Appendix 1

SHENTON RIDGE PROPOSED QUARRY SITE.
GEOLOGICAL RECONNAISSANCE

by

C.F. Swindells

September 1982

INTRODUCTION:

Following a request from R J Griffin, District Inspector, State Mining Engineers Branch, geological reconnaissance of a potential quarry site at Shenton Ridge (4km from the Coalfields Highway) was carried out on 4/8/82. Prior to the visit a trial production blast had been performed at the site, exposing freshly broken bedrock.

GEOLOGICAL CONDITIONS

The area lies within the Collie 1:250 000 sheet. The underlying rock throughout the Collie area is largely obscurred by superficial deposits of laterite, colluvium and alluvium. The plateau areas are generally laterite capped and locally deeply weathered.

Suitable rock for quarrying is mainly restricted to steeper slopes, with felsic and mafic rocks being suitable. The felsic rocks include granite and granitic gneiss where as the mafic comprise meta-dolerite granofels and amphibolite. Operating quarries at Roelands and Fernbrook work both microcline rich granite gneiss (Fernbrook) and microcline gneiss, augen gneiss and amphibolite (Roelands). The geology of these sites, notably Roelands is structually complex.

Geological structures that can affect rock condition and quality include joints, shear zones and also in the case of the granitic rocks of the Collie area, the gneissic foliation. Joints are generally more widely spaced in the felsic rocks than in the mafic rocks, however local zones of higher joint intensity can be present. The gneissic foliation does not always form planes of breakage when quarried, particularly in fresh rock. However, thicker mica rich layers may control fracturing in the quarried rock, particularly if the zones are weathered.

SITE GEOLOGY

The geological plan (Fig. 1), based on the 1:250 000 Collie geological map, shows the regional geology in the area of the proposed quarry. The local geology shows outcrops of mica rich granitic gneiss, overlain by gravelly laterite. In general the outcrops are of fresh granitic gneiss, locally with stained joints. However areas of completely weathered in situ granitic gneiss are present to the east and north-west of the proposed quarry site. The depth of any weathering in the gneiss is not known, further investigation was beyond the scope of the brief field inspection. The geology of the quarry site is given in Figure 2.

Many of the outcrops have curved surfaces suggestive of large scale sheet joints - such joint surfaces extend, with gentle dips of 15-25°, over several m^2. These joint surfaces are often cut by steeply dipping joints both sub-parallel (dip 60-80° N, strike 095°) and broadly normal (dip 55-80°E and W, strike 350-025°) to the foliation in the granitic gneiss. The regional foliation in the granite dips 75-80° W and strikes approximately 070°. Joint spacing is variable between 0.1 and > 1.5 metres.

The trial blast has exposed good quality, unweathered granitic gneiss (Fig. 3). The gneiss contains a local foliation defined by micaceous rich layers. These often coarse grained mica layers (individual micas to 15 mm) form layers up to 20 cms thick. The stock pile of blasted material comprises a range of flakey to blocky fragments of rock (Fig. 4) up to 15 m^3. Whilst a range in fragment sizes and shapes has been produced in general, the larger and more cuboidal blocks are a product of the granitic gneiss and contain sparce or poorly defined micaceous foliation. Locally both the micaceous layering and jointing have controlled rock breakage, however, in the more massive parts of the granitic gneiss breakage is independent of the micaceous foliation.

The strength of the blasted rock was measured using a Schmidt hammer, which determines the rebound hardness of a test material. The rebound number correlates with uniaxial compressive strength in both concrete and rock, when the dry density is taken into account. Strength values for the various rock types at the Shenton Ridge Quarry Site are given in Table 1.

TABLE 1. Uniaxial Compressive strengths, derived from Schmidt Rebound values, Shenton Ridge Quarry site.

Rock Type	Mean Uniaxial Compressive Strength	Range in St. value
Granite gneiss outcrop	100± 40 Mn/m^2	52-200 Mn/m^2
Quartz rich gneiss (blasted rock)	95± 40 Mn/m^2	48-155 Mn/m^2
Micaceous banding (blasted rock)	35± 20 Mn/m^2	17.5-145 Mn/m^2

* derived assuming a rock density of 2.7 kN/m^3

The strength values for the gneiss outcrop and quartz rich blasted rock are typical of rock classified in the range as very high strength to extremely high strength. The micaceous foliation yields values in the range low to medium strength.

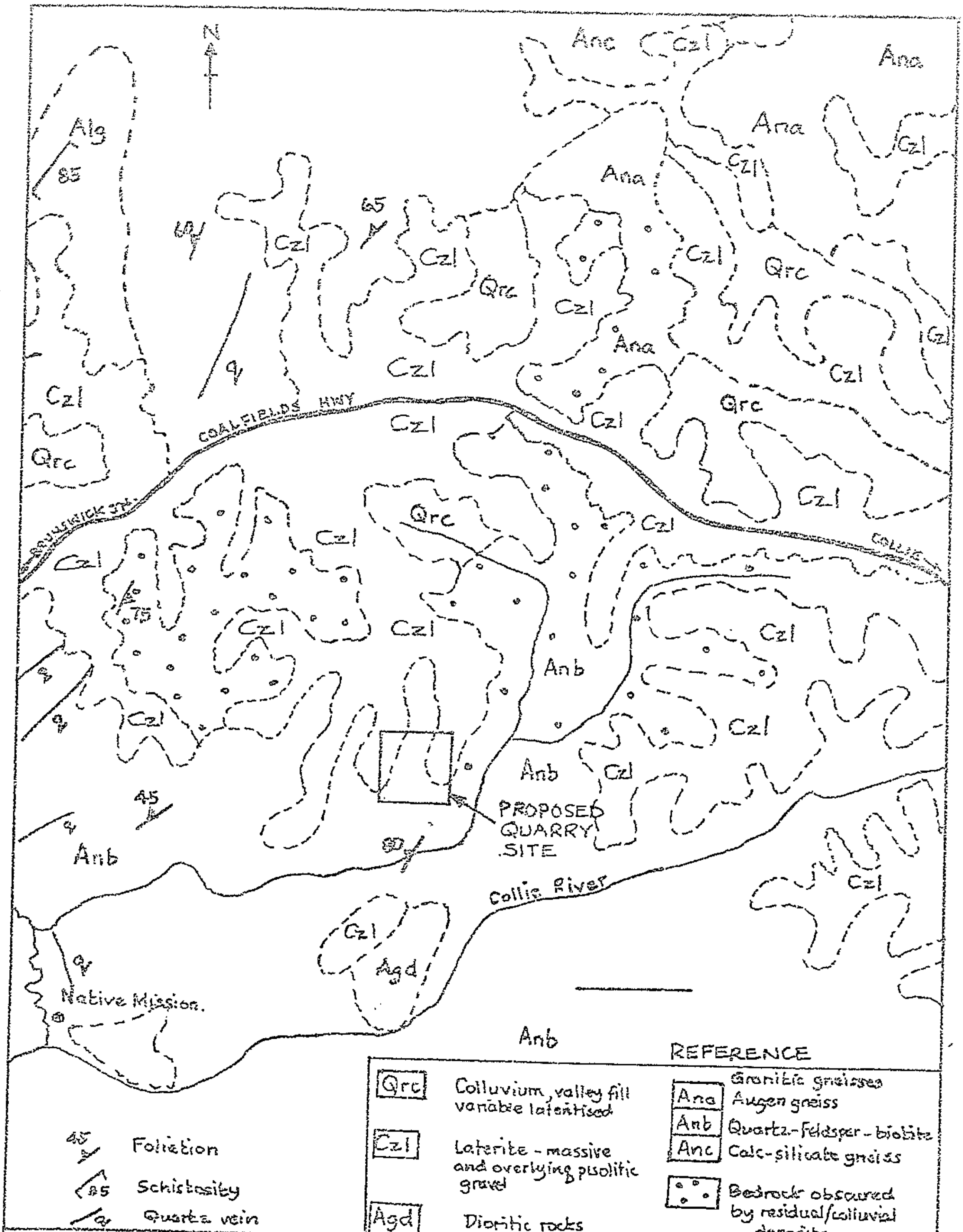
CONCLUSIONS

(1) Good quality, unweathered granitic gneiss has been exposed by the trial blast. The gneiss contains variable proportions of micaceous foliation.

(2) Jointing is sub-parallel and broadly normal to the foliation, with spacings of 0.1 m to > 1.5 m. Such jointing may well control the size of the blasted material.

(3) Locally the micaceous foliation has also controlled the breakage pattern of the rock, producing predominantly flakey fragment shapes. Such micaceous rich material will be less strong and more susceptible to weathering than the less micaceous granitic gneiss.

(4) The effects of jointing and/or the micaceous foliation may well reduce the quantities of blocky material produced, dependent on local variations within the rock mass.



GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

	Initial	Date
Comp	CFS	20/8/82
Drawn	CFS	20/8/82
Chkd		
Apvd		

FIGURE 1 :

GEOLOGY OF THE SHEATON RIDGE AREA

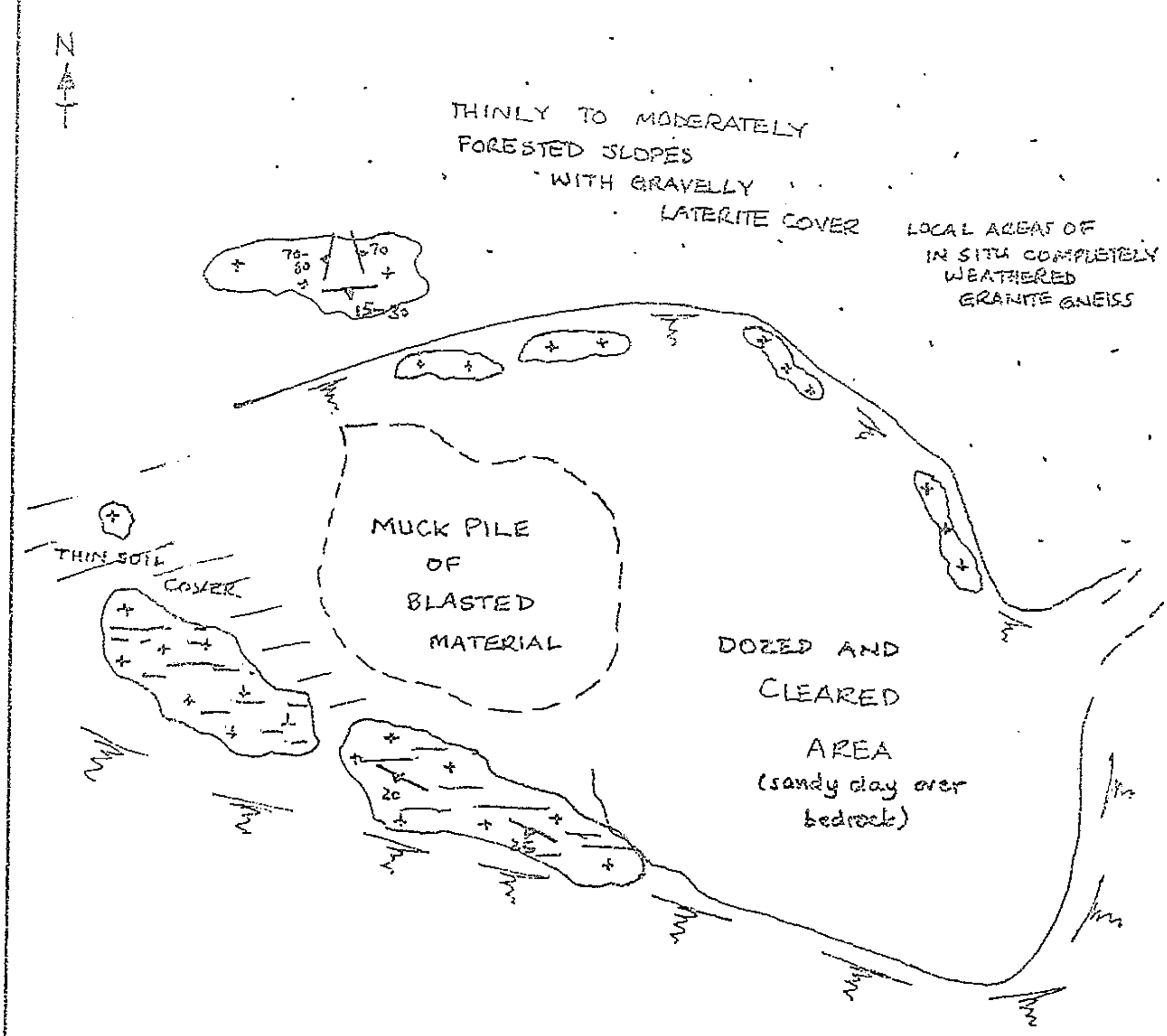
Map Index

SI 50-6 (2031 III)

To accompany GEOLOGICAL REPORT

GSWA 20158

81712/12/78-2,250-R72



REFERENCE

GRANITE GNEISS OUTCROP

20 JOINT

FOLIATION.

NOT DRAWN TO SCALE

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

	Initial	Date		
Comp	CFS	20/8/82	FIGURE 2 SHENTON RIDGE QUARRY SITE GEOLOGICAL PLAN	Map Index
Drawn	CFS	20/8/82		
Chkd				SI 50-6 (2031 III)
Apvd			To accompany GEOLOGICAL REPORT	GSWA 20159

81712/12/78-2,250-R72

FIG. 3: Part of the blasted rock pile showing unweathered granitic gneiss

Appendix 2

Blast Management Plan,

Lot 501, Coalfields Road,

Wellington

(Shenton Ridge)

March 2014

B and J CATALANO

Prepared by Landform Research

BLAST MANAGEMENT

1.0 Need for Blasting

There is a proposal to extract hard rock from Lot 501 Coalfields Road Wellington, in conjunction with an approved gravel extraction operation.

The whole site is underlain by the Granitoid rocks of the Boddington Terrane of Archaean age (Wilde 2001). The Boddington Terranne consists of granitic migmatites which have granitic composition but have lineations and some gneissosity, generally trending north.

A geological investigation of the resource was prepared by C F Swindells in 1992 who examined the quality and fracturing of the rock and its suitability for hard rock aggregates and construction products. A copy of that report is attached to the main report as Appendix 1. The rock was also reviewed by Lindsay Stephens of Landform Research.

The area selected for the pit is an existing small hard rock quarry, located low in the landscape, to provide visual and noise protection. The pit has been selected to be extended to the north if the demand justifies it, at a later stage.

2.0 Geology

The granitic rocks are described by Swindells 1982 which is appended to this report.

The resource is a light coloured fresh mica rich granitic gneiss that is highly suitable for aggregates, as discussed by Swindells.

The Mean uniaxial compressive strength is 95 – 100 Mn/m2. Some minor micaceous bands have lower strength and will be selected and sorted during excavation.

The rock has curved surfaces suggestive of large scale sheet joints that are often steeply dipping and broadly normal to the foliation and gneissosity.

3.0 Discussion of Blasting Techniques

Blasting is used to break the rock from the face. This is achieved by drilling holes into the rock in a defined pattern. The holes are then filled with explosive and capped. An electric detonator is used to remotely detonate the charge by triggering the chemical reaction within the explosive. This produces a very large volume of gas in a very short time which places pressure on the sides of the drill hole, fracturing and breaking the adjoining rock.

Blasts are normally designed in a rectangular pattern of multiple holes that are fired with milli-second delays in a particular pattern that lifts and pushes the rock from the face in a sequence. The pattern of blasting can be designed to maximise the production of a certain sized rock fragment which can assist in reducing the amount of crushing or secondary breaking that is required.

Blast impacts consist of air blast overpressure and ground vibration. Ground vibration tends to push back into the face whereas airblast is an air pressure wave that emanates forwards out into the quarry, usually in the opposite direction to ground vibration. Both ground vibration and air blast spread out in a spherical manner and, with the same impact spreading out in an increasingly large volume or area, both dissipate quickly with distance.

For ground vibration there is also normally a distinct drop off of impact with distance, although occasionally the geology can reduce this drop off impact under certain conditions or may even lead to an enhancement of ground vibration. There are certain situations such as a particular geological structure or land surface that may lead to an impact travelling further in one direction than another.

On this site, with the quarry located on a south facing spur and the rocks striking north, there may be a possibility that ground vibration will travel further north than east or west. As blasting will be conducted on a northern face, southern travel of ground vibration is less likely.

Generally there is a distinct drop off of blast effects with distance. This is most pronounced with airblast. However there can be times when airblast carries further, such as the direction of the blast, or under conditions when the airblast is restrained such as under a temperature inversion.

The nature of the blast in terms of the degree of fracturing of the rock to be moved, the orientation of the face, the size of the blast and the weather conditions can all influence the potential impact of a blast. Therefore it is not uncommon for each blast to appear different in character.

Therefore potential blast impacts consist of air blast overpressure and ground vibration.

Changes to the blast levels of air blast overpressure and ground vibration, received at a particular sensor, depend on which face is being excavated.

With progress of the proposed pit, and the orientation of the face, it can be expected that when the northern face is fired, airblast will have a greater tendency to travel south. Ground vibration from the northern face blast will have a greater tendency to travel north.

Sometimes it is difficult for residents to distinguish between air blast or ground vibration because both can make windows rattle under certain conditions. The Statutory Blast limits are set at levels that will not lead to structural impacts but yet may still be heard.

Therefore monitoring of blast impacts is undertaken to provide better design of the succeeding blasts and better management of potential impacts.

Trial Blast

In 1982 a trial blast was conducted. This was found by Swindells to produce good quality fresh granitic rock that was separated into blocks by micaceous layers and jointing.

The rock was tested by Swindells and found to vary in mean uniaxial strength from 100 +/- 40 Mn/m^2 for fresh granite to 95 +/- 40 Mn/m^2 for quartz rich gneiss with much lower results for the micaceous banding.

4.0 Normal Blasting Procedures used at Quarries

Blasting today is much better understood and controlled than previously, with good control of blast design, strength of the blast and potential impacts.

Nowadays consultants and good operators are able to closely predict the likely implications after several test blasts, and design the drilling and blasting pattern accordingly. This will be undertaken on this site. A trial blast was undertaken in 1982 but techniques are significantly better today and additional trial blasting will be required using modern techniques.

Blasts are designed with millisecond delays so they do not go off with one bang but are sequential and provide heave to the rock. The blast also has to be designed to provide the correct fracturing and the desired rock size for the purpose.

However normal procedure is to undertake several test blasts and monitor the blast levels. From the data, adjustments, as necessary, can be made to the drilling and blasting pattern.

Considering the distances, and the geology as known, it is unlikely that any blast will have significant impact on sensitive premises. In any event the blast design can be used to mitigate any such impacts.

Mitigation can, for example, include which face is fired, the design of the excavation, the amount of rock fired, the depth of drill holes, the spacings of the drill patterns, the number of blasts, time of firing and the time delay patterns.

Explosives will not be stored on quarry site, but will be brought to site as required. The materials commonly used are fertiliser and petroleum substances that only become explosive when mixed in a particular ratio and manner and when triggered by a detonator in an enclosed situation. Detonators will be brought to site as required for each blast.

Explosives management procedures are required. People using explosives are required to hold a Shotfirer's Licence through the Department of Mines and Petroleum.

5.0 Regulation

Blasting noise (airblast overpressure) is controlled by the Department of Environment Regulation under the *Environmental Protection (Noise) Regulations 1997.*

The Environmental Protection (*Noise Regulations 1997*) were changed on 5 December 2013, *Environmental Protection (Noise) Amendment Regulations 2013 – gazetted on 5 December 2013*, and state that no blast should exceed 120 dB for a sensitive premises and 125 dB for a non sensitive location. In addition nine in every 10 consecutive blasts are required to be below 115 dB for a sensitive premises and 120 dB for a non sensitive premises. These levels do not appear to apply when a person is not present at the receiving premises.

Prior to 5 December 2013 the levels of air blast were 5 dB higher.

AS2187 Explosives Storage Transport and Use also provides control on the transport, storage and use of explosives. Storage and Transport and use of explosives is controlled by the Department of Mines and Petroleum and there are several Guidelines and Regulations relating to them, for example *Dangerous Goods Handling and Storage Regulations 1992.*

Blasting controls are also covered by *the Mines Safety and Inspection Act 1994 and Regulations 1995.* These are now covered by compliance with *Australian Standard AS2187 Explosives Storage Transport and Use.*

DER Licence requirements normally require blasts to comply with 9 out of 10 blasts below 5mm/sec with none above 10mm/sec. Where peak particle velocity exceeds 5mm/sec, notification of the Director of the DER is normally required within 24 hours.

Even though the Statutory Blast limits are set at levels that will not lead to structural impacts they may still be heard or felt.

Ground vibration is often set in Western Australia at 5mm/s with only one in every 10 consecutive blasts being permitted above that level. The Australian Standard for dwellings is 10mm/s for which no blast is to exceed.

6.0 Proposed Blast Methodology

When blasting is required, a section of the face will be pattern drilled and then blasted with explosives. Millisecond delays are used on all blasts to reduce both the air blast over-pressure and the ground vibration.

All drilling equipment will be fitted with noise suppression features and regularly checked to ensure compliance with all safety standards.

No explosives are to be kept on site. They will be brought to site as required by the explosives contractor.

Consultants will design the blasts in conjunction with Catalano staff, and the same consultants will monitor each blast and provide written documentation to the company.

The blast holes are to be located in the patterns and spacings, combined with blast design using various combinations of airdecks, charging and stemming to produce the best outcome with the least impact. The blasts will then be fired using millisecond delay detonators to reduce noise and ground vibration.

At the time of each blast, the weather conditions are to be recorded. The main weather conditions of concern are the wind speed and direction, and the possibility of a temperature inversion in the atmosphere, which may have the potential to reflect blast noise downwards.

To minimise these features the shots will be fired, wherever possible, around midday, when temperature inversions have broken up and when the wind is most commonly from the south west, blowing away from the main settled areas to the west of the quarry.

Blasting will be conducted below the surrounding level of the hills, located low in the landscape, with the adjoining ridges adding to the shielding of adjoining properties.

It is anticipated that blasting will be in the order of four times per year.

The Shire of Harvey and the nearest residences will be rung prior to each blast as a matter of courtesy.

A consultation program will be implemented prior to blasting as outlined in the Blast Management Plan in Appendix 3.

A complaints register will be maintained and all complaints will be investigated. As far as is known no complaints have been received within the last five years relating to noise.

7.0 Potential Blast Impacts

7.1 Number of Blasts Proposed

For normal operations it is anticipated that 50 000 – 100 000 tonnes of resource will be removed from the pit annually. It is anticipated that up to 4 blasts will be used per year, at least initially. When testing and opening the pit there may be several more smaller blasts.

However when the faces have been formed the number of blasts per year may reduce to two.

The design of the pit is summarised below. The figures attached to the main report should be consulted in relation to the location and design of the pit.

The pit will be operated with a series of northern faces and three x 10 metre operational benches. The height of the benches will depend on the mobile plant used and may eventually go to two x 15 metre benches if plant, safety and efficiency dictates. See Figures 3, 4, 5, 6A, 6B, 9 and 11.

Initially a northern face of 5 – 10 metres, will be established from the existing operational area. The elevation will be approximately 210 m AHD.

A 210 metre bench will enable the pit to be cut back to the north because the top of the spur is at an elevation of 220 – 222 metres AHD. The first bench and northern face will be cut to the northern extremity of the pit.

This will take a floor east west across the spur. From there the excavation face will be work north to near the northern end of the existing operational area.

A new bench and northern face will then be formed at an elevation of 200 metres AHD, cut to the northern extremity with a bench retained for future access and stability.

The next bench will be 190 metres AHD. After the 190 m bench, which is anticipated to take more than ten years, excavation will then jump back to the north in another sequence of benches.

7.2 Compliance of Blasts - Dwellings

The existing land uses of the area surrounding the quarry have not changed within the time the gravel excavation has been operating.

The land to the east, north and south is pasture with mainly grazing activities. Forest lies to the east and plantation forest to the west. Gravel extraction has been approved on Lot 501 for the past 4 years.

The only nearby dwellings are isolated and a significant distance from the site. There is a cluster of sensitive premises to the south west.

The closest dwellings are;

Dwelling to south Lot 28	2800 metres from pit 3500 metres from crusher	Will probably be able to see the pit and the crushing area
Dwelling to north east Lot 23	3200 metres from pit 2480 metres from crusher	Located behind ridge
Dwelling to the west Lot 17	2690 metres from pit 2530 metres from crusher	Generally located behind ridge
Sensitive premises to the south west Lot 29	2800 metres from pit 3500 metres from crusher	The pit appears to be located behind the landform. The processing area is higher but also appears likely to be protected by landform
Building. Dwelling/shed Lot 5	2550 metres to the north west	Protected by landform and the intervening ridge.
Shed? Lot 17	2600 metres north from processing area	Protected by landform and the intervening ridge

Other dwellings are further away, protected by landform. See Figure 2. Section lines from the dwellings are shown in Figures 8A to 8D.

There have been some initial community concerns with respect to the gravel crushing operation. These relate to erosion and have now been addressed through contouring and pasture establishment.

7.3 Existing Quarry data

B and J Catalano is a large company which has extensive experience in extraction of basic raw materials and quarries, and in particular the removal of laterite duricrust.

They will use the assistance of consultants to plan the quarry and design the blasting and operation of the hard rock quarry.

Some background on current quarrying in Western Australia will illustrate how this site matches other hard rock quarries and the risk that may apply from blasting.

Other major hard rock quarries are located at much closer distances to dwellings than this quarry. For example, WA Bluemetal, Byford, Hanson at Byford, Boral at Orange Grove, Hanson at Red Hill and Holcim at Gosnells.

In fact the proposed quarry will have some of the largest buffers to any hard rock quarry. The examples below illustrate how well blasting is now understood and the minimal impacts that can be designed for. Lindsay Stephens of Landform Research is familiar with all the examples below and worked in some capacity on those quarries.

For example the closest dwellings to Boral quarry at Orange Grove are located 500 metres from the active face. Boral (orange Grove) is a major hard rock quarry producing perhaps ten times the amount of rock annually that this quarry is to produce and yet all blasts are well within compliance.

At Esperance the buffer available when the Port of Esperance was expanded in 2001 – 2002 was very small. The quarry produced rock for the break water construction and the contractor monitored all blasts. There were 399 blasts, all in compliance with the Regulations/ Standards, with the closest dwelling being as close as 220 metres from one edge of the quarry.

At Hanson Mt Barker Quarry the nearest dwelling is 120 metres from the closest face, there is a second dwelling at 300 metres and other dwellings at 700 metres. Blasting is within compliance.

At Bunbury the closest dwellings to the Hanson Quarry are 600 metres. The closest distance from Holcim Quarry at Gelorup is 250 metres. Again blasting is in compliance.

At Byford, the Hanson and WA Bluemetal Quarries have dwellings at 800 metres. Blast levels are also in compliance.

Compared to the distances available for this proposed quarry, in excess of 2.5 km to all dwellings the risks are considered to be minimal to nil with effective design and management of blasting.

The above quarries, like all such operations, comply with the *Environmental Protection (Noise) Regulations 1997* for air pressure and *Australian Standard AS2187 Explosives Storage Transport and Use* for ground vibration and illustrate the significant improvements that have taken place in blast technology, design and monitoring in recent years.

The main points demonstrated from the existing quarries is that blasting techniques today are very good and can be designed to minimise airblast and ground vibration at relatively small distances that would apply to the existing dwellings.

In addition the data shows that there is a large difference between isolated dwellings and a new urban or rural living development. For example the proposed quarry has only four isolated residences in the locality. This should be compared to urban land at Orange Grove, Esperance and Gelorup which are near the quarries in those locations.

For new blasting operations in hard rock the allocation of larger buffers is very prudent to prevent potential real or perceived landuse conflicts.

As discussed below a 1 000 metre buffer is recommended for this pit and is readily available.

7.4 Required Buffer

Even though some quarries have isolated dwellings and developed areas closer than 1 000 metres, this does not mean that buffers of less than 1 000 are recommended.

A study of the buffer requirements for the Gelorup Area was commissioned by the Western Australian Planning Commission; *Orica, 2001, Gelorup Basalt Quarry Buffer Study – Bunbury WA*.

Whilst the rock types are different, basalt versus hard schists with some dolerite and granite, the principles are the same. Orica concluded that it was likely that at distances of less than 1 000 compliance was likely to be able to be achieved and this has generally proven to be the case. There is a risk, that occasional blasts may exceed the recommended limits.

In 2000 the WAPC released the Greater Bunbury Region Scheme. In the Strategic Minerals and Basic Raw Materials Resource Policy of the Greater Bunbury Region Scheme, the WAPC nominated a 1 000 metre buffer referral area in Section 3.0 Application and Figure 1.

A number of other Government Policies relate to buffer distances and the protection of basic raw materials. State Planning Policy No 4.1, State Industrial Buffer Policy, (draft July 2004) discusses the need to consider adjoining land uses when locating buffers but does not prescribe set buffers for operations such as this.

EPA guidance No 3, "Separation Distances between Industrial and Sensitive Land Uses", June 2005 lists the generic buffers for hard rock quarries as 1000 metres depending on the extent of processing. A generic buffer relates to the distance at which there are unlikely to be any problems without some further investigations and does not mean that smaller buffers are not acceptable.

The proposed pit exceeds the generic buffers by substantial margins.

As is normal practice, blasting consultants are to be used to design and monitor blasts, to ensure that the most efficient, safe and environmentally sensitive blasting techniques are used. This is proposed for the Shenton Ridge Pit.

There is no means of definitively modeling blast impact prior to blasting occurring, because the geology cannot be intimately known until the quarry commences and faces of rock are exposed. However current knowledge of blasting has reached a level of sophistication that quarry operators and Blast Management Consultants can be confident that blasts can be designed and fired in compliance with the regulations and standards, and that potential impacts are minimised.

Normal practice when opening a quarry is to use small blasts to check compliance. When monitored results are available, and the first faces are exposed, the design of the blasts can be adjusted and increased, to the point where greater production efficiency is achieved whilst maintaining compliance and minimising any blast impacts on local residents.

Blasts at the large hard rock quarries in the south west of Western Australia are normally in the range of 95 to 115 dB for airblast and < 2mm/sec for ground vibration, at the monitoring stations which are normally located at the closest dwellings.

The existing hard rock quarries demonstrate that blasting can be managed within the buffer distances available. In addition B and J Catalano is committed to minimising any adverse impact on the existing local residents and will work with them to ensure a satisfactory outcome is achieved.

The buffer to dwellings is listed previously and shown in Figure 2 and in the sections in Figures 8A to 8D.

8.0 Management of Blasting

B and J Catalano is committed to minimising any risk of impact on local residents or structures and will ensure that the concerns of residents are noted and incorporated into all operational and blast procedures.

A number of mechanisms are available to minimize blast impact from airblast and ground vibration. These are summarised from *Orica, 2001, Gelorup Basalt Quarry Buffer Study – Bunbury WA* and current practices.

- Use smaller diameter drill holes.
- Reduce the height of benches.
- Use blast initiation sequences that drive away from areas of concern.
- Achieve the best firing time by delaying the blast, if necessary. This can raise other issues and is not always available.
- Increase stem lengths in blast holes.
- Splitting charges in half to reduce the kg of explosives per delay.
- Manipulate the delay sequences and point of initiation.
- Use greater front row burdens.
- Generate ground vibration reduction trenches, although this may not be possible in all situations on site.
- Firing more holes less frequently, because it is found the local people generally prefer less blasts rather than more blasts even if they are smaller.
- Use of pre-splitting or line drilling to create a smooth face and reduce impacts.
- Use of air decks to manipulate the blast.

The following Blast Management is proposed.

1. No explosives or detonators will be stored on site. Blasting materials will only be brought to site by a licensed supplier. The materials will be blended on site, only at the time of charging the blast holes; the same practice used in all hard rock quarries.

2. Catalano will inform the nearby residents prior to the commencement of blasting.

3. Catalano will undertake blasting in compliance with *Australian Standard 2187* which sets out good management practices and procedures for blasting.

4. Catalano will comply with the *Environmental Protection (Noise) Regulations 1997* for air blast over pressure and *Australian Standard AS2187 Explosives Storage Transport and Use* for ground vibration. They will also comply with any Department of Environmental Regulation Licences, if they condition blasting.

5. Blasting consultants will be used to design all blasts, to ensure that the most efficient, safe and environmentally sensitive blasting techniques are used.

6. All drilling equipment will be fitted with noise suppression devices and regularly checked to ensure compliance with all standards.

7. All blasts will be designed to heave the rock with millisecond delays in firing to reduce the impacts. This produces a slightly extended rumble rather than a loud bang.

8. There is potential to have smaller more frequent blasts or larger less frequent blasts. At other quarries residents prefer larger less frequent blasts and Catalano will use this procedure.

9. For each blast an assessment of the risks from fly rock will be made to determine what management is required for each individual blast for site operations.

10. All initial blasts will be monitored by a consultant. Later blasts will be monitored either by consultants or by Catalano staff under the supervision of consultants depending on the frequency of blasts.

11. Initial blasts will be small, with blast size increasing only gradually. The blasts will be monitored and the size of subsequent blasts will only be increased when Catalano and the consultants are confident that impacts of a larger blast can be maintained within the required levels.

12. Blast monitoring stations will be established at strategic locations around the pit, on Lot 501. The monitoring equipment will be rotated around the monitoring sites.

13. On this site, with the quarry located on a south facing spur and the rocks striking north, there may be a possibility that ground vibration will travel further north than east or west. As blasting will be conducted on a northern face, southern travel of ground vibration is less likely. Therefore, at this stage, it is anticipated that the main monitoring station will be located north of the pit along the ridge.

14. Initial monitoring will be conducted at two sites, but as the characteristics of the pit become better known, and bearing in mind the distances involved, it may be possible for one monitoring station to be representative of potential impacts. On the other hand there may be occasions when more monitoring stations are used.

15. Catalano will have in place an operational Blast Management Plan that will detail, among other procedures, that only a licensed Shotfirer will be permitted to use explosives, and the procedures for on site warning of an impending blast, traffic and road management. This will be based on an appropriate guideline such as *The Institute of Quarrying Australia, Explosives Management.*

16. A record will be kept of all blast monitoring and the weather conditions at the time of blasting.

17. Blasts will normally be conducted between 11.00 am and 2.00 pm.

18. During normal operations, the Shire of Harvey and any of the four closest residences who wish to be informed will be notified 24 hours prior to a blast occurring.

19. A complaints register will be maintained and all complaints will be investigated. Records will be kept of all complaints and the results of the investigations into those complaints.

Appendix 3

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PROPOSED HARD ROCK QUARRY
LOT 501 COALFIELDS ROAD
WELLINGTON

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CONTENTS

APPENDICIES

1. INTRODUCTION

Herring Storer Acoustics was commissioned by Landform Research to carry out an acoustical assessment of noise emissions from a proposed hard rock quarry located at Lot 501 Coalfields Road, Wellington. The objectives of the study were to:

- Determine, by modelling, noise propagation from the pit.
- Assess the predicted noise levels received at the neighbouring noise sensitive premises, for compliance with the *Environmental Protection (Noise) Regulations 1997*.
- If exceedances are predicted, investigate possible noise control options that will reduce noise emissions to achieve compliance with the regulations.

For information a locality plan is attached in Appendix A.

2. SUMMARY

It is understood that the pit would only operate during the day period, therefore, noise emissions from the pit need to comply with the assigned day period noise levels at the neighbouring residences. As shown on the locality plan attached, the closest residences to the pit operations are located to the west and south.

Given the location of the neighbouring residence, it is likely that noise received at these residence would be deemed not to contain any annoying characteristics, however to be conservative, the assessment includes a +5 dB(A) adjustment for tonality.

For the proposed operating hours, noise received at the neighbouring residence would, even with the inclusion of the +5 dB(A) penalty for a tonal component, comply with the requirements of the Environmental Protection (Noise) Regulations 1997.

3. CRITERIA

The *Environmental Protection (Noise) Regulations 1997* stipulate the allowable noise levels that can be received at a premise from other premises. The allowable noise level when received at a residence is determined by the calculations of an influencing factor, which is then added to base noise levels. In this case the influencing factor for the noise sensitive premises located around the quarry would be 0 dB. Therefore, the assigned noise levels for the neighbouring noise sensitive premises are listed in Table 1.

TABLE 1 - ASSIGNED NOISE LEVEL

Time of Day	Type of Assigned Noise Level		
	L_{A10}	L_{A1}	L_{max}
0700 - 1900 hours - Monday to Saturday (Day Period)	45	55	65
0900 - 1900 hours - Sunday & Public Holidays (Evening Period)	40	50	65
1900 - 2200 hours - All Days (Evening Period)	40	50	55
2200 - 0700 hours - Monday to Saturday (Night Period)	35	45	55
2200 - 0900 hours - Sunday & Public Holidays (Night Period)	35	45	55

Note: The L_{A10} noise level is the noise that is exceeded for 10% of the time.
The L_{A1} noise level is the noise that is exceeded for 1% of the time.
The L_{Amax} noise level is the maximum noise level recorded.

The assigned noise levels are also conditional on no annoying characteristics existing such as tonal components etc. If such characteristics exist, then any measured level is adjusted accordingly. The adjustments that apply are shown in Table 2.

TABLE 2 - ADJUSTMENTS TO MEASURED LEVELS

Where **tonality** is present	Where **modulation** is present	Where **impulsiveness** is present
+5 dB(A)	+5 dB(A)	+10 dB(A)

Note: these adjustments are cumulative to a maximum of 15 dB.

The Influencing Factor at these neighbouring noise sensitive premises of concern has been determined to be 0.

It is noted that under the regulation 3, noise emissions from vehicles travelling on roads are exempt from the Regulations. Hence it is only the noise received at the neighbouring from the truck movement on site that needs to be assessed under the Regulations.

4. QUARRY OPERATIONS

It is understood that the quarry activity and crushing / processing would only operate during the day period, this being between 0700 and 1900 hours Monday to Saturday (excluding Public Holidays). However, transport of material would occur between 0600 and 1900 hours Monday to Saturday (excluding Public Holidays). Therefore, noise emissions from the entire site (i.e. pit, processing and transport) needs to comply with the assigned L_{A10} day period noise level of 45 dB(A) at the neighbouring residences. Additionally, noise from the loading of road trucks and road truck movements on site needs to comply with the assigned L_{A10} night period noise level of 35 dB(A).

From information supplied, we understand that the equipment of concern, used on site is as outlined below. However, not all are expected to be running at once as some will not be required and there would be some diversity of operations.

Front end loaders (2)

- Crusher feed Loading of road trucks in stockpile areas
- Load road trucks

Excavator (1)

- Loading articulated truck in quarry.

Dump Truck (1)

- Articulated dump truck in quarry.

Crushers and screens mobile (3)

- Primary, secondary and tertiary crushers
- screens

Water Cart (1)

- Water cart for dust suppression..

Drill Rig (1)

- Within quarry.

From information supplied, we understand that there would be on average 8 road truck movements per day. Given this number of truck movements, noise emissions from trucks movements on site would be for less than 10% of the time. Therefore, noise emissions from truck movements would need to comply with the assigned L_{A1} noise level at the neighbouring residence. However, as the number of trucks per day would vary, to be conservative, the road truck movements have been included in the L_{A10} assessment for the entire operation.

5. MODELLING

Modelling of the noise emission propagation was carried out using "SoundPlan". SoundPlan uses the theoretical sound power levels determined from measured sound pressure levels to calculate the noise level received at a specific location. For this study, single point calculation were undertaken to determine the noise that would be received at the neighbouring residence.

The calculations used the following input data:

a) Ground contours.
b) Sound power levels as listed in Table 7.
c) Ground contours.

Weather conditions for the modelling were as stipulated within the Environmental Protection Authority's "*Draft Guidance for Assessment of Environmental Factors No. 8 - Environmental Noise"* for the day period were as listed in Table 6.

TABLE 6 - WEATHER CONDITIONS

Condition	Day Period
Temperature	20 ^{o}C
Relative Humidity	50%
Pasquill Stability Class	E
Wind Speed	4m/s*

* From sources, towards receivers.

TABLE 7 - SOUND POWER LEVELS dB(A)

Item	Sound Power Level dB(A)
Primary Crusher	116 (1 off)
Secondary Crusher	114 (1 off)
Tertiary Crusher	114 (1 off)
Screens	112 (3 off)
Generators	100 (3 off)
Excavator	109 (1 off)
Drill Rig	121 (1 off)
Front End Loaders	109 (2 off)
Articulated Truck	115 (1 off)
Haulage Trucks	104 (2 off)

Note : To be conservative, noise modelling was undertaken with all the equipment located at ground level, without any bunding or screening.

Noise modelling was undertaken for the following scenarios :

Day Period - All plant and equipment operating, as listed in Table 7.

Night Period - 1 Front End Loader and 2 road trucks.

The results of the modelling, are lised in Table 8 below.

TABLE 8 - CALCULATED NOISE LEVELS AT RESIDENCES

Residence	Calculated Noise Level dB(A)	
	Day Period	Night Period
South	34	23
South West	19	6
West	38	28

6. ASSESSMENT

Given the location of the residence, it is likely that noise received at the neighbouring residence would be deemed not to contain any annoying characteristics, however to be conservative, the assessment includes a +5 dB(A) adjustment for tonality.

Based on the above total calculated noise level, the following adjustments as listed in Tables 9 and 10 would be applicable.

Table 9 – Applicable Adjustments and Assessable Level of Noise Emissions – Day Period, dB(A)

Residence	Calculated Noise Level	Applicable Adjustments to Measured Noise Levels			Assessable Noise Level
		Where Noise Emission is NOT music			
		Tonality	Modulation	Impulsiveness	
South	34	+5	-	-	39
South West	19	+5	-	-	24
West	38	+5	-	-	43

Table 10 – Applicable Adjustments and Assessable Level of Noise Emissions – Night Period, dB(A)

Residence	Calculated Noise Level	Applicable Adjustments to Measured Noise Levels			Assessable Noise Level
		Where Noise Emission is NOT music			
		Tonality	Modulation	Impulsiveness	
South	23	+5	-	-	28
South West	6	+5	-	-	11
West	28	+5	-	-	33

Tables 11 and 12 summarise the applicable Assigned Noise Levels, and assessable noise level emissions for each identified noise.

Table 10 – Assessment of Day Period Operations Operations

Residence	Assessable Noise Level, dB(A)	Applicable Times of Day	Applicable L_{A10} Assigned Noise Level (dB)	Exceedance to Assigned Noise Level (dB)
South	39	0700 – 1900 hours Monday to Saturday	45	Complies
South West	24	0700 – 1900 hours Monday to Saturday	45	Complies
West	43	0700 – 1900 hours Monday to Saturday	45	Complies

Table 11 – Assessment of Night Period

Residence	Assessable Noise Level, dB(A)	Applicable Times of Day	Applicable L_{A10} Assigned Noise Level (dB)	Exceedance to Assigned Noise Level (dB)
South	28	2200 – 0700 hours Monday to Saturday	35	Complies
South West	11	2200 – 0700 hours Monday to Saturday	35	Complies
West	33	2200 – 0700 hours Monday to Saturday	35	Complies

Note : The assessment during the night period for the loading and movement of trucks before 0700 hours (ie night period), should be assessed under the L_{A1} assigned noise level of 45 dB(A), but to be conservative, this activity has been assessed under the L_{A10} assigned noise level of 45 dB(A).

7. DISCUSSION

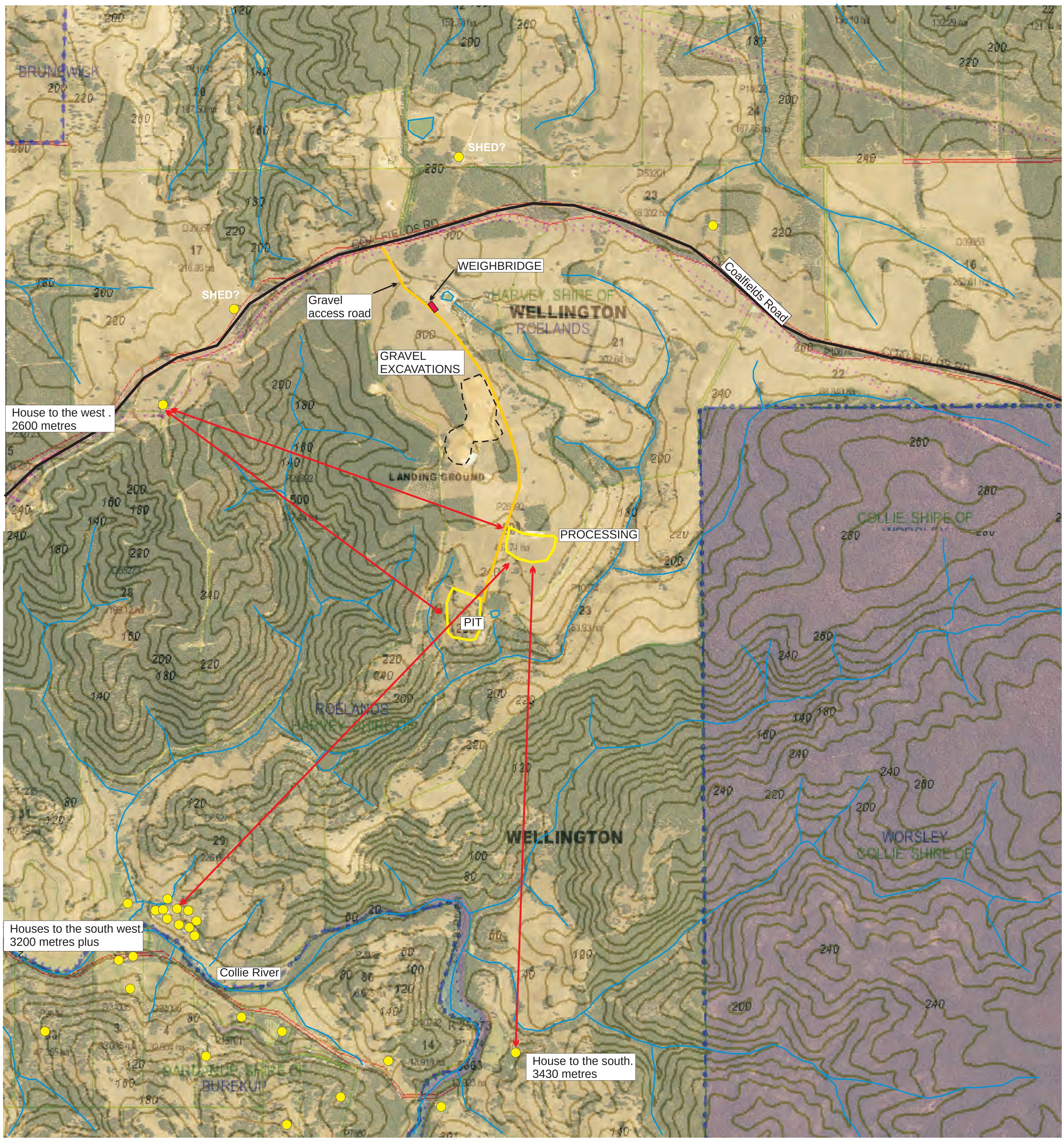
Given the location of the residence, it is likely that noise received at the neighbouring residence would be deemed not to contain any annoying characteristics, however to be conservative, the assessment includes a +5 dB(A) adjustment for tonality.

It is understood that the quarry would only operate during the day period. Therefore, noise emissions from the entire quarry operations needs to comply with the assigned L_{A10} day period noise of 45 dB(A) at the neighbouring residences. Additional to the above operations, it is also understood that the loading of road trucks could occur between 0600 and 0700 hours. From information supplied, there would be on average 4 road truck movements per day and given this number of truck movements, noise emissions from trucks movements on site would be for less than 10% of the time. Therefore, noise emissions from truck movements would need to comply with the assigned L_{A1} noise level at the neighbouring residence. However, to be conservative, the loading of trucks and the truck movements on site during the night period has been assessed against the L_{A10} night period assigned noise level of 35 dB(A).

Noise received at the neighbouring residence from the proposed operations of the hard rock quarry, would, even with the inclusion of the +5 dB(A) penalty for a tonal component, comply with the requirements of the Environmental Protection (Noise) Regulations 1997. Noise received at the neighbouring residence from trucks being loaded, entering and leaving the site during the night period (ie between 0600 and 0700 hours) would also comply with the Regulatory requirements.

APPENDIX A

LOCALITY PLAN



Dwelling identified from aerial photograph

0 500m

Figure 2

B and J CATALANO	
LOT 501, COALFIELDS ROAD, WELLINGTON	
SURROUNDING LAND	
Landform Research	June 2013
Basemap LANDGATE	Scale 1 : 22 500