BLAST IMPACT ASSESSMENT

For a Proposed Extractive Industry

at

Lot 1 DP 366036 & Lot 12 DP 582916
Edenville & Omagh Roads
Cedar Point

PREPARED BY:
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1.0 INTRODUCTION

An Environmental Impact Statement (EIS) and Development Application (DA) have been lodged with Kyogle Council for a proposed extractive industry (quarry) at Lot 1 DP366036 and Lot 12 DP 582916 Edenville Road, Cedar Point. The quarry proposes to extract up to 47,000m³ per year of the basalt rock material.

The proposal includes blasting the basalt rock up to four times a year, with processing of the material to be undertaken during the proposed 250 days that the quarry may be open.

The Development Application was referred to Joint Regional Planning Panel (JRPP), and upon a peer review of the submission by Umwelt Environment Consultants (September, 2011) the JRPP provided a Final Record of Decision.

The Final Record of Decision has requested the following in relation to the blast design:

> *Provision of further detail in relation to the assessment conducted in relation to the proposed blast design, and confirmation of the quarry and blast design that ensures that relevant criteria can be met at each of the nearest surrounding private residences. Confirmation of the proposed approach to avoiding safety hazard from blast flyrock.*

The following report addresses the key factors being:

- Blast Design and
- Blast Flyrock

1.2 Background

The proposed quarry site is a steep sided, flat top basaltic plateau that resulted from an ancient lava flow filling a sandstone valley, from which all the surrounding material has been eroded leaving an inverted landscape.

The site rises steeply from a gently undulating and level plain of approximately 65 metres elevation to reach a plateau height of approximately 120 metres.

Geological investigations that have been undertaken at the site, determined that the proposed quarry contains blue metal which is most likely to have resulted from two thick lava flows, which are separated by 3 m thick basalt agglomerate zone (Smith and Cotter, 1996). The thick lava flows have created superior quarry products (Smith and Cotter, 1996) however, the material can most efficiently be won through blasting. The soils of the proposed quarry site are shallow, with bedrock exposed in some areas and variations of cover from 0.5 m to up to about 1 m depth.

It is proposed that the basalt rock will be extracted through drilling and blasting. The blasting is proposed to be a maximum of four blasts days per year. The material will then be stockpiled, crushed and screened as required on the quarry work floor.

2.0 SURROUNDING LAND USES

The subject site is located in a rural landscape, with the majority of the surrounding land areas being used for cattle grazing and occasional cropping. There are smaller, rural residential allotments located within 500 m of the subject site.

This assessment examines the potential impact from the proposed blasting on the nearest residences on the rural residential allotments. Section 2.1 describes the nearest receptors which may be impacted from vibration or noise from the blasts.

2.1 Closest Receptors

The following details are of the closest receptors are based on the information provided in the original Noise Impact Assessment prepared by this office:

Receptor 1 Dwelling on Lot 2 DP 232453, Edenville Road, approximately 500 metres north east of the southeastern edge of the proposed quarry. This dwelling is owned by P. and R. Carlill who are the owners of the land on which the proposed quarry is to be established.

Receptor 2 Dwelling on Lot 1 DP 559560 Edenville Road, approximately 315 metres south of the Southern Edge of the proposed quarry.

Receptor 3 Dwelling on Lot 13 Section B DP 5080 Omagh Road, “Omagh Vale” approximately 265metres from the north eastern edge of the proposed quarry.

Receptor 4 Dwelling on Lot 11 DP 582916 Omagh Road, approximately 550 metres east north east of the eastern side of the proposed quarry.

All noise monitors were installed in rural surroundings that consist mainly of grassy paddocks with trees and some dense vegetation spread over the fields. During the day, the dominant sources of noise were traffic, birds and crickets.

3.0 GROUND VIBRATION AND AIRBLAST OVERPRESSURE

Blasting is proposed to be undertaken at the site up to four times per year in order to win the hard basalt rock, which would then be crushed on-site at other times.

Blasting has the potential to impact the surrounding environment through producing flyrock and environmental effects of blasting being ground vibration and airblast. AS 2187.2-2006 recognises that ground vibration and air blast has the potential to:

- Cause human discomfort;
- Cause damage to structures, architectural elements and services;
- Airblast is normally the cause of more complaints than ground vibration

3.1 Ground Vibration and Airblast Overpressure Limit Criteria

The blasting criteria is set in accordance with AS 2187.2 -2006 Section J. Blasting is required to win the raw material and the blasting times will be restricted to the hours between 10am to 3pm, Monday to Friday.

Table 1: Blasting Criteria

Time of Blasting	Blast Overpressure (dBL)	Peak Component Particle Velocity (mm/s)
Monday - Saturday 9am to 3 pm	115	5

Blasting is permitted to exceed the limits as shown in Table 1 for 5% of blasts per year, with an upper limit to be 120dBL for blast over pressure and 10 mm/s for peak component particle velocity. However, blasts will be limited to an average of 4 blasts per year for the life of the quarry, hence at no times can the blast exceed the criteria as presented in **Table 1**.

3.2 Monitored Ground Vibration and Airblast Overpressure Limits from Trial Blast

A trial blast was undertaken in 1996 for Kyogle Council and this blast was monitored at two locations at approximately 400 m and 600 m from the blast site. The trial blast was undertaken by Ron Southon P/L and the monitoring sheets are provided in Appendix A report.

The details of this blast are summarised as follows:

Date of blast:	18th June, 1996
Total explosives:	1350 kg (ANFO 1300 kg and Emulite 50 kg)
Max. Instantaneous charge:	18.5 kg
Number of holes:	83 total
Average depth:	6 m
Stemming depth:	2.3 m
Total cubic metres:	1935 m³
Area:	387 m²

The blast was monitored at the nearest residences, being at the corner of Ettrick Road and Edenville Road and Receptor 2. The results from the test blast are presented in Table 2.

Table 2: Results of 1996 Trial Blast

Parameter	LOCATION	
	Corner Ettrick and Edenville Road	**Receptor 2**
Distance from Trial Blast (m)	600	400
Peak Particle Velocity (mm/s)	0.25	1.7
Air Overpressure (dBL)	107.5	114

3.3 Prediction of Ground Vibration and Airblast Overpressure Limits at nearest receptors

It is proposed that there will be up to four blasts per year, which will obtain sufficient material to permit the processing of product to occur through the year as required. It is estimated that for four blasts a year.

The proposal for the site will be as per the following:

Hole depth:	6 m (will be variable on benching requirements)
Hole diameter:	89 mm
Stemming depth:	Burden Height to be equivalent to stemming height
Stemming material:	10 mm aggregate or as specified in Specific Blast Design
Typical area of blast:	800 m²

When available, blasts are to be executed from a free face, with adequate burden coverage to the face.

Calculations are undertaken based on information from AS 2187.2-2006, which has been correlated with the site specific information obtained from the trial blast undertaken in 1996 to ensure that the theoretical predictions are representative to the site. As there are difficulties in predicting a blast due to variability of weather conditions, bedrock characteristics, moisture content etc, calculations have been performed based on typical constants and alternative constants to be site specific.

3.3.1 Ground Vibration

Ground vibration being the peak particle velocity was monitored during the trial blast of 1996 at the two locations as presented in Table 2, the results were 0.25 and 1.7 mm/s at 600 m from the site and at Receptor 2 respectively.

AS 2187.2 -2006 provides an estimate for ground vibration based on the following equation:

$$\mathbf{V = K_g (R/Q^{1/2})^{-B}}$$

Where:

V = Ground vibration as vector peak particle velocity, in millimetres per second

R = distance between charge and point of measurement in metres

Q = Maximum instantaneous charge (effective charge mass per delay), in kilograms

$\mathbf{K_g}$ and **B** = constants related to site and rock properties. In 'average' conditions $\mathbf{K_g}$ is **1140** and **B** is **1.6**

Vibration can vary from 0.4 to four times the estimations, which is based on variability such as rock type, blasting methods and weather conditions.

The following calculations use the data from the trial blast in order to predict the ground vibration at the nearest receptors.

Predicted Vibration of Trial Blast using Default Constants on Receptor

R = 400 m (distance)

Q = 18.5 kg (MIC)

K_g and B = K_g is 1140 and B is 1.6

$$V = 1140 (400/18.5^{1/2})^{-1.6} \quad \textit{Equation 1}$$

= 0.81 mm/second

As noted, the actual recorded result during the trial blast was **1.7 mm/second**, hence it is considered that the default constant is not appropriate to be used, and the following equation uses modified constants.

Predicted Vibration of Trial Blast using Adjusted Constants on Receptor

Literature presents that k_g of 5000 is more suitable for heavily confined blasting sites.

Therefore, changing the constants of $\mathbf{K_g}$ to **5000** and **B** to **1.76** will provide the following:

R = 400 m (distance)

Q = 18.5 kg (MIC)

K_g and B = K_g is 5000 and B is 1.76

$$V = 5000 (400/18.5^{1/2})^{-1.76} \quad \textit{Equation 2}$$

= **1.71 mm/second**

Therefore, this estimate correlates well with the monitored result of 1.7 mm/s.

The calculation is repeated for the other monitored location being 600 m from the trial blast site:

R = 600 m (distance)

Q = 18.5 kg (MIC)

K_g and B = K_g is 5000 and B is 1.76

V = $5000\ (600/18.5^{1/2})^{-1.76}$ *Equation 3*

= **0.84 mm/second**

Actual result was **0.25** mm/second

Altering constant B to 2 would result in the measured result of 0.25, however, this would result in a lower estimate for Receptor 2. In order to be conservative, it is considered that the constants shall be **K_g 5000** and **B 1.76**, which are used for estimating the potential impact on the nearest receptors.

It is noted that the maximum instantaneous charge (MIC) used in the trial blast is relative to the size of the blast being the amount of product won, and hence it is expected that the MIC will increase for future blasts at the site in order to yield more product.

The calculated peak particle vibration is further governed by the distance to the blast and the MIC. Scenarios are provided in Table 3 presenting maximum permitted MIC to achieve the vibration limit of 5 mm/second.

Table 3: MIC loading Limit for Compliance of 5 mm/S Peak Particle Vibration

Receptor No.	Distance from proposed blast site to receptor (m)	MIC (kg)
3	265	20.7
2	330	32
1	500	73.9
4	550	89
N/A	800	189

NB Table 3 is for PPV only and has not addressed Overpressure Limitations

3.3.2 Airblast Overpressure

Airblast overpressure was also monitored during the trial blast of 1996 at the two locations as presented in Table 2. These results were 107.5 dB(L) and 114 dB(L) at 600 m from the site and at Receptor 2 respectively.

AS 2187.2 -2006 provides an estimate for airblast overpressure based on the following equation:

$$\mathbf{P = K_a\,(R/Q^{1/3})^{a}}$$

Where:

V = pressure, in kilopascals

Q = explosives charge mass, in kilograms (MIC)

R = distance between charge and point of measurement in metres

K_a = site constant

a = site exponent

For unconfined surfaces and when not affected by meteorological conditions, AS 2187.2-2006 states that a site exponent **(a)** of **-1.45** and the site constant **(K_a)** in the range of 10 to 100.

Predicted Airblast Overpressure of Trial Blast using Constants on Receptor

Q	=	18.5 kg
R	=	400 m
K_a	=	10
a	=	-1.45

P	=	$10\ (400/18.5^{1/3})^{-1.45}$	*Equation 4*
	=	0.0069 kPA	
	=	110.8 dB (SPL)	

Actual result was **114 mm/second,** therefore the constants will be modified to provide similar result to the monitored overpressure as shown in the equations below.

It is noted that conversion of pressure from kPA to dB is by the following equation:

$$Lp = 10 \log(p^2 / p_{ref}^2) = 10 \log(p / p_{ref})^2 = 20 \log (p / p_{ref})$$

Where:

L_p	=	sound pressure level (dB)
p	=	sound pressure (Pa)
pref	=	$2\ 10^{-5}$ reference sound pressure (Pa)

Predicted Airblast Overpressure using Adjusted Constants on Receptor
Therefore, changing the site exponent to **-1.4** will provide the following:

Q	=	18.5 kg
R	=	400 m
K_a	=	10
a	=	**-1.4**

P	=	$10\ (400/18.5^{1/3})^{-1.92}$	*Equation 5*
	=	0.0088 kPA	
	=	**113 dB**	

This is repeated for the other monitored location being 600 m from the trial blast site:

Q	=	18.5 kg
R	=	600 m
K_a	=	10
a	=	-1.4

P	=	$10\ (600/18.5^{1/3})^{-1.4}$	*Equation 6*
	=	0.005 kPA	
	=	**108 dB (SPL)**	

Actual result was 107.5 dBL, therefore it is considered that these figures are suitable to use for site conditions.

These will vary due to free face becoming available and with meteorological conditions therefore it is recommended that remodeling be undertaken as part of the updates to the Operational Plan of Management as required with the additional data that will be obtained from future blasts.

The calculated peak blast overpressure is further governed by the distance to the blast and the MIC. Scenarios are provided in **Table 4** presenting maximum total mass of explosives to achieve the overpressure limit of 115 dB.

Table 4: Explosive MIC Limit for Compliance of 115 dB Airblast Overpressure

Receptor No.	Distance from proposed blast site to receptor (m)	MIC (kg)
3	265	8.9
2	330	17.3
1	500	59.9
4	550	79.8
N/A	800	189

NB Table 4 is for Overpressure only and has not addressed PPV Limitations

3.3.3 Limitations for Blasting Criteria

The assessment from Sections 3.3.1 and 3.3.2 have presented the MIC limited to the peak particle velocity 5 mm/s and airblast overpressure 115 dB respectively.

The following table presents the maximum limit of MIC to ensure that compliance for both of the criterions are achieved for the receptors.

Table 5: Explosive MIC Limit for Compliance of AS 2187-2

Receptor No.	Distance from proposed blast site to receptor (m)	MIC (kg)	Overpressure (dB)	PPV (mm/s)
3	265	8.9	115	2.4
2	330	17.3	115	2.9
1	500	59.9	115	4.2
4	550	79.8	115	4.5
N/A	800	189	114	5

Table 5 presents that all blasts are to be individually assessed in terms of potential impact on the nearest receptors from overpressure and vibration, hence it is recommended that the MIC be reduced accordingly to ensure compliance with the acceptable limits, as well as adjusting the blast design to suit other conditions that may affect results, including but not limited to:

- Weather – temperature inversions;
- wind and cloud;
- blast location – constrained or near free face;
- Amount of overburden present;
- Stemming depths;
- Blasthole diameter

4.0 FLYROCK MANAGEMENT

Flyrock from blasting can result in fatalities. Flyrock is caused from expanding gases in the blasthole explosion pushing to the area of the least resistance, such as free faces or weak rock, rock fractures or weathered material, which results in the fractured rock being pushed for long distances.

It is expected that flyrock control will be more difficult at the subject site in the initial stages where blasting is required on the surface, as no free face is offered.

The following factors are considerations to be undertaken for the blast design in order minimise flyrock:

- Blast pattern;
- Burden depth and type;
- Drill hole depth, diameter and angle;
- Delay systems, powder factor, and MIC;
- Explosive material used; and
- Stemming depth and material used.

4.1 Stemming

Stemming material in conjunction with other best practice techniques is required to be used in order to reduce the potential of flyrock. The stemming material is to consist of evenly sized rocks in order to reduce the blast gas.

Short holes can lead to overcharging and digging problems, whilst overcharged blastholes can cause fly and airblast hazards.

In accordance with AS 2187.2 – 2006 the required stemming height is to be either:

- Equal to or greater than the burden; or
- 25 times the basthole diameter

4.2 Cover

Flyrock may be able to be reduced with adequate cover, such as overburden. It is noted that at this site the rock appears as outcrops or is located at a shallow depth. Therefore, blasting mats and backfill is required to be in place at adequate depths. The blast design plan is required to present the proposed cover. Adequate burden depth will also be required when free faces are established at the site in order to reduce fly rock caused from fracturing the rock face.

4.3 Limiting Explosive Weight

Limiting explosive weight per delay can also reduce potential flyrock. Limited explosive weight is required to reduce potential noise and vibration as discussed in Section 3 when the blasting occurs at certain distances from residences, but further reduction may be required if adequate cover or stemming can not be achieved. The hole diameter will also govern the weight of explosives used, therefore limiting diameter will reduce fly rock.

4.4 Flyrock Management

Flyrock management us required to be undertaken at this site due to the proximity to the public road and private residences. A blast design is required to be prepared prior to any blast that is undertaken at the site, in accordance with AS 2187.2 – 2006.

A summary of measurements to be undertaken to reduce the potential of flyrock is as follows:

- Reduce quantity of explosives;
- Increase stemming height;
- Use of overburden;
- Use of blast mats.

5.0 BLAST MANAGEMENT REQUIREMENTS

A summary of the following requirements is to be undertaken to ensure best practice is undertaken for each blast at the site:

- Blasting to be in accordance with AS 2187.2 – 2006 and as modified;
- Blasting design plan should be prepared prior to each blast upon examination of the proposed blast site by the blasting contractor;
- Blast design may alter for each blast, such as change burden and spacing by altering drilling pattern and/or delay layout, alter hole inclination;
- Assess weather conditions at the time of the blast (avoid heavy cloud cover and avoid firing if a strong wind is blowing towards residences. In particular, avoid days of severe temperature inversion).
- Reducing maximum instantaneous charge (MIC);
- Ensure stemming is adequate.
- Eliminate exposed detonating cord (cover with at least 300mm of road base).
- Eliminate secondary blasting. Also, make extra efforts to eliminate the need for toe shots, (e.g. better control of drill patterns).
- Reduced hole diameter and/or deck loading to the minimum possible loading;
- Use of evenly distributed stemming material;
- Ensuring that broken lumps and excessive humps are removed prior to the firing of the main blastholes;
- Use mats and overburden to reduce flyrock;
- Exercising strict control over the spacing and orientation of all blast drill holes and use of the minimum practicable sub-drilling which gives satisfactory toe conditions;
- Ensure that the holes are spaced in such a manner that the explosive force is just sufficient to break the stone to the required size.
- Accurate records are to be maintained for each blast, which present:
    - Blast location;
    - Date and time of blast;
    - Names of personnel
    - Number of blastholes
    - Quantity of explosive in each blasthole
    - Maximum instantaneous charge (MIC) (kg);
    - Blast design, explosives and initiating system used;
    - Face survey information indicating proximity of the nearest blastholes to any free faces within the blast
    - Structures (artificial or natural) that may be affected by the blast

- Location of the measurement equipment;
- Peak Component Particle Velocity (mm/s) is to be recorded for the ground vibration at closest receptor(s);
- Airblast measurement at closest receptor(s) in dB(L) (linear scale);
- Measurement equipment used to be in accordance with Section J3.2.1 and J3.3.1 of AS 2187.2-2006 or as approved by the regulatory authority
- Weather conditions (wind speed, cloud cover, rain and other notable conditions)

6.0 CONCLUSIONS

The preliminary blasting assessment has been undertaken for the proposed quarry at Cedar Point on Lot 1 DP 366036 and Lot 12 DP 582916, Edenville Road, Cedar Point.

A trial blast was undertaken in 1996 which was monitored at two locations for peak particle velocity and airblast overpressure. The data from this assessment was used to calibrate the calculations to predict potential impacts on the nearest receptors from the proposed blasting at the quarry.

It is concluded that blasting can be undertaken at the site which would not exceed the acceptable criteria of 115 dB(L) for airblast overpressure or 5 mm/s for vibration at the nearest residences provided that the best practice techniques as outlined in this report are undertaken and work is carried out in accordance with AS 2178.2 -2006 or as approved by the regulatory authority. An outline of the management practices to reduce flyrock is also provided, which correlates with the reduction of vibration and airblast overpressure, such as minimising the weight of MIC and minimising blasthole diameter.

All blasts are required to be monitored for both overpressure and vibration at the nearest receptor. A blast design plan is required prior to any blast at the site, with all blasts to be in accordance AS 2187-2006.

APPENDIX A - TRIAL BLAST LOG RECORD SHEET

RON SOUTHON PTY. LIMITED

Drilling & Blasting Contractors

A.C.N. 067 549 003

P.O. Box 43, Alstonville, NSW 2477
Phone: (066) 280 477, Fax: (066) 281 756
Mobile Phone: 018 666 242

BLAST SUMMARY RECORD

Customer: Kugala Shire C/o Mark Smith

Date: 18 / 6 / 96 Time: 2.26 pm.

Quarry: Carlill Quarry

Position in Quarry: First blast

Elect: Nonel. Delay Nos: 17 m/s & 42 m/s.

No of Holes per Delay: 1 Mic: 18.5 kgs.

Total Exp: 1350 kgs.

P.F: 0.69 Stemming: 2.3 m.

Pattern: 2.4 x 2.4 Hole Size: 89 mm.

No of Holes 72 + 21 Depth/Range: 6m. - 4m.

Avg. Depth of Holes: 6m + 4m Total Lin. Metres: 432 + 84 = 516

Measurements (m3):

Total Cubic Metres: 1935 m³

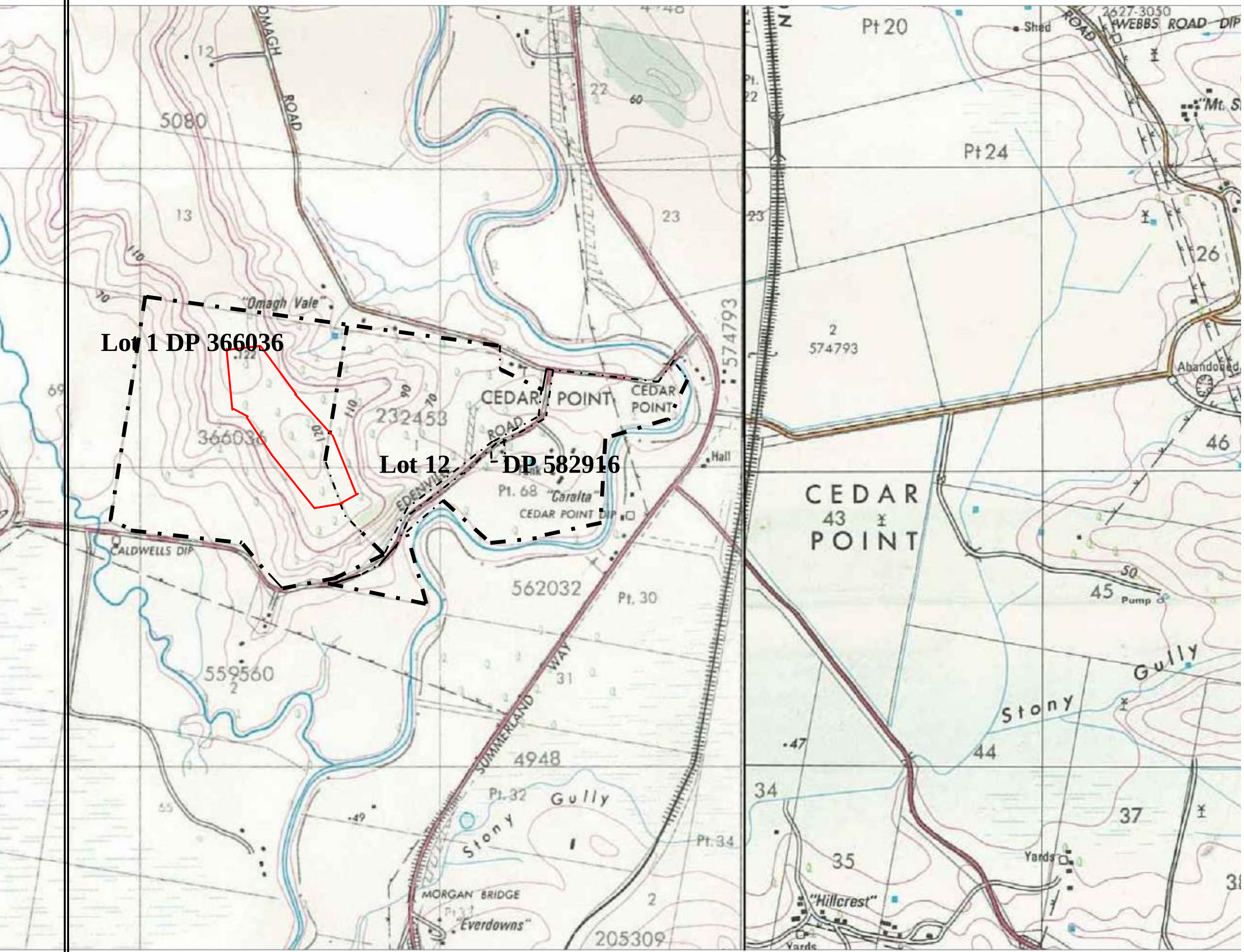
Payment: Lineal ☑ Cubic ☐

EXPLOSIVES Explosive Type		Total Explosives Used (kg)	
Dry	ANFO	Dry	1300 kgs.
Wet	EMULITE	Wet	50 kgs
		Total	1350 kgs

GROUND AND AIR VIBRATION

Peak Particle Velocity (mm/s)	1.669 mm/s	0.25 mm/s.
Air Overpressure (dBL)	114 dbs	107.5 dbs
Distance to Geophone (m)	400m.	600m approx

Compiled by: Glen Turley.



Greg Alderson and Associates Pty Ltd. **ABN 60 059 559 858** Scarrabelottis Road Nashua NSW 2479 Phone: (02) 6629 1552	Drawing Title: **SITE LOCATION** **Lot1 DP 366036 & Lot 12 DP 582916, Edenville Road, Cedar Point**

Source: Ettrick 9440-I-S CMA 1979	:	Project No. **09094_BIA**	Sheet No. **Exhibit No. 1.**
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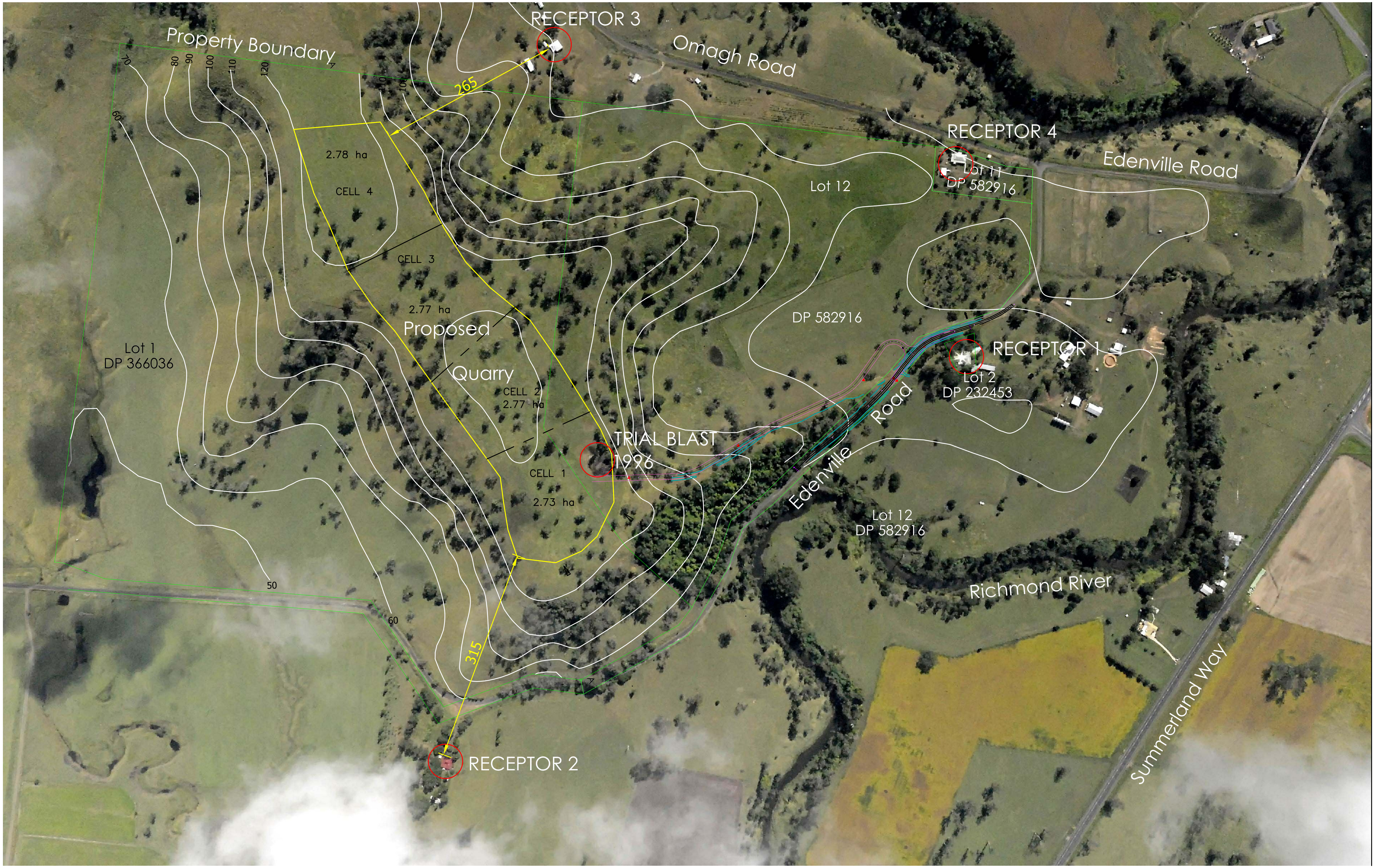

Date: 5-4-12
Scale: 1:500 @ A3
Drawn: WAA
Source: Google Maps, Wade Engineering Surveying and Ettrick 9440-I-S
Drawing file: 09094 quarry_BLAST.dwg

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EXHIBIT 2
RECEPTOR LOCATION AND PROPOSED QUARRY

LOT 1 DP 366036 AND LOT 12 DP 582916
EDENVILLE ROAD, CEDAR POINT

Job No. 09094

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