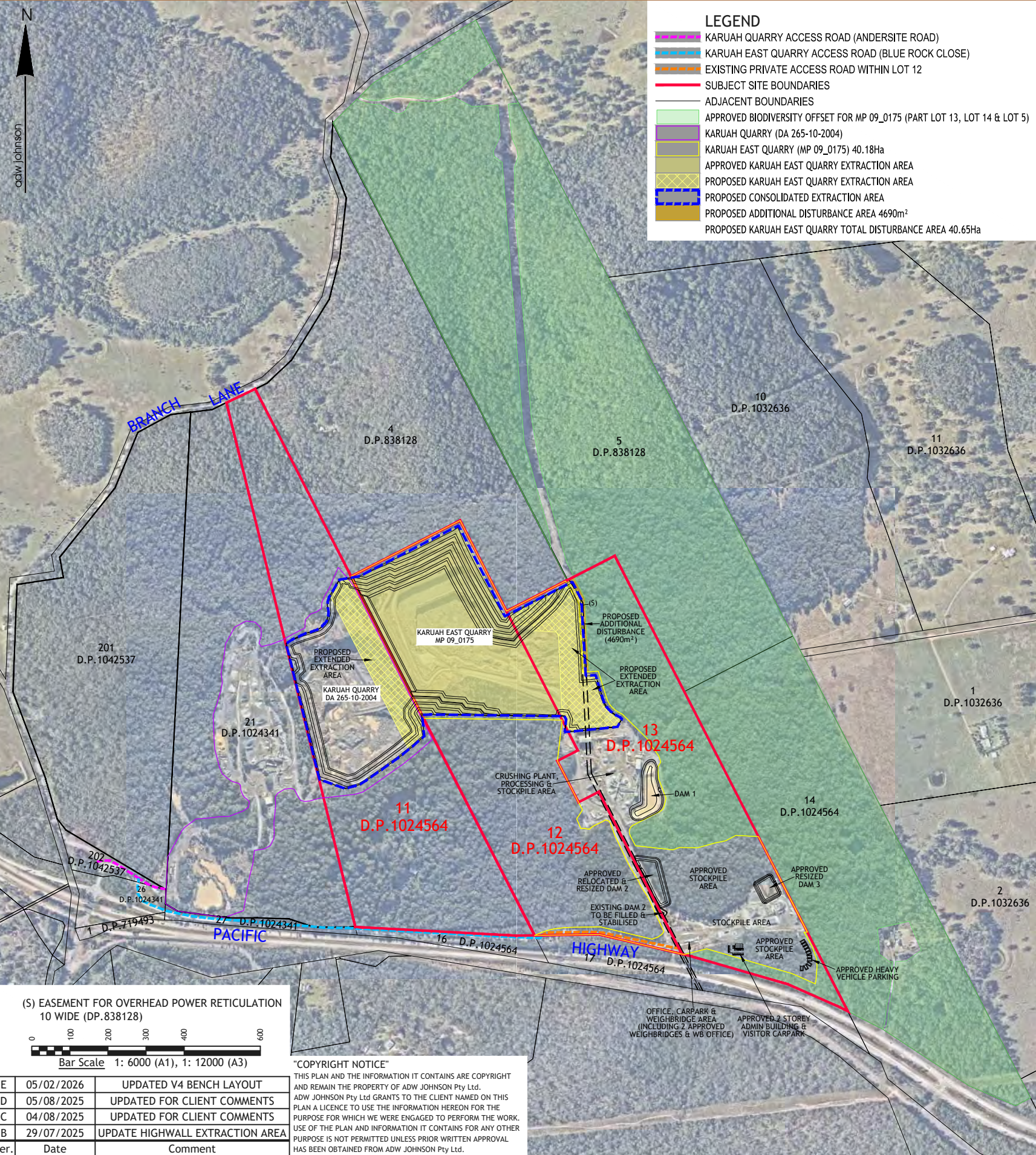
19. APPENDIX 1



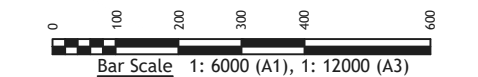
PROPOSED SITE PLAN
KARUAH EAST QUARRY
LOTS 11, 12 & 13 D.P.1024564
ANDERSITE ROAD & BLUE ROCK CLOSE, KARUAH

Location: Andersite Road &
Blue Rock Close
Karuah
Council: Mid Coast

Datum: A.H.D.
Origin: Lidar Data
Projection: M.G.A.
Origin: Grid
North Direction: Grid
Contour Interval: 2.0m
Create Date: 23rd July 2025
Sheet: 1 of 1
Plan By: ZJ
Project Manager: MR
Office: Hunter
Plan Purpose: Scoping
Version: E (05/02/2026)
Client: Hunter Quarries Pty Ltd
Survey: N/A
AutoCAD: Dwg\11819-SITE-018-E
Our Ref: 11819



(S) EASEMENT FOR OVERHEAD POWER RETICULATION
10 WIDE (DP.838128)



E	05/02/2026	UPDATED V4 BENCH LAYOUT
D	05/08/2025	UPDATED FOR CLIENT COMMENTS
C	04/08/2025	UPDATED FOR CLIENT COMMENTS
B	29/07/2025	UPDATE HIGHWALL EXTRACTION AREA
Ver.	Date	Comment

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