



APPENDIX O: RESOURCE EVALUATION INVESTIGATION



3rd June
2020

**Geological & Indicative Staged
Assessment
for
Deep Creek Quarry
Ironstone Developments Pty Ltd**



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Revision Table

Date	Version	Author	Reviewed	Approved
20/5/2020	F0	Greg Thomson	Tim Mullaney	N/A
03/06/2020	F1	Greg Thomson	Tim Mullaney	N/A
03/06/2020	F2	Greg Thomson	Tim Mullaney	

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Acronyms and Terms Used Throughout the Report

Through this document, a number of Acronyms and reference terms are frequently used. To assist the reader, the following lists are provided.

ACRONYMS	
ISD	Ironstone Developments Pty Limited
AHD	Australian Height Datum
Ma	Million years
Carboniferous	A time period that occurred between 298 to 354 ma
RMS	Road and Maritime Services

Geology Glossary

Word	Meaning
AHD – Australian Height Datum	A height of zero was assigned to the mean sea level determination at 30 tide gauges around the Australian Mainland coastline, measured over a three-year period from 1966 to 1968. Ref 2
Andesite	Named after the Andes Mountain range in South America. This is a fine grained intermediate volcanic igneous rock characterised by the presence of Oligoclase or Andesine. These rocks are often porphyritic and have 57 to 63 % SiO ₂ .
Arenite	Arena means Sand in Latin, being the material, they threw onto the arena before the Gladiators fought. Arenite is a general term meaning sand-based rocks.
Bed Rock	The unweathered rock that lies below loose surface deposits of soil and alluvium.
Carboniferous	A time period that occurred between 298 to 354 ma
Decomposed Rhyolite	This is a type of weathered Rhyolite that has seen the plagioclase feldspars change into Kaolin clays, leaving a Quartz (sandy) clay mix.
Devitrification	The development of crystals, initially on a very small scale, in a glassy igneous rock such as obsidian (or Rhyolite). Ref 3
Earthworks	The process of extracting, moving and depositing earth during construction.
Embankment	A mound or bank of earth or stone formed to support a roadway, serve as a protective barrier, or the like.
Erosion	The natural process where wind or water detaches a soil particle and provides energy to move the particle.
Excavation	The act or process of digging out earth during construction.
Faulting	A fracture in rock along which there has been an observable amount of displacement. Ref 3
Hydrology	The study of rainfall and surface water runoff processes.

Word	Meaning
Ignimbrite	Derived the term 'ignimbrite' from 'fiery rock dust cloud' (from the Latin <i>igni-</i> (fire) and <i>imbri-</i> (rain)), formed as the result of immense explosions of pyroclastic ash, lapilli and blocks flowing down the sides of volcanoes. Or sometimes known as Welded Tuffs. An ignimbrite is the deposit of an extremely hot pyroclastic ash, such that the edges of fragments can be seen to weld together. This term describes how the rock is formed not the chemical composition of the rock. Ignimbrites can only form as a result of sub-aerial volcanic activity Ref 3. Ignimbrites can be Rhyolite, Rhyodacite or Dacite in composition. Sometimes the crystals can appear flat to show a flow effect, but this is due to a layering of the material as the material compacts and presses down on the hot beds.
Induration	A process by which soft sediments becomes hard rock. Ref 3
Indicative	When you want to show that something is suggestive or serves as a sign of something. Ref 4
Leucocratic	An igneous rock consisting of light-coloured minerals, like quartz and feldspars. Ref 3
Lithology	A term usually applied to sediments, referring to their general characteristics. Ref 3 Can also be a general term for any rock, found in the field.
pH	A measure of the degree of acidity or alkalinity expressed on a logarithmic scale of 1-14, on which 1 is most acid, 7 is neutral and 14 is most basic.
Pyrite	The most widespread sulphide mineral, FeS ₂ found as an accessory mineral in igneous rocks. Ref 3
Quartz	Chemically SiO ₂ this mineral is very resistant to weathering which allows it to be the most common mineral on the surface of the earth.
Rhyolite	Has greater than 69 % SiO ₂ with quartz, Alkali feldspar and plagioclase common. This is a highly viscous lava, and can be highly explosive, during the formation process. This can be formed on the earth surface as an Ignimbrite or Tuff.
Rhyodacite	Rhyodacite is an extrusive volcanic rock, intermediate in composition between dacite and rhyolite. Rhyodacite is a high silica rock (20 to 60%) and often exists as explosive pyroclastic rocks, at the time of its creation. This can be formed on the earth surface as an Ignimbrite or Tuff.
Sand	Are categorised as particles that range between 0.0625 mm to 2.00 mm. (Ref 1.) These can be made from quartz, limestone, feldspar, basalts, latites, organic particles and olivine. These deposits are found on beaches, dunes, rivers, glacial outwash and volcanic slopes.
Sediment	Material of varying sizes that has been or is being moved from its site of origin by the action of wind, water or gravity.
Sedimentation basin	An area where run-off is ponded to allow sediment to be deposited. The longer the period that run-off is held, the smaller the size of the sediment deposited. Such basins can be man-made or natural have to be cleaned regularly.
Silt	Are categorised as particles that range between 0.0625 mm to 0.0039 mm. Ref 1

Word	Meaning
Soil	That part of the upper weathered layer of the earth's crust that can support plant growth. Any naturally occurring loose or soft deposit forming part of the earth's crust and resulting from weathering or breakdown of rock formation or from the decay of vegetation.
Soil Texture Group	An important attribute of soils that affects the effectiveness of sediment retention structures is the proportion of particles finer than 0.02 mm. Particles that are finer than 0.02 mm are relatively difficult to trap in simple sediment retention basins, while those that are coarser are not.
Trachyte	Fine grained alkali to intermediate igneous rock. Feldspars are often the dominant minerals, being sanidine, albite or sodic potassic. A characteristic feature of Trachytes is the packing together of lath like feldspars in parallel alignment. Trachytes occur mainly as lava flows of small extent due to their high viscous nature. Trachytes grade into Rhyolites with an increase in quartz. Ref 3.
t – tonnes	Weight measurement being 1000 kilograms.
Vesicles	Holes or bubbles in the rock could be formed during deposition, or a weathering effect post deposition.
Volcanolithic	Rocks sourced from volcanic origins.
Waste	Includes any matter (whether liquid, solid, gaseous or radioactive) that is discharged, emitted or deposited in the environment in such volume, constituency, or manner as to cause an alteration to the environment.
Weathering	The process by which rocks are broken down and decomposed by the action of external agencies such as wind, rain, temperature changes, plants, and bacteria. Ref 3

References

- Ref 1. Pettijohn F.J, Potter, P.E. and Siever R. 1972 Sand and Sandstone.
- Ref 2. G.C. Luton and G.M Johnson 2001
- Ref 3. Penguin Geology Dictionary, Whitten and Brooks 1982
- Ref 4. <https://www.vocabulary.com/dictionary/indicative>
- Ref 5. NSW Resources Regulator Health and Safety at Quarries (2018) *NSW Resources Regulator Mines and Quarries Book Versions*

1 Executive Summary

This Geological and Resource Review has been prepared by VGT Environmental Compliance Solutions Pty Ltd (VGT) on behalf of Ironstone Developments Pty Ltd (proponent) for the Deep Creek Quarry (DCQ). This report examines the geology and four indicative extraction stages for DCQ.

The site been drilled and mapped to provide the best insight as to the varying rock types. A total of 4,930,000 cubic metres or 11.8 million Tonnes of material has been identified within a carefully determined extraction envelope, which is considerate of neighbours, flora, geology and geotechnical parameters.

This site is part of a complex suite of rocks that was formed during a period of active volcanoes, glaciers and river systems, which has left Rhyolites, sandstone and claystone rock sequences.

2 Introduction

2.1 SECRETARY'S ENVIRONMENTAL ASSESSMENT REQUIREMENTS(SEARS)

At the time of preparing this report SEAR's had not been issued but the relevant items from a typical list of SEAR's from DPIE and the Division of Resources & Geoscience (DRG) have been tabulated below for reference in the document.

Table 1. Typical SEARs

Item	Source	Where addressed in this document
- "the resource to be extracted, including amount, type and composition."	SEAR's	Section 3, Section 5
- "the site layout and extraction plan, including cross sectional plans. "	SEAR's	Figure Two, Figure Six, Figure Seven, Figure Eight, Figure Nine, Figure Ten
- "waste (overburden, rejects tailings etc) management strategy"	SEAR's	Section 4, Section 5.3
1. Summary of the regional and local geology	DRG	Section 2.3
2. Amount of material to be extracted and the method or methods used to determine the size of the resource	DRG	Section 5
3. Characteristics of the material to be produced: a) grainsize and mineralogy, nature and extent of weathering or alteration, and amount and type of deleterious mineral, if any. b) range of intended uses for the particular material	DRG	Section 3
4. An assessment of the quality of the material and its suitability for the anticipated range of applications	DRG	Section 3, Section 5.3
5. 11. Disposal of waste products and location of stockpiles.	DRG	Section 4

2.2 SCOPE

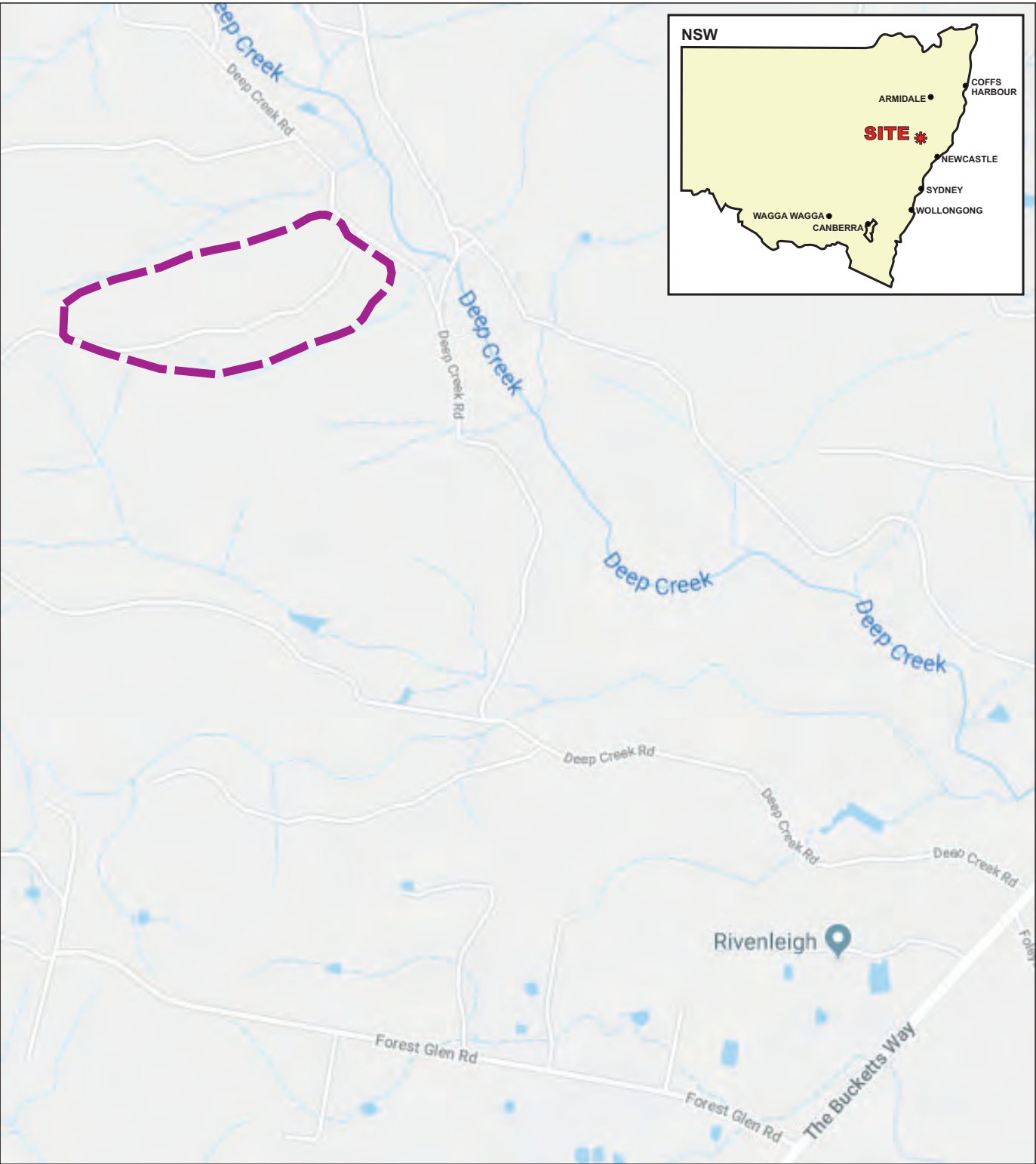
The proposed Deep Creek Quarry (DCQ) site is located on Lot 472 DP 1162208 and Lot 48 DP 753178 Deep Creek Road, Limeburners Creek, refer to Figure One.

VGT Environmental Compliance Solutions Pty Ltd (VGT) were engaged by Ironstone Developments Pty Ltd (proponent) to evaluate the geology and available resources located within the footprint defined by the proponent and Kleinfelder.

As part of this assessment four indicative stages of quarry development have been proposed. These attempt to show how the site could be developed which considers many factors.

Plan of:	Deep Creek Quarry - Site Location	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipnShip	Our Ref:	5414_DC_RR19_C001_V0_F1.cdr
Figure:	ONE	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK/JD
Sheet:	1 of 1	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 14/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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Approx Scale: 0 200 400m

Legend

Subject Land (Site)

Extraction Envelope

Cadastral Boundary

Roads (ClipnShip)

Approx Scale: 0 500m

2.3 REGIONAL GEOLOGY

The site is underlain by Late Carboniferous aged (approximately 310 million years ago) Volcanics such as Rhyolite, and Rhyodacite, as well as sedimentary rock including sandstone and claystone. The depositional environment during this period of Australia's development was very cold conditions with glaciers, little flora and high volcanic activity.

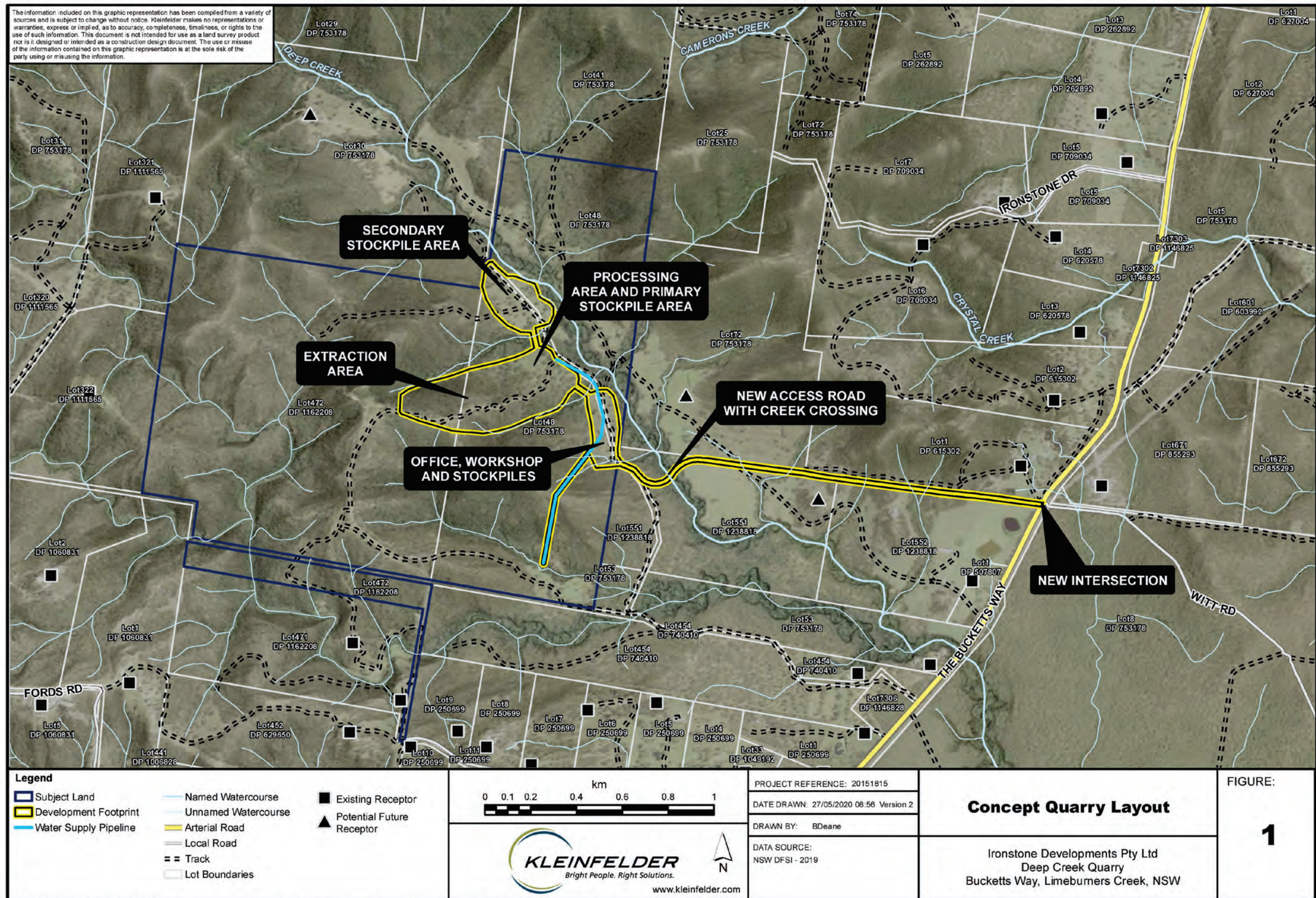
2.3.1 Site Geology

The Newcastle 1:100,000 geological sheet shows the Deep Creek Quarry site is underlain by the Italia Road Formation, which forms part of the Kings Hill Group. The unit is described as containing lithic sandstones, shale, coal, chert, ignimbrites and tuffs.

The proposed quarry envelope is dominated by a sloping ridge from west to east with steep slopes to the north and south. As seen in *Figure Five*, the uppermost point is located on the western portion of the site being 116m RL and the down to lowest point to east at 37m RL.

Plan of:	Deep Creek Quarry - Site Layout by Kleinfelder	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Kleinfelder Reference 20151815	Our Ref:	5414_DC_RR19_C002_V1_F2.cdr
Figure:	TWO	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	1 of 1	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V1 27/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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3 Geological Investigations

The goals of this assessment are to identify, assess and quantify available insitu resources for the construction industry.

3.1 EXPLORATION METHODOLOGY

The evaluation methods included:

- Review any existing geology data;
- Map the surface geology of the site;
- Log and photograph drill core;
- Prepare drill logs;
- Plot, correlate and interpolate all available data; and
- Undertake resource assessments.

3.2 EXPLORATION RESULTS

3.2.1 Survey

During December 2018, VGT were able to access the ELVIS – Spatial and Depth - Foundation Spatial Data made available through NSW Spatial Services website. This survey was flown using Light Detection and Ranging (LiDAR) in December 2012 and provides much more detail for the site compared with Photomapping data, particularly in areas of tall vegetation on steep slopes. This LiDAR survey has been utilised in volume calculations since the date it was acquired.

3.2.2 Mapping Discussion

The topographical survey plan was used in conjunction with GPS to locate outcrops.

The site has been sampled by Tim Mullaney (proponent), in a 50 metre by 50 metre grid set up by Greg Thomson. The proponent collected the samples and were reviewed by VGT under a microscope, the results are presented in the summary sheet of the samples in *Appendix C*. The corresponding map of the sample locations is shown *Figure Five* and the photographs of the samples are included in *Appendix C*.

Mapping was undertaken over a two-week period, providing a large number of samples. The mapping was constrained in part by:

1. Steep terrain;
2. Very thick bush land;
3. Poor outcrop.

The sampling plan shows the three key mapped units, shown in *Table 2*.

Table 2. General Mapped Geological Units

Geological Suites	Rock types	Description
Volcanics	Rhyolite/ Rhyodacite / Trachyte /	Fresh, orange pink, cream, hard blocky outcrop, white feldspar laths, set in a fine-grained mass. High pitched ring when struck by hammer.
Altered Volcanic	Altered Volcanic	Red, cream, lower density than the fresh volcanic, vesicules, blocky in part. Dull muted tone when struck by hammer.
Sediment	Volcanolithic Arenite (sandstone)	Grey, medium to coarse indurated, with occasional pebbles and minor claystone. Most outcrop encountered was the hard-indurated sandstones.
Pegmatite Vein	Pegmatite	Sub angular to Sub-rounded opaque and clear quartz grains, dominant with 10% muscovite mica (platy) up to 1mm in size, randomly interspersed rounded to sub-rounded, minor weathered clays overall colour orangey pinky coarse grained rock.
Quartz Vein	Quartz vein or highly indurated sandstone	Quartz opaque, clear quartz, sub-rounded to sub-angular to 1mm, orangey red iron throughout, no mica indurated sandstone? – no plagioclase.

The topography of the site does provide some insight into differing lithologies. Typically, steep blocky boulder slopes were found to be Volcanics and the hard Arenites were sometimes found as rounded boulder fields. Of note, little to no outcrop was located on the flat or gently sloped surfaces, which could signify boundaries between lithologies or some of the softer sediments. The eastern flank of the site also has no visible outcrop, but test pitting has found that this is made up of decomposed Rhyolite.

Other rocks found on site included, pegmatite and quartzite, these are very typical in this volcanic setting and mostly occur as narrow veins that form during the late stages of the volcanic event and they tend to shoot across the site in random directions.

The “altered Volcanics” found on the surface in south western portion of the site could be:

- a weathering effect of the Volcanics created along a contact zone between sediments and the Volcanics; or
- a pumice like flow feature which is similar to a super-heated froth that hardens quickly on the surface.

Alteration is a geological term which means a change from its original. Weathering is a very common type of change that occurs in most outcrop rocks. Some rocks are more affected than others and this can be due to a variety of reasons, including:

- Longer periods of exposure to water and oxygen that breaks down the minerals;
- Water seeping down fractures or bedding planes that can alter the minerals along these contacts; or
- A higher proportion of minerals prevalent to weathering.

The other possibility for the alteration or difference from the Volcanics is that it could occur during formation. The volcanic nature of these deposits can see a variety of rocks being deposited which can include:

- Ash flow.
- Ash fall.
- Surface flow; and/or
- Shallow intrusive.

3.2.3 Exploration Drilling Discussion

Diamond core drilling was undertaken by Total Drilling Pty Ltd based in Thornton NSW. The drilling occurred in April 2014 and November 2018, the drill core from each hole was laid out, logged and photographed. Samples were also taken from each drill core for geotechnical testing. The drill hole locations are found on *Figure Five* and drill hole details are presented in *Table 3*.

Table 3. Drill Hole Details

Drill Number	Hole Depth (m)	Easting ***	Northing ***	Collar RL (m)**
DDH17	39.6	397618	6397829	77.7
DDH18	55.7	397400	6397834	92.5
DDH19	62.4	397203	6397829	101.5
DDH7*	72.05	397502	6397800	90.0

Note: *Drilled April 2014

** Approximated from 3D survey, not surveyed.

*** Coordinates supplied by Client

DDH7 was drilled in a previous geological investigation but has been included in this report to assist with correlation and geo-technical analysis. Core boxes were laid out, logged and photographed as seen in *Appendix A*. Samples were taken from selected holes for geotechnical analysis which can be found in *Appendix D*.

Table 4. Geological Contact Zones

Drill Number	Rock Type	RL	Contact RL	Depth
DDH17	Rhyolite	78	No sediment encountered	-
DDH18	Sedimentary	92.5	78.01	14.49m
DDH18	Rhyolite	78.01	36.80	41.21m
DDH19	Sedimentary	101.5	88.5	13m
DDH19	Rhyolite	88.5	39.9	48.6m
DDH7	Sedimentary	90	83.2	6.8m
DDH7	Rhyolite	83.2	18	65.2m

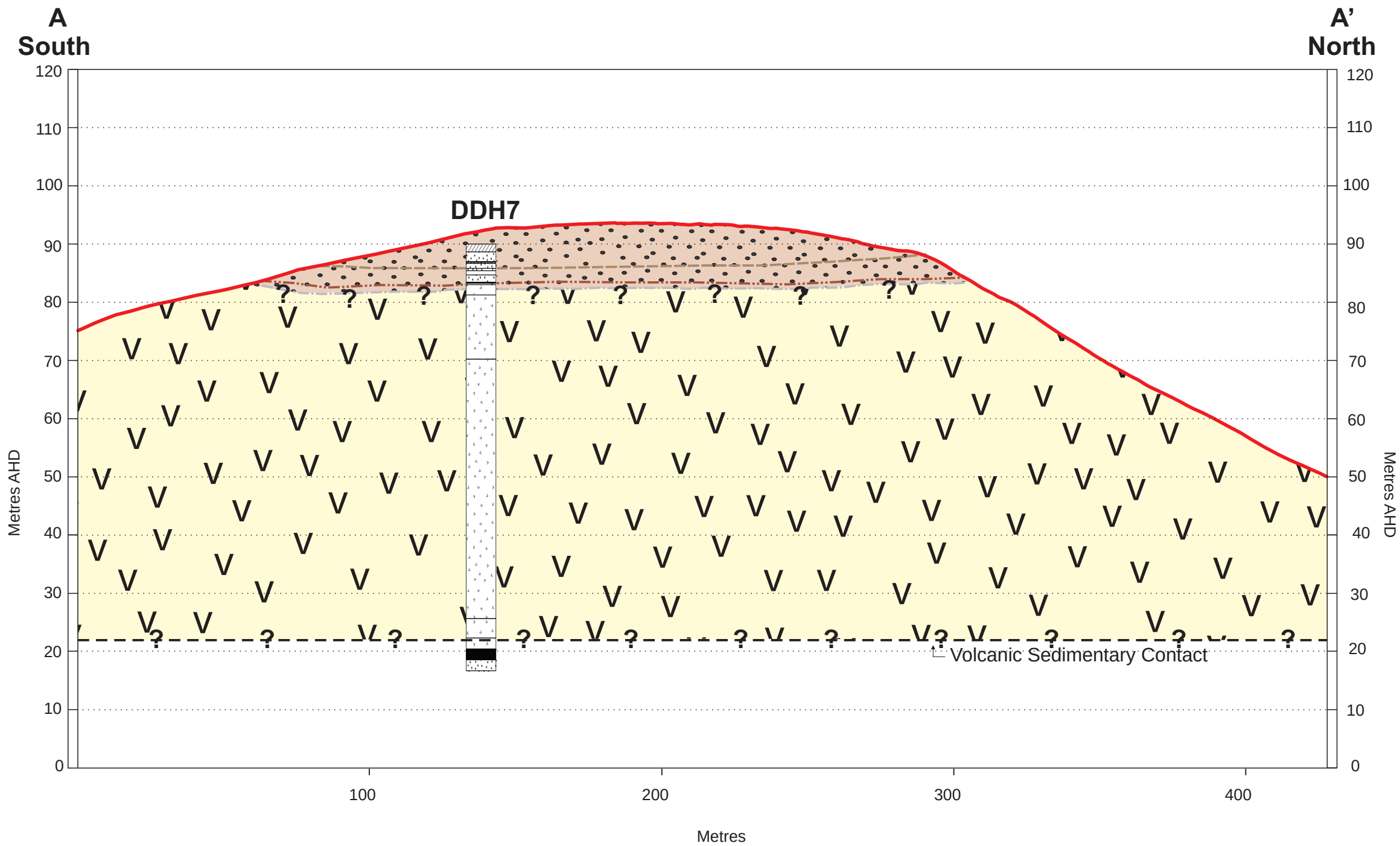
Based upon the data presented in Table 4 the sedimentary and volcanic contact for the deposit has been averaged out to RL 82 metres, although in reality it will probably be an undulating feature.

3.2.4 Cross Section Discussion

From the drill core logs and interpolation of these logs, cross sections of the area were interpreted and drawn to assess the sedimentary and volcanic rock found between DDH17, 18, 19 and DDH7. The cross sections can be seen in Figure Three and Figure Four. The four holes presented in Figure 4 show a sedimentary sequence overlying a thick volcanic sequence, a thin black carbonaceous band was identified in DDH19, 18 and 7. DDH7 did also intersect sediments at the base of the hole. The red dashed line represents the proposed floor of the quarry. DDH17 did not encounter any sedimentary sequence.

Plan of:	Deep Creek Quarry - Geological Cross Section 1	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Client & VGT Environmental Compliance Solutions Pty Ltd	Our Ref:	5414_DC_RR19_C003_V2_F3.cdr
Figure:	THREE	Council:	Mid Coast Council	Survey:	NSW Government Spatial Services, December 2018 Survey, Accessed Through ELVIS	Plan By:	SC/JD
Sheet:	1 of 1	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V2 03/06/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

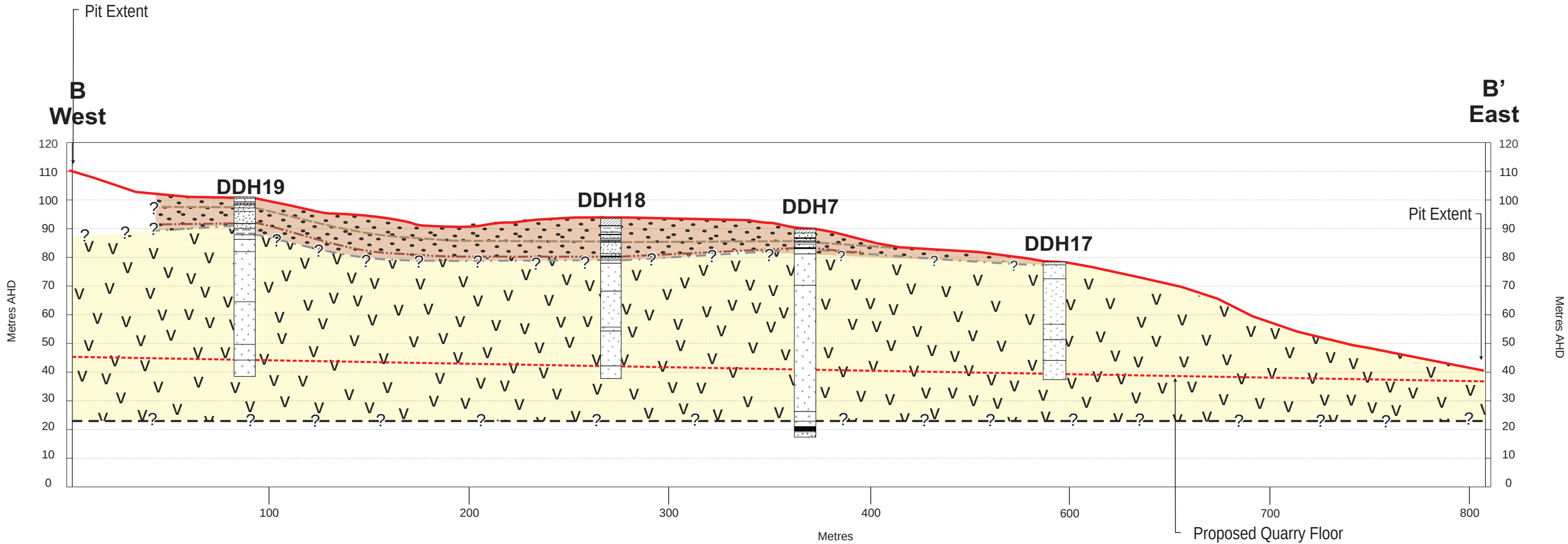
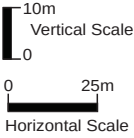
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- Legend**
- Final Profile
 - Base of Weathering
 - Base of Extraction
 - Volcanic Contact
 - Carbonaceous Band
 - Rhyolite
 - Sedimentary

Plan of:	Deep Creek Quarry - Geological Cross Section 2	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Client & VGT Environmental Compliance Solutions Pty Ltd	Our Ref:	5414_DC_RR19_C004_V1_F4.cdr
Figure:	FOUR	Council:	Mid Coast Council	Survey:	NSW Government Spatial Services, December 2018 Survey, Accessed Through ELVIS	Plan By:	SC/JD
Sheet:	1 of 1	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V1 14/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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- Legend**
- Surface Profile
 - Proposed Quarry Floor
 - Base of Weathering
 - Base of Extraction
 - Volcanic Contact
 - Carbonaceous Band
 - Rhyolite
 - Sedimentary

3.2.5 Geotechnical Results

After the drill core boxes were laid out assessed and logged, samples were taken from each drill hole for geotechnical analysis. Previous results from DDH7 have been compared with samples taken from DDH18 and DDH19. The key geotechnical results are shown below in Table 5. Photos of each of drill hole were taken after samples were taken out and shown in *Appendix B* the geotechnical results are shown in *Appendix D*.

Table 5. Geotechnical Results of DDH7, DDH18 & DDH19

Hole Number		DDH7	DDH18	DDH19
Test Method	Reported Results	Rhyolite	Rhyolite	Rhyolite
Test Method AS1141.5 (Fine particle Density)	Dry Basis (t/m ³)	2.42	2.52	2.50
	Saturated Surface Dry Basis (t/m ³)	2.51	2.57	2.55
	Apparent Particle Density (t/m ³)	2.67	2.65	2.65
	Water Absorption	3.8	2.0	2.3
AS1141.6(Coarse Particle Density)	Dry Basis (t/m ³)	2.48	2.54	2.51
	Saturated Surface Dry Basis (t/m ³)	2.54	2.58	2.56
	Apparent Particle Density (t/m ³)	2.64	2.65	2.64
	Water Absorption	2.4	1.7	2.1
AS1141.6.1 (Particle Density - Weighted)	Dry Basis (t/m ³)	2.47	2.53	2.50
	Saturated Surface Dry Basis (t/m ³)	2.54	2.58	2.56
	Apparent Particle Density (t/m ³)	2.65	2.65	2.65
	Water Absorption	2.7	1.7	2.1
AS1141.11 (Particle Size Distribution)	Percent (%) Passing			
	37.5	100	100	100
	26.5	100	99	97
	19.00mm	100	84	82
	13.2mm	65	54	51
	9.5mm	40	33	34
	6.7mm	29	22	25
	4.75mm	21	16	18
	2.36mm	14	10	11
	1.18mm	9	6	8

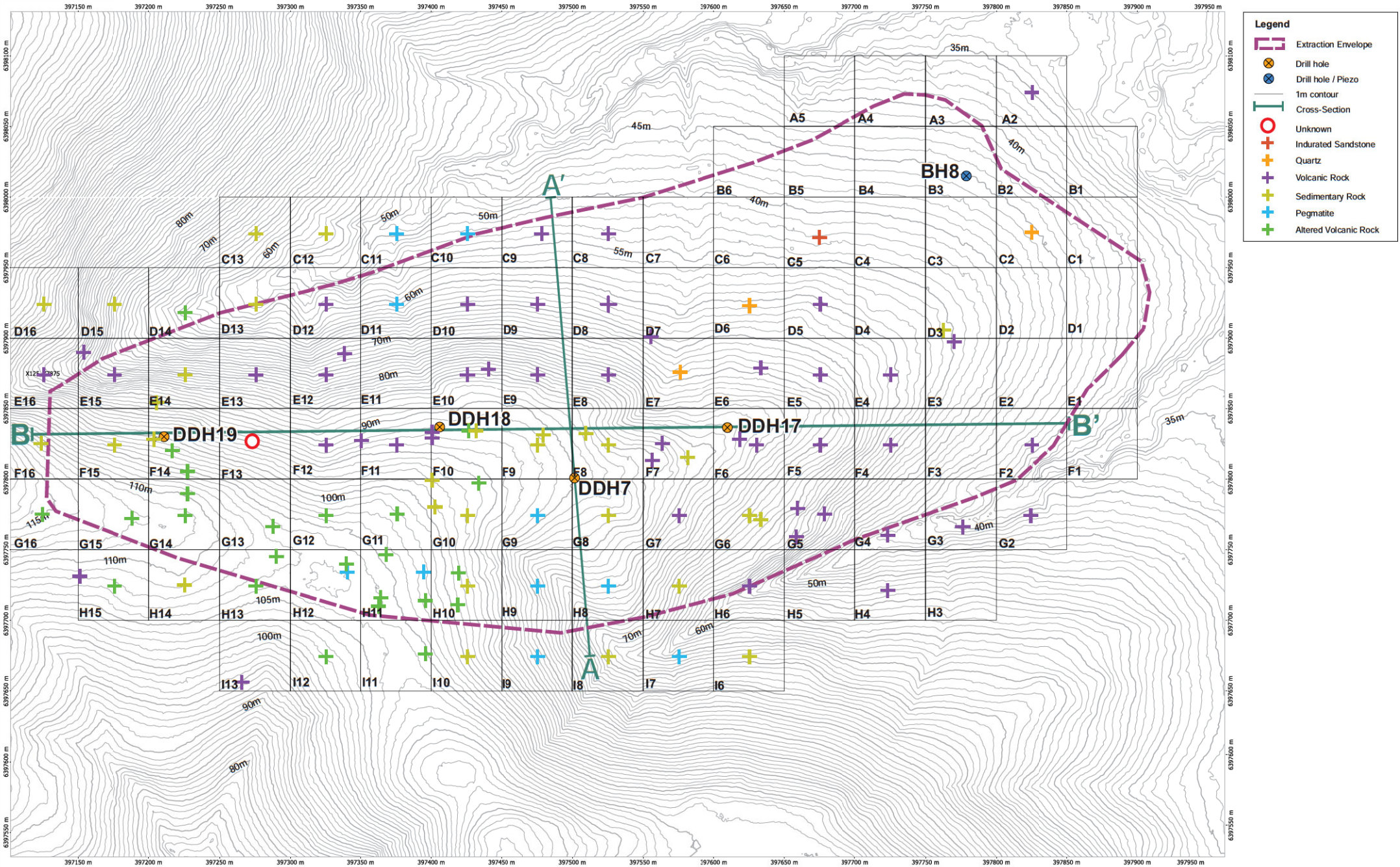
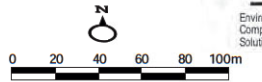
Hole Number		DDH7	DDH18	DDH19
	600um	6	4	5
	425um	5	3	4
	300um	4	2	3
	150um	2	1	2
	75um	1	1	1
AS1012.20 (Chlorides and Sulphates)	Chlorides (Cl%)	0.003	0.002	0.001
	Sulfates (SO4%)	0.080	0.017	0.047
AS1141.41/42 (Polished Aggregate Friction Value)		57	65	62
RMS T659 (Methylene Blue Value)		5		
AS1289.3.1.1, 3.2.1,3.3.1,3.4.1 (Atterberg Limits)		Non-Plastic	4	Non-Plastic
AS4133.4.2.1 (Uniaxial Compressive Strength of Rock)	UCS	80.7		

3.3 GEOTECHNICAL RESULTS

The geotechnical results shown in Table 5 display a small range of difference between the results of all three samples tested. From the geotechnical testing it was concluded that the rocks were predominately Rhyolite. The results from the samples taken show similar results to DDH7 indicating a correlation across the three drill holes.

Plan of:	Deep Creek Quarry - Surface Rock Sampling Plan	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	ELVIS NSW Spatial Services, Woodbury Civil & VGT Environmental Compliance Solutions Pty Ltd	Our Ref:	5414_DC_RR19_C005_V3_F5.cdr
Figure:	FIVE	Council:	Mid Coast Council	Survey:	ELVIS NSW Spatial Services, Woodbury Civil & VGT Environmental Compliance Solutions Pty Ltd	Plan By:	SC/JD
Sheet:	1 of 1	Tenures:	N/A	Projection:	MGA	Project Manager:	GVT
Version/Date:	V3 14/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	1m	Office:	Thornton

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.



4 Indicative Staged Extraction Plans

There are number of extraction stages prepared for this assessment, within the extraction envelope. The indicative staged plans have been prepared to show how the site has been proposed to be developed, but these could change based upon geology, safety and product demand. This is not an engineering document; any design and construct will be undertaken by appropriate experts.

4.1 PRELIMINARY WORKS

Aims for this stage

Develop the operation into three distinct zones: Weighbridge and Offices, Extraction Area and Stockpile area, refer to *Figure Two*, and establish access into the Stage One extraction area. Create a haul road from the south to the Primary Stockpile area. Extract decomposed Rhyolite to reveal the hard, fresher Rhyolite for Stage One.

Considerations

The access from the weighbridge north to the extraction area is via a culvert over a creek, culvert design and construct and sediment controls are not examined in this document.

The entry level has been agreed to be 37m RL, through the extraction east flank to another creek crossing culvert to the north. The road is flat to save on fuel and will minimise noise, this will create a significant cut into the eastern flank. The haul road will be 10 metres wide with a safety berm (half wheel height) in the centre and side of the road to provide two-way haul access, with drainage.

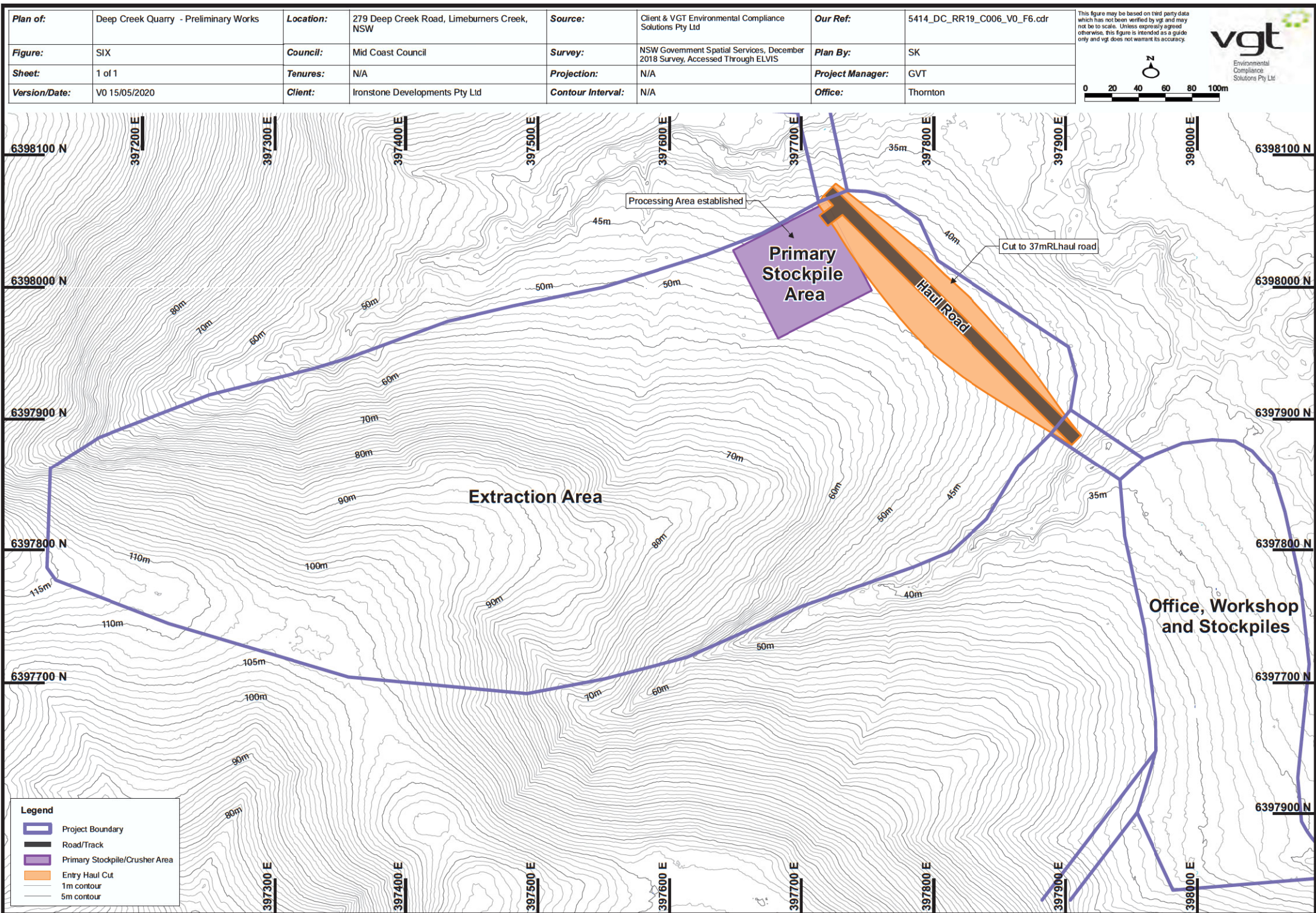
Constraints and Issues

The geology in this area is predominantly decomposed rhyolite as identified by the proponent via test pitting. This can be excavated using excavators and dump trucks, this material will be used as noise attenuation on site or sold. The batters have been designed to be nominally 1 horizontal to 1 vertical, but as extraction progresses it is recommended a review be undertaken by a suitably qualified engineer.

The stockpile area will be a flat pad, with some cut required on the western flank of the pad.

Outcomes

The weighbridge, haul road and stockpile envelopes have been plotted on *Figure Six*.



4.2 STAGE ONE

Aims for this stage

Commence extraction in the northern portion of the extraction area. This will require drill and blast techniques and face development will progress east to west.

Considerations

The development of this Stage considers data from:

- Kleinfelder Geo Technical Review bench and batter design parameters; and
- Drill and mapping data

Constraints and Issues

The site has steep slopes and haul trucks are designed to travel on 1 vertical to 10 horizontal (1V:10H) grades ^{Ref 5}. A haul road has been designed to provide on average (1V:10H) as seen in *Figure Eight*. Straighter haul roads are more preferred in these operations but due to local conditions turns or switch backs are required here.

The initial stage will see the first 10 metre bench be developed, this can be developed across the whole north section of the deposit, see *Figure Seven*. If, due to geological variations or other product requirements, the proponent decides to move up the hill then the internal haul road will be utilised to gain access to other benches.

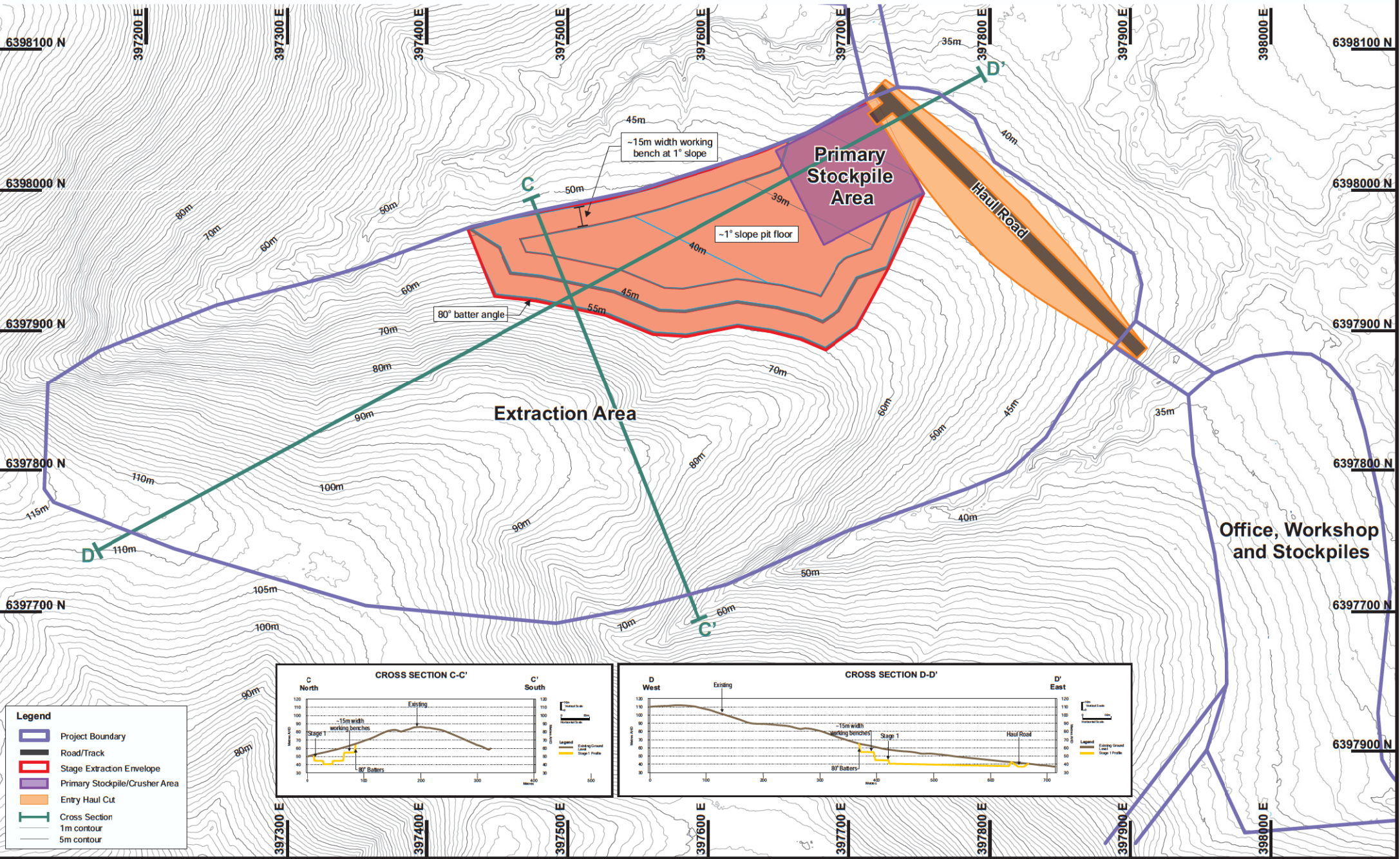
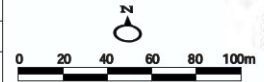
Mobile crushing and processing plant will follow the extraction faces to minimise haulage times; crushing and processing will be done on the quarry floor and final products will be stored in the Primary and Secondary stockpile areas. Overburden will be used to create acoustic and visual bunds where required. Excess overburden will be stockpiled in available stockpile areas.

Outcomes

A Stage One development has been plotted on *Figure Seven*, which would produce approximately 350,000m³.

Plan of:	Deep Creek Quarry - Stage One	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Client & VGT Environmental Compliance Solutions Pty Ltd	Our Ref:	5414_DC_RR19_C007_V1_F7.cdr
Figure:	SEVEN	Council:	Mid Coast Council	Survey:	NSW Government Spatial Services, December 2018 Survey, Accessed Through ELVIS	Plan By:	SK
Sheet:	1 of 1	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V1 27/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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4.3 STAGE TWO

Aims for this stage

Continue extraction in the northern half of the extraction area up to the internal haul road.

Considerations

The development of this Stage considers data from:

- Kleinfelder Geo Technical Review working and final landform bench and batter design parameters; and
- Drill and mapping data.

Constraints and Issues

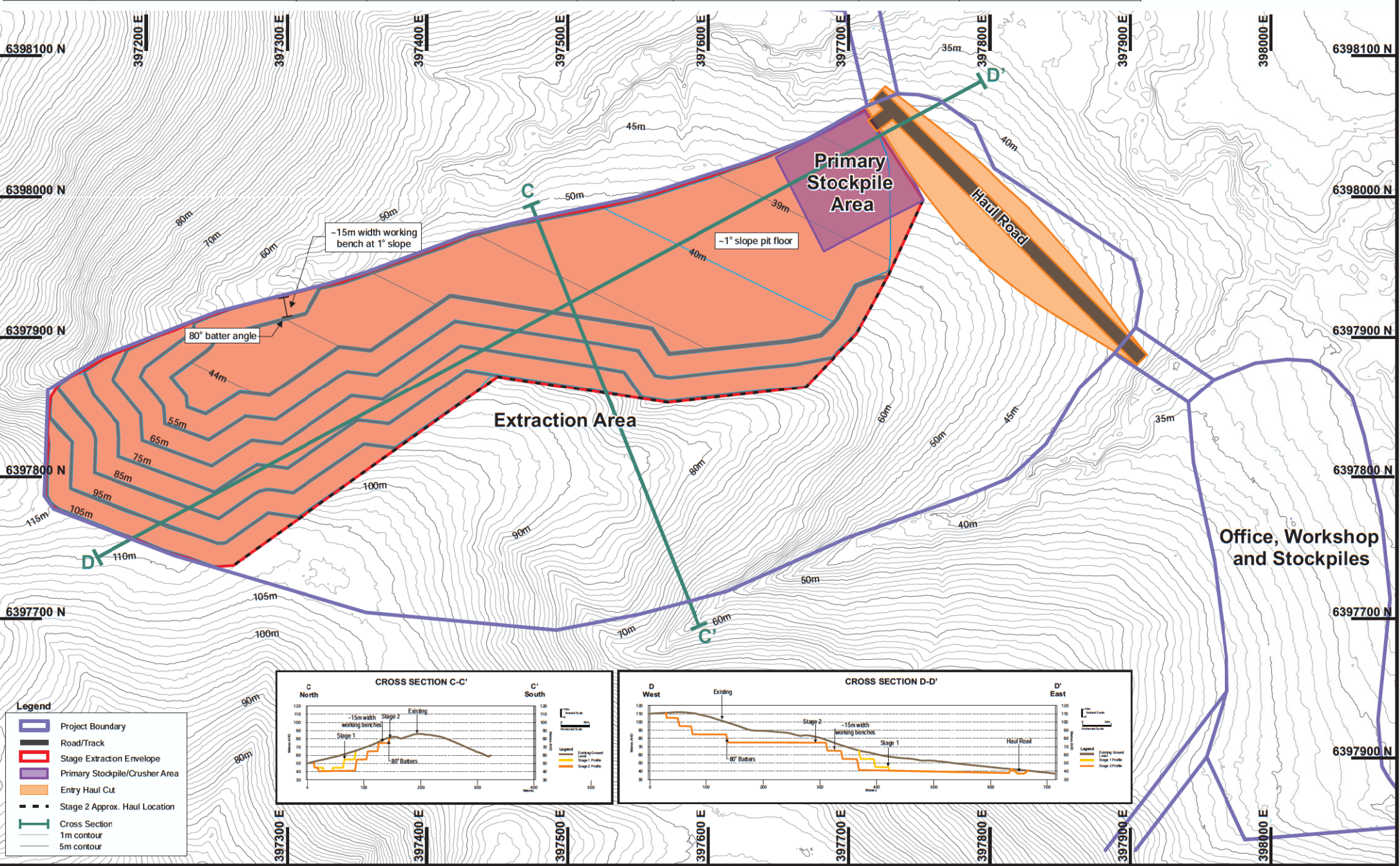
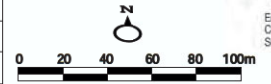
This stage will see the southern highwall with up to 8 working benches (10-metre-high batter faces). There will also be some opportunity to start and create some final landform faces on the western and northern faces. As the formation of final faces are created in the northern portion of the site, overburden will be placed in this area. The actual amounts of overburden have not been determined as the proponent proposed to utilise as much of this as possible.

Outcomes

A Stage Two development has been plotted on *Figure Eight* which would produce approximately a further 1,330,000m³.

Plan of:	Deep Creek Quarry - Stage Two	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Client & VGT Environmental Compliance Solutions Pty Ltd	Our Ref:	5414_DC_RR19_C008_V1_F8.cdr
Figure:	EIGHT	Council:	Mid Coast Council	Survey:	NSW Government Spatial Services, December 2018 Survey, Accessed Through ELVIS	Plan By:	SK
Sheet:	1 of 1	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V1 27/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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4.4 STAGE THREE

Aims for this stage

Progress the extraction faces southwards, utilising the working faces to the south and the east as buffers from neighbours.

Considerations

The development of this Stage considers data from:

- Kleinfelder Geo Technical Review working and final landform bench and batter design parameters; and
- Drill and mapping data

Constraints and Issues

The face orientation and working with highwall shields proposed here provides neighbours the best protection from:

- Overpressure from blasting; and
- Noise from loading and processing.

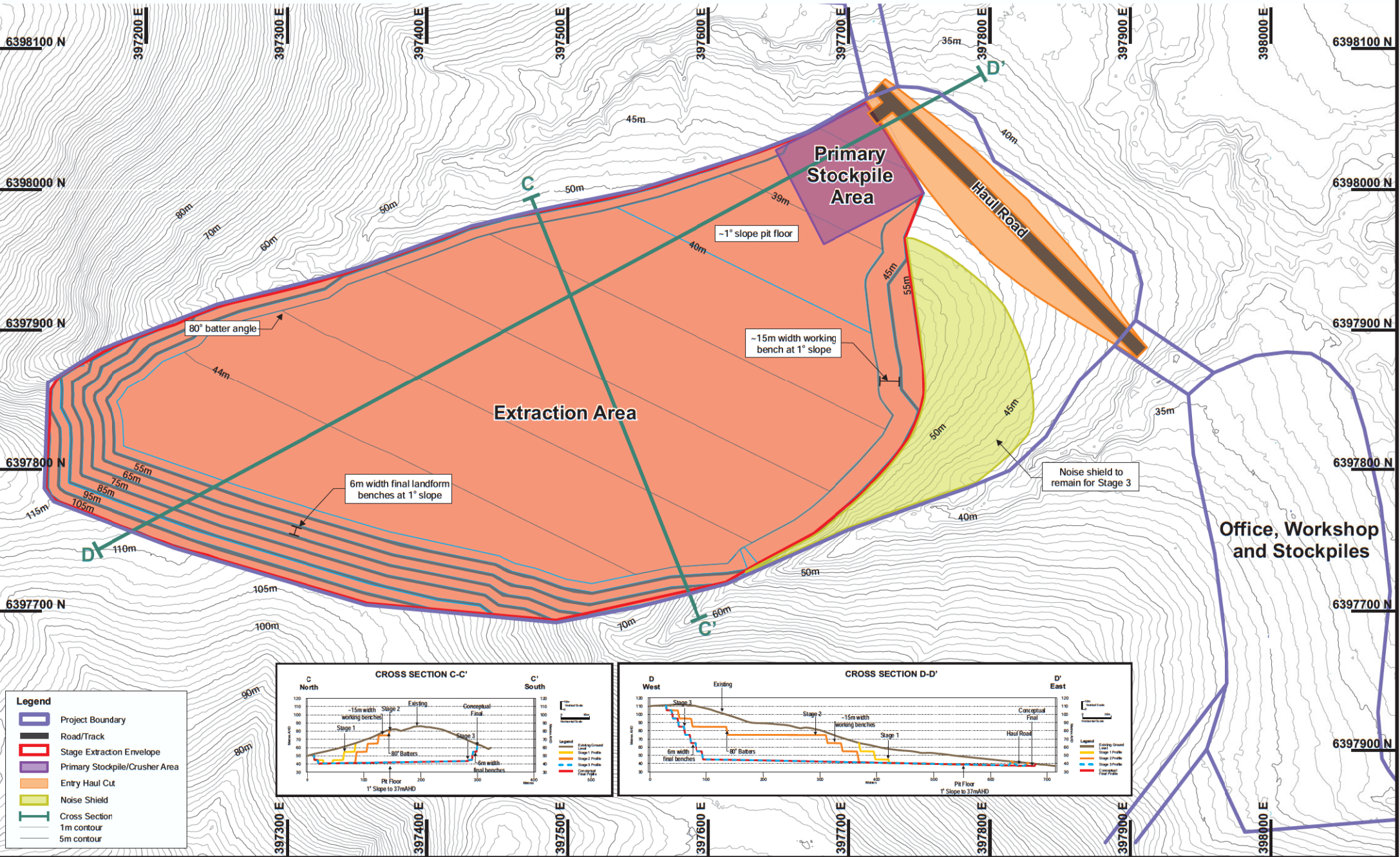
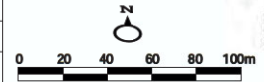
Unusable overburden will continue to be placed on finished landforms in the west and north of the site.

Outcomes

A Stage Three development has been plotted on *Figure Nine*, which would produce approximately a further 3,044,000m³.

Plan of:	Deep Creek Quarry - Stage Three	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Client & VGT Environmental Compliance Solutions Pty Ltd	Our Ref:	5414_DC_RR19_C009_V1_F9.cdr
Figure:	NINE	Council:	Mid Coast Council	Survey:	NSW Government Spatial Services, December 2018 Survey, Accessed Through ELVIS	Plan By:	SK
Sheet:	1 of 1	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V1 27/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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4.5 FINAL LANDFORM

Aims for this stage

Complete the extraction and construct final landform benches and batters.

Considerations

The development of this Stage considers data from:

- Kleinfelder Geo Technical Review working and final landform bench and batter design parameters.

Constraints and Issues

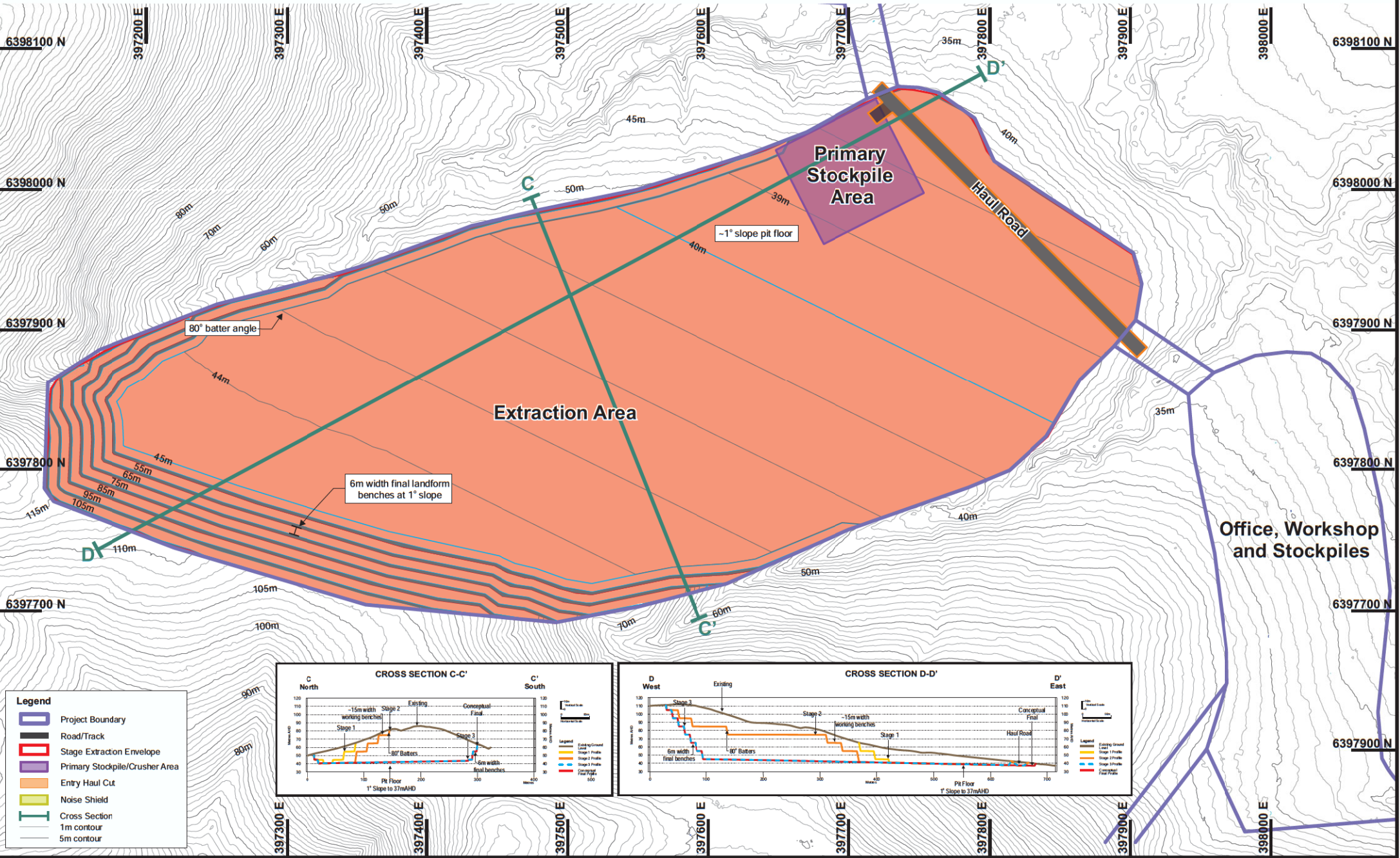
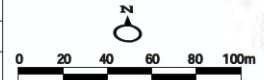
The final faces may vary due to varying geological and stability conditions. Conceptual design shows 10-metre high batters with 6 metre width benches.

Outcomes

A Final Landform has been plotted on *Figure Ten*, which would produce approximately a total of 4,930,000 cubic metres from the existing landform or 11.8 million tonnes at a density of 2.4 g/cm³. *Figure Eleven* shows a schematic of how the quarry may progress extraction within the boundaries.

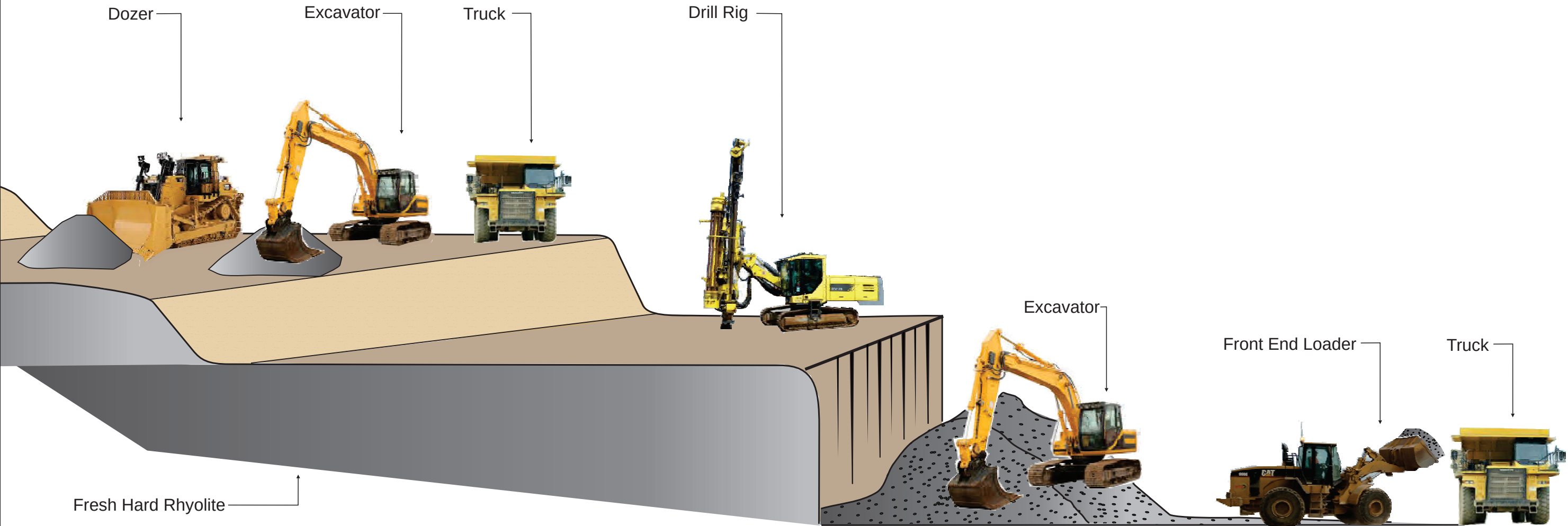
Plan of:	Deep Creek Quarry - Final Landform	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Client & VGT Environmental Compliance Solutions Pty Ltd	Our Ref:	5414_DC_RR19_C010_V2_F10.cdr
Figure:	TEN	Council:	Mid Coast Council	Survey:	NSW Government Spatial Services, December 2018 Survey, Accessed Through ELVIS	Plan By:	SK
Sheet:	1 of 1	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V2 03/06/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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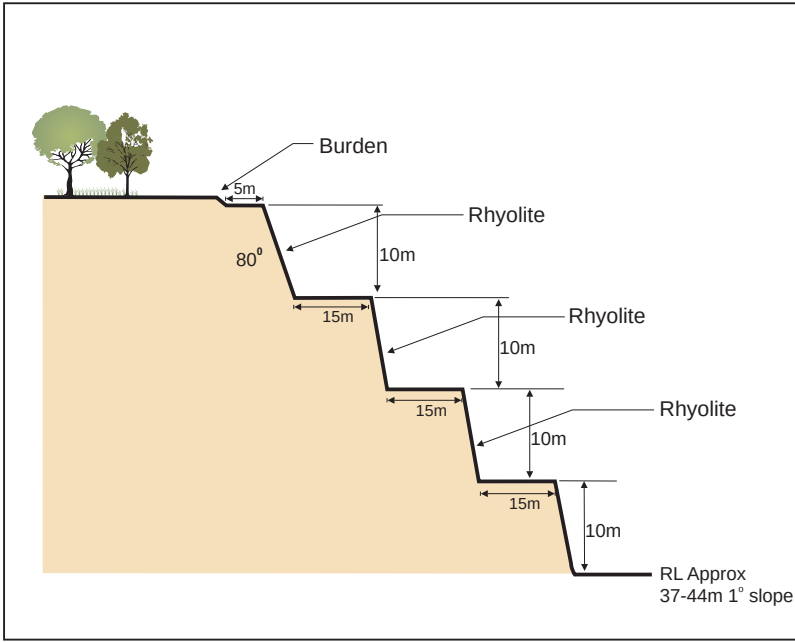


Plan of:	Deep Creek Quarry - Quarry Progression Schematic	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Client & VGT Environmental Compliance Solutions Pty Ltd	Our Ref:	5414_DC_RR19_C011_V1_F11.cdr
Figure:	ELEVEN	Council:	Mid Coast Council	Survey:	NSW Government Spatial Services, December 2018 Survey, Accessed Through ELVIS	Plan By:	SK/JD
Sheet:	1 of 1	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V1 27/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

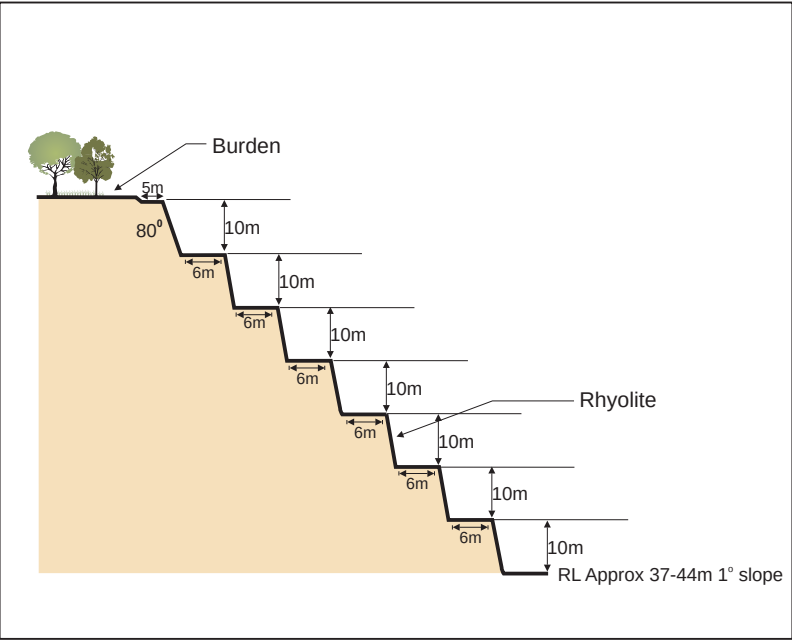
This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.



Indicative Working Bench Designs:



Indicative Final Landform Bench Designs:



5 Resource Assessment

Geological assessments use all available information in an attempt to determine the insitu resources. There is, as always, significant amounts of interpolation between on surface samples and drill core to determine the resources below the surface.

5.1 RESOURCE CALCULATION ASSUMPTIONS AND PARAMATERS

All calculations are based on these assumptions and parameters:

- Survey was obtained from ELVIS spatial data acquired from NSW Spatial Services website, the data was downloaded as a Digital Elevation Model (DEM), converted to a Triangular Irregular Network (TIN) and 3d contours created from the TIN in 12d software;
- The extraction envelope was defined by the proponent and Kleinfelder, adopting a careful review of onsite constraints including; flora, geology, neighbours, quarry development and final landform;
- The drill hole locations determined by the proponent and VGT;
- The surface sampling was undertaken by the proponent under the supervision of VGT;
- Surface samples were reviewed by VGT;
- Drill Core logged by VGT;
- Volume Calculations prepared by VGT with the aid of SURPAC and 12D – 3d modelling programs;
- The base of deposit was set on sloping floor 45 m RL in the west and 37 m RL in the east as determined by Kleinfelder to obtain a self-draining final landform floor; and
- Bench and batter designs by Kleinfelder.

5.2 MODELLING STATEMENT

Two modelling packages were used by VGT for this project, to provide a higher level of confidence in the numbers obtained. The detailed modelling for all stages was undertaken using 12D modelling package using all the parameters listed in Section 5.1.

SURPAC was used as a check calculation to determine the total resource using an average batter and floor level. This calculation was within 1% of the 12D calculation which is considered acceptable.

5.3 POTENTIAL PRODUCTS

The proponent is proposing dry crushing and screening processes on the raw materials and there will be no washing of materials, as such there will be no wet tailings generated on site.

5.3.1 Sedimentary Materials

Sedimentary materials consist of primarily sandstone and claystone. Hard sandstone could be utilised for armour materials, landscape products and the claystones will be utilised to increase the plasticity index when combined with the Volcanics for road base and road sub-base applications. The sedimentary materials would also be suitable for fill applications. Note the sediments have not been tested as yet.

5.3.2 Volcanic Materials

As identified in the Qualtest report, the Volcanics are suitable for following applications:

Table 25 – Material Suitability Summary									
Sample Number	Identification	Durable	Potential Product Suitability						
			Concrete Aggregate	Concrete Sand	Road Base	Asphaltic/ Sealing Aggregate	Rail Ballast	Rip Rap	Select Fill
DDH7	Rhyolite	Yes	Yes (i)	Yes (i)	Yes	Yes	Yes	Yes	Yes
DDH17	Rhyolite	Yes	Yes (i)	Yes (i)	Yes	Yes	Yes	Yes	Yes
DDH18	Rhyolite	Yes	Yes (i)	Yes (i)	Yes	Yes	Yes	Yes	Yes
DDH19	Rhyolite	Yes	Yes (i)	Yes (i)	Yes	Yes	Yes	Yes	Yes

(i) Provided that the appropriate precautions are taken in mix and engineering design to take into account the potential for mild or slow deleterious alkali-silica reactivity.
(ii) The Rhyolite is likely to be suitable for dimension stone and marine armour rock, if defect spacing is minimal and suitable boulders are procured.

The testing to date shows the Volcanic materials are suitable for a wide range of construction applications.

6 Limitations Of this Document

This geological and resource assessment has been prepared in good faith with the data made available by the client. This report makes use of interpolations and assumptions of continuity between points of known data.

Appendix A

Core Photography

Plan of:	Deep Creek Quarry Appendix A - DDH7 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipnShip	Our Ref:	5414_DC_RR19_C0A7_V0_DD7 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	1 of 8	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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Drill Hole Number: DDH 7

Project: Ironstone Developments Pty Ltd
Drilling Co: Total Drill
Date: April 2014

Job Number: LBC
Logged By: G THOMSON

Hole Depth: 72.05 m
Hole Dia: 4.5 inch

Description	Depth	Graphic Log	Sample	Strength	Remarks
Ground Surface	0				
OPEN HOLE - no sample	0.0 - 1.35m				Auger 0.0 - 1.35m
Weathered Sandstone - Orange brown Coarse with pebbles, Fracture 1.53, 1.65, 1.80, 2.10, 2.53, 2.58, Light grey brown between joints, 2.73-2.79 X, broken	1.35 - 3.05m			Hard	
Coreloss	3.05 - 3.17m			hard	
Crushed core - Loss ?	3.17 - 3.25m			Soft	
Weathered Sandstone- Orange Brown Medium Coarse, broken in part, volcano-lithic fragments	3.25 - 3.60m			Mod soft	
Weathered Siltstone- dark grey Hard altered	3.60 - 4.00m			Hard	
Weathered Sandstone- Orange Brown Clayey broken, coarse	4.00 - 4.40m			Mod soft	
Weathered Sandstone- Orange Brown Coarse to very coarse	4.40 - 6.78m			Mod hard	
Carbonaceous Claystone - black	6.78 - 7.05m			Mod hard	Carbonaceous Band Contact 6.78m
Rhyolite - Cream brown, Plagioclase laths, Fractures 6.90, 6.95 X - 7.05 30 / 70 degrees, 7.35- 8.25 broken	7.05 - 9.12m				
Rhyolite - Light grey, minor brown Fractures 9.12-9.40 70deg, broken, 10-15cm 10 to 20 deg	9.12 - 10.65m			H-V Hard	



			Potential Product Suitability						
Sample Number	Identification	Durable	Concrete Aggregate	Concrete Sand	Road Base	Asphaltic/Sealing Aggregate	Rail Ballast	Rip Rap	Select Fill
DDH7	Rhyolite	Yes	Yes (ii)	Yes (ii)	Yes (i)	Yes	Yes	Yes	Yes

(ii) Provided that the appropriate precautions are taken in mix and engineering design to take into account the potential for mild or slow deleterious alkali-silica reactivity.
(iv)The Rhyolite, Rhyodacite and Quartz Trachyte are likely to be suitable for dimension stone and marine amour rock, if suitable boulders are found. The Trachyte is not recommended for use as dimension stone due to high percentage of clay.

Plan of:	Deep Creek Quarry Appendix A - DDH7 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipnShip	Our Ref:	5414_DC_RR19_C0A17_V0_DDH7 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	2 of 8	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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Drill Hole Number: DDH 7

Project: Ironstone Developments Pty Ltd Job Number: LBC Hole Depth: 72.05 m
Drilling Co: Total Drill Logged By: G THOMSON Hole Dia: 4.5 inch
Date: April 2014

Description	Depth	Graphic Log	Sample	Strength	Remarks
Rhyolite - Light grey, minor brown Fractures 9.12-9.40 70deg, broken, 10-15cm 10 to 20 deg	11 12 13 14 15 16 17 18 19 20			H-VHard	



			Potential Product Suitability						
Sample Number	Identification	Durable	Concrete Aggregate	Concrete Sand	Road Base	Asphaltic/Sealing Aggregate	Rail Ballast	Rip Rap	Select Fill
DDH7	Rhyolite	Yes	Yes (ii)	Yes (ii)	Yes (i)	Yes	Yes	Yes	Yes

(ii) Provided that the appropriate precautions are taken in mix and engineering design to take into account the potential for mild or slow deleterious alkali-silica reactivity.
(iv)The Rhyolite, Rhyodacite and Quartz Trachyte are likely to be suitable for dimension stone and marine armour rock, if suitable boulders are found. The Trachyte is not recommended for use as dimension stone due to high percentage of clay.

Plan of:	Deep Creek Quarry Appendix A - DDH7 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipnShip	Our Ref:	5414_DC_RR19_C0A17_V0_DDH7 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	4 of 8	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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Drill Hole Number: DDH 7

Project: Ironstone Developments Pty Ltd
Drilling Co: Total Drill
Date: April 2014

Job Number: LBC
Logged By: G THOMSON

Hole Depth: 72.05 m
Hole Dia: 4.5 inch

Description	Depth	Graphic Log	Sample	Strength	Remarks
Rhyolite-Light brown brown Solid sticks, Fractures at 21.26-21.38 70deg, 28.97-29.11 70deg35.00-35.40 4 breaks joints, 38.40 70deg, 40.00, 40.75, 40.95, 41.08, 41.65, 42.00, 42.25-42.56, 70 deg, 45.35-45.6 51.40-52.25 4 breaks, 70deg veins, 53-10 10-20cm segments veins calcite and chlorite Calcite veins 28.25-30.00 50%,	31 32 33 34 35 36 37 38 39 40			H-VHard	



Petrographic Sample

Rhyolite
Feldspar 38%
Quartz 29%
pH 9.08

			Potential Product Suitability						
Sample Number	Identification	Durable	Concrete Aggregate	Concrete Sand	Road Base	Asphaltic/Sealing Aggregate	Rail Ballast	Rip Rap	Select Fill
DDH7	Rhyolite	Yes	Yes (ii)	Yes (ii)	Yes (i)	Yes	Yes	Yes	Yes

(ii) Provided that the appropriate precautions are taken in mix and engineering design to take into account the potential for mild or slow deleterious alkali-silica reactivity.
(iv)The Rhyolite, Rhyodacite and Quartz Trachyte are likely to be suitable for dimension stone and marine amour rock, if suitable boulders are found. The Trachyte is not recommended for use as dimension stone due to high percentage of clay.

Plan of:	Deep Creek Quarry Appendix A - DDH7 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipnShip	Our Ref:	5414_DC_RR19_C0A17_V0_DDH7 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	5 of 8	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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Drill Hole Number: DDH 7

Project: Ironstone Developments Pty Ltd Job Number: LBC Hole Depth: 72.05 m
Drilling Co: Total Drill Logged By: G THOMSON Hole Dia: 4.5 inch
Date: April 2014

Description	Depth	Graphic Log	Sample	Strength	Remarks
Rhyolite-Light brown brown Solid sticks, Fractures at 21.26-21.38 70deg, 28.97-29.11 70deg35.00-35.40 4 breaks joints, 38.40 70deg, 40.00, 40.75, 40.95, 41.08, 41.65, 42.00, 42.25-42.56, 70 deg, 45.35-45.6 51.40-52.25 4 breaks, 70deg veins, 53-10 10-20cm segments veins calcite and chlorite Calcite veins 28.25-30.00 50%,	41 42 43 44 45 46 47 48 49 50			H-VHard	



			Potential Product Suitability						
Sample Number	Identification	Durable	Concrete Aggregate	Concrete Sand	Road Base	Asphaltic/Sealing Aggregate	Rail Ballast	Rip Rap	Select Fill
DDH7	Rhyolite	Yes	Yes (ii)	Yes (ii)	Yes (i)	Yes	Yes	Yes	Yes

(ii) Provided that the appropriate precautions are taken in mix and engineering design to take into account the potential for mild or slow deleterious alkali-silica reactivity.
(iv)The Rhyolite, Rhyodacite and Quartz Trachyte are likely to be suitable for dimension stone and marine amour rock, if suitable boulders are found. The Trachyte is not recommended for use as dimension stone due to high percentage of clay.

Plan of:	Deep Creek Quarry Appendix A - DDH7 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipnShip	Our Ref:	5414_DC_RR19_C0A17_V0_DDH7 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	6 of 8	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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Drill Hole Number: DDH 7

Project: Ironstone Developments Pty Ltd Job Number: LBC Hole Depth: 72.05 m
Drilling Co: Total Drill Logged By: G THOMSON Hole Dia: 4.5 inch
Date: April 2014

Description	Depth	Graphic Log	Sample	Strength	Remarks
Rhyolite-Light brown brown Solid sticks, Fractures at 21.26-21.38 70deg, 28.97-29.11 70deg35.00-35.40 4 breaks joints, 38.40 70deg. 40.00, 40.75, 40.95, 41.08, 41.65, 42.00, 42.25-42.56, 70 deg, 45.35-45.6 51.40-52.25 4 breaks, 70deg veins, 53-10 10-20cm segments veins calcite and chlorite Calcite veins 28.25-30.00 50%,	51 52 53 54 55 56 57 58 59 60			H-VHard	



			Potential Product Suitability						
Sample Number	Identification	Durable	Concrete Aggregate	Concrete Sand	Road Base	Asphaltic/Sealing Aggregate	Rail Ballast	Rip Rap	Select Fill
DDH7	Rhyolite	Yes	Yes (ii)	Yes (ii)	Yes (i)	Yes	Yes	Yes	Yes

(ii) Provided that the appropriate precautions are taken in mix and engineering design to take into account the potential for mild or slow deleterious alkali-silica reactivity.
(iv)The Rhyolite, Rhyodacite and Quartz Trachyte are likely to be suitable for dimension stone and marine amour rock, if suitable boulders are found. The Trachyte is not recommended for use as dimension stone due to high percentage of clay.

Plan of:	Deep Creek Quarry Appendix A - DDH7 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipnShip	Our Ref:	5414_DC_RR19_C0A17_V0_DDH7 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	7 of 8	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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Drill Hole Number: DDH 7

Project: Ironstone Developments Pty Ltd
Drilling Co: Total Drill
Date: April 2014

Job Number: LBC
Logged By: G THOMSON

Hole Depth: 72.05 m
Hole Dia: 4.5 inch

Description	Depth	Graphic Log	Sample	Strength	Remarks
Rhyolite-Light brown brown Solid sticks, Fractures at 21.26-21.38 70deg, 28.97-29.11 70deg35.00-35.40 4 breaks joints, 38.40 70deg, 40.00, 40.75, 40.95, 41.08, 41.65, 42.00, 42.25-42.56, 70 deg, 45.35-45.6 51.40-52.25 4 breaks, 70deg veins, 53-10 10-20cm segments veins calcite and chlorite Calcite veins 28.25-30.00 50%,	61				
	62				
	63			H-VHard	
Rhyolite -Brown, with purple Feldspar flecks minor calcite veins	64				
	65				
	66				
Rhyolite - Light grey brown, with Inclusions of calcite bearing nodules increasing toward base upto 40 mm rounded.	67				
	68				
Calcite Vein -crushed core Carbonaceous Claystone Black Indurated occasional sandstone bands	69				
	70			H-VHard	Carbonaceous Band



			Potential Product Suitability						
Sample Number	Identification	Durable	Concrete Aggregate	Concrete Sand	Road Base	Asphaltic/Sealing Aggregate	Rail Ballast	Rip Rap	Select Fill
DDH7	Rhyolite	Yes	Yes (ii)	Yes (ii)	Yes (i)	Yes	Yes	Yes	Yes

(ii) Provided that the appropriate precautions are taken in mix and engineering design to take into account the potential for mild or slow deleterious alkali-silica reactivity.
(iv)The Rhyolite, Rhyodacite and Quartz Trachyte are likely to be suitable for dimension stone and marine armour rock, if suitable boulders are found. The Trachyte is not recommended for use as dimension stone due to high percentage of clay.

Plan of:	Deep Creek Quarry Appendix A - DDH7 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipnShip	Our Ref:	5414_DC_RR19_C0A17_V0_DDH7 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	8 of 8	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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Drill Hole Number: DDH 7

Project: Ironstone Developments Pty Ltd Job Number: LBC Hole Depth: 72.05 m
Drilling Co: Total Drill Logged By: G THOMSON Hole Dia: 4.5 inch
Date: April 2014

Description	Depth	Graphic Log	Sample	Strength	Remarks
Sandstone-Light Grey, pebbles at base	71				
	72				
	73				
	74				
	75				
	76				
	77				
	78				
	79				
	80				



			Potential Product Suitability						
Sample Number	Identification	Durable	Concrete Aggregate	Concrete Sand	Road Base	Asphaltic/Sealing Aggregate	Rail Ballast	Rip Rap	Select Fill
DDH7	Rhyolite	Yes	Yes (ii)	Yes (ii)	Yes (i)	Yes	Yes	Yes	Yes

(ii) Provided that the appropriate precautions are taken in mix and engineering design to take into account the potential for mild or slow deleterious alkali-silica reactivity.
(iv)The Rhyolite, Rhyodacite and Quartz Trachyte are likely to be suitable for dimension stone and marine amour rock, if suitable boulders are found. The Trachyte is not recommended for use as dimension stone due to high percentage of clay.

Plan of:	Deep Creek Quarry Appendix A - DDH17 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipShip	Our Ref:	5414_DC_RR19_C0A17_V0_DDH17 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	1 of 4	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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BOREHOLE LOG

Name of Hole: DDH17

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 78m

Collar Height : N/A

Coordinates: 397618E 6397829N

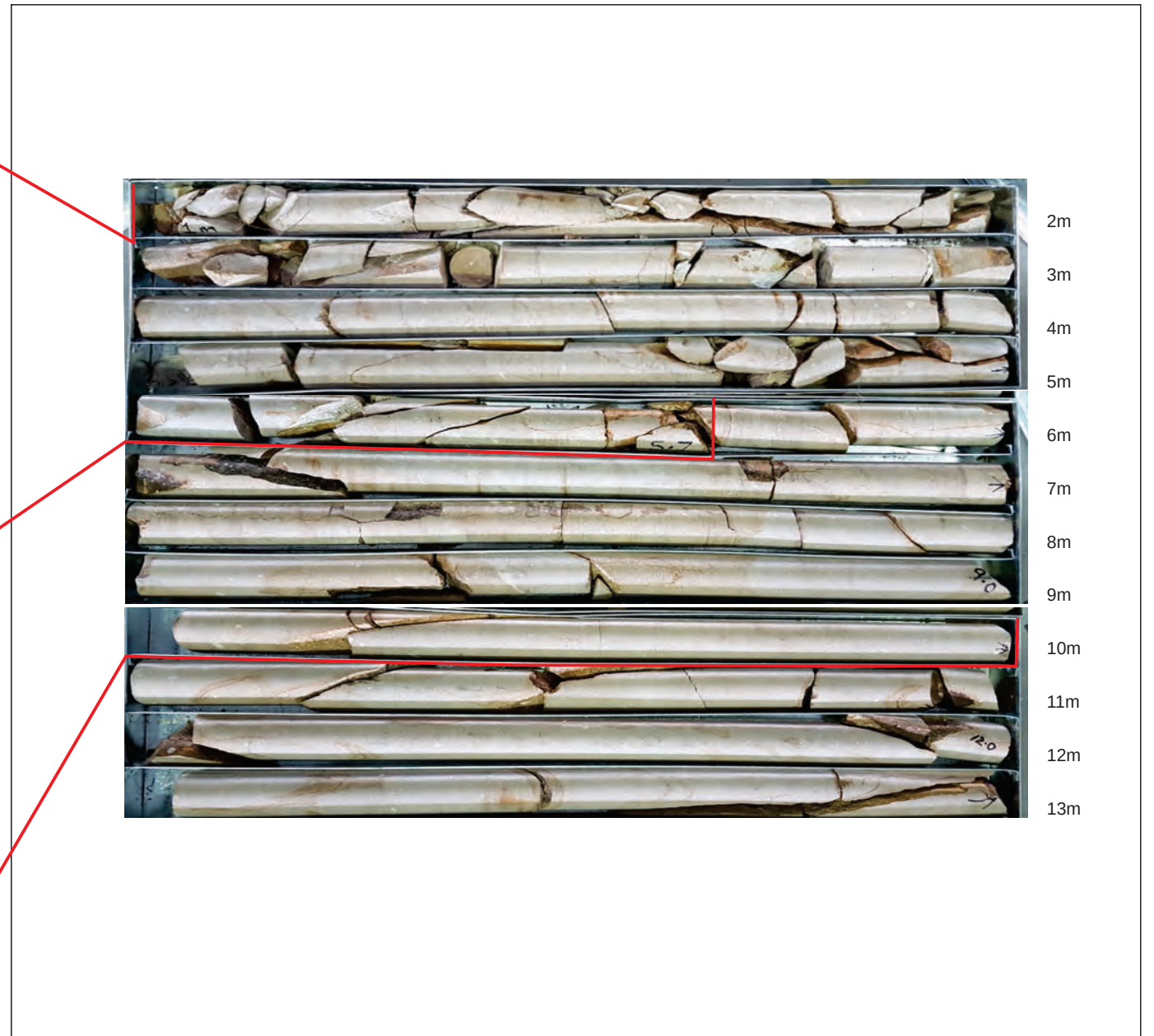
Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 1 of 4

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description	Additional Information
78	0		0	1	Auger to 1m - No sample.	
			>5	4.7	Rhyolite - Light orange, yellow, plagioclase laths 5%.	
76	2		>5			
			5			
74	4		>5			
			>5			
72	6		3		Rhyolite - Light orange, pink, plagioclase laths 10%, some calcite inclusions. Fracturing, broken at 17m.	
			4			
70	8		4			
			3			
68	10					



Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Plan of:	Deep Creek Quarry Appendix A - DDH17 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipShip	Our Ref:	5414_DC_RR19_C0A17_V0_DDH17 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	2 of 4	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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BOREHOLE LOG

Name of Hole: DDH17

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 78m

Collar Height : N/A

Coordinates: 397618E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 2 of 4

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description	Additional Information
68	10		5	15.3	Rhyolite - Light orange, pink, plagioclase laths 10%, some calcite inclusions. Fracturing, broken at 17m.	
			2			
66	12		3			
			3			
64	14		2			
			>5			
62	16		>5			
			3			
60	18		1			
			3			
58	20				Highly fractured	



11m
12m
13m
14m
15m
16m
17m
18m
19m
20m
21m

Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Plan of:	Deep Creek Quarry Appendix A - DDH17 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipShip	Our Ref:	5414_DC_RR19_C0A17_V0_DDH17 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	3 of 4	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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BOREHOLE LOG

Name of Hole: DDH17

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 78m

Collar Height : N/A

Coordinates: 397618E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 3 of 4

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description	Additional Information
58	20		5	5.2	Rhyolite - Lighter pink orange, plagioclase laths 15%, some calcite inclusions.	
			2			
56	22		3			
			4			
54	24		5			
			5			
52	26		2	7	Rhyolite - Lighter orange pink, larger calcite inclusions, some green inclusions.	
			1			
50	28		2			
			2			
48	30					



Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Plan of:	Deep Creek Quarry Appendix A - DDH17 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipShip	Our Ref:	5414_DC_RR19_C0A17_V0_DDH17 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	4 of 4	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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BOREHOLE LOG

Name of Hole: DDH17

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 78m

Collar Height : N/A

Coordinates: 397618E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 4 of 4

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description	Additional Information
48	30		>5		Rhyolite - Lighter orange pink, larger calcite inclusions, some green inclusions.	
			2			
46	32		4			
			3	6.46	Rhyolite - Darker orange pink, more calcite and green inclusions. END OF HOLE.	
44	34		>5			
			>5			
42	36		4			
			>5			
40	38		3			
			5			



Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Plan of:	Deep Creek Quarry Appendix A - DDH18 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipShip	Our Ref:	5414_DC_RR19_C0A18_V0_DDH18 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	1 of 6	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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BOREHOLE LOG

Name of Hole: DDH18

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 92.5m

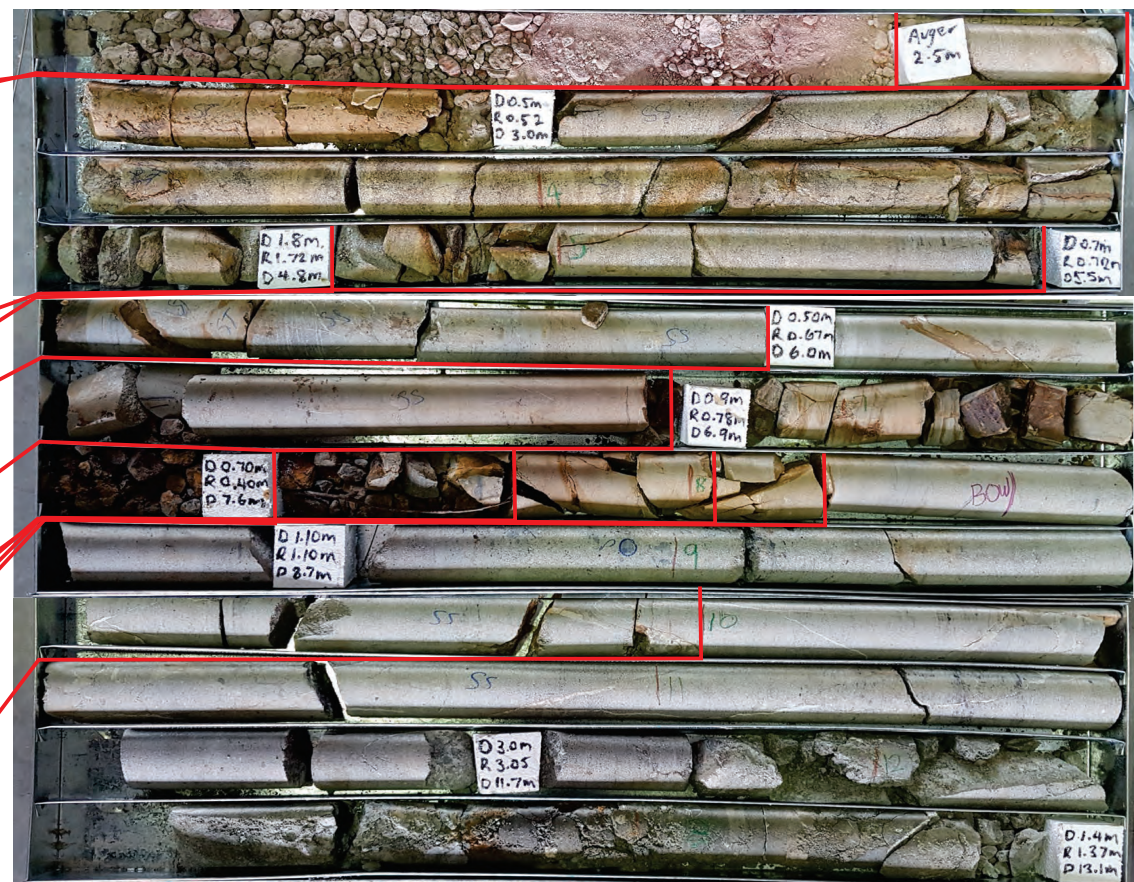
Collar Height : N/A

Coordinates: 397400E 6397834N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
92	0		>5		
			>5	2.5	Auger to 2.5m - No sample.
90			>5	0.15	Weathered Sandstone - Light orange, medium to coarse grained.
			>5	2.15	Weathered Siltstone - Orange, fine grained.
88			>5		
				0.7	Weathered Sandstone - Light orange to brown, coarse to very coarse grained.
			>5	0.2	Weathered Siltstone - Light brown some orange, medium to coarse grained.
86			4	1.2	Sandstone - Dark grey some orange, black silty laminar.
				0.6	Silty Sandstone - Orange to grey, ironstained weathering.
			>5	0.3	Siltstone - dark grey with some orange.
				0.34	Sandstone - Light orange, medium grained.
84			4	0.18	Sandstone - Light grey brown laminae, medium to coarse grained, some calcite inclusions. Base of Weathering.
			>5		
	10				



Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Plan of:	Deep Creek Quarry Appendix A - DDH18 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipShip	Our Ref:	5414_DC_RR19_C0A18_V0_DDH18 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	2 of 6	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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BOREHOLE LOG

Name of Hole: DDH18

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

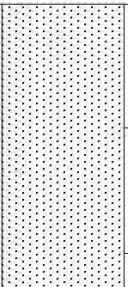
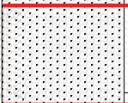
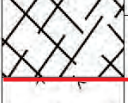
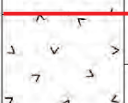
Surface RL: 92.5m

Collar Height : N/A

Coordinates: 397400E 6397834N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
82	10		1	3.98	Sandstone - Light grey, coarse to very coarse, occasional pebble, calcite veining, fractured and broken at base.
			>5		
80	12		>5	0.8	Sandstone - Light grey, coarse to very coarse, fractured thrust faulting.
			>5	0.39	Siltstone - Grey, carbonaceous claystone, coaly in part.
78	14		1		Core loss.
			>5	1.11	Rhyolite - Grey, highly fractured.
76	16		>5		
			>5		
74	18		2		Rhyolite - Light olive, 10 - 20% plagioclase laths, calcite veining.
			>5		
72	20				



Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Plan of:	Deep Creek Quarry Appendix A - DDH18 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipShip	Our Ref:	5414_DC_RR19_C0A18_V0_DDH18 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	3 of 6	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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BOREHOLE LOG

Name of Hole: DDH18

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 92.5m

Collar Height : N/A

Coordinates: 397400E 6397834N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 3 of 6

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
72			>5	9.7	Rhyolite - Light olive, 10 - 20% plagioclase laths, calcite veining.
	22		>5		
70			3		
	24		>5		
68			3		
	26		>5		
66			>5		
	28		>5		Rhyolite - green olive, 10 % plagioclase laths.
64			>5		
	30		>5		



Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Plan of:	Deep Creek Quarry Appendix A - DDH18 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipShip	Our Ref:	5414_DC_RR19_C0A18_V0_DDH18 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	4 of 6	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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BOREHOLE LOG

Name of Hole: DDH18

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 92.5m

Collar Height : N/A

Coordinates: 397400E 6397834N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 4 of 6

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
62			3		
			3	12.5	Rhyolite - green olive, 10 % plagioclase laths.
32					
60			>5		
			>5		
34					
58			2		
			2		
36					
56			4		
			>5		
38					
54			>5	1.37	Dyke - green, grey, fine grained, no plagioclase laths.
			>5		Rhyolite and Mylonitic throughout. Pit Floor at 43.2m.
40					



Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Plan of:	Deep Creek Quarry Appendix A - DDH18 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipShip	Our Ref:	5414_DC_RR19_C0A18_V0_DDH18 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	5 of 6	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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BOREHOLE LOG

Name of Hole: DDH18

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 92.5m

Collar Height : N/A

Coordinates: 397400E 6397834N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 5 of 6

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
52			>5		
			>5		
42					
50			>5		
			>5		
44					
48			>5		
			>5	12.13	Rhyolite and Mylonitic throughout. Pit Floor at 43.2m.
			>5		
46			>5		
46			>5		
			>5		
48					
44			>5		
			>5		
50					



Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Plan of:	Deep Creek Quarry Appendix A - DDH18 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipShip	Our Ref:	5414_DC_RR19_C0A18_V0_DDH18 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	6 of 6	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.



BOREHOLE LOG

Name of Hole: DDH18

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 92.5m

Collar Height : N/A

Coordinates: 397400E 6397834N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 6 of 6

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
42			>5		
			>5		
52			>5		
40			>5		
			>5	4.4	Rhyolite - grey light olive, 30% plagioclase laths, minor fractures, broken at base. END OF HOLE.
54			>5		
38			>5		



Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Plan of:	Deep Creek Quarry Appendix A - DDH19 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipShip	Our Ref:	5414_DC_RR19_C0A19_V0_DDH19 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	1 of 7	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

BOREHOLE LOG

Name of Hole: DDH19

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 101.5m

Collar Height : N/A

Coordinates: 397203E 6397829N

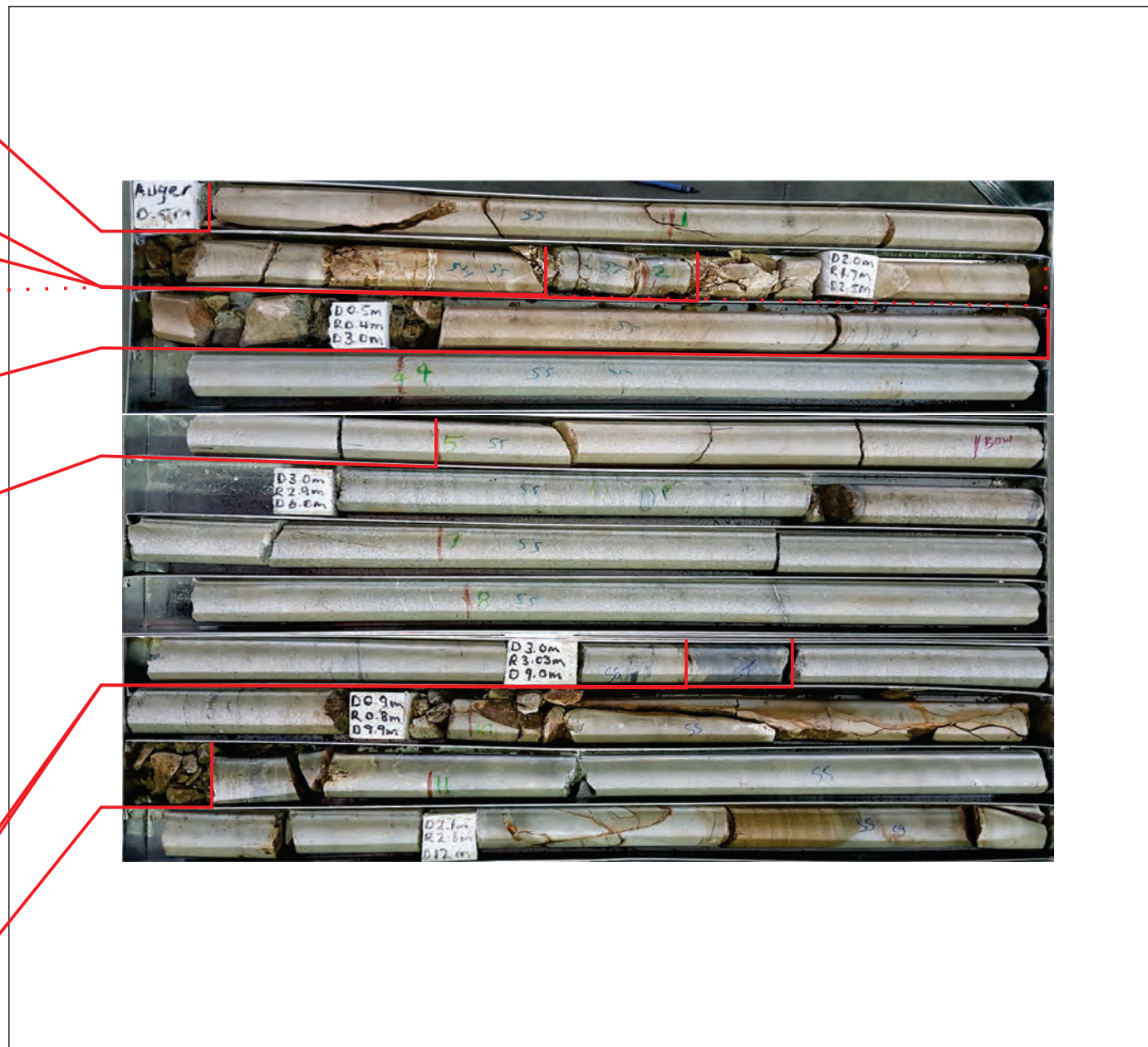
Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 1 of 7

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
100	0			0.5	Auger - No sample
			2	1.2	Weathered Sandstone - Light brown, medium to coarse grained, Hard.
			>5		
98	2			0.5	Weathered Silty Sandstone - Light brown minor grey, broken.
			>5	0.3	Core loss
			>5	1.28	Weathered Sandstone - Light brown black, Silty Laminar, medium to coarse grained, broken around 3m.
96	4		1	1.22	Weathered Sandstone - Grey brown, medium to coarse grained, hard.
			1		
94	6		3		
				4.9	Sandstone - Grey, coarse to very coarse grained, pebbly in part.
			2		
92	8		0		
				0.12	Siltstone Band
			>5		
	10				Weathered Sandstone - Light grey, medium grained, sub vertical



Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Plan of:	Deep Creek Quarry Appendix A - DDH19 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipShip	Our Ref:	5414_DC_RR19_C0A19_V0_DDH19 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	2 of 7	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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BOREHOLE LOG

Name of Hole: DDH19

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 101.5m

Collar Height : N/A

Coordinates: 397203E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 2 of 7

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
90	10		>5	0.87	joint ironstained, Aquifer?
88	12		2	2.23	Siltstone - Grey brown, medium to coarse grained.
86	14		>5	1.6	Volcanic contact? - Large inclusions, calcite inclusions, vugg like.
84	16		4	4.2	Rhyolite - Grey matrix, pinky laths 20%, becoming pinky brown at base.
82	18		>5		
	20		>5		



Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Plan of:	Deep Creek Quarry Appendix A - DDH19 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipnShip	Our Ref:	5414_DC_RR19_C0A19_V0_DDH19 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	3 of 7	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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BOREHOLE LOG

Name of Hole: DDH19

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 101.5m

Collar Height : N/A

Coordinates: 397203E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 3 of 7

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
80			4		
			>5		
22			>5		
78			1		
24			2		
76			1		
26			4		
74			4		
28			4		
72			<5		
30					
				17.2	Rhyolite - pinky orange, plagioclase laths 15 - 20%, high angle calcite vein at 13.8m.



Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Plan of:	Deep Creek Quarry Appendix A - DDH19 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipnShip	Our Ref:	5414_DC_RR19_C0A19_V0_DDH19 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	4 of 7	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

BOREHOLE LOG

Name of Hole: DDH19

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 101.5m

Collar Height : N/A

Coordinates: 397203E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 4 of 7

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
70			>5		
			>5		
32			<5		
68			3		Rhyolite - pinky orange, plagioclase laths 15 - 20%
			>5		
			>5		
36			>5		
64			4		
			2		Rhyolite - Light brown with green inclusions, calcite inclusions, becoming light grey towards bottom.
38			3		
62					
40					



Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Plan of:	Deep Creek Quarry Appendix A - DDH19 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipShip	Our Ref:	5414_DC_RR19_C0A19_V0_DDH19 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	5 of 7	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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BOREHOLE LOG

Name of Hole: DDH19

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 101.5m

Collar Height : N/A

Coordinates: 397203E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 5 of 7

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
60			1		
			>5		
42			>5		
58			>5		
			>5	14.6	Rhyolite - Light brown with green inclusions, calcite inclusions, becoming light grey towards bottom.
44			>5		
56			>5		
			>5		
46			>5		
54			>5		
			>5		
48			>5		
52			>5		
			>5		
50					



Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Plan of:	Deep Creek Quarry Appendix A - DDH19 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipnShip	Our Ref:	5414_DC_RR19_C0A19_V0_DDH19 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	6 of 7	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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BOREHOLE LOG

Name of Hole: DDH19

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 101.5m

Collar Height : N/A

Coordinates: 397203E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 6 of 7

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
50			>5		
			1		
52			0		
48			4	5.4	Rhyolite - Light grey, plagy laths, green inclusions, calcite inclusions.
			3		
54			2		
46			>5		
			>5		
56			>5	5.6	Rhyolite - Light grey, plagy laths, green inclusions, calcite inclusions highly fractured thrust zone, mylonitic in nature, less faulting at base (but broken). END OF HOLE
44			>5		
			>5		
58			>5		
42			>5		
			>5		
60					



Plan of:	Deep Creek Quarry Appendix A - DDH19 Geology	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Google Earth Pro - Image Date 02/08/2018, Google Maps 2020 & Cadastral Boundaries & Roads from NSW ClipnShip	Our Ref:	5414_DC_RR19_C0A19_V0_DDH19 App A.cdr
Figure:	Appendix A	Council:	Mid Coast Council	Survey:	N/A	Plan By:	SK
Sheet:	7 of 7	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 18/05/2020	Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton

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BOREHOLE LOG

Name of Hole: DDH19

Project Number: 5414

Client: Ironstone Developments Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 101.5m

Collar Height : N/A

Coordinates: 397203E 6397829N

Drilling Supervisor: Tim Mullaney

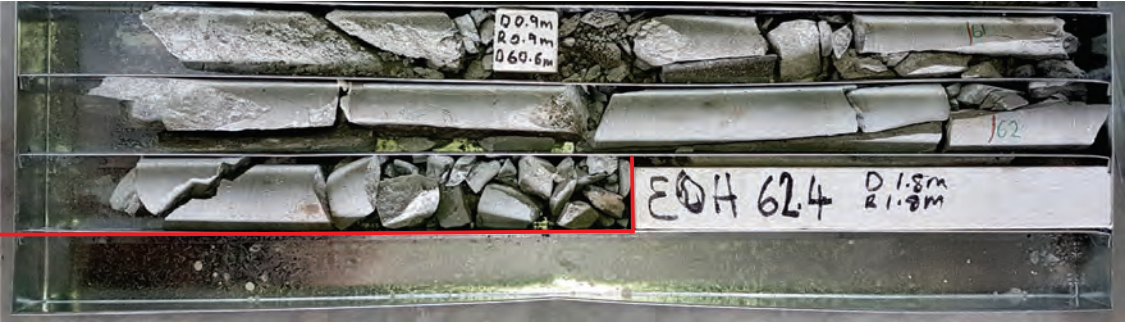
Drilling Contractor: Total Drilling



Page 7 of 7

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
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40			>5		Rhyolite - Light grey, plagy laths, green inclusions, calcite inclusions highly fractured thrust zone, mylonitic in nature, less faulting at base (but broken). END OF HOLE
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Other Information:

Log Created By: SC 27/11/2018
V2: SK 18/05/2020

Checked By:
V2: GT

Version: V2 18/05/2020

Appendix B

Core Photography with Samples Removed

Plan of:	Deep Creek Quarry - DDH17 Drill Core Samples Taken	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy. 			
Figure:	APPENDIX B				
Sheet:	1 of 2				
Version/Date:	V1 19/05/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C0AB_V1_DDH1
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Plan of:	Deep Creek Quarry - DDH17 Drill Core Samples Taken	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy. 			
Figure:	APPENDIX B				
Sheet:	2 of 2				
Version/Date:	V1 19/05/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C0Ab_V1_DD17 App B.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Plan of:	Deep Creek Quarry - DDH18 Drill Core Samples Taken
Figure:	APPENDIX B
Sheet:	1 of 3
Version/Date:	V1 19/05/2020

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C0AB_V1_DDH18 App B.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Plan of:	Deep Creek Quarry - DDH18 Drill Core Samples Taken
Figure:	APPENDIX B
Sheet:	2 of 3
Version/Date:	V1 19/05/2020

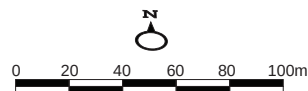
This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C0AB_V1_DDH18 App B.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Plan of:	Deep Creek Quarry - DDH18 Drill Core Samples Taken
Figure:	APPENDIX B
Sheet:	3 of 3
Version/Date:	V1 19/05/2020

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.



Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C0AB_V1_DDH18 App B.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Manager/Authorisation Holder Ironstone Development Pty Ltd: Tim Mullaney
Signed: _____
Date: _____
Project Manager VGT: Greg Thomson
Signed: _____
Date: _____

Plan of:	Deep Creek Quarry - DDH19 Drill Core Samples Taken	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy. 			
Figure:	APPENDIX B				
Sheet:	1 of 4				
Version/Date:	V1 19/05/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C0AB_V1_DDH19.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Plan of:	Deep Creek Quarry - DDH19 Drill Core Samples Taken	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy. 			
Figure:	APPENDIX B				
Sheet:	2 of 4				
Version/Date:	V1 19/05/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C0AB_V1_DDH19.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Plan of:	Deep Creek Quarry - DDH19 Drill Core Samples Taken	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.					
Figure:	APPENDIX B						
Sheet:	3 of 4						
Version/Date:	V1 19/05/2020						
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C0AB_V1_DDH19.cdr		
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD		
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT		
Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton		



Plan of:	Deep Creek Quarry - DDH19 Drill Core Samples Taken	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.  Environmental Compliance Solutions Pty Ltd			
Figure:	APPENDIX B				
Sheet:	4 of 4				
Version/Date:	V1 19/05/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C0AB_V1_DDH19.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Developments Pty Ltd	Contour Interval:	N/A	Office:	Thornton



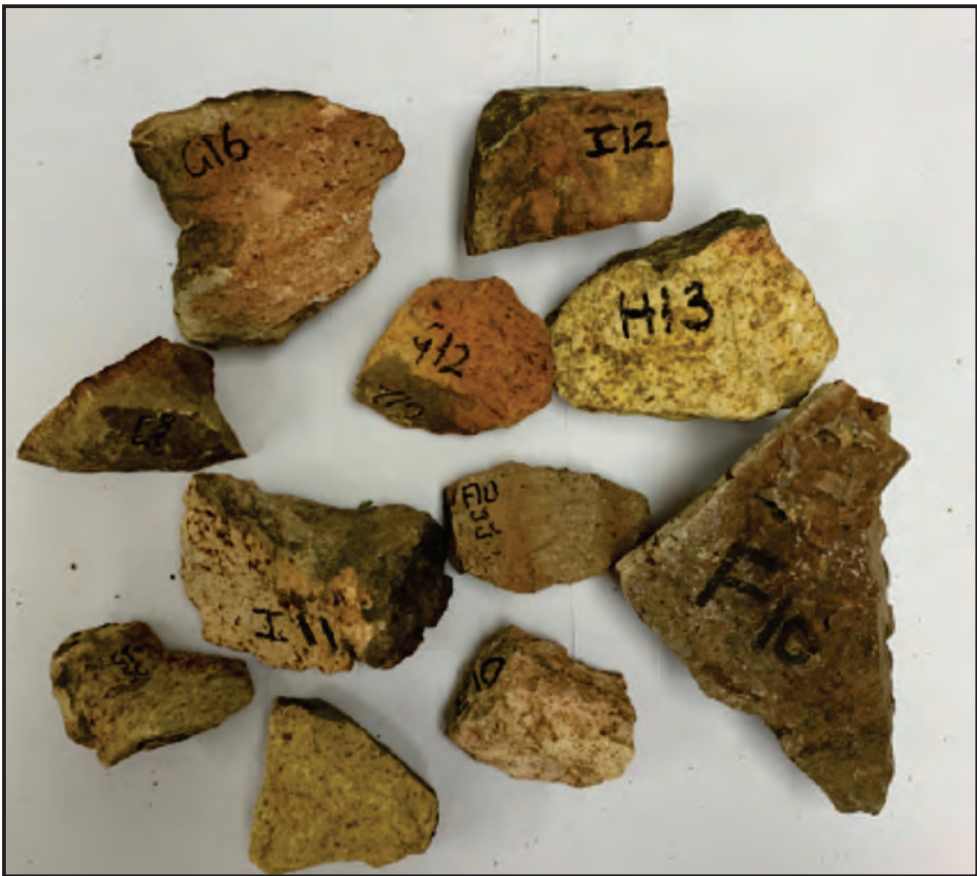
Appendix C

Surface Mapping Samples and Photography

Plan of:	Deep Creek Quarry - Surface Mapping Samples and Photography	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Our Ref:	5414_DC_RR19_C0AC_V0 App C.cdr
Figure:	APPENDIX C	Council:	Mid Coast Council	Plan By:	SK
Sheet:	1 of 3	Client:	Ironstone Developments Pty Ltd	Project Manager:	GT
Version/Date:	V0 19/05/2020	Source:	VGT Environmental Compliance Solutions Pty Ltd - February 2019	Office:	Thornton

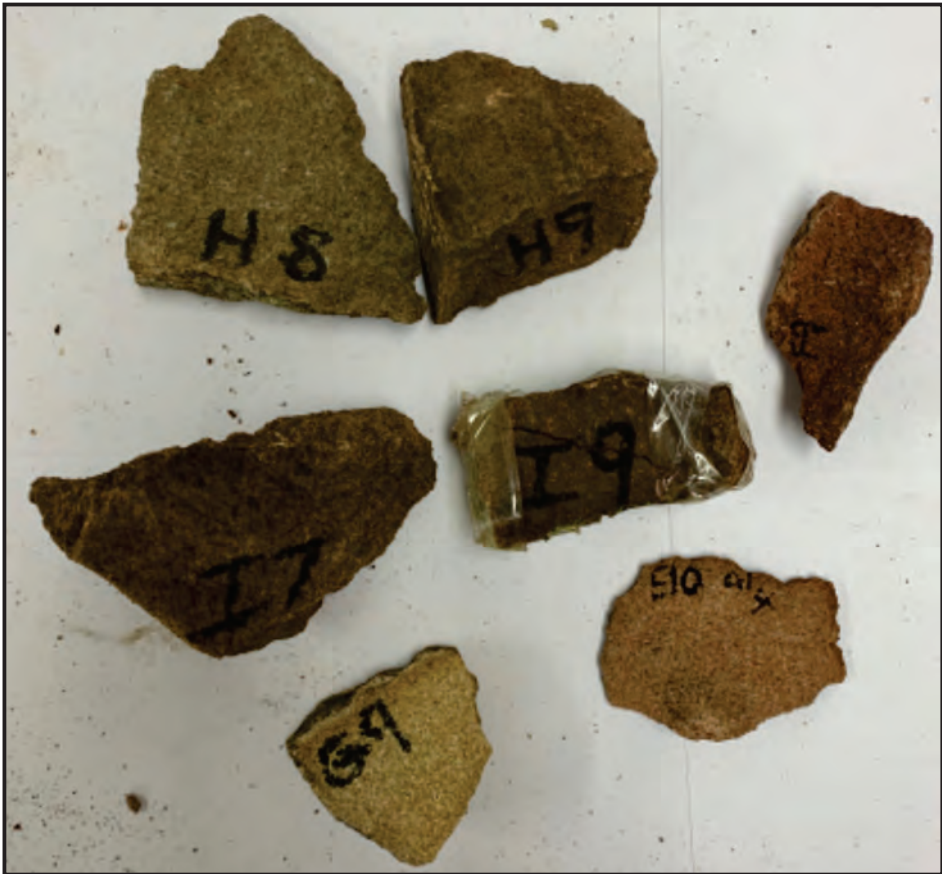


This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.



Photograph 1

Altered Volcanics



Photograph 2

Pegmatite

Plan of:	Deep Creek Quarry - Surface Mapping Samples and Photography	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Our Ref:	5414_DC_RR19_C0AC_V0 App C.cdr
Figure:	APPENDIX C	Council:	Mid Coast Council	Plan By:	SK
Sheet:	2 of 3	Client:	Ironstone Developments Pty Ltd	Project Manager:	GT
Version/Date:	V0 19/05/2020	Source:	VGT Environmental Compliance Solutions Pty Ltd - February 2019	Office:	Thornton



Photograph 3

Sedimentary



Photograph 4

Volcanics

Plan of:	Deep Creek Quarry - Surface Mapping Samples and Photography	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Our Ref:	5414_DC_RR19_C0AC_V0 App C.cdr
Figure:	APPENDIX C	Council:	Mid Coast Council	Plan By:	SK
Sheet:	3 of 3	Client:	Ironstone Developments Pty Ltd	Project Manager:	GT
Version/Date:	V0 19/05/2020	Source:	VGT Environmental Compliance Solutions Pty Ltd - February 2019	Office:	Thornton



This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.



Photograph 5

Surface Sample Map

Deep Creek Quarry Surface Rock Survey Samples Tracker and Coordinates 2018								
Description Key:		1 = Weathered Sandstone / Clay Stone - Soft / Clay/ flatter terrain/ sparse outcrop.						
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		3 = Altered Volcanics - Red in colour/ porous/softish /doughy/flattish terrain/ sparse outcrops.						
		4 = Volcanics (VR) Rhodacite/ hard/blocky/steep terrain/yellow/pink numerous laths (littls square flecks).						
		5 = Volcanics (VT) Trachyte / hard/no quartz / pink specks (DDH2).						
		6 = Volcanics (VV) fine grained pink brown matrix with some laths with red / hollow vesicles , hard and heavy.						
Date	POI	Cell / Sample No	Sample Description	Coordinates	Coordinates	Survey Comments	Photo's	Post survey comments VGT review with microscope 7-12-2018 .
12/11/2018		A 2	Highly weathered volcanic.	397825	6398075	Very soft rock. Would break under a boot, few rocks about.	4	Angular quartz surrounded by clay.
12/11/2018		A 3	No Sample	397775	6398075	Bush and leaf litter no rocks visible.		No Sample
15/11/2018		A 4	No Sample	397725	6398075	Bush before gully.		No Sample
15/11/2018		A 5	No Sample	397675	6398075	Bush and leaf litter and soil no rocks visible.	3	No Sample
7/11/2018		B 1	No Sample	397875	6398025	Trees and lantana		No Sample
12/11/2018		B 2	No Sample	397825	6398025	Bush and leaf litter and soil no rocks visible.		No Sample
12/11/2018		B 3	No Sample	397775	6398025	Open paddock, grass no rocks.	5	No Sample
15/11/2018		B 4	No Sample	397725	6398025	Open paddock, grass no rocks.		No Sample
15/11/2018		B 5	No Sample	397675	6398025	Open paddock, grass no rocks.	2	No Sample
15/11/2018		B 6	No Sample	397625	6398025	Open paddock long grass and thick bracken fern, no rocks.		No Sample
7/11/2018		C 1	No Sample	397875	639975	Long grass and trees		No Sample
12/11/2018		C 2	Quartz vein.	397825	6397975	Red and heavy, 3 small rocks next to a tree.	4	
12/11/2018		C 3	No Sample	397775	6397975	Open paddock, grass no rocks.		No Sample
15/11/2018		C 4	No Sample	397725	6397975	Open paddock, grass no rocks.	8	No Sample
15/11/2018		C 5	Quartz vein.	397675	6397975	Small rocks near a tree on the edge of the cell.		(highly indurated sandstone ?)
15/11/2018		C 6	No Sample	397625	6397975	Open paddock long grass and thick bracken fern, no rocks.		No Sample
15/11/2018		C 7	No Sample	397575	6397975	Open paddock long grass and thick bracken fern, no rocks.		No Sample
12/11/2018		C 8	4	397525	6397975	Hard, heavy, red and yellow.		Quartz matrix.
12/11/2018		C 9	4	397478	6397975	Medium hardness and reddish.		Lighter in weight sample C8.
8/11/2018		C 10	Fine grained pegmatite.	397425	6397975	Very soft small boulders with pebbles.		Fine grained pegmatite (muscovite micas).
8/11/2018		C 11	Fine grained pegmatite.	397375	6397975			Fine grained pegmatite (muscovite micas) , redder than sample C10.
8/11/2018		C 12	2	397325	6397975	Hard , (large flow underneath).	3	Sandstone Fine to medium grained.
8/11/2018		C 13	2	397275	6397975	Medium hardness.		Sandstone Fine to medium grained.
7/11/2018		D 1	3	397875	639925	One small rock only in 50 m cell.		Lone floater?
12/11/2018		D 2	No Sample	397825	6397925	Open paddock, grass no rocks.		No Sample
12/11/2018		D 3	No Sample	397775	6397925	Open paddock, grass no rocks.		No Sample
15/11/2018		D 4	No Sample	397725	6397925	Open paddock, and scrub and leaf litter.		No Sample
15/11/2018		D 5	4	397675	6397925	Hard and heavy.	5	High quartz content in matrix.
15/11/2018		D 6	Quartz vein.	397610	6397930	Hard and heavy some reddish alteration.		Some red mottling.
15/11/2018		D 7	4	397555	6397902	Extremely hard, located on edge of bush just in cell.	1	Bleached?
12/11/2018		D 8 A	4	397525	6397925	Hard and heavy some reddish alteration.		
12/11/2018		D 8 B	4	397525	6397925	Hard and heavy some reddish alteration.		
12/11/2018		D 9	4	397475	6397925	Doughey yellow and a little red.		Heavy, weathered and bleached.

Deep Creek Quarry Surface Rock Survey Samples Tracker and Coordinates 2018								
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		3 = Altered Volcanics - Red in colour/ porous/softish /doughy/flattish terrain/ sparse outcrops.						
		4 = Volcanics (VR) Rhodacite/ hard/blocky/steep terrain/yellow/pink numeriois laths (littls square flecks).						
		5 = Volcanics (VT) Trachyte / hard/no quartz / pink specks (DDH2).						
		6 = Volcanics (VV) fine grained pink brown matrix with some laths with red / hollow vesicles , hard and heavy.						
Date	POI	Cell / Sample No	Sample Description	Coordinates	Coordinates	Survey Comments	Photo's	Post survey comments VGT review with microscope 7-12-2018 .
8/11/2018		D 10	4	397425	6397925	Medium weight, lightly altered, pinkish colour, not too soft.	6	Weathered and bleached.
14/11/2018		D 11	Quartz mica pegmatite?	397375	6397925	Heavy, (Terrain flattening out into a steep gully).	5	Possible pebbles?
14/11/2018		D 12	4	397325	6397925	Very hard and heavy with some pinkish colour on the edge (sample from swoop beforebefore exposed volcanic boulders in gully).	2	Epidote alteration.
8/11/2018		D 13	2	397275	6397925	Medium hardness.		
8/11/2018		D 14	3	397225	6397919	Soft and yellow.		
8/11/2018		D 15	2	397175	6397925	Very hard.		
8/11/2018		D 16	2	397125	6397925	Very hard.	3	Small muscavite micas.
7/11/2018		E 1	No Sample	397875	639875	No rocks visible.		
12/11/2018		E 2	No Sample	397825	6397875	Open paddock, grass no rocks.		
12/11/2018		E 3	No Sample	397775	6397875	Open paddock, grass no rocks.		
12/11/2018		E 4	4	397725	6397875	Medium to soft / doughy.		Highly weathered (reddish).
12/11/2018		E 5	4	397675	6397875	Medium to soft , sparse rocks.		Weathered and doughy.
15/11/2018		E 6	4	397633	6397880	Hard, located in a small rocky outcrop.		Slightly bleached.
15/11/2018		E 7	Quartz vein.	397576	6397882	Hard, located in a small rocky outcrop.	2	
12/11/2018		E 8	4	397525	6397875	Very hard, steep terrain.	3	Slightly bleached.
12/11/2018		E 9	4	397475	6397875	Very hard.		Slightly bleached.
8/11/2018		E 10	5	397425	6397875			Altered with minor vuggs.
14/11/2018		E 11	4	397375	6397875	Hard, located on side of steep slope, some reddish colour.	6	Heavy.
14/11/2018	POI	E 11	4	397374	6397855	The terrain is steeper than the contours on the map here starts at approx 15 to 20 degrees and goes to approx 40.		
14/11/2018		E 12	4	397325	6397875	Very hard, exposed rocks.	4	
14/11/2018	POI	E12		397338	6397890	exposed flow of volcanic boulders .		
14/11/2018		E 13	4	397275	6397875	Hard, located on side of a flow / slope.	3	Heavy.
14/11/2018		E 14	4	397225	6397875	Extremely hard, located on side of a flow / slope.	2	Not quite as heavy.
14/11/2018	POI	E 14		397202	6397879	Steep terrain, vertical exposed volcanic face.		
14/11/2018		E 15	4	397175	6397875	Extremely hard, located on side of near vertical face.		Heaps of quartz.
8/11/2018	POI	E15		397153	6397891	Large sandstone boulders and ferns.	4	
8/11/2018		E 16	4	397125	6397875	Heavy.	4	Quarts feldspar matrix and Quarts feldspar grains.
7/11/2018		F 1 A	4	397876	639827	Heavy, few rocks about in 50 m cell		
7/11/2018		F 1 B	2	397876	639827	Few rocks about in 50 m cell		Small floater?
12/11/2018		F 2 A	4	397825	6397825	Soil and leaf litter, few rocks.	3	Moderately weathered.

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		3 = Altered Volcanics - Red in colour/ porous/softish /doughy/flattish terrain/ sparse outcrops.						
		4 = Volcanics (VR) Rhyodacite/ hard/blocky/steep terrain/yellow/pink numerous laths (littls square flecks).						
		5 = Volcanics (VT) Trachyte / hard/no quartz / pink specks (DDH2).						
		6 = Volcanics (VV) fine grained pink brown matrix with some laths with red / hollow vesicles , hard and heavy.						
Date	POI	Cell / Sample No	Sample Description	Coordinates	Coordinates	Survey Comments	Photo's	Post survey comments VGT review with microscope 7-12-2018 .
12/11/2018		F 2 B	Medium grained pegmatite.	397825	6397825	Soil and leaf litter, few rocks.	1	Quartz feldspar mica angular all about the same size.
12/11/2018		F 3	No Sample	397775	6397825	Open paddock, grass no rocks.		No Sample
12/11/2018		F 4	4	397725	6397825	Doughy, located on a gentle slope , few rocks.		Weathered with red mottles.
12/11/2018		F 5	4	397675	6397825	Hard.		Bleached.
15/11/2018		F 6	4	397630	6397825	Hard, located in a small rocky outcrop.	1	Finer grained matrix.
15/11/2018		F 7	4	397563	6397826	Hard, located in a large rocky outcrop.	3	Finer grained matrix. (visit)
12/11/2018		F 8	1?	397525	6397825	Medium to hard, flatter terrain.		Follow up visit.
12/11/2018		F 9	1?	397475	6397825			
8/11/2018		F 10	6	397400	6397830		1	Highly siliceous with vuggs.
14/11/2018		F 11	6	397375	6397825	Numerous surface rocks/ outcrop.	6	Coarser grain than F10 with vuggs.
14/11/2018		F 12 A	4	397325	6397825	Hard, scattered rocks.	6	Very few laths.
14/11/2018	POI	F 12 B	4	397350	6397828	Hard, medium sized outcrop approx 40 m long.	2	Minor vuggs.
14/11/2018		F 13	Quartz vein high silica FE staining.	397275	6397825	Sparse surface rocks.		Very fine grain looks siliceous.
8/11/2018		F 14	4	397225	6397825	Sampled by Greg and Steph	1	Minor vuggs, few laths.
14/11/2018		F 15 A	2?	397175	6397825	A light grey with reddish spots.		No vuggs or laths and sandy.
14/11/2018		F 15 B	4	397175	6397825	Yellow with reddish spots.		Minor vuggs, remnant laths?
8/11/2018		F 16	2	397123	6397826			No vuggs or laths, sandy and red.
7/11/2018		G 2	4	397824	6397775			Red iron staining(slightly altered).
7/11/2018		G 3	4	397776	6397767	side of gully.	1	Heavier than G2 sample.
7/11/2018		G 4	4	397723	6397761	sample was on flood plain adjacent to the gully centre.		Bleached, slightly weathered.
7/11/2018	POI	G 5 A	4	397658	6397760	Top of huge volcanic rock face.	5	
7/11/2018	POI	G 5 B	4	397658	6397760	Top of huge volcanic rock face.	1	
7/11/2018	POI	G 5 C	4	397659	6397780	Top of huge volcanic rock face.	1	Slightly altered. Red
7/11/2018	POI	G 5 D	4	397678	6397776	Top of huge volcanic rock face.		Slightly altered. Red
12/11/2018		G 6	2	397625	6397775	Medium to hard.		quartz with iron red staining.
12/11/2018		G 7	4	397575	6397775	Very very hard surface rocks.		Minor Laths.
12/11/2018		G 8	2	397525	6397775	Boulders outcrop.		Iron stained.
12/11/2018		G 9	2?	397475	6397775			Quartz, mica, plag.
8/11/2018		G 10	2?	397425	6397775	Soft, outcrop of sandstone boulders.		Quartz, mica, plag.
8/11/2018		G 11	4	397375	6397775	Very hard.		Pale, minor laths and vuggs in a fine grained matrix.
8/11/2018		G 12	3	397325	6397775			
8/11/2018		G 13	4	397275	6397775	Yellow and very soft.		Weathered with very minor laths.
8/11/2018		G 14	4	397225	6397775	Soft.		With red mottles, slightly altered with minor laths.

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		4 = Volcanics (VR) Rhodacite/ hard/blocky/steep terrain/yellow/pink numerous laths (littls square flecks).						
		5 = Volcanics (VT) Trachyte / hard/no quartz / pink specks (DDH2).						
		6 = Volcanics (VV) fine grained pink brown matrix with some laths with red / hollow vesicles , hard and heavy.						
Date	POI	Cell / Sample No	Sample Description	Coordinates	Coordinates	Survey Comments	Photo's	Post survey comments VGT review with microscope 7-12-2018 .
8/11/2018		G 15	4?	397175	6397775	Yellow and very soft.		Weathered, minor vuggs and plags.
8/11/2018		G 16	3	397125	6397775			Good example.
7/11/2018		H 3 A	4	397776	63977730			Slightly weathered.
7/11/2018		H 3 B	4	397776	63977730			Bleached.
7/11/2018		H 4	4	397723	6397722			Slightly altered, pinky iron staining, high mica content.
7/11/2018		H 5	4	397677	6397719		9	Moderately heavy.
7/11/2018	POI	H 5		397660	6397743	Base of Volcanic cliff face and volcanic rock scattered all over the ground.		
12/11/2018	POI	H 6 A	4	397625	6397725	Very hard steep face north side of gully.	8	Moderately heavy, fine grained matrix, minor quartz and plag crystals.
12/11/2018		H 6 B	4	397625	6397725	Opposite side of gully.	2	Moderately heavy, fine grained matrix, minor quartz and plag crystals.
12/11/2018		H 7	2	397575	6397725	Sandstone Boulders.	2	Quartz, mica, feldspar.
12/11/2018		H 8	2	397525	6397725	Very hard boulders.	2	Visible rounded pebbles.
12/11/2018		H 9	2	397475	6397725	Very hard.	2	
12/11/2018		H 10	1 to 2	397425	6397725	Large boulders adjacent.	2	
15/11/2018		H 11	4?	397394	6397735		2	Heavy, altered, quartz, mica, k-spar, no vuggs.
15/11/2018		H 12	2	397340	6397735	Open paddock, grass.		
15/11/2018		H 13	3	397275	6397725	Medium to soft.		Moderately heavy, vuggs, clay alteration.
14/11/2018		H 14	2	397225	6397725	Sparse rocks.		
14/11/2018		H 15 A	4	397151	6397731	Small volcanic outcrop.		Minor laths.
14/11/2018		H 15 B	3	397175	6397725	Sparse rocks.		
12/11/2018		I 6	2	397625	6397675	Hard, blocky and steep.	2	
12/11/2018		I 7	2	397575	6397675	Sandstone boulders.		Slightly weathered.
12/11/2018	POI	I 8	2	397525	6397675	Large andstone boulders.	3	Slightly weathered.
12/11/2018		I 9	2	397475	6397675			Coarse grained.
12/11/2018		I 10	2	397425	6397675			Fine to medium grained.
15/11/2018		I 11	3	397396	6397677		2	
15/11/2018		I 12	3	397325	6397675	Medium to soft.		
15/11/2018		I 13	4	397265	6397657	Hard, located in bush , sparse rocks.	2	
Review of Rock Survey GT & SC								
5/02/2019		G6	Volcanic rock	397656	6397788			POI Two 5m bench basalt flows
5/02/2019		G6	Volcanic rock	397643	6397752			Lost upper volcanic bench, this is lower bench before drop off height
5/02/2019		G6	Sedimentry rock	397633	6397772			Large Boulders not as steep

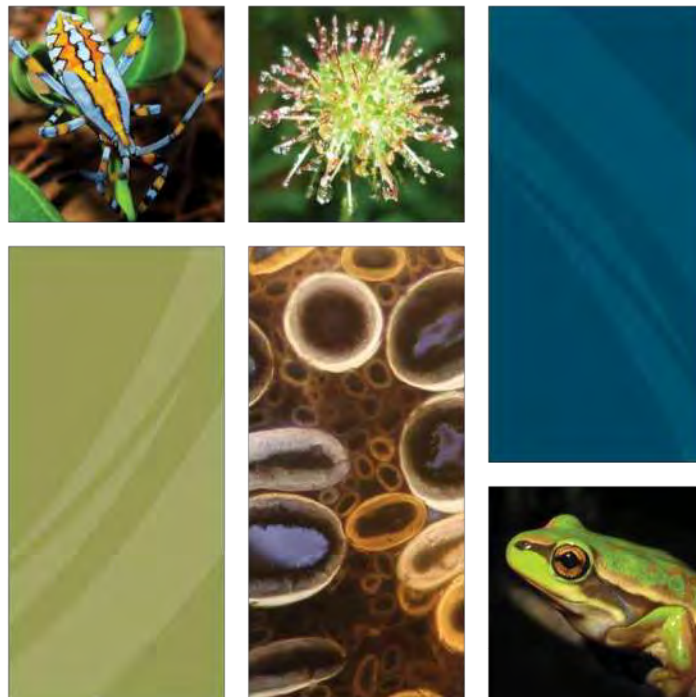
Deep Creek Quarry Surface Rock Survey Samples Tracker and Coordinates 2018								
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		4 = Volcanics (VR) Rhyodacite/ hard/blocky/steep terrain/yellow/pink numerous laths (little square flecks).						
		5 = Volcanics (VT) Trachyte / hard/no quartz / pink specks (DDH2).						
		6 = Volcanics (VV) fine grained pink brown matrix with some laths with red / hollow vesicles , hard and heavy.						
Date	POI	Cell / Sample No	Sample Description	Coordinates	Coordinates	Survey Comments	Photo's	Post survey comments VGT review with microscope 7-12-2018 .
5/02/2019		F7	Sedimentary rock	397581	6397816			Large boulder indurated sandstone with 5cm rounded pebble adjacent
5/02/2019		F8	Volcanic rock	397504	6397854			Edge of drop off
5/02/2019		F8	Sedimentary rock	397509	6397833			

Appendix D

Geotechnical Reports



Quarry Face Geotechnical Design Report



IRONSTONE DEVELOPMENTS PTY LTD

Deep Creek Quarry
The Bucketts Way, Limeburner's Creek,
NSW

26 March 2020

Quarry Face Geotechnical Design Report

Deep Creek Quarry

The Bucketts Way, Limeburner's Creek, NSW

Kleinfelder Document Number: NCA20R108678

File Name: Quarry Stability Report Draft

Project No: 20203258.001

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Prepared for:

IRONSTONE DEVELOPMENTS PTY LTD

PO BOX 2185
GREENHILLS
NSW 2323

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Document Control:

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Kleinfelder Australia Pty Ltd

Newcastle Office

95 Mitchell Road
Cardiff NSW 2282
Phone: (02) 4949 5200

ABN: 23 146 082 500

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Appendices

Appendix A. Test Pit Logs

Appendix B. Supplied Information

Appendix C. Important Information about this Geotechnical-Engineering Report

ABBREVIATIONS

Acronym	Definition
AHD	Australian Height Datum
AS	Australian Standard
BCA	Building Code of Australia
bgs	Below the Ground Surface
cm	Centimetres
ha	Hectares
km	Kilometre
kN	Kilonewton
KPa	Kilopascals
Kleinfelder	Kleinfelder Australia Pty Ltd
L	Litres
m	Metres
MDD	Maximum dry density
mm	Millimetres
OMC	Optimum moisture content
Client / IDPL	Ironstone Developments Pty Ltd
HSQ	NSW Resources Regulator Guide, Health and Safety at Quarries (HSQ), 20 November 2018, Version 1.1
FOS	Factor of Safety

REFERENCES

- Australian Standard – AS 1726-1993 Geotechnical Site Investigation.
- Australian Standard – AS3798-2007 Guidelines on Earthworks for Commercial and Residential Developments.
- NSW Resources Regulator Guide Health and Safety at Quarries (HSQ), 20 November 2018, Version 1.1:
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- Geoscience Australia, Atlas of seismic hazard maps of Australia: seismic hazard maps, hazard curves and hazard spectra, Record 2013/41, M. Leonard, D. Burbidge and M. Edwards.

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- The Rock Mass Rating System (RMR) by Bieniawski Z.T. 1989. Engineering rock mass classifications. New York: Wiley.
- Quantification of the Geological Strength Index chart Hoek, E. Vancouver, British Columbia, Canada Carter, T.G. Golder Associates, Toronto, Ontario, Canada Diederichs, M.S. Queens University, Kingston, Ontario, Canada. American Rock Mechanic Association, 2013.
- The Hoek–Brown failure criterion and GSI – 2018 edition, E Hoek and ET Brow. Journal of Rock Mechanics and Geotechnical Engineering, Volume 11, Issue 3, June 2019, Pages 445-46.

1. INTRODUCTION

Kleinfelder has been engaged by Ironstone Developments Pty Limited (IDPL) to provide a design-level geotechnical evaluation for the proposed Deep Creek Quarry located in Limeburner's Creek, NSW. The brief included reviewing the existing information, undertaking slope stability analysis and providing recommendations on suitable slope angles and bench widths of the working faces and final landform of the quarry. These works have been undertaken in line with Kleinfelder's proposal dated 16 January 2020.

1.1 SCOPE OF SERVICES

Our scope of services is detailed below and is based on our understanding of the project and our experience in advising similar quarry operators.

Kleinfelder proposed to undertake the following services.

- Review of all relevant client supplied information including existing geological and geospatial data, borehole logs and reports, operation plans, plant specifications and publicly available geological information;
- Inspection of rock core;
- Derivation of suitable rock strength and design parameters;
- Assessment of maximum practical bench heights for quarry operation;
- Assessment of minimum practical bench widths for quarry operation;
- Stability analysis of quarry faces and highwall for working profiles;
- Stability analysis of quarry faces and highwall for final landform;
- Provide a report compiling the results of the analysis and providing recommendations on suitable slope angles and stability of the final landform and the working faces of the quarry.

The conclusions and recommendations presented in this report are based on the supplied subsurface information and laboratory testing, inspection of the available rock core by the author and our experience with similar developments. The recommendations contained in this report are subject to the provisions and requirements outlined in the Limitations sections of this report. In addition, an article prepared by Geoprofessional Business Association (GBA), "Important Information about This Geotechnical Engineering Report", has been included in **Appendix C**. We recommend that all individuals who read this report understand the report

limitations and the included GBA document. This report and all figures, appendices, attachments and any future supplements are a single document that should not be divided.

The findings, conclusions, and recommendations are specific to the site and should not be extrapolated to other areas or used for other projects. Furthermore, this report should be considered invalid if the site has been altered, or if a prolonged period has elapsed since the date of the report, without Kleinfelder's review.

1.2 Supplied Information

We have been supplied with and relied upon the following information for use in the production of this report:

- Core Photographs for Boreholes DDH7, DDH17, DDH18 and DDH19;
- VGT Borehole Logs for Boreholes DDH7, DDH17, DDH18 and DDH19;
- Photographs of Surface Samples in Figures E10-E13 from Appendix E of the VGT Deep Creek Quarry Resource Review Report (ref 5414_DC_RR19_C)10_V1_E10-E13);
- Figure 2 Site Layout from the VGT Deep Creek Quarry Resource Review Report (ref 5414_DC_RR19_C)10_V1_E10-E13).
- Specification for Kobelco 30t and 35t Excavators.

The supplied information is included in **Appendix A**.

2. OBJECTIVES AND DESIGN CRITERIA

2.1 OBJECTIVES

The design objectives for Deep Creek Quarry are to construct a quarry that has stable slopes both in the short term during the working life of the quarry (30 years) and as the final landform slopes with long term stability (i.e., a minimum design life of 100 years) whilst allowing the operator to effectively access the slopes and benches with the proposed quarry.

Detailed descriptions of analyses performed for analysis and design of the excavation and of Deep Creek Quarry and other construction requirements are described and summarised below.

Overburden material excavated during operation such as topsoil, weathered rock and residual clays will be stockpiled on site for reuse in the rehabilitation phase of the quarry based on material characteristics and project requirements.

2.2 DESIGN CRITERIA

The design criteria used in the geotechnical analyses for Deep Creek Quarry include the following:

1. Limit equilibrium analyses for static and pseudostatic seismic slope stability.
2. The minimum required slope stability Factors of Safety (FOS) are:
 - Greater than 1.2 for short-term face stability during quarry operation;
 - Greater than 1.3 for long-term face stability for the final landform;
 - Greater than 1.5 for short and long-term stability for the overall slope; and
 - Greater than 1.1 for pseudostatic stability assuming a horizontal acceleration coefficient (k_h) = $\frac{1}{2}$ of the peak ground acceleration (PGA) for the quarry walls.
3. IDPL have indicated that they would prefer the following slope configurations, if possible:
 - Bench height = 10m (to allow for clearing of loose material off the face);
 - Operational Bench width = 25m with bund (however, it will be required to turn a 40 tonne articulated dumper around on the benches);
 - Final landform Bench width = 6m with bund;

- Final and working bench face angle = 80 degrees; and
 - Final and working bench to slope forward at 1 degree (to avoid water ponding).
4. The following Criteria from HSQ have been adopted:
- Ensure there is enough room to allow for the:
 - o implementation of exclusion zones in areas of unsafe ground conditions that may occur;
 - o bench access to be a suitable distance from the batter face
 - o excavators and other mobile plant to work;
 - o correct positioning of trucks being loaded; and
 - o safe queuing of trucks while waiting to be loaded.
 - The design must also allow adequate design for haul roads with provision for safety features as necessary, i.e. suitable road widths, with:
 - o inner rock trap and berm;
 - o outer edge protection (i.e. windrow);
 - o other specific design features (i.e. lines of site cross cambering); and
 - o face edge stand-off.

3. SITE DESCRIPTION & GEOLOGICAL SETTING

3.1 LOCATION AND SITE DETAILS

The site is located at 279 Deep Creek Road, described as Lot 472 in Deposited Plan 753178, off The Bucketts Way, Limeburners Creek, New South Wales some 5km north of Limeburners Creek township and 2.5km west of The Bucketts Way. The quarry will occupy an area of approximately 18 hectares (ha) within a broader development footprint of approximately 32 ha.

Based on the resource mapping undertaken by VGT Pty Ltd in December 2013, further quality considerations in 2018 and consideration of potential constraints based on ecological surveys in 2016, we understand that a quarrying resource of approximately 13 million tonnes can be developed.

The quarrying resource comprises a mixture of durable rhyolite, moderately durable trachyte, durable volcanolithic arenite and quartz trachyte, with a secondary resource containing a decorative dimension stone. The primary target material for the quarry will be a high-quality rhyolite resource aimed at satisfying NSW Roads and Maritime Services (now Transport for NSW) demand for high friction road aggregates.

We understand the project will comprise the following:

- A resource of 13Mt.
- Extraction of up to 500,000t per annum of quarry products. The aggregate quarry resource is approximately 17 hectares in size, quarrying to a floor of approximately 37 m AHD (i.e. just above the level of the existing access road).
- A project life of up to 30 years (it is noted that the resource may be in excess of that which can be extracted in that period, especially considering the project is likely to have a gradual ramp up to achieve the maximum extraction levels).
- Extraction of resource within one pit. Initial quarry areas will be used to establish stockpile and crushing areas that would provide the resource to construct the access road.
- Winning of resource through blasting, bulldozers, excavators and front-end loaders loading to articulated haulage trucks or directly to road registered trucks.
- Access to the site from The Bucketts Way via a new road crossing along the northern boundary of a neighbouring property to a new intersection on The Bucketts Way. The road will include a crossing of Deep Creek (large box culverts), and culvert crossings over other minor drainage lines.

- The processing area and initial stockpile area will be located to the south of the pit connected by a dedicated haul road across a drainage gully.
- The main stockpile will be located to the north of the quarry accessed by a dedicated haul road across a drainage gully.
- Reticulated power, via a new connection that will run adjacent the new access road.
- Crushing and separating equipment will be located in pit. It is likely that the equipment will be kept on the quarry floor to minimise noise propagation.
- Water will be sourced from onsite dams, in pit groundwater and a pipeline from the former sawmill dam for water supply for site office and dust suppression. Additional water may be required during drought periods.
- Rehabilitation of the site following completion of extraction to open grassland that may provide a dwelling site generally consistent with the existing approved subdivision of the lot.

3.2 TOPOGRAPHY & SITE FEATURES

The quarry is situated within a ridgeline that varies in level from approximately 41 m AHD in the east to around 120 m AHD in the west. The quarry floor will be approximately 37m to 42 m AHD. Currently, the area largely comprises mature woodland with small cleared areas near the eastern and western boundaries. An informal track passes along the top of the ridgeline.

3.3 GEOLOGY

Geologic mapping of the site¹ indicates that the site soils are of the Paterson Volcanics. This Formation is part of the New England Orogen Province that was formed by a volcanic eruption in the Serpukhovian (lower Carboniferous) age some 323-330 million years ago. The Formation is described as grey-green rhyodacitic ignimbrite and is up to 150m thick.

¹ NSW Geoscience website <https://minview.geoscience.nsw.gov.au/>

3.4 SUBSURFACE CONDITIONS

The following description provides a general summary of the subsurface conditions encountered during the VGT resource evaluation investigation. Copies of the borehole logs are presented in **Appendix A**.

Four boreholes (designated as DDH7, DDH17, DDH18 and DDH19) have been drilled by others within the proposed Quarry Area. Those boreholes were logged by VGT and core samples taken have been inspected by the author. The ground conditions encountered in the boreholes are summarised **Table 3-1** below. The approximate depth ranges of the units are shown as meters below ground level (bgl).

Table 3-1: Summary of Encountered Stratum

Stratum	DDH7 (m bgl)	DDH17 (m bgl)	DDH18 (m bgl)	DDH19 (m bgl)
Soil Overburden	0 – 1.35	0 – 1.0	0 – 2.5	0 – 0.5
Weathered Sandstone/Siltstone/Claystone	1.35 – 6.8	–	2.5 – 5.6	0.5 – 5.0
Fresh Sandstone/Siltstone	–	–	5.6 – 14.2	5.0 – 14.6
Rhyolite	6.8 – 68.4	1.0 – 39.6	14.2 – 55.6	14.6 – 61.6
Fresh Sandstone/Siltstone/Claystone	68.4 – 72.0	–	–	–

3.5 GROUNDWATER

No groundwater seepage was observed in any of the boreholes drilled and logged by VGT; however, groundwater is known to be present on site and generally flows through fissures in the rock after rainfall. Groundwater is known to fluctuate due to local and regional factors including, but not limited to dust control during operation, irrigation, precipitation events, site topography, seasonal changes, well pumping, and periods of wet or dry weather. Therefore, subsurface water conditions at other times may be different from those described in this report.

The quarry extraction area is essentially a ridgeline surrounded by valleys and, therefore, during the geotechnical analyses performed in support of the design and excavation of the quarry, we have assumed that the groundwater surface will be below the quarry floor at all

times. If significant seepages are encountered that indicate there will be a water surface within the rock slope, the advice of a suitably qualified and experienced geotechnical engineer should be sought without delay, as groundwater within steeply inclined rock fractures can reduce stability.

4. GEOTECHNICAL ANALYSIS

4.1 GROUND CHARACTERISATION

Characterisation of the materials present at the quarry are based upon the VGT logs and core photographs provided by the client, which are included in **Appendix A**. The author also undertook an inspection of the rock cores.

4.1.1 Strata Characterisation

4.1.1.1 Superficial Soil Deposits

Soil deposits were not recovered or logged during the exploratory investigation; however, they were recorded as being present between 0.5 and 2.5m deep. This material will be removed and stockpiled for potential sale or reuse in the rehabilitation of the quarry.

4.1.1.2 Sandstone/Siltstone and Claystone Deposits

Encountered in three of the four boreholes was a laminated sequence of siltstone, sandstone and claystone between about 1.0 and 14.1m thick, initially weathered and of low strength, but increasing to medium strength with depth. This material has varying degrees of fracturing and laminations/bedding planes.

4.1.1.3 Rhyolite

Encountered for the majority of the boreholes, the rhyolite is the target rock for the quarry and is generally of hard to very hard strength with between 1 and 10 fractures per metre. Fractures judged to be natural, not machine breaks from core drilling, were generally tight and rough with no or occasional mineralised infill of calcite and occasional iron staining.

4.1.2 Rock Mass Characterisation

Rock mass classifications are used to characterise the rock mass conditions for use in analysing the rock slope cuts. Rock mass classifications are a design tool and are estimated using laboratory and rock core data. The Rock Mass Rating System (RMR) by Bieniawski

representing a Very Blocky - Fair classification. Working procedures should be put in place during the quarry operation to ensure significant areas of slope with a GSI below this are detected and suitable measures adopted to prevent instability.

The intact sandstones, siltstones and claystone have been conservatively assessed to have a Very Blocky Fair classification with a slightly lower GSI of 45 to take into account their additional variability.

Soils and weathered sandstone, siltstones and claystones have not been assessed as they occur only sporadically across the site near the surface and are planned to be cut back to a slope of 1V to 2H during the site striping of working areas prior to blasting.

4.2 GEOMETRIC ANALYSIS

The following working criteria have been specified by the client:

- Bench height = 10m (to allow for clearing of rocks off the face);
- Operational Bench width = 25m with bund (however, it will be required to turn a 40t articulated dumper around on the benches);
- Final landform Bench width = 6m with bund;
- Final and working bench face angle = 80 degrees; and
- Final and working bench to slope forward at 1 deg (to avoid water ponding)

The turning radius of a Volvo 40t dumper is approximately 9 m or a diameter of 18 m. Additional items requiring space on the benches are 2 x safety windrow of 1.8m width, inner and outer clearance to windrow of 2 x 1.0m, and dumper passing clearance of 1.0m. This totals 24.5m. Therefore, a 25m bench width is considered adequate.

4.3 SLOPE STABILITY

Global slope stability was evaluated for the static and pseudostatic, conditions using limit equilibrium methods. Kinematic analysis was not considered because the lack of available data would not produce meaningful results. Rockfall analysis has also not been undertaken because all blasted faces will be scarified and non-vehicular access to the quarry faces is planned to be restricted and occasional.

Both overall stability and the stability of individual benches has been assessed including the possibility that the upper bench will comprise interbedded sandstone, siltstone and mudstone.

The soil deposits sparsely distributed at the crest of the cut slopes are thin and, therefore, are not considered to affect the overall slope stability; however, soil deposits, where encountered, should be cut back at a 1V to 2H slope.

As surcharge of 20kPa has been applied to each bench to represent blasted rock stockpiles and quarry plant traffic. It is unlikely that every bench will be surcharged at the same time so the assumption is conservative, but serves to simplify the model.

4.3.1 Limit Equilibrium Analyses

Limit equilibrium analyses were performed via the computer program SLIDE V8.0® by Rocscience to estimate a safety factor for the proposed slope geometries. A limit equilibrium analysis was performed at the maximum proposed height for the quarry face assuming moderately conservative rock strength parameters. The geologic model considers the initial 1 to 1.5m of the rock face will be disturbed from blasting (i.e., D=1) and the remaining rock mass is considered as undisturbed. The failure criterion used to model the rock mass conditions is the generalized Hoek-Brown (2018) criterion. The model units and properties are summarized in **Table 4-3** and are presented for the analysed sections in **Appendix B**.

Table 4-3: Geologic Units and Geomechanical Properties

Material	UCS1 Strength (MPa)	GSI2	Unit Weight (kN/m3)	mi3	D4
Sandstone/Siltstone Mudstone blasted Face	20	45	22	13	1
Sandstone/Siltstone Mudstone undisturbed rock	20	45	22	13	0
Rhyolite Blasted Face	50	50	23	20	1
Rhyolite Blasted Face undisturbed rock	50	50	23	20	0

Notes:

1. UCS values based on core inspection and limited laboratory testing
2. GSI based on conservative values observed from logs, core photo and visual inspection evaluation.
3. mi values dependant on rock type, selected as lower bound values.
4. D blasting coefficient 1 represents blasting and 0 no blasting.

The geologic models that were evaluated for slope stability are presented in **Appendix B**.

4.3.1.1 Static Analyses

The static-limit equilibrium model considers two scenarios:

1. The working face of the quarry at the maximum anticipated height.
2. The final face of the quarry if it is left at the maximum anticipated height.

4.3.1.2 Pseudostatic Analyses (Earthquake)

The pseudostatic equilibrium model also considers the above two scenarios. In the pseudostatic analysis, a horizontal acceleration coefficient (k_h) is applied to simulate the additional driving force resulting from ground shaking during an earthquake. The project criteria require the use of one-half of the PGA for k_h . A PGA of 0.1 has been adopted derived from The Atlas of Seismic Hazard Maps of Australia, for a 1/2500 year return-period earthquake. Results of the static and pseudostatic limit equilibrium analyses are summarised in **Table 4-4**. The calculation outputs are presented in **Appendix B**.

4.3.1.3 Summary of Limit Equilibrium Results

Based on the limit equilibrium analyses performed, the proposed designs for the Quarry satisfy the project requirements as summarised in **Table 4-4**. Models in rock slopes are evaluated for a non-circular failure path.

Table 4-4: Summary of Global Stability Results

Analysis		Non-Circular FOS	Required FOS
Working Face	Upper Sandstone Bench	2.1	1.2
	Upper Sandstone Bench pseudostatic	1.6	1.1
	Rhyolite Bench	5.3	1.2
	Rhyolite Bench pseudostatic	5.0	1.1
	Overall Slope	7.5	1.5
	Overall Slope pseudostatic	6.5	1.1
Final Landform	Upper Sandstone Bench	2.0	1.3
	Upper Sandstone Bench pseudostatic	1.6	1.1
	Rhyolite Bench	5.2	1.3
	Rhyolite Bench pseudostatic	5.0	1.1
	Overall Slope	3.4	1.5
	Overall Slope pseudostatic	3.2	1.1

Localized small wedge failures along pre-existing discontinuities are possible on the edges of benches and inspections shall be undertaken by suitably qualified and experienced personnel after each bench excavation to identify any potential failure areas which should be excavated or if appropriate a geotechnical engineer should be engaged to provide suitable engineering solutions. If failures do occur, it may reduce bench width by 2-3m and limit the ability for dumpers to turn around for a short distance.

5. CONCLUSIONS & RECOMMENDATIONS

Based on the results of the geotechnical investigation, assumptions and analyses, conclusions and recommendations are as follows:

- The working face of the quarry can be constructed according to the following geometry and have acceptable factors of safety against slope failure:
 - o Up to 8 intermediate benches can be constructed;
 - o Bench Heights up to 10m;
 - o Bench Widths up to 25m;
 - o Slope of bench 1° forward;
 - o 0.65m high windrow on both sides of bench with pipes or 1m gaps to allow drainage at suitable spacings;
- The final landform of the quarry can be constructed according to the following geometry and have acceptable factors of safety against slope failure:
 - o Up to 8 intermediate benches can be constructed;
 - o Bench Heights up to 10m;
 - o Bench Widths min 6m;
 - o Slope of bench 1° forward;

Cut slopes in soil, intermediate geomaterials and decomposed rock should be cut to a minimum of 1V to 2H (note shallower slopes of less than 1V: 4H are advisable for longer term vegetation growth). If steeper slopes are desired, they should be assessed on a case by case basis by a suitably qualified and experienced geotechnical engineer.

Given the limited data available, as the quarry is developed it is envisaged that face heights and bench widths will vary based upon changing weathering depths, rock types and geotechnical conditions (such as jointing and faulting), it is recommended that IDPL engages a suitably qualified and experienced geotechnical engineer, as required, to review these variations during quarry operation and for the final landform.

During excavation there may be occurrences of small steep discontinuities local the front of a bench where 2-3m depth of bench collapses, this can be readily accommodated in the working benches; however, for the final 6m wide benches it will leave only a narrow exit/entry. We do

not have enough information to advise further on this at present, but it will become clear during operation what the chances of this occurring are.

All slopes should be scarified using a machine bucket as soon as practicable after excavation to ensure no loose material remains. If excavation is halted for more than one year then each slope should be similarly scarified before recommencement of operations at the toe of said slope.

If, during quarry operation, conditions associated with local or global instability such as but not limited to weak or spalling zones of rock, large faults or other discontinuities, or previously unencountered rock types are identified, the quarry operator should cease excavation and an inspection should be undertaken by a suitably qualified and experienced geotechnical engineer who will advise on stability and suitable stabilisation measures.

The proposed cut slopes have been assumed to be dry as the site is essentially a ridgeline surrounded by valleys. The presence of groundwater in rock fractures and joints will have a significant adverse effect on slope stability. Any water flow or seepages that persist for more than 24 hours should be inspected by a suitably qualified and experienced geotechnical engineer as soon as possible.

Annual slope inspections should be undertaken by a by a suitably qualified and experienced geotechnical engineer.

6. LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder's profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions and recommendations are based on a limited number of observations and data. It is likely that conditions could vary between or beyond the data evaluated. Kleinfelder makes no other representation, guarantee or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

This report may be used only by the Client and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than two years from the date of the report.

The scope of services was limited to interpretation of borehole logs and photographs supplied by others and providing specific geotechnical design and construction recommendations for use in the design of the quarry. It should be recognized that definition and evaluation of subsurface conditions are difficult. Judgments leading to conclusions and recommendations are generally made with incomplete knowledge of the subsurface conditions present due to the limitations of data from field studies. The conclusions of this assessment are based on subsurface exploration conditions at the time of our field activities, laboratory testing, and engineering analyses.

Recommendations contained in this report are based on supplied information and our present knowledge of the proposed construction. It is possible that soil, rock, or groundwater conditions could vary between or beyond the points explored. If the project alignment or details change, or if subsurface conditions are encountered during construction that differ from those described herein, the client is responsible for ensuring that Kleinfelder is notified immediately so that we may re-evaluate the recommendations of this report.

Kleinfelder offers various levels of investigative and engineering services to suit the varying needs of different clients. Although risk can never be eliminated, more detailed and extensive studies yield more information, which may help understand and manage the level of risk. Since detailed study and analysis involves greater expense, our clients participate in determining levels of service, which provide information for their purposes at acceptable levels of risk. The

client and key members of the design team should discuss the issues covered in this report with Kleinfelder, so that the issues are understood and applied in a manner consistent with the owner's budget, tolerance of risk and expectations for future performance and maintenance.

As the geotechnical engineering firm that performed the geotechnical evaluation for this project, Kleinfelder should be retained to confirm that the recommendations of this report are properly incorporated in the design of this project, and properly implemented during construction. This may avoid misinterpretation of the information by other parties and will allow us to review and modify our recommendations if variations in the soil conditions are encountered. As a minimum Kleinfelder should be retained to provide the following continuing services for the project:

- Review the project plans and specifications, including any revisions or modifications;
- Observe foundation bearing soils to confirm conditions are as anticipated.

The scope of services for this subsurface exploration and geotechnical report did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater at this site. The scope of this study does not include environmental evaluations of surface and subsurface conditions, and the lack of that information in this report does not indicate an absence of potential environmental problems

APPENDIX A – SUPPLIED INFORMATION

Plan of:	Deep Creek Quarry Resource Review 2019 - Site Layout	Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Client & VGT Environmental Compliance Solutions Pty Ltd	Our Ref:	5414_DC_RR19_C002_V0_F2.cdr
Figure:	TWO	Council:	Mid Coast Council	Survey:	NSW Government Spatial Services, December 2018 Survey, Accessed Through ELVIS	Plan By:	SK/JD
Sheet:	1 of 1	Tenures:	N/A	Projection:	N/A	Project Manager:	GVT
Version/Date:	V0 23/01/2020	Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton

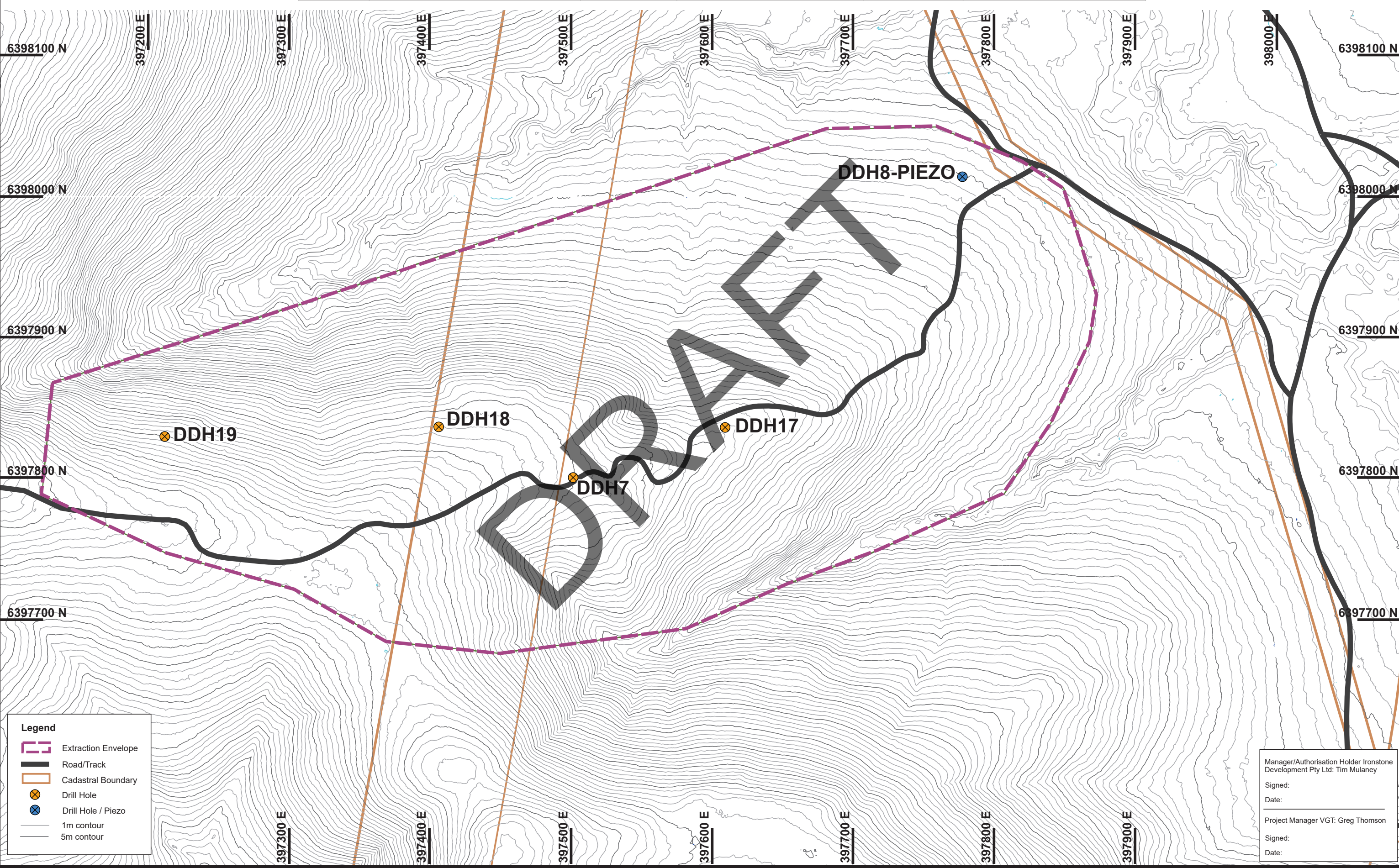
This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.



Environmental Compliance Solutions Pty Ltd



0 20 40 60 80 100m



Plan of:	Deep Creek Quarry Resource Review 2019 - DDH17 Drill Core	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.			
Figure:	APPENDIX A - A1				
Sheet:	1 of 2				
Version/Date:	V1 16/01/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos - VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney Woodbury Civil	Our Ref:	5414_DC_RR19_C021_V1_A1.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Manager/Authorisation Holder Ironstone Development Pty Ltd: Tim Mullaney
Signed: _____
Date: _____
Project Manager VGT: Greg Thomson
Signed: _____
Date: _____

Plan of:	Deep Creek Quarry Resource Review 2019 - DDH17 Drill Core	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.  Environmental Compliance Solutions Pty Ltd			
Figure:	APPENDIX A - A1				
Sheet:	2 of 2				
Version/Date:	V1 16/01/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos - VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney Woodbury Civil	Our Ref:	5414_DC_RR19_C021_V1_A1.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Manager/Authorisation Holder Ironstone Development Pty Ltd: Tim Mullaney
 Signed: _____
 Date: _____
 Project Manager VGT: Greg Thomson
 Signed: _____
 Date: _____

Plan of:	Deep Creek Quarry Resource Review 2019 - DDH18 Drill Core
Figure:	APPENDIX A - A2
Sheet:	1 of 3
Version/Date:	V1 16/01/2020
Location:	279 Deep Creek Road, Limeburners Creek, NSW
Council:	Mid Coast Council
Tenure:	N/A
Client:	Ironstone Development Pty Ltd

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Source:	Photos - VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney Woodbury Civil	Our Ref:	5414_DC_RR19_C022_V1_A2.cdr
Survey:	N/A	Plan By:	SC/JD
Projection:	N/A	Project Manager:	GVT
Contour Interval:	N/A	Office:	Thornton



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Signed: _____
Date: _____
Project Manager VGT: Greg Thomson
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Date: _____

Plan of:	Deep Creek Quarry Resource Review 2019 - DDH18 Drill Core	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy. 			
Figure:	APPENDIX A - A2				
Sheet:	2 of 3				
Version/Date:	V1 16/01/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos - VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney Woodbury Civil	Our Ref:	55414_DC_RR19_C022_V1_A2.cdr
Council:	Great Lakes Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



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 Signed: _____
 Date: _____
 Project Manager VGT: Greg Thomson
 Signed: _____
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Plan of:	Deep Creek Quarry Resource Review 2019 - DDH18 Drill Core	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy. 			
Figure:	APPENDIX A - A2				
Sheet:	3 of 3				
Version/Date:	V1 16/01/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos - VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney Woodbury Civil	Our Ref:	5414_DC_RR19_C022_V1_A2.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Manager/Authorisation Holder Ironstone Development Pty Ltd: Tim Mullaney
 Signed: _____
 Date: _____
 Project Manager VGT: Greg Thomson
 Signed: _____
 Date: _____

Plan of:	Deep Creek Quarry Resource Review 2019 - DDH19 Drill Core	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.			
Figure:	APPENDIX A - A3				
Sheet:	1 of 4				
Version/Date:	V1 16/01/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos - VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney Woodbury Civil	Our Ref:	5414_DP_RR19_C023_V1_A3.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Plan of:	Deep Creek Quarry Resource Review 2019 - DDH19 Drill Core
Figure:	APPENDIX A - A3
Sheet:	2 of 4
Version/Date:	V1 16/01/2020
Location:	279 Deep Creek Road, Limeburners Creek, NSW
Council:	Mid Coast Council
Tenure:	N/A
Client:	Ironstone Development Pty Ltd

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Source:	Photos - VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney Woodbury Civil	Our Ref:	5414_DP_RR19_C023_V1_A3.cdr
Survey:	N/A	Plan By:	SC/JD
Projection:	N/A	Project Manager:	GVT
Contour Interval:	N/A	Office:	Thornton



Manager/Authorisation Holder Ironstone
Development Pty Ltd: Tim Mullaney
Signed: _____
Date: _____
Project Manager VGT: Greg Thomson
Signed: _____
Date: _____

Plan of:	Deep Creek Quarry Resource Review 2019 - DDH19 Drill Core	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.			
Figure:	APPENDIX A - A3				
Sheet:	3 of 4				
Version/Date:	V1 16/01/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos - VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney Woodbury Civil	Our Ref:	5414_DP_RR19_C023_V1_A3.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Plan of:	Deep Creek Quarry Resource Review 2019 - DDH19 Drill Core	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy. 			
Figure:	APPENDIX A - A3				
Sheet:	4 of 4				
Version/Date:	V1 16/01/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos - VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney Woodbury Civil	Our Ref:	5414_DC_RR19_C023_V1_A3.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Manager/Authorisation Holder Ironstone Development Pty Ltd: Tim Mullaney
Signed: _____
Date: _____
Project Manager VGT: Greg Thomson
Signed: _____
Date: _____

Plan of:	Deep Creek Quarry Resource Review 2019 - DDH7 Drill Core	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.			
Figure:	APPENDIX A - A4				
Sheet:	1 of 4				
Version/Date:	V1 23/01/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos - VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney Woodbury Civil	Our Ref:	5414_DP_CP18_C004_V1_F4.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Manager/Authorisation Holder Ironstone Development Pty Ltd: Tim Mullaney
Signed: _____
Date: _____
Project Manager VGT: Greg Thomson
Signed: _____
Date: _____

Plan of:	Deep Creek Quarry Resource Review 2019 - DDH7 Drill Core
Figure:	APPENDIX A - A4
Sheet:	2 of 4
Version/Date:	V1 17/01/2019

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos - VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney Woodbury Civil	Our Ref:	5414_DP_CP18_C004_V1_F4.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Manager/Authorisation Holder Ironstone Development Pty Ltd: Tim Mullaney
Signed: _____
Date: _____
Project Manager VGT: Greg Thomson
Signed: _____
Date: _____

Plan of:	Deep Creek Quarry Resource Review 2019 - DDH7 Drill Core	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.			
Figure:	APPENDIX A - A4				
Sheet:	3 of 4				
Version/Date:	V1 23/01/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos - VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney Woodbury Civil	Our Ref:	5414_DP_CP18_C004_V1_F4.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Plan of:	Deep Creek Quarry Resource Review 2019 - DDH7 Drill Core	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.			
Figure:	APPENDIX A - A4				
Sheet:	4 of 4				
Version/Date:	V1 23/01/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos - VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney Woodbury Civil	Our Ref:	5414_DC_RR19_C024_V1_A4.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



BOREHOLE LOG

Name of Hole: DDH7

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: April 2014

Date Completed: April 2014

Surface RL: 90.0m

Collar Height : N/A

Coordinates: 397502E 6397800N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 1 of 8

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
90	0		N/A	1.35	Open hole - no sample.
88	2			1.65	Weathered Sandstone - Orange brown, coarse with pebbles, Light grey brown between joints.
				0.05	Coreloss
				0.2	Crushed core - Loss?
86	4			0.4	Weathered Sandstone - Orange brown, medium coarse, broken in part, volcano-lithic fragments.
				0.7	Weathered Siltstone - dark grey, hard altered.
				1.2	Weathered Sandstone - Orange Brown, clayey broken, coarse.
84	6			1.2	Weathered Sandstone - Orange Brown, coarse to very coarse.
				0.4	Carbonaceous Claystone - Black.
82	8			1.8	Rhyolite - Cream brown.
80	10				

Other Information:

Log Created By: SC 20/12/2018

Checked By:
V0:

Version: V1 30/01/2019

BOREHOLE LOG

Name of Hole: DDH7

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: April 2014

Date Completed: April 2014

Surface RL: 90.0m

Collar Height : N/A

Coordinates: 397502E 6397800N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 2 of 8

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
80	10		N/A	10.85	Ryholite - Light grey, minor brown.
78	12				
76	14				
74	16				
72	18				
70	20				

Other Information:

Log Created By: SC 20/12/2018

Checked By:
V0:

Version: V1 30/01/2019

BOREHOLE LOG

Name of Hole: DDH7

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: April 2014

Date Completed: April 2014

Surface RL: 90.0m

Collar Height : N/A

Coordinates: 397502E 6397800N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
68	22		N/A		
66	24				
64	26				
62	28				
60	30				

Other Information:		
Log Created By: SC 20/12/2018	Checked By: V0:	Version: V1 30/01/2019

BOREHOLE LOG

Name of Hole: DDH7

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: April 2014

Date Completed: April 2014

Surface RL: 90.0m

Collar Height : N/A

Coordinates: 397502E 6397800N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 4 of 8

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
58	32		N/A		
56	34				
54	36				
52	38				
50	40				

Other Information:

Log Created By: SC 20/12/2018

Checked By:
V0:

Version: V1 30/01/2019

BOREHOLE LOG

Name of Hole: DDH7

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: April 2014

Date Completed: April 2014

Surface RL: 90.0m

Collar Height : N/A

Coordinates: 397502E 6397800N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



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Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
48	42		N/A	43.75	Ryholite - Light brown brown.
46	44		N/A		
44	46		N/A		
42	48		N/A		
40	50		N/A		

Other Information:

Log Created By: SC 20/12/2018

Checked By:
V0:

Version: V1 30/01/2019

BOREHOLE LOG

Name of Hole: DDH7

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: April 2014

Date Completed: April 2014

Surface RL: 90.0m

Collar Height : N/A

Coordinates: 397502E 6397800N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 6 of 8

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
38	52		N/A		
36	54				
34	56				
32	58				
30	60				

Other Information:

Log Created By: SC 20/12/2018

Checked By:
V0:

Version: V1 30/01/2019

BOREHOLE LOG

Name of Hole: DDH7

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: April 2014

Date Completed: April 2014

Surface RL: 90.0m

Collar Height : N/A

Coordinates: 397502E 6397800N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 7 of 8

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
28	62		N/A		
26	64			3.35	Ryholite - Brown with purple feldspar flecks minor calcite veins.
24	66			1.83	Ryholite - Light grey brown with inclusions of calcite bearing nodules increasing toward base up to 40mm rounded.
22	68			0.1	Clacite Vein - crushed core
20	70			1.72	Carbonaceous Claystone - Black, immdurated occasional sandstone bands.

Other Information:

Log Created By: SC 20/12/2018

Checked By:
V0:

Version: V1 30/01/2019

Version: V1 30/01/2019

BOREHOLE LOG

Name of Hole: DDH17

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 78m

Collar Height : N/A

Coordinates: 397618E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 1 of 4

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description	Additional Information
78	0		0	1	Auger to 1m - No sample.	
76	2		>5	4.7	Ryholite - Light orange, yellow, plagioclase laths 5%.	
			>5			
			>5			
			>5			
74	4		>5			
			>5			
			>5			
			>5			
72	6		>5			
			>5			
			>5			
			>5			
70	8		>5			
			3			
68	10					

Other Information:

Log Created By: SC 27/11/2018

Checked By:
V0: GT

Version: V3 30/01/2019

BOREHOLE LOG

Name of Hole: DDH17

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 78m

Collar Height : N/A

Coordinates: 397618E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 2 of 4

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description	Additional Information
68	10		>5	15.3	Rhyolite - Light orange, pink, plagioclase laths 10%, some calcite intrusions. Fracturing, broken at 17m.	
			>5			
66	12		4			
			3			
64	14		4			
			2			
62	16		>5			
			>5			
60	18		4			
			2			
58	20					

Other Information:

Log Created By: SC 27/11/2018

Checked By:
V0: GT

Version: V3 30/01/2019

BOREHOLE LOG

Name of Hole: DDH17

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 78m

Collar Height : N/A

Coordinates: 397618E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 3 of 4

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description	Additional Information
58	20		>5			
			2			
56	22		4			
			>5	5.2	Ryholite - Lighter pink orange, plagioclase laths 15%, some calcite inclusions.	
54	24		>5			
			>5			
52	26		>5			
			2			
			1			
50	28		1			
			2	7	Ryholite - Lighter orange pink, larger calcite inclusions, some green inclusions.	
48	30					

Other Information:

Log Created By: SC 27/11/2018

Checked By:
V0: GT

Version: V3 30/01/2019

BOREHOLE LOG

Name of Hole: DDH17

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 78m

Collar Height : N/A

Coordinates: 397618E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 4 of 4

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description	Additional Information
48	30		>5			
			2			
46	32		4			
			4			
44	34		>5	6.46	Rhyolite - Darkger orange pink, more calcite and green inclusions. END OF HOLE.	
			>5			
42	36		>5			
			>5			
40	38		>5			
			>5			
			>5			
			>5			

Other Information:

Log Created By: SC 27/11/2018

Checked By:
V0: GT

Version: V3 30/01/2019

BOREHOLE LOG

Name of Hole: DDH18

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 92.5m

Collar Height : N/A

Coordinates: 397400E 6397834N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 1 of 6

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
92	0		>5	2.5	Auger to 2.5m - No sample.
			>5		
	2		>5	0.15	Weathered Sandstone - Light orange, medium to coarse grained.
90			>5	2.15	Weathered Siltstone - Orange, fine grained.
			>5		
	4		>5	0.7	Weathered Sandstone - Light orange to brown, coarse to very coarse grained.
88			>5		
			>5	0.2	Weathered Siltstone - Light brown some orange, medium to coarse grained.
	6		4	1.2	Sandstone - Dark grey some orange, black silty laminar.
86			>5	0.6	Silty Sandstone - Orange to grey, ironstained weathering.
			>5	0.3	Siltstone - dark grey with some orange.
	8		>5	0.34	Sandstone - Light orange, medium grained.
			4	0.18	Sandstone - Light grey brown laminae, medium to coarse grained, some calcite inclusions. Base of Weathering.
84			>5		
	10				

Other Information:

Log Created By: SC 27/11/2018

Checked By:
V0: GT

Version: V3 30/01/2019

BOREHOLE LOG

Name of Hole: DDH18

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 92.5m

Collar Height : N/A

Coordinates: 397400E 6397834N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 2 of 6

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
82	10		1	3.98	Sandstone - Light grey, coarse to very coarse, occasional pebble, calcite veining, fractured and broken at base.
			>5		
	12		>5	0.8	Sandstone - Light grey, coarse to very coarse, fractured thrust faulting.
80			>5		
			>5	0.39	Siltstone - Grey, carbonaceous claystone, coaly in part.
	14		>5	1	Core loss.
			>5		
78			>5	1.11	Rhyolite - Grey, highly fractured.
			>5		
	16		>5		
76			>5		
			>5		
			>5		
	18		>5		
74			>5		
			>5		
			>5		
	20		>5		

Other Information:

Log Created By: SC 27/11/2018

Checked By:
V0: GT

Version: V3 30/01/2019

BOREHOLE LOG

Name of Hole: DDH18

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 92.5m

Collar Height : N/A

Coordinates: 397400E 6397834N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 3 of 6

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
72	22		>5	9.7	Ryholite - Light olive, 10 - 20% plagioclase laths, calcite veining.
			>5		
70			>5		
			>5		
	24		>5		
68			>5		
			>5		
			>5		
	26		>5		
66			>5		
			>5		
			>5		
	28		>5		
64			>5		
			>5		
			>5		
	30		>5		

Other Information:

Log Created By: SC 27/11/2018

Checked By:
V0: GT

Version: V3 30/01/2019

BOREHOLE LOG

Name of Hole: DDH18

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 92.5m

Collar Height : N/A

Coordinates: 397400E 6397834N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 4 of 6

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
62			>5		
			3	12.5	Rhyolite - green olive, 10 % plagioclase laths.
	32		>5		
60			>5		
			>5		
	34		2		
58			2		
			>5		
	36		>5		
56			>5		
			>5		
	38		>5	1.37	Dyke - green, grey, fine grained, no plagioclase laths.
54			>5		
			>5		
	40				

Other Information:

Log Created By: SC 27/11/2018

Checked By:
V0: GT

Version: V3 30/01/2019

BOREHOLE LOG

Name of Hole: DDH18

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 92.5m

Collar Height : N/A

Coordinates: 397400E 6397834N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 5 of 6

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
52		< > ^ v	>5		
		< > ^ v	>5		
	42	< > ^ v	>5		
50		< > ^ v	>5		
		< > ^ v	>5		
	44	< > ^ v	>5		
48		< > ^ v	>5		
		< > ^ v	>5		
	46	< > ^ v	>5	12.13	Ryholite and Mylonitic throughout. Pit Floor at 43.2m.
46		< > ^ v	>5		
		< > ^ v	>5		
	48	< > ^ v	>5		
44		< > ^ v	>5		
		< > ^ v	>5		
	50	< > ^ v	>5		

Other Information:

Log Created By: SC 27/11/2018

Checked By:
V0: GT

Version: V3 30/01/2019

Version: V3 30/01/2019

BOREHOLE LOG

Name of Hole: DDH19

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 101.5m

Collar Height : N/A

Coordinates: 397203E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 1 of 7

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
	0			0.5	Auger - No sample
100			>5	1.2	Weathered Sandstone - Light brown, medium to coarse grained, Hard.
			>5		
	2			0.5	Weathered Silty Sandstone - Light brown minor grey, broken.
98			>5	0.3	Core loss
			>5	1.28	Weathered Sandstone - Light brown black, Silty Laminar, medium to coarse grained, broken around 3m.
	4		1	1.22	Weathered Sandstone - Grey brown, medium to coarse grained, hard.
96			1	4.9	Sandstone - Grey, coarse to very coarse grained, pebbly in part.
	6		3		
94			2		
	8		7		
92			>5	0.12	Siltstone Band
	10				Weathered Sandstone - Light grey, medium grained, sub vertical

Other Information:

Log Created By: SC 27/11/2018

Checked By:
V0: GT

Version: V3 30/01/2019

BOREHOLE LOG

Name of Hole: DDH19

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 101.5m

Collar Height : N/A

Coordinates: 397203E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 2 of 7

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
90	10		>5	0.87	joint ironstained, Aquifer?
			2	2.23	Siltstone - Grey brown, medium to coarse grained.
88	12		>5		
			4	1.6	Volcanic contact? - Large inclusions, calcite inclusions, vugg like.
86	14		>5		
			>5		
	16		>5	4.2	Rhyolite - Grey matrix, pinky laths 20%, becoming pinky brown at base.
84			>5		
			>5		
	18		>5		
82			>5		
			>5		
	20		>5		

Other Information:

Log Created By: SC 27/11/2018

Checked By:
V0: GT

Version: V3 30/01/2019

BOREHOLE LOG

Name of Hole: DDH19

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 101.5m

Collar Height : N/A

Coordinates: 397203E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 3 of 7

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
80			4	17.2	Rhyolite - pinky orange, plagioclase laths 15 - 20%, high angle calcite vein at 33.8m.
			>5		
	22		>5		
78			>5		
			>5		
	24		>5		
76			>5		
			>5		
	26		4		
74			4		
			4	17.2	Rhyolite - pinky orange, plagioclase laths 15 - 20%, high angle calcite vein at 33.8m.
	28		4		
72			4		
			1	17.2	Rhyolite - pinky orange, plagioclase laths 15 - 20%, high angle calcite vein at 33.8m.
	30				

Other Information:

Log Created By: SC 27/11/2018

Checked By:
V0: GT

Version: V3 30/01/2019

BOREHOLE LOG

Name of Hole: DDH19

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

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Deep Creek Quarry

Date Commenced: November 2018

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Surface RL: 101.5m

Collar Height : N/A

Coordinates: 397203E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 4 of 7

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
70			>5		
			>5		
32			>5		
68			>5		
			4		
34			>5		
66			>5		
			>5		
36			>5		
64			>5		
			4		
38			2		
62			3		
40					

Other Information:

Log Created By: SC 27/11/2018

Checked By:
V0: GT

Version: V3 30/01/2019

Version: V3 30/01/2019

BOREHOLE LOG

Name of Hole: DDH19

Project Number: 5414

Client: Ironstone Development Pty Ltd

Project: Deep Creek Quarry

Location: Lot 472 DP 753178, Forest Glen Road, NSW

Logged by: VGT Environmental Compliance Solutions Pty Ltd

Deep Creek Quarry

Date Commenced: November 2018

Date Completed: November 2018

Surface RL: 101.5m

Collar Height : N/A

Coordinates: 397203E 6397829N

Drilling Supervisor: Tim Mullaney

Drilling Contractor: Total Drilling



Page 6 of 7

Elevation (RL)	Depth (m)	Graphic Log	Fractures Per Metre	Stratum Thickness (m)	Description
50			>5		
	52		1		
48			3		
	54		4	5.4	Ryholite - Light grey, plagioclase laths, green inclusions, calcite inclusions.
46			4		
	56		2		
44			>5		
	58		>5		
42			>5	5.6	Ryholite - Light grey, plagioclase laths, green inclusions, calcite inclusions highly fractured thrust zone, mylonitic in nature, More Compentent at base. END OF HOLE
	60		>5		

Other Information:

Log Created By: SC 27/11/2018

Checked By:
V0: GT

Version: V3 30/01/2019

Log Created By: SC 27/11/2018	Checked By: V0: GT	Version: V3 30/01/2019
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Plan of:	Deep Creek Quarry Resource Review 2019 - DDH17 Drill Core Samples Taken
Figure:	APPENDIX D - D5
Sheet:	1 of 2
Version/Date:	V1 23/01/2020

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C025_V1_D5.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Manager/Authorisation Holder Ironstone Development Pty Ltd: Tim Mullaney
Signed: _____
Date: _____
Project Manager VGT: Greg Thomson
Signed: _____
Date: _____

Plan of:	Deep Creek Quarry Resource Review 2019 - DDH17 Drill Core Samples Taken	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.			
Figure:	APPENDIX D - D5				
Sheet:	2 of 2				
Version/Date:	V1 23/01/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C025_V1_D5.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Manager/Authorisation Holder Ironstone Development Pty Ltd: Tim Mullaney
Signed: _____
Date: _____
Project Manager VGT: Greg Thomson
Signed: _____
Date: _____

Plan of:	Deep Creek Quarry Resource Review 2019 - DDH18 Drill Core Samples Taken	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.			
Figure:	APPENDIX D - D6				
Sheet:	1 of 3				
Version/Date:	V1 23/01/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C026_V1_D6.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Plan of:	Deep Creek Quarry Resource Review 2019 - DDH18 Drill Core Samples Taken
Figure:	APPENDIX D - D6
Sheet:	2 of 3
Version/Date:	V1 23/01/2020

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

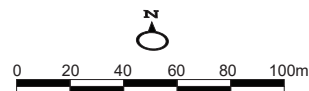
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C026_V1_D6.cdr
Council:	Great Lakes Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Manager/Authorisation Holder Ironstone
Development Pty Ltd: Tim Mullaney
Signed: _____
Date: _____
Project Manager VGT: Greg Thomson
Signed: _____
Date: _____

Plan of:	Deep Creek Quarry Resource Review 2019 - DDH18 Drill Core Samples Taken
Figure:	APPENDIX D - D6
Sheet:	3 of 3
Version/Date:	V1 23/01/2020

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.



Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C026_V1_D6.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



Manager/Authorisation Holder Ironstone Development Pty Ltd: Tim Mullaney
Signed: _____
Date: _____
Project Manager VGT: Greg Thomson
Signed: _____
Date: _____

Plan of:	Deep Creek Quarry Resource Review 2019 - DDH19 Drill Core Samples Taken
Figure:	APPENDIX D - D7
Sheet:	3 of 4
Version/Date:	V1 23/01/2020

This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.

Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C027_V1_D7.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton

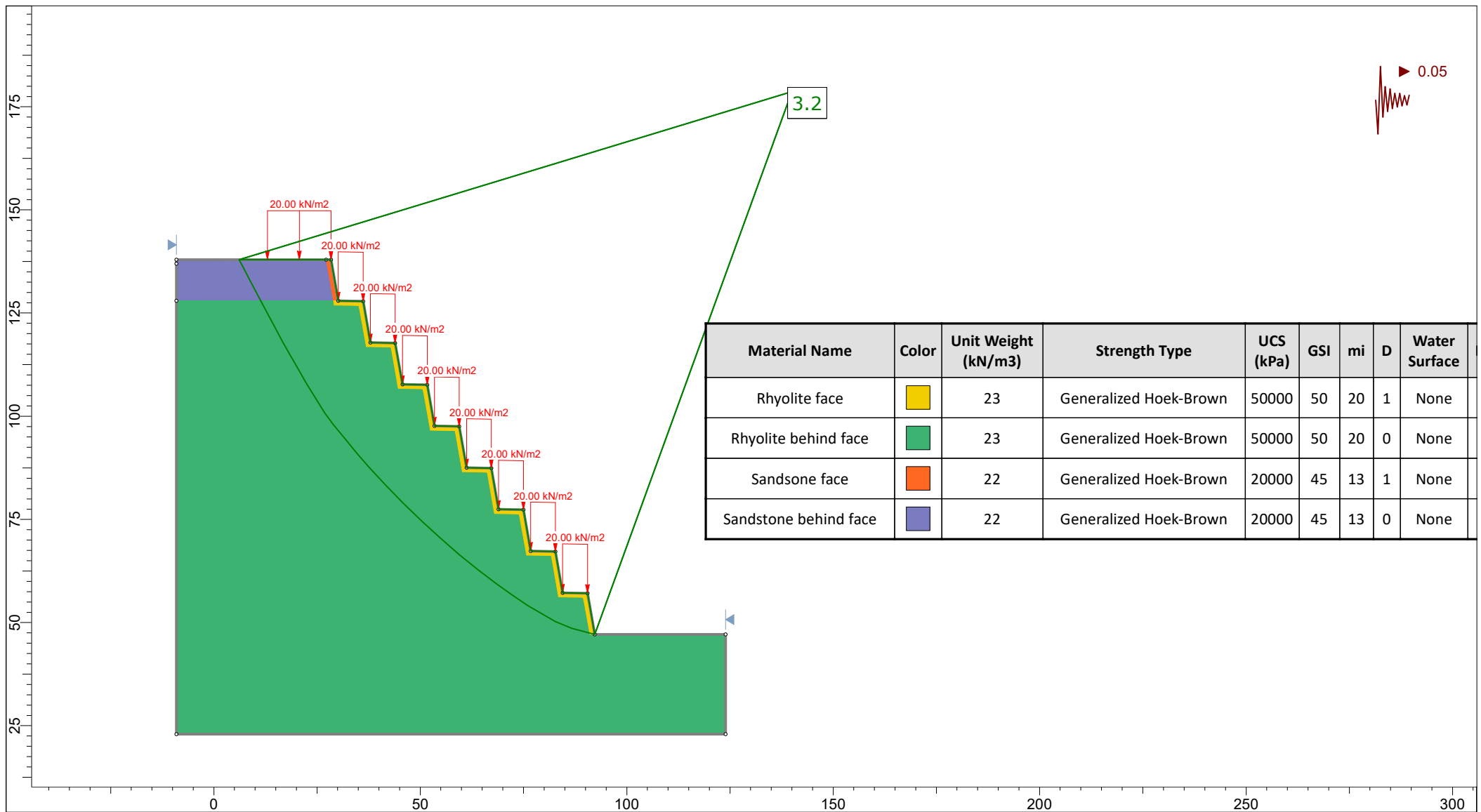


Manager/Authorisation Holder Ironstone Development Pty Ltd: Tim Mullaney
Signed: _____
Date: _____
Project Manager VGT: Greg Thomson
Signed: _____
Date: _____

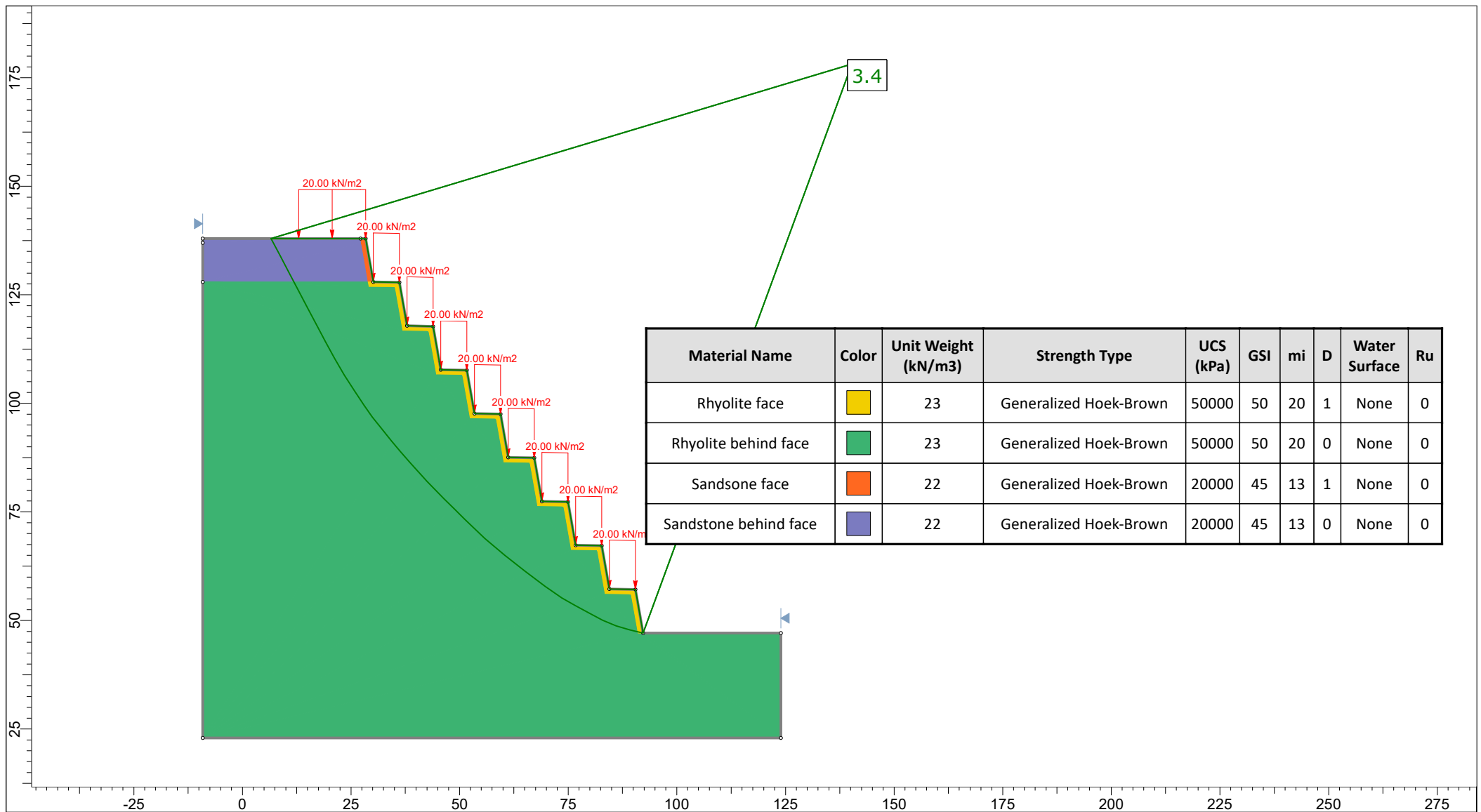
Plan of:	Deep Creek Quarry Resource Review 2019 - DDH19 Drill Core Samples Taken	This figure may be based on third party data which has not been verified by vgt and may not be to scale. Unless expressly agreed otherwise, this figure is intended as a guide only and vgt does not warrant its accuracy.			
Figure:	APPENDIX D - D7				
Sheet:	4 of 4				
Version/Date:	V1 23/01/2020				
Location:	279 Deep Creek Road, Limeburners Creek, NSW	Source:	Photos VGT Environmental Compliance Solutions Pty Ltd, Drill Core - Tim Mullaney	Our Ref:	5414_DC_RR19_C027_V1_D7.cdr
Council:	Mid Coast Council	Survey:	N/A	Plan By:	SC/JD
Tenure:	N/A	Projection:	N/A	Project Manager:	GVT
Client:	Ironstone Development Pty Ltd	Contour Interval:	N/A	Office:	Thornton



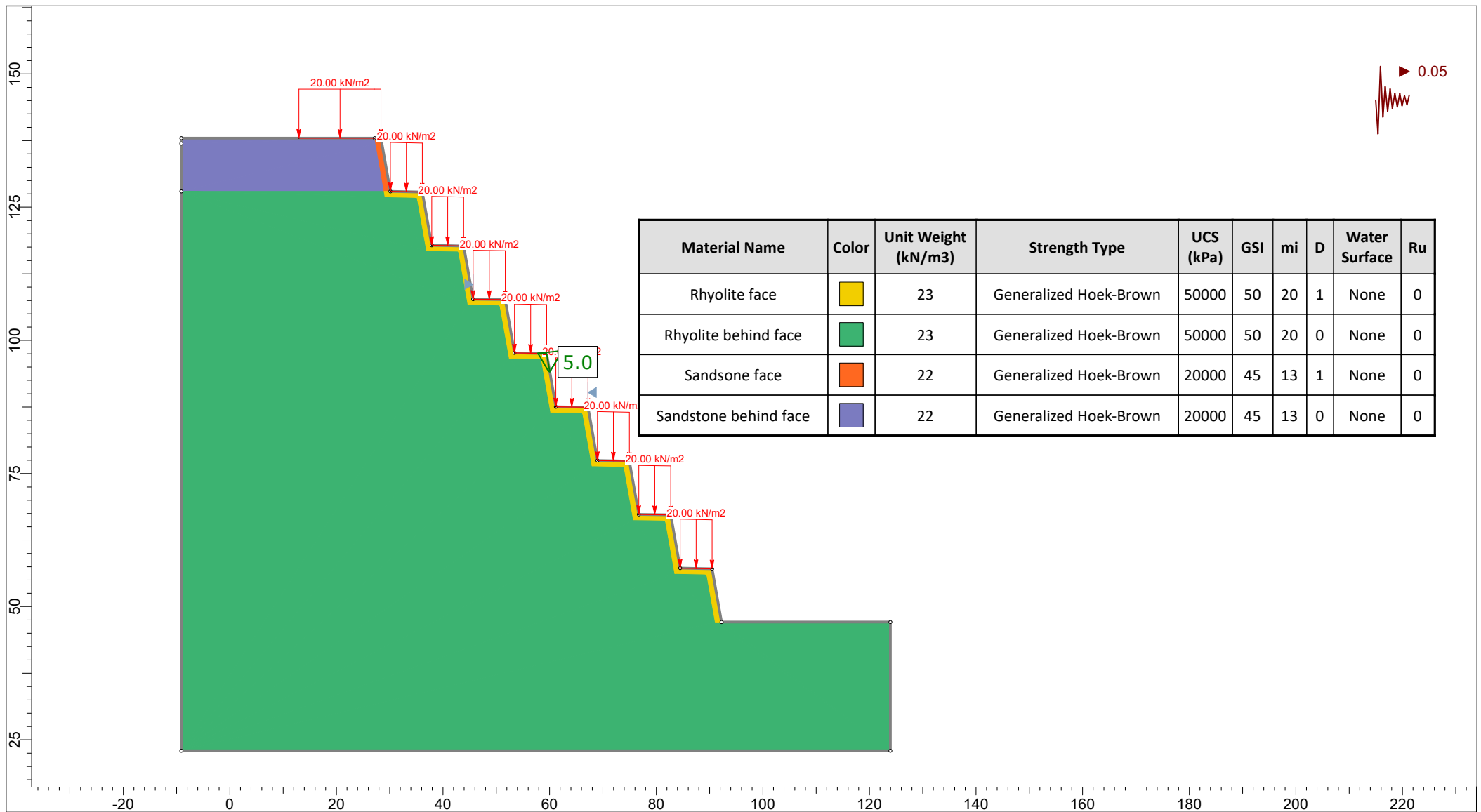
APPENDIX B – SLOPE STABILITY ANALYSIS



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	Analysis Description				
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	Date		18/03/2020, 2:33:59 PM		File Name
SLIDEINTERPRET 8.031					Quarry face final 6m benches earth.slmd

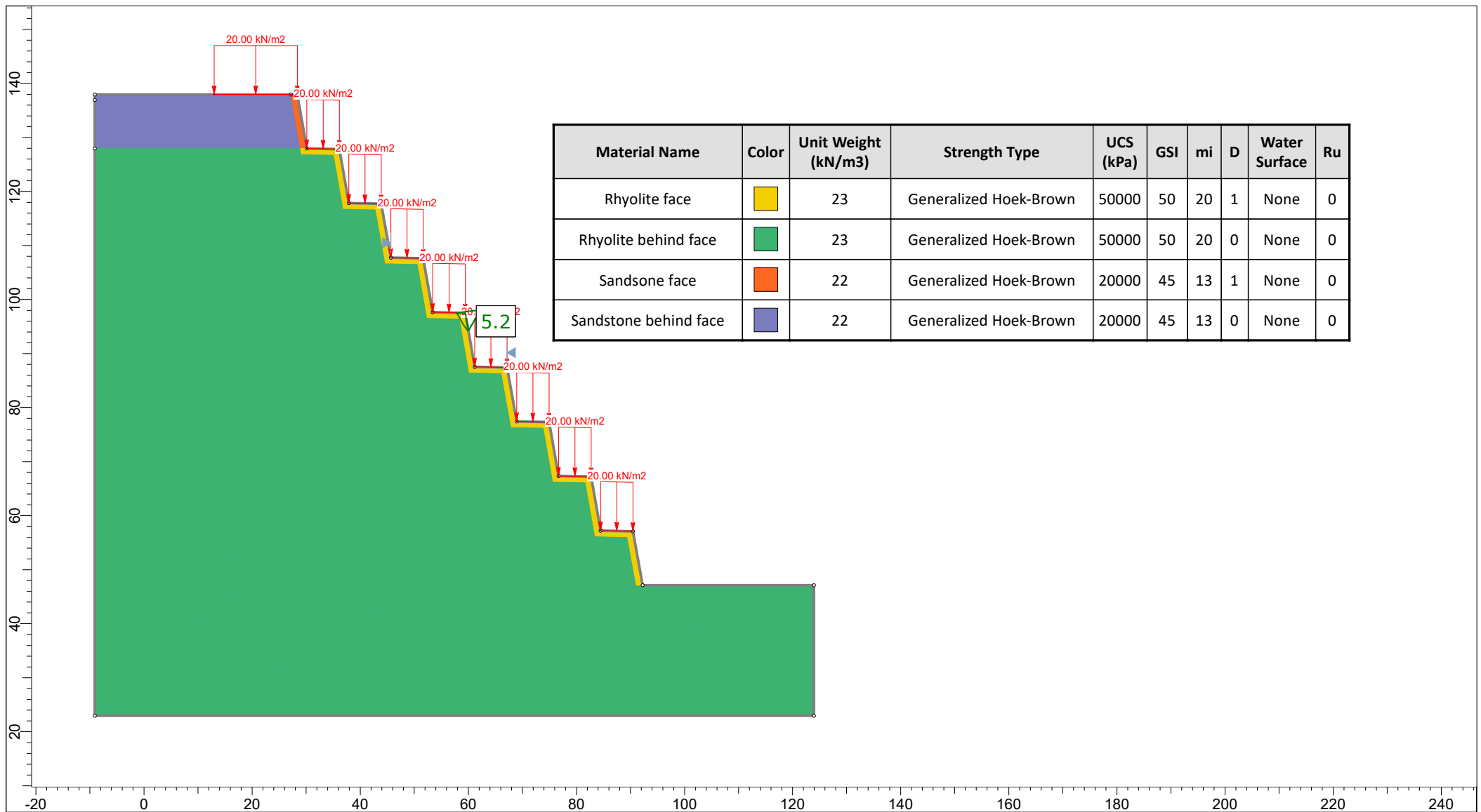


	Project		
	SLIDE - An Interactive Slope Stability Program		
	Analysis Description		
	Drawn By	Scale	Company
Date	18/03/2020, 2:33:59 PM	File Name	Quarry face final 6m benches.slmd

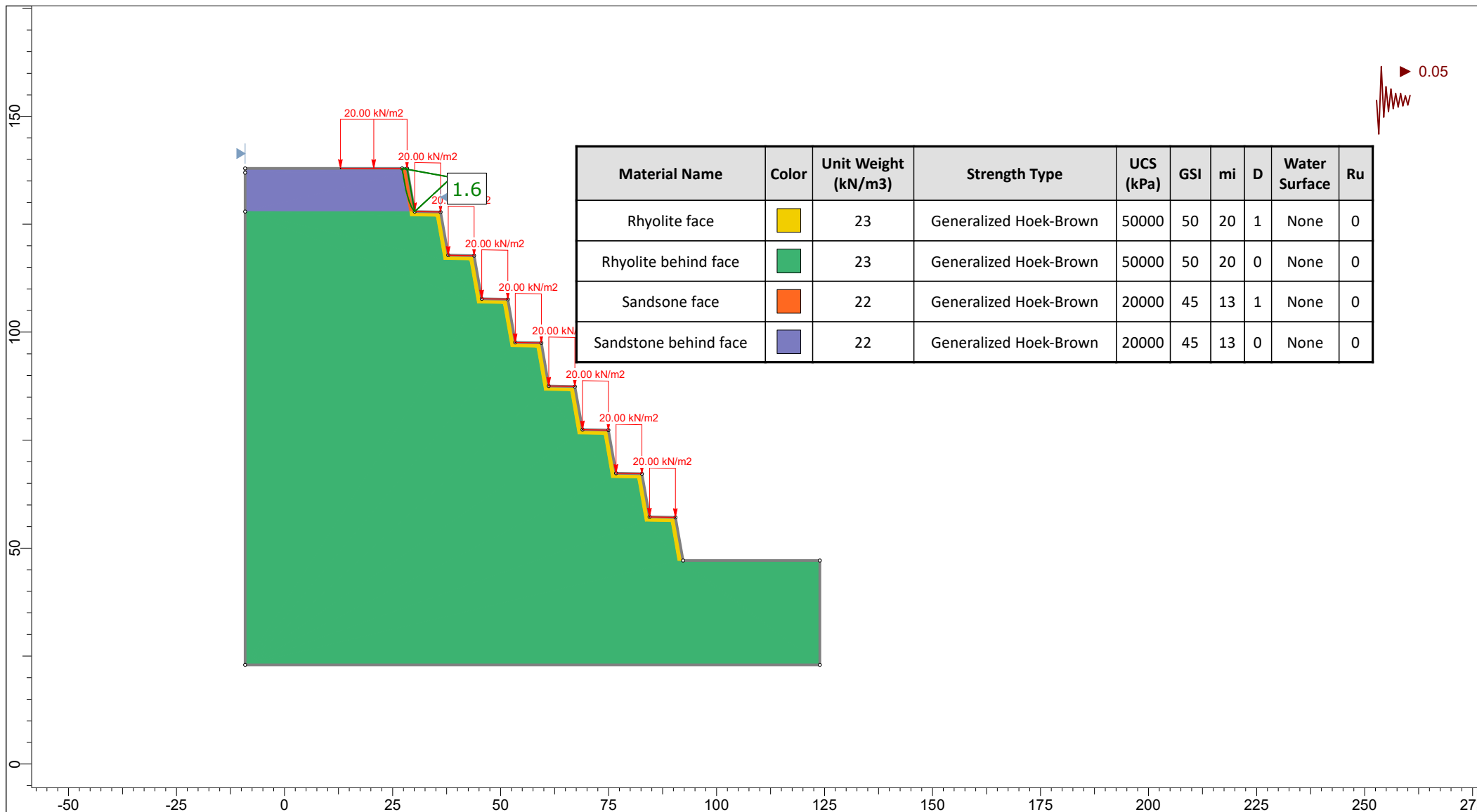


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	SLIDE - An Interactive Slope Stability Program				
	Analysis Description				
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					Quarry face final 6m benches earth.slmd

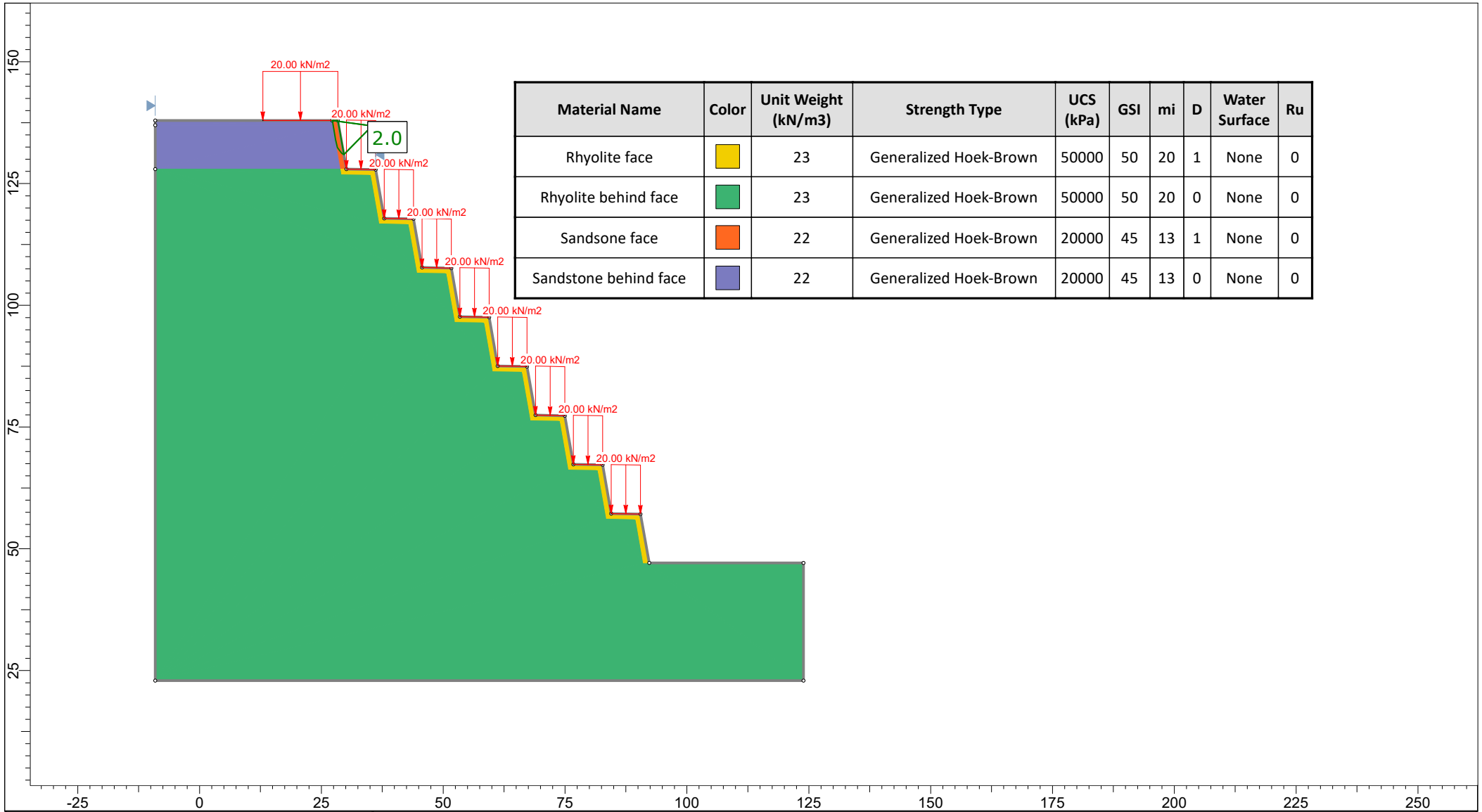
rocscience



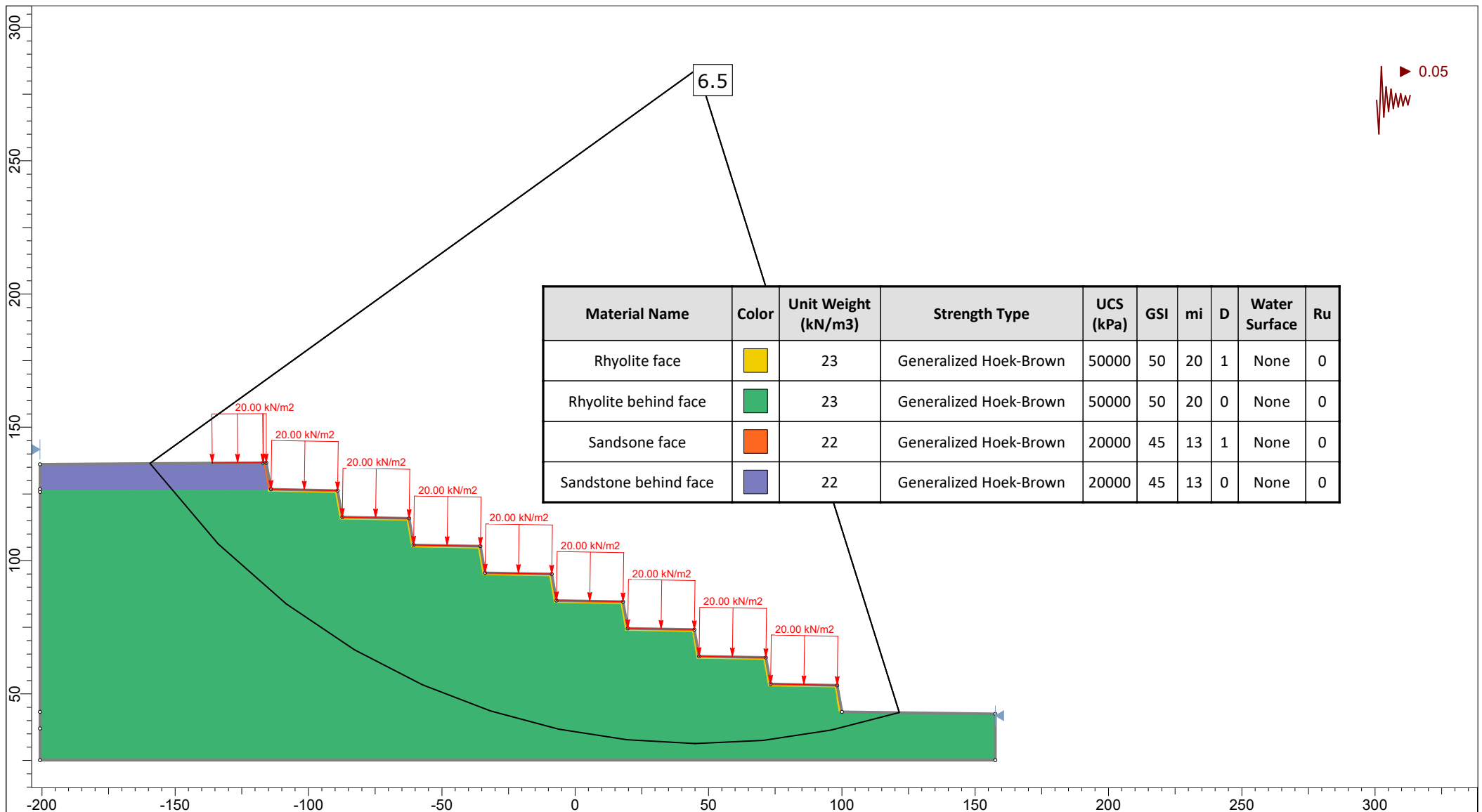
 rocscience	Project				
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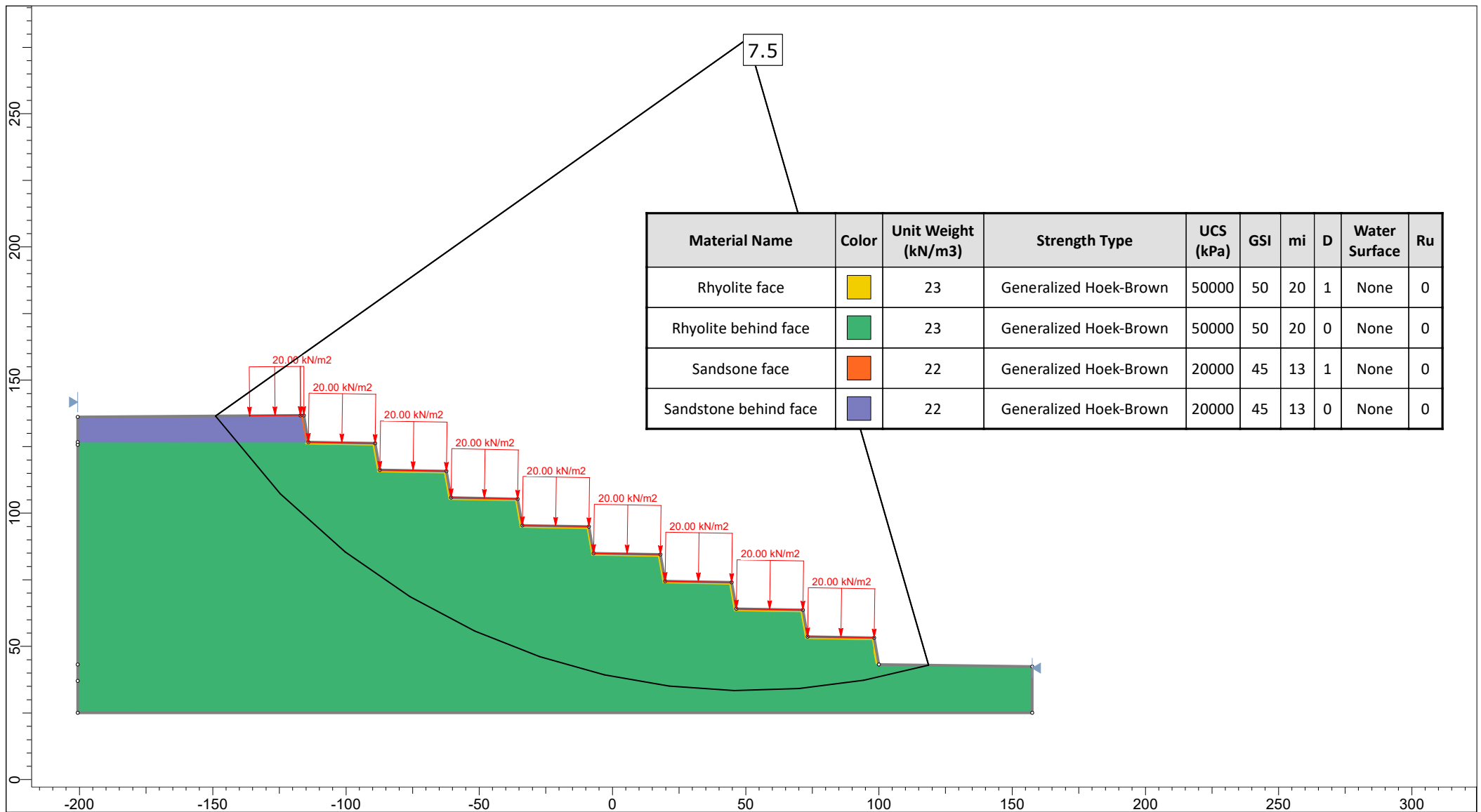
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	<i>Analysis Description</i>		
	<i>Drawn By</i>	<i>Scale</i> 1:1230	<i>Company</i>
	<i>Date</i> 18/03/2020, 2:33:59 PM	<i>File Name</i> Quarry face final 6m benches earth.slmd	



	Project		
	SLIDE - An Interactive Slope Stability Program		
	Analysis Description		
	Drawn By	Scale	Company
Date	18/03/2020, 2:33:59 PM	File Name	Quarry face final 6m benches.slmd

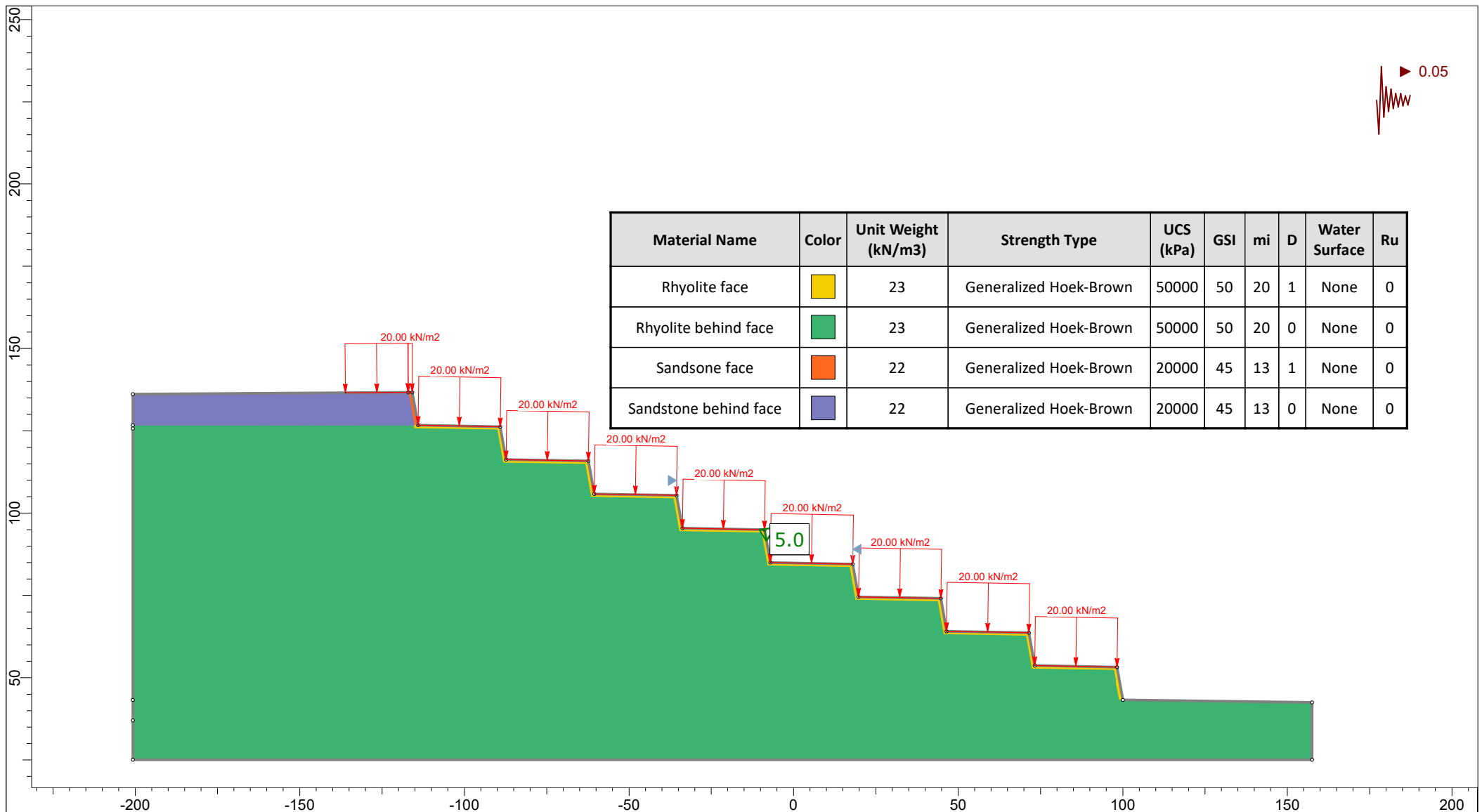


 rocscience	Project			
	SLIDE - An Interactive Slope Stability Program			
	Analysis Description			
	Drawn By	Scale	Company	
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SLIDEINTERPRET 8.031	Date	1/28/2020, 8:31:25 AM	File Name	Quarry face working - Earth.slmd

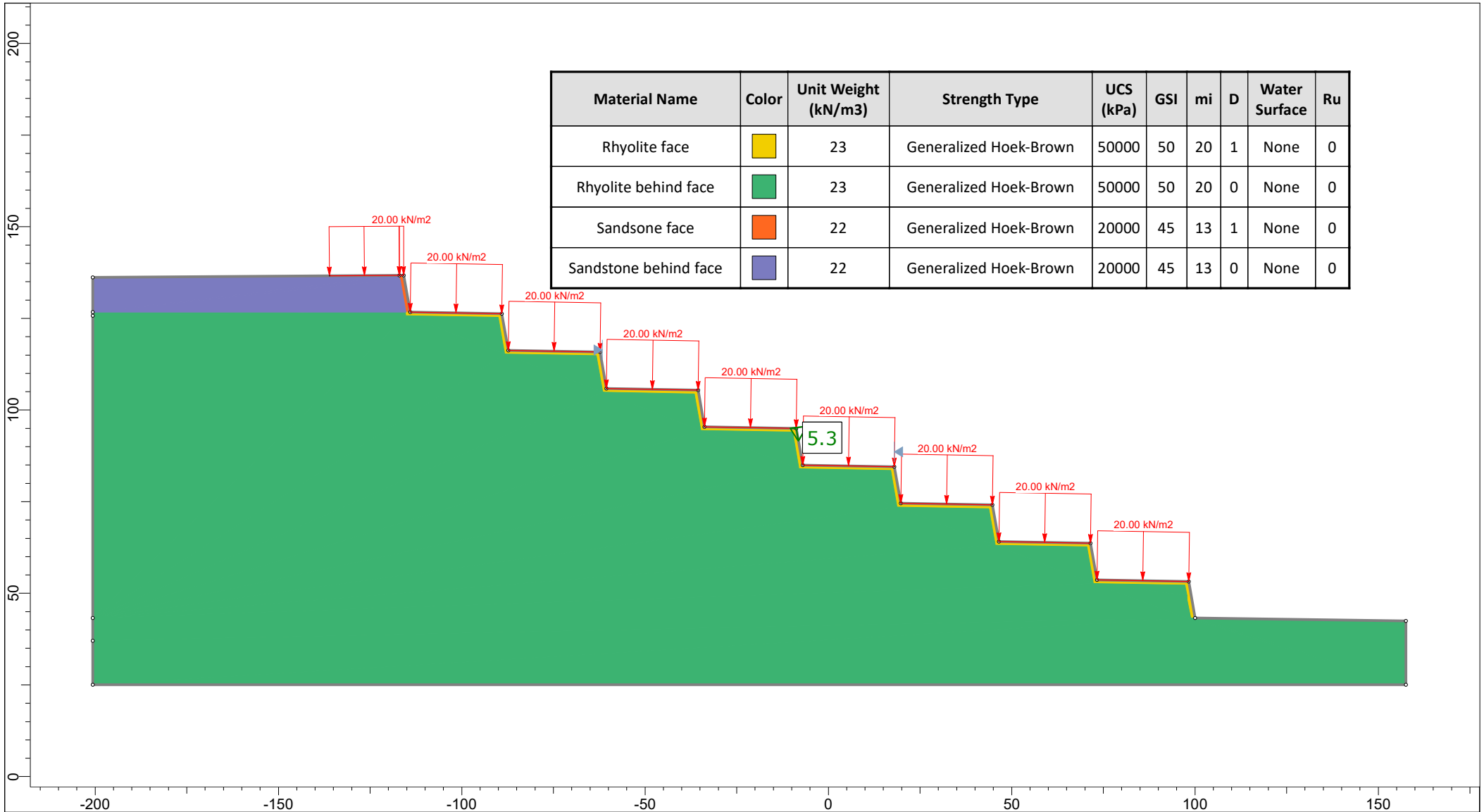


Material Name	Color	Unit Weight (kN/m3)	Strength Type	UCS (kPa)	GSI	mi	D	Water Surface	Ru
Rhyolite face	■	23	Generalized Hoek-Brown	50000	50	20	1	None	0
Rhyolite behind face	■	23	Generalized Hoek-Brown	50000	50	20	0	None	0
Sandstone face	■	22	Generalized Hoek-Brown	20000	45	13	1	None	0
Sandstone behind face	■	22	Generalized Hoek-Brown	20000	45	13	0	None	0

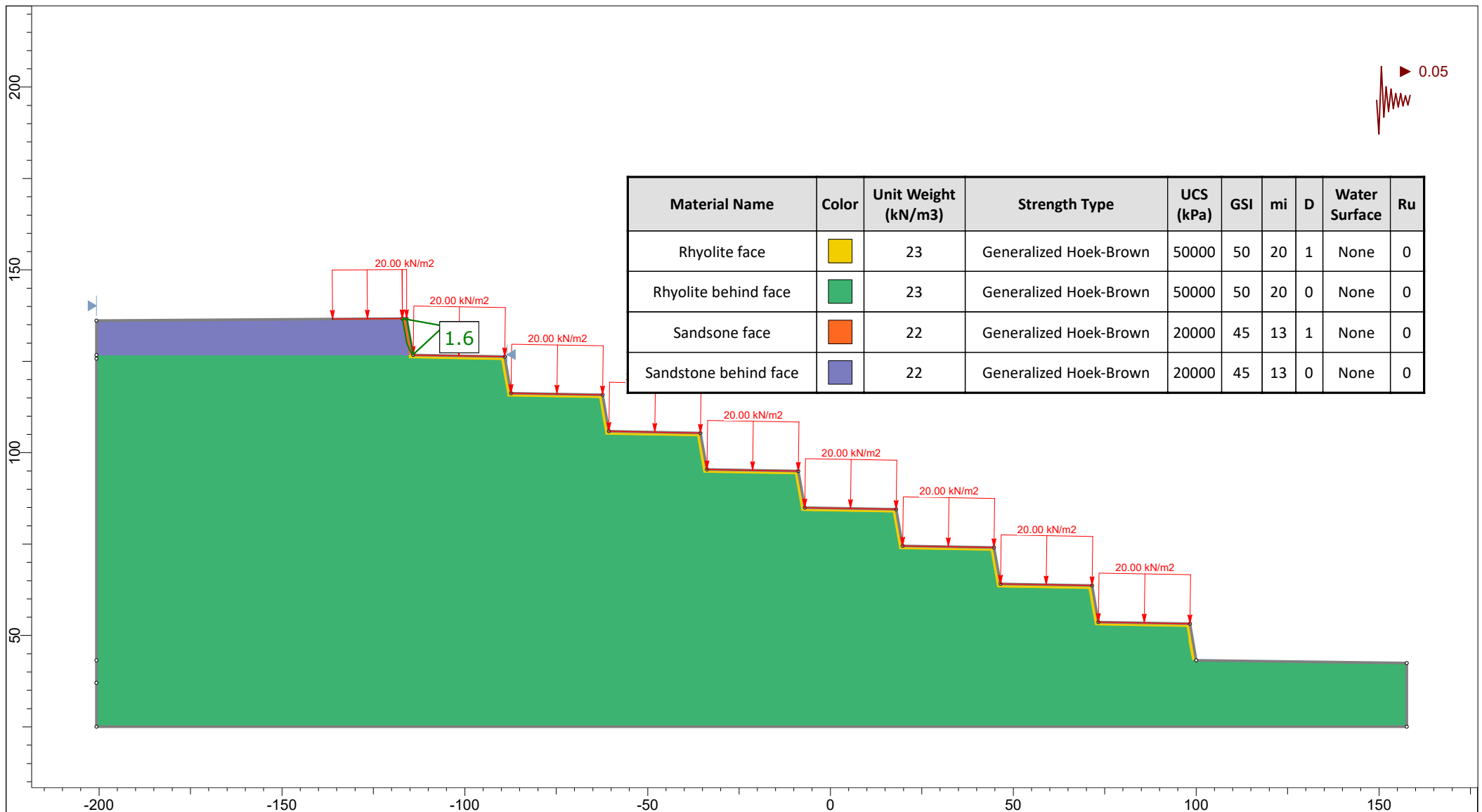
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	Drawn By	Scale	Company
Date	1/28/2020, 8:31:25 AM	File Name	Quarry face working.slmd



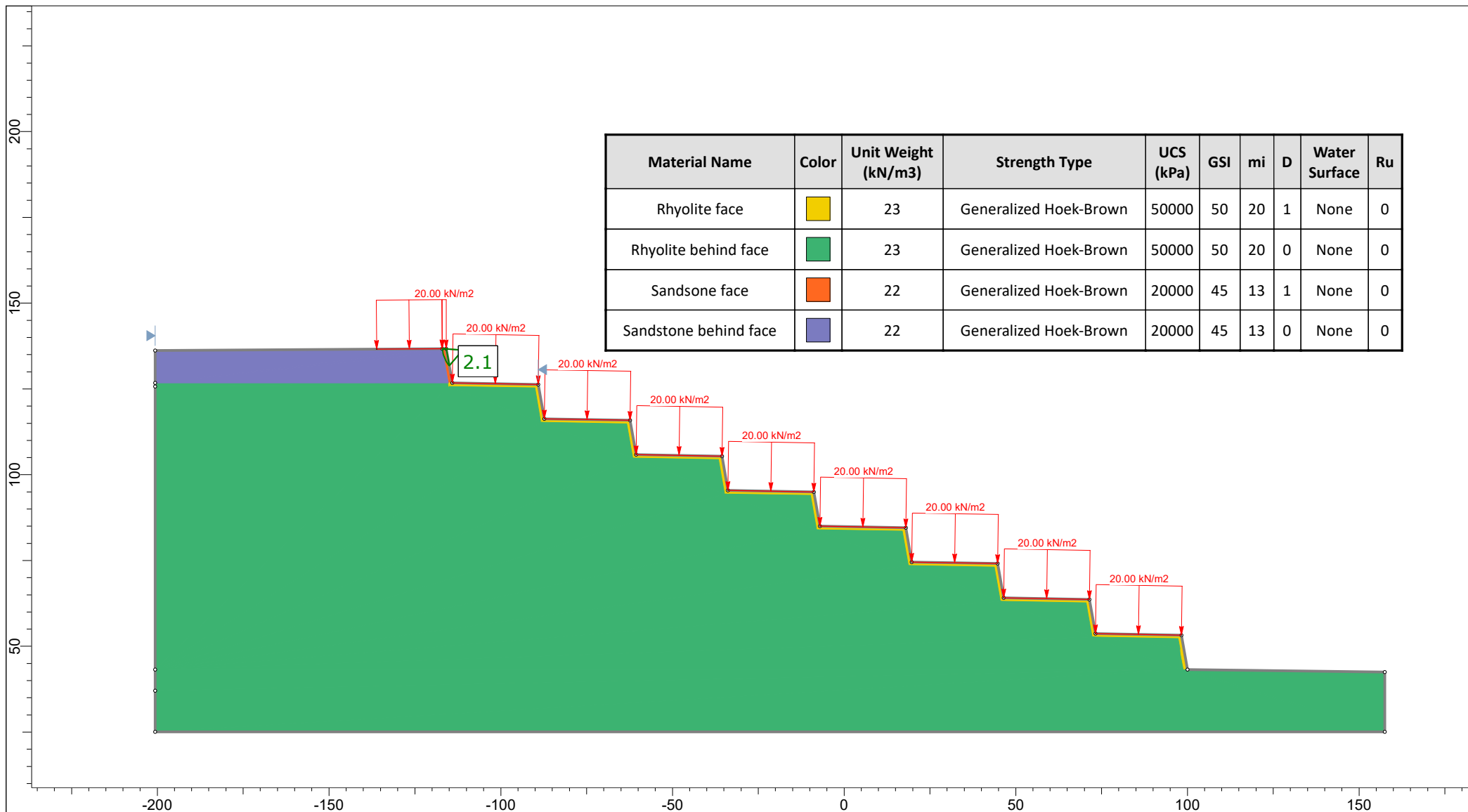
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 SLIDEINTERPRET 8.031	Project				
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	Analysis Description				
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	Date		1/28/2020, 8:31:25 AM		File Name
					Quarry face working.slmd



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	Analysis Description					
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					Quarry face working - Earth.slmd	



 rocscience	Project		
	SLIDE - An Interactive Slope Stability Program		
	Analysis Description		
	Drawn By	Scale	Company
		1:1548	
	Date	1/28/2020, 8:31:25 AM	File Name
			Quarry face working.slmd

SLIDEINTERPRET 8.031

APPENDIX C – IMPORTANT INFORMATION ABOUT THIS GEOTECHNICAL ENGINEERING REPORT

Important Information about This Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can construction project.

Geotechnical-Engineering Services Are Performed for

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be, and, in general, if you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying it.* A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only*. To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may

perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely*. Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures*. If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old*.

Obtain Professional Assistance to Deal with Moisture

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, *proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration*. Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. *Geotechnical engineers are not building-envelope or mold specialists*.



Telephone: 301/565-2733

e-mail: info@geoprofessional.org www.geoprofessional.org

Resource Material
Testing Assessment

Deep Creek Quarry,
Limeburners Creek

NEW14P-0043A-AA
10 September 2019



10 September 2019

Ironstone Developments Pty Ltd
PO Box 2185
Greenhills NSW 2323
tim@woodburycivil.com.au

Attention: Mr Tim Mullaney

Dear Tim,

**RE: PROPOSED RESOURCE DEVELOPMENT – DEEP CREEK QUARRY, LIMEBURNERS CREEK
MATERIAL TESTING ASSESSMENT**

Please find enclosed our Material Testing Assessment report for the proposed Quarry Resource Development located at Limeburners Creek and referred to as Deep Creek Quarry.

The report includes test results, descriptions and discussion of the engineering properties of the Rhyolite rock type encountered during drilling investigations performed by others within the resource. A broad range of tests were performed to demonstrate the engineering properties of the resource, primarily for use as construction aggregate in the concrete, asphalt, sealing and road building industry.

If you have any questions regarding this report, please do not hesitate to contact Alan Cullen or the undersigned.

For and on behalf of Qualtest Laboratory (NSW) Pty Ltd

A handwritten signature in blue ink, appearing to read "Jason Lee".

Jason Lee
Principal Geotechnical Engineer

A handwritten signature in blue ink, appearing to read "Alan Cullen".

Alan Cullen
Principal Geotechnician

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1.0 Introduction

Qualtest Laboratory NSW Pty Ltd (Qualtest) is pleased to present this report on behalf of Ironstone Developments Pty Ltd for the proposed resource development located at Limeburners Creek and referred to as Deep Creek Quarry.

This report presents the results of laboratory testing conducted by Qualtest and other specialist laboratories on samples obtained from the recent drilling investigations performed by VGT Pty Ltd - Environmental Compliance Solutions (VGT) and Ironstone Developments Pty Ltd, together with discussion and recommendations on the engineering properties of the resource, primarily for use as construction aggregate in the concrete, asphalt, sealing and road building industry.

1.1 Geology

Reference to the Statewide Geology GIS data base and the Newcastle 1:100,000 Geology sheet, copyright to the Department of Industry and Investment (Minerals and Petroleum), indicates that the following two geological units are present on or near the site.

- Italia Road Formation (Cuk) – Comprising of Lithic Sandstone, Lenticular Conglomerate.
- Karuah Formation (Cui) – Comprising Lithic Sandstone, Shale, Coal, Chert, Ignimbrites, Tuffs.

1.2 Drilling Investigation

In November 2018, drilling investigations were undertaken at the site of the proposed quarry by others. Table 1 below shows the location and depths of the holes drilled, in conjunction with DDH7 which was drilled in previous investigations. Drilling details have been provided by the client. Refer to Figure 1 for details of drill hole locations.

Table 1 – Drilling Investigation

Sample ID	Easting	Northing	RL (m)	Depth Drilled (m)
DDH7	397502	6397800	90.0	72.05
DDH17	397618	6397829	77.7	39.60
DDH18	397400	6397834	92.5	55.70
DDH19	397203	6397829	101.5	60.60

2.0 Scope of Testing

The following scope of testing was undertaken on samples retrieved from cored boreholes. The scope performed was aimed at providing a broad suite of testing to cover as many potential markets within the construction materials industry. Tests were chosen to give an overall performance comparison with current Australian Standards (AS2758) and NSW Roads and Maritime Services (RMS) standards. The tests covered physical characteristics, durability, geological properties, and chemical performance of the recovered samples. The scope of testing performed on samples of potential quarry materials provided included:

- AS1141.4 Bulk Density
- AS1141.5 Fine Particle Density & Absorption
- AS1141.6 Coarse Particle Density & Absorption
- AS1141.6.1 Coarse & Fine Weighted Bulk Density & Absorption
- AS1141.11 Particle Size Distribution

- AS1141.12 Material finer than 75 micron
- AS1141.14 Particle Shape
- AS1141.22 Wet/Dry Strength Variation
- AS1141.23 Los Angeles Abrasion
- AS1141.24 Sodium Sulphate Soundness
- AS1141.35 Sugar in Aggregates
- AS1141.41/42 Polished Aggregate Friction Test
- AS1012.20 Chlorides and Sulphates
- AS4133.4.1 Point Load Strength
- AS4133.4.2.1 Uniaxial Compressive Strength of Rock
- AS1289.3.1.1,3.2.1,3.3.1,3.4.1 Atterberg Limits including Plasticity Index
- RMS T219 Acid Soluble Sulphates
- RMS T363 Alkali Reactivity
- RMST659 Methylene Blue Value
- ASTM C 295 Petrographic Analysis

The purpose of the study was to assess the Rhyolite portion of the overall deposit, and the potential uses of this material within the construction industry. The scope of tests listed above was carried out on a selection of composite rock core samples considered to be representative of the potential Rhyolite resource, and were sampled from across varying depths between 0.0m and 72.0m from recovered core from Borehole DDH7, DDH18 & DDH19.

The resource identified Rhyolite rock types based upon the Petrographic Analysis results as summarised in Table 2. A composite of representative samples were selected and tested based on their potential material qualities and potential suitability for use as construction industry material.

Table 2 – Description of Representative Rock Types and Samples Tested

Sample ID	Depth (m)	Rock Type
DDH7	10.0 - 67.0	Rhyolite
DDH17	No samples tested	Rhyolite
DDH18	16.6 - 36.5	Rhyolite
DDH19	13.4 - 49.5	Rhyolite

3.0 Results

3.1 Bulk Density (AS1141.4)

Bulk Density is defined as the mass of particles divided by the total volume they occupy. The total volume includes particle volume, inter-particle void volume and internal pore volume.

Table 3 – Bulk Density Results (AS1141.4)

Sample ID	Rock Type	Uncompacted Bulk Density (t/m³)	Compacted Bulk Density (t/m³)
DDH7 (10.0m to 67.0m)	Rhyolite	1.33	1.50
DDH18 (16.6m to 36.5m)	Rhyolite	NT	NT
DDH19 (13.4m to 49.5m)	Rhyolite	NT	NT
AS2758 Concrete Aggregate Specification	-	-	-

3.2 Particle Density and Water Absorption (AS1141.5, 6 & 6.1)

The Particle Density and Water Absorption test is universally accepted within the Australian Construction Industry as the definitive measure of fine and coarse aggregate density and water absorption. It is used to determine these properties for both coarse grained aggregate and natural and manufactured sands.

The Particle Density test produces results similar to Specific Gravity (Apparent Particle Density), but also takes into account the voids that may be present in the material being tested. At the same time, the amount of water that is held within those voids is calculated and reported as the Water Absorption of the material. The definition of the four reportable parameters which are calculated is set out below: -

Apparent Density: The dry mass of particles divided by their volume, with the volume including only the impermeable voids.

Particle Density – Dry: The dry mass of particles divided by their volume, with the volume including both permeable and impermeable voids.

Particle Density - Saturated Surface Dry (SSD): The SSD mass of particles divided by their volume, with the volume including both permeable and impermeable voids.

Water Absorption: The ratio expressed as a percentage, of the mass of water held in the permeable voids of the particles brought to SSD condition following soaking under water for 24 hours, to the oven dried mass of the material.

The test properties listed above provide key design parameters for concrete and asphalt mixes.

For concrete mixes, the SSD density which accounts for water contained within permeable voids allows for calculation of the mix yield and concrete voids in the design calculation process. Attempts have been made in some specifications to limit the water absorption of aggregates, to minimise the practical difficulties that arise when dealing with highly absorptive aggregates. Because the density determination has accounted for the water in voids, they do not impede the cement hydration process, thus a more accurate determination of water demand and water-cement ratio design is possible. In other words, whilst low water absorptions are preferable, higher absorptions do not present insurmountable hurdles to concrete and asphalt mix designs.

Table 4 – Particle Density Fine Results (AS1141.5 – <4.75mm)

Sample ID	Rock Type	Particle Density Dry Basis (t/m ³)	Particle Density SSD Basis (t/m ³)	Apparent Particle Density (t/m ³)	Water Absorption (%)
DDH7 - composite (10.0m to 67.0m)	Rhyolite	2.42	2.51	2.67	3.8
DD18 - composite (16.6m to 36.5m)	Rhyolite	2.52	2.57	2.65	2.0
DDH19 - composite (13.4m to 49.50m)	Rhyolite	2.50	2.55	2.65	2.1
Average	Rhyolite	2.48	2.54	2.66	2.6
AS2758 Concrete Aggregate Specification (Dry Basis)	-	> 2.1 t/m³ to < 3.2 t/ m³	-	-	-

The AS 1141.5 Particle Density test can be used to determine particle density and water absorption properties in natural and manufactured fine materials.

For fine aggregates, the particle density test is carried out on material of size less than 4.75mm and a test portion of about 500g. This portion is immersed in water at room temperature for at least 24 hours and agitated in a manner that removes all the entrapped air. This is to ensure the pores are filled with water. The sample is then dried back to a point where the SSD condition can be determined.

This point is normally determined by using a cone apparatus and tamping rod.

When the material is Surface Saturated Dry (SSD), it should collapse on removal of the supporting cone. If it fails to collapse, it is deemed to still be too wet and further drying is required. This procedure of determining SSD works well for rounded natural sands with low quantities of passing 75 micron fines.

The results indicate that the absorption of the fines produced is below the preferable limit of 3% in RMS 3152 for asphalt.

The composite fine aggregate Rhyolite samples tested returned an average water absorption value of 2.6%. DDH18 and DDH19 (which are located towards the bottom half of the proposed extraction resource footprint); both had low water absorptions of 2.0% and 2.1% respectively. The concrete and asphalt industry generally prefers materials to have water absorptions less than 2.5%.

Table 5 – Particle Density Coarse Results (AS1141.6 – >4.75 mm to <19.0mm)

Sample ID	Rock Type	Particle Density Dry Basis (t/m ³)	Particle Density SSD Basis (t/m ³)	Apparent Particle Density (t/m ³)	Water Absorption (%)
DDH7 - composite (10.0m to 67.0m)	Rhyolite	2.48	2.54	2.64	2.4
DDH18 - composite (16.6m to 36.5m)	Rhyolite	2.54	2.58	2.65	1.7
DDH19 - composite (13.4m to 49.5m)	Rhyolite	2.51	2.55	2.64	2.1
Average	Rhyolite	2.51	2.56	2.64	2.1
AS2758 Concrete Aggregate Specification (Dry Basis)	-	> 2.1 t/m³ to < 3.2 t/m³	-	-	-

Whilst the fines portion of Rhyolite from DDH7 had an absorption of 3.8%, the coarse fraction produced a lower water absorption of 2.4%, which is within acceptable and normal working limits.

When assessing aggregates for mix design purposes that have both fine and coarse portions, it is normal to refer to their weighted ratio density and absorption to get an overall picture of the Particle Density and Water Absorption characteristics as outlined below in Table 6.

Table 6 – Particle Density Results (AS1141.6 – Weighted)

Sample ID	Rock Type	Particle Density Dry Basis (t/m ³)	Particle Density SSD Basis (t/m ³)	Apparent Particle Density (t/m ³)	Water Absorption (%)
DDH7 - composite (10.0m to 67.0m)	Rhyolite	2.47	2.54	2.65	2.7
DDH18 - composite (16.6m to 36.5m)	Rhyolite	2.53	2.58	2.65	1.7
DDH19 - composite (13.4m to 49.5m)	Rhyolite	2.50	2.56	2.65	2.1
Average	Rhyolite	2.50	2.56	2.65	2.2
AS2758 Concrete Aggregate Specification (Dry Basis)	-	> 2.1 t/m³ to < 3.2 t/m³	-	-	-

The particle density and water absorption results obtained from the composite sample of Rhyolite from Borehole DDH7 (in either the fine, coarse or combined weighted state), are marginally outside the normal absorption maximum requirement of 2.5% required by the concrete and asphalt Industry. The average across the three samples tested in either the fine, coarse or combined weighted state is below the normal absorption maximum of 2.5%. The dry density and apparent particle density of material from this source also exceed the minimum density requirements of 2.1 t/m³. This would indicate that the resource density and absorption characteristics are reasonably uniform, and blending or mixing of the resource products during production process (either by design or inadvertently), should not create undue problems.

3.3 Particle Size Distribution (AS1141.11.1)

The Particle Size Distribution or grading of the aggregates tested is primarily a function of the crushing process. The rock core samples provided for testing were crushed in a laboratory "Jaw Crusher" to produce a targeted 20mm minus run of crush product. This crushed product was then graded to produce the particle size distribution results presented below in Table 7.

Once graded, certain portions of the graded aggregate and fines were extracted from the total sample to perform the respective testing nominated in the testing schedule.

In the particle size distribution test, the aggregate is dried to a constant mass and then separated through a series of sieves, made with punched plate and woven wire in progressively smaller openings. For samples tested to Australian Standards, the sieves conform to ISO3310 and form part of the metric "half Series", where each successive sieve opening is half the size of the next largest sieve in the series.

Once separated, the mass of particles retained on each sieve is measured and compared with the mass of the total sample. Particle size distribution is then expressed as the cumulative mass percentage passing each sieve. Results are presented in a tabulated form or as graphs in a logarithmic format.

The test method for grading used in this assessment is described in AS1141.11.1, and was performed in a dried, unwashed state. The percent passing the 75 micron fraction was performed to AS1141.12 method and is a washed method where the dried sample is soaked for 12 hours and then washed over a 75 micron wash sieve.

Particle size distribution (or grading), is one of the most influential and commonly reported characteristics of an aggregate. Grading influences concrete durability, road base compatibility, porosity, workability, cement and water requirements, strength and shrinkage. However, it is the total aggregate grading in the mix that is critical to the mix performance. The grading of an individual component is not critical to the mix performance and an unsuitable grading can be improved by blending with other components. In this case the individual grading is not critical but once the blend is established, the consistency of individual components is critical to the production of a consistent product.

The individual grading percentages presented in below Table 7, whilst not comparable to any individual specification, are indicative of a material that when crushed with normal crushing and screening equipment, will produce similar material with the same physical characteristics and shape. The shape of individual particles can be changed and improved depending upon the screening and crushing equipment utilised in the production process. Improvement in the shape to a more cubical dimension will ultimately improve some durability aspects associated with the rock crushed from this resource, such as wet /dry variation.

Table 7 – Particle Size Distribution Results (AS1141.11)

Rock Type	Sieve Size (mm)	DDH7 composite (10.0m to 67.0m)	DDH18 composite (13.4m to 36.5m)	DDH19 composite (13.4m to 49.5m)
		% Passing	% Passing	% Passing
Rhyolite	37.5	-	100	100
	26.5	-	99	97
	19.0	100	84	82
	13.2	65	54	51
	9.5	40	33	34
	6.7	29	22	25
	4.75	21	16	18
	2.36	14	10	11
	1.18	9	6	8
	0.60	6	4	5
	0.425	5	3	4
	0.300	4	2	3
	0.150	2	1	2
	0.075	1	1	1

3.4 Passing 75 Micron in Aggregates – By Washing (AS1141.12)

The percentage passing 75 microns is calculated as the loss on washing expressed as a percentage of the original sample mass.

The 75 micron fraction size is used in Australia as a near approximation to the 60 micron size limit that in geological terms marks the boundary between fine Sand and Silt/Clay.

In natural aggregates, the total passing 75 microns will include the silt and clay fractions and will be composed of silt and clay minerals. In many specifications including AS 2758.1, the percentage passing 75 microns has been specified as a control over clay and silt fines that may cause water and cement demand, shrinkage, cracking, and control the permeability of some materials.

Percent passing results provided in Table 8 give indicative values that may be expected from material crushed in the normal manner.

The percent passing the 75 micron is an indication of the silt and clay fines within a particular crushed product. The percentage returned from crushed rock composite sample DDH7 was 2%. This is expected to consist of predominately silt materials, as the fines produced were non-plastic when Atterberg Limits testing was performed on the recovered fines.

Table 8 – Material Finer Than 75µ Results (AS1141.12)

Sample ID	Rock Type	Material Finer Than 75µ (%)
DDH7 - composite (10.0m to 67.0m)	Rhyolite	2.0
DDH18 - composite (13.4m to 36.5m)	Rhyolite	Not Tested
DDH19 - composite (13.4m to 49.5m)	Rhyolite	Not Tested
AS2758 Concrete Aggregate Specification	-	0 – 2
RMS 3151 Sealing Aggregate Specification	-	0 – 1

The result indicates that after the primary run of crush process in the laboratory, material passing the 75 micron sieve was equal to the specification limits for concrete. In the quarry production environment, this can be improved by either appropriate screening, dust extraction systems or by washing of the end product. Through implementation of such measures, it is anticipated that specification limits outlined in Table 8 may be met for Sealing Aggregate. Manufactured sand for concrete production is generally washed to control the minus 75 micron percentage.

3.5 Particle Shape by Proportional Calliper (AS1141.14)

The shape of the aggregate and crushed fines is primarily influenced by the crushing and screening process. The material processed and tested has been crushed with a primary “jaw crusher” which produces more flaky and elongated shapes than a cone crusher or “Barmac” system.

Aggregate is generally shaped through a series of primary and secondary crushers and recirculated to obtain more cubical, better shaped aggregate for concrete, sealing aggregate and asphalt production.

The shape of individual particles influences not only the durability test results / performance, but also the physical flow ability of concrete and the ultimate compatibility and stability of the end product. Improving the shape characteristics of a material to make it more cubical can have a positive influence on these physical and durability test parameters.

The particle shape test determines the percent of Misshapen or poorly shaped less desirable particles within a sample at 2:1 and 3:1 size ratios. The test determines the shape of individual particles and grades them according to their length, breadth and thickness.

The samples tested demonstrated total misshapen particles percentages of 24% to 37% at a tested ratio of 2:1. These shaped results are typical of a single run of crush product through a primary jaw crusher. The percentage misshapen should decrease when recirculated over a

secondary crushing process such as a “cone crusher”, which will generally halve these current percentage misshapen values.

It is assessed that aggregate crushed in the above manner (single run of crush through a jaw crusher), would be suitable for road base pavement products and certain asphalt applications, but would generally require further processing to be suitable for high strength concrete and superior performance aggregate.

Table 9 – Particle Shape Results (AS1141.14)

Sample ID	Rock Type	Total Misshapen Particles 2:1 (%)	Total Misshapen Particles 3:1 (%)
DDH7 - composite (10.0m to 67.0m)	Rhyolite	24	Not Tested
DDH18 - composite (13.4m to 36.5m)	Rhyolite	32	Not Tested
DDH19 - composite (13.4m to 49.5m)	Rhyolite	37	Not Tested
AS2758 Concrete Aggregate Specification	-	-	<10
RMS 3151 Sealing Aggregate Specification	-	<35	<10
RMS 3152 Asphalt Aggregate Specification	-	<25	<10

3.6 Wet/Dry Strength Variation (AS1141.22)

The Wet/Dry Strength Variation test determines the load (in kN) required to produce 10% fines in an aggregate sample when tested in dry (oven), and wet (SSD) conditions. The difference between these two strengths is expressed as a % variation. Wet strength is typically lower than the dry strength due to the presence of moisture within the aggregate particles during crushing, while a large difference between wet and dry conditions indicates potential water sensitivity of the rock when placed in saturated site conditions.

Table 10 – Wet/Dry Strength Variation Results (AS1141.22)

Sample ID	Rock Type	Dry Strength (kN)	Wet Strength (kN)	Wet/Dry Strength Variation (%)
DDH7 - composite (10.0m to 67.0m)	Rhyolite	365	277	24
DDH18 - composite (13.4m to 36.5m)	Rhyolite	309	231	25
DDH19 - composite (13.4m to 49.5m)	Rhyolite	310	250	16
AS2758 Concrete Aggregate Specification (Category C)	-	-	>100	<25

The wet/dry variation test is an excellent method of assessing the durability and wet strength of a product. The wet/dry test performed on a composite sample of the cored rock from DDH7, DDH18 and DDH19 indicate that despite the crushed rock's shape characteristics, the Rhyolite material performed well, further demonstrating the rock deposits high strength and durability characteristics.

It is assessed that in general, the Rhyolite would be suitable for concrete and asphalt production, as it returned results of 25% or less without any allowance for the poor shape characteristic of the tested material. The wet/dry results after the material has been properly shaped through secondary crusher system will improve the wet /dry result obtained.

DDH19 composite returned a low wet/dry variation result of 16%; however this result is expected to improve further with better shaping, which would occur during actual production.

Based on these wet/dry results the Rhyolite rock types are assessed to be hard and durable and likely suitable for concrete, asphalt and road base applications. Blending of the different rock types in the correct ratios would also improve the overall performance of the end products. All composite crushed core samples also complied with the wet strength criteria of greater than 100kN.

3.7 Los Angles Abrasion Value (AS1141.23)

This test involves placing a portion of aggregate in a steel drum, fitted with an internal baffle, with a specified number of steel balls. The drum is rotated a fixed number of times to distress the aggregate by impact loading, with some contribution from self-abrasion.

The test was originally developed in the context of wear resistance in cold areas (where the surfacing is trafficked by studded tyres) and for relatively low strength rocks such as limestone. The test result is determined by sizing the post-test material at a specified sieve size (1.8 mm), with the ratio of the -1.8mm fraction to the original charge mass giving the LA Value. The higher the LA Value, the less durable the rock. It is generally accepted that results of lower than 25% indicate that the rock is suitable for most construction industry applications.

The results of the testing on the composite sampled material from DDH7 demonstrated that the Rhyolite performed well under the Los Angeles abrasion test, with values of 15%. There is a general correlation of the Los Angeles Value test results with wet/dry strength variation testing.

Table 11 – Los Angeles Abrasion Value Results (AS1141.23)

Sample ID	Rock Type	Los Angeles Value
DDH7 - composite (10.0m to 67.0m)	Rhyolite	15
AS2758 Concrete Aggregate Specification (Category C)	-	<30%

3.8 Sodium Sulphate Soundness (AS1141.24)

This test is commonly used to assess an aggregate's suitability for use in concrete. Whilst the test is designed for aggregates in concrete, the exposure classifications can be used as a guide when assessing the suitability of source rock for similar applications.

The test is designed to assess the resistance of rock fabric to salt crystallization pressure, which is a measure of the susceptibility of the rock to physical breakdown. The extent of this breakdown is assessed by repeated immersion of the aggregate in a saturated solution of Sodium Sulphate. This is followed by oven drying to dehydrate the salt precipitated in permeable pores and rehydration of the salt during subsequent immersion, which generates crystallization pressure. Internal expansive forces derived from rehydration of the salt on re-immersion, mimic

freezing (crystallization of water) or salt action. This provides a measure of the integrity of the rock fabric when subjected to physical weathering associated with the expansion caused by the freezing of water in aggregate pores, and the expansion of salts on rehydration in marine conditions, following repeated wetting and drying.

Table 12 – Sodium Sulphate Soundness Results (AS1141.24)

Sample ID	DDH7 - composite (10.0m to 67.0m)	DDH19 - composite (13.4m to 49.5m)
Individual Fractions Tested (mm)	Individual Sample Size Loss (%)	Individual Sample Size Loss (%)
Loss 19.0 to 13.2mm	0.3	0.0
Loss 13.2 to 9.5mm	0.6	0.0
Loss 9.5 to 4.75 mm	1.3	0.1
Loss 4.75 to 2.36 mm	3.2	0.0
Total Weighted Loss	0.8	0.0

The results of Sodium Sulphate Soundness testing are highly dependent on particle size, a consequence of variation to the surface area/volume ratio and its effect on the degree of saturation achieved during the wetting cycle.

High loss results are a fairly reliable indication of poor durability; consequently low losses are an indication of good durability. The Rhyolite from this resource has extremely low losses, which demonstrates the sources excellent durability characteristics, making it likely suitable for all concrete and asphalt applications.

AS2758 specification breaks the requirements into 3 sub-classes based on the material's maximum weighted average loss of 6%, 9% and 12%. The weighted loss results for the composite sampled material within DDH7 and DDH19 of the resource are all below 6%, and are therefore assessed to be suitable for any exposure conditions, including armour rock and dimension stone, providing suitable quarrying methods are used to minimise fractures.

3.9 Sugar in Aggregates (AS1141.35)

Sugar retards the set-in concrete; therefore, aggregates are tested to ensure there is no presence of sugar in materials crushed and proposed for use as concrete aggregate. No sugar was detected within any samples of crushed aggregate tested.

Table 15 – Sugar in Aggregates Results (AS1141.35)

Sample ID	Rock Type	Content
DDH7 - composite (10.0m to 67.0m)	Rhyolite	Not Detected

3.10 Soluble Salts (AS1012.20)

Excessive quantities of some soluble salts may cause efflorescence on concrete, corrosion of reinforcing steel, or disintegration of the mass of concrete. Permissible levels of soluble salts are generally expressed as a proportion of the relevant ion present in the concrete by mass of concrete or by mass of Portland cement.

AS1141.20 determines the chloride ion and sulphate ion content within aggregates proposed for use as concrete aggregate. The total individual percentage of chloride and sulphate ion reportable in aggregate is for amounts in excess of 0.01%. The total combined aggregate chloride salt content should not exceed 0.04% for use in reinforced concrete. The total sulphate ion content allowable within a concrete mix and expressed as SO_3 should not exceed 5% by mass of Portland cement.

Table 16 – Chlorides Results (AS1012.20)

Sample ID	Rock Type	Chlorides (Cl) (%)	Sulphates (SO ₄) (%)
DDH18 – composite (13.4m to 36.5m)	Rhyolite	0.002	0.017
DDH19 – composite (13.4m to 49.5m)	Rhyolite	0.001	0.047

Table 17– Sulphates Results (RMS T219)

Sample ID	Rock Type	Sulphates (SO ₃) (%)
DDH7 – composite (10.0m to 67.0m)	Rhyolite	0.041

Samples from the deposit (depending upon the rock source) demonstrated different content levels of soluble salt ions, but despite slightly elevated sulphates (SO₄) the total sulphates expressed as (SO₃) are below AS2758.1 guideline requirement.

3.11 Alkali Reactivity (RMS T363)

Effect of Alkali Reactivity

Research has been performed in relation to the effect of Alkali Reactivity on concrete aggregates.

The following is an excerpt from an online article (PCA America's Cement Manufacturers), sourced from <https://www.cement.org/learn/concrete-technology/durability/alkali-aggregate-reaction>. The article states:

“In most concrete, aggregates are more or less chemically inert. However, some aggregates react with the alkali hydroxides in concrete, causing expansion and cracking over a period of many years. This alkali-aggregate reaction has two forms: Alkali-Silica Reaction (ASR) and Alkali-Carbonate Reaction (ACR).

Alkali-Silica Reaction (ASR) is of more concern as aggregates containing reactive silica materials are more common. In ASR, aggregates containing certain forms of silica will react with alkali hydroxide in concrete to form a gel that swells as it absorbs water from the surrounding cement paste or the environment. These gels can induce enough expansive pressure to damage concrete.

Alkali-silica reaction can be controlled using certain supplementary cementitious materials. In proper proportions, silica fume, fly ash, and ground granulated blast-furnace slag have significantly reduced or eliminated expansion due to alkali-silica reactivity. In addition, lithium compounds have been used to reduce ASR.

Although potentially reactive aggregates exist throughout Australia, alkali-silica reaction distress in concrete is not that common because of the measures taken to control it. It is also important to note that not all ASR gel reactions produce destructive swelling.

Alkali-Carbonate Reaction (ACR) is observed within certain dolomitic rocks. Dedolomitisation (the breaking down of dolomite) is normally associated with expansion. This reaction and subsequent crystallization of brucite may cause considerable expansion. The deterioration caused by alkali-carbonate reactions is similar to that caused by ASR, however, ACR is relatively rare because aggregates susceptible to this phenomenon are less common and are usually unsuitable for use in concrete for other reasons".

Minimising the Risk of ASR

Information on commonly used methods of minimising the risk of ASR have been sourced from VIC Roads Technical Note 30 (Alkali Silica Reaction in Concrete, dated May 2008). This technical note states:

"There are several methods commonly used to prevent or minimise the risk of ASR. These include:

- where practical use of non-reactive aggregates, use of low alkali cement (i.e. less than 0.6% alkali expressed as Na₂O equivalent);*
- limit the total alkali content (from all sources) within the concrete mix to less than 2.8kg/m³;*
- incorporate lithium salts in the concrete mix to produce a non-expansive gel product in contrast to the alkali. However, more field performance data using this method is required;*
- and use of Supplementary Cementitious Materials (SCMs).*

The use of SCMs as cement replacements has proven to be very effective in reducing the negative effects of ASR. SCMs reduce the availability of alkalis for expansion reactions and make the concrete more water tight. Depending on the type of aggregate and magnitude of potential reactivity the effective cement replacement levels are:

- Flyash 10% to 30%;*
- Slag 40% to 65%;*
- Silica fume 5% to 15%"*

The samples obtained from the respective boreholes were crushed and combined with Gladstone GP and Berrima SL cement, and tested for alkali reactivity in accordance with RMS T363 procedures. The mortar bar expansion percentages set out below in Table 18, range from a maximum of 0.161% at 10 days, to a maximum of 0.341% at 21 days when used in combination with Gladstone GP cement.

When tested with Berrima SL cement, the resulting range was significantly reduced from a maximum of 0.073% at 10 days, to a maximum of 0.167% at 21 days.

Based on the assessment criteria, the samples when tested with Berrima SL cement are classified as "Slowly Reactive", as the sample has less than 0.10% expansion at 10 days, and greater than 0.10% expansion after 21 days.

Table 18 – Alkali Reactivity Results (RMS T363)

Sample ID	Rock Type	Cement source/Type	10 Day Expansion (%)	21 Day Expansion (%)	Classification
DDH7 - Composite (10.0 to 67m)	Rhyolite	Cement Australia Berrima SL Cement	0.043	0.104	Slowly Reactive
DDH18 - composite (13.4m to 36.5m)	Rhyolite	Cement Australia Gladstone GP Cement	0.146	0.315	Reactive
DDH18 - composite (13.4m to 36.5m)	Rhyolite	Cement Australia Berrima SL Cement	0.064	0.167	Slowly Reactive
DDH19 - composite (13.4m to 49.5m)	Rhyolite	Cement Australia Gladstone GP Cement	0.161	0.341	Reactive
DDH19 - composite (13.4m to 49.5m)	Rhyolite	Cement Australia Berrima SL Cement	0.073	0.145	Slowly Reactive

Where samples are reactive, further testing with fly ash-based cements or other SCR product combinations is recommended.

Sampled materials are not considered dolomitic rocks so ACR is considered unlikely in regards to material from this source.

3.12 Polished Aggregate Friction Value (PAFV – AS1141.41/42)

In NSW, the measurement of aggregate polishing values can be obtained from using a horizontal testing wheel/flat mould system and applied to Australian Polished Aggregate Friction Value (PAFV).

An aggregate's resistance to polishing is measured by performing pendulum friction tests on laboratory polished pieces of aggregate, and comparing to a known reference sample of 'Panmure Basalt'. The Australian standards relevant to polishing of aggregates are:

AS1141.40-1999: Methods for sampling and testing aggregates – Polished aggregate friction value - Vertical road-wheel machine.

AS1141.41-1999: Methods for sampling and testing aggregates – Polished aggregate friction value – Horizontal bed machine.

AS1141.42-1999: Methods for sampling and testing aggregates – Pendulum friction test.

The first two standards describe alternative methods for accelerated polishing of aggregates in the laboratory, using coarse and then fine abrasive materials to wear away (polish) the aggregate's micro texture. Following polishing by either method, the third standard is used to determine the friction angle value of the resulting polished aggregate using a pendulum friction test. Depending on the test method used, this value is then reported as the PAFV (AS1141.41 & AS1141.42, and also NSW RMS 3151 & 3152), or PSV (other states) of the aggregate.

The two polishing regimes in AS1141.40 and AS1141.41 were designed to give results that were comparable between the two methods. However, there are differences between the PAFV and the PSV test, including the coarse abrasive, water and abrasive feed rates, polishing time, reference aggregate and rubber for friction testing. Therefore, PSV and PAFV results may not be directly comparable.

The RMS 3151 and 3152 specification standards for use as sealing aggregates and asphalt aggregate vary slightly with regards to their PAFV requirements. Aggregates with PAFV values of greater than 44 are required for sealing aggregates and greater than 48 for asphalt. The general accepted rule is that the higher the PAFV value, the better the performance of the aggregate in terms of skid resistance. This should also be judged in conjunction with suitable aggregate strength, abrasion and durability results.

Table 19 – PAFV Results (AS1141.41/42)

Sample ID	Rock Type	PAFV Value
DDH7 - composite (10.0m to 67.0m)	Rhyolite	57
DDH18 - composite (13.4m to 36.5m)	Rhyolite	65
DDH19 - composite (13.4m to 49.5m)	Rhyolite	62
RMS 3151 Sealing Aggregate	-	>44
RMS 3152 Asphalt Aggregate	-	≥48

Samples that were crushed and tested in accordance AS1141.41 and AS1141.42 displayed PAFV values in excess of the specification requirements. It is therefore assessed that all resource material tested may be suitable for use as both sealing and asphalt aggregate.

Whilst all samples tested performed well relating to their strength and abrasion characteristics, durability and mineralogical make up should also be considered when assessing their performance.

The Rhyolite materials from all three locations exceeded specified requirements, performed well, and are typical results for Rhyolite resourced material. Rhyolite materials won from this resource are likely to be suitable materials for sealing and asphalt aggregate.

3.13 Methylene Blue Value

Methylene Blue (MB) dye absorption has been used for a considerable period as a means of determining and specifying the presence of clay minerals in aggregates. The test determines the quantity of MB dye required to coat the active agents in the soil in a mono molecular layer.

The test is completed on the passing 75 micron fraction recovered from a sample of fine aggregate of known mass. A MB of 1mg/ml is titrated against slurry of the passing 75 micron material. As each aliquot of MB is added, the sample is tested for end point by removing a small drop of the slurry on a stirring rod and placing the dyed dust and liquid drop onto a filter paper. The filter paper draws off a 'halo' of water from around the dust particles. At the end point, when the dust cannot absorb any further MB, this 'halo' is permanently stained a light blue colour. The Methylene Blue Value (MBV) of the aggregate is reported as the number of milligrams of dye absorbed per gram of material passing 75 microns.

The MBV expresses the quantity of MB required to cover the total surface of the clay fraction with a mono-molecular layer of the MB. It is therefore proportional to the product of the clay content times the specific surface of the clay. However, the result can be affected by the presence of organics, zeolites and iron hydroxides. Some literature also suggests minor

absorption by carbonates and unbalanced charged particles on freshly crushed surfaces, but these effects are considered minor. The MB test is used to evaluate the amount and nature of deleterious fines in a fine aggregate which may cause stripping. The higher the MBV the more susceptible the aggregate or mix will be to stripping.

The ISSA procedure (Bulletin 145) recommends that mineral aggregate fillers and fines be rejected if the MBV exceeds 10mg/g for basalt rocks, or 7 mg/g for grit stones (meta-Greywackes). RMS specifications for fines used in asphalt (RMS 3152) require further investigation of an aggregate if the MBV exceeds 8mg/g.

Table 20 – Methylene Blue Value Results

Sample ID	Rock Type	Methylene Blue Value (mg/g)
DDH7 – composite (10.0m to 67.0m)	Rhyolite	5.0
RMS 3152 Recommended Limit	-	8

The MBV obtained on crushed fines from borehole DDH7 indicate that the clay activity in the samples tested is below recommended limits.

This would indicate that rock quarried from the resource meets the recommended specification requirements and would be unlikely to liberate further fines during the production processes.

3.14 Atterberg Limits (AS1289.3.1.1, 3.2.1, 3.3.1, 3.4.1)

The knowledge of the crushed rock soil consistency is important in defining or classifying a rock type and aids in predicting crushed rock performance when used as a construction material. The soil or crushed rock fines have been assessed for their soil consistency by means of the Atterberg Limits test.

For cohesive soils, there is a range of moisture contents within which the soil (silt or clay) is of a plastic consistency. The Atterberg Limits test provides a means of measuring the plastic range of a cohesive soil in numerical terms.

Water can be added and mixed into cohesive soil until the soil becomes slurry, and behaves as a viscous fluid. This is defined as the liquid state. As the cohesive soil is dried back slowly and evenly it begins to gain strength and offers resistance to deformation. The condition is known as the plastic state. Further reduction of moisture in the soil will cause it to shrink and become stiffer until it shows little plastic condition and the cohesive soil becomes brittle. This is defined as the semi-solid state. With further drying, the soil will continue to shrink until no further moisture can be removed. At this point further drying has no more effect on the volume change and the soil is defined as being in a solid state.

The change from one phase to the next does not occur at a precise time but takes place as a transition over a period of time. The plastic range is then reported in the following terms:

- Liquid Limit (W_L) – Liquid State;
- Plastic Limit (W_P) – Plastic State;
- Plasticity Index (I_P) – Plasticity Index;
- Linear Shrinkage (L_S) – Liquid Linear Shrinkage.

The plasticity index is not determined by a test, it is the measure of plasticity of a soil as the difference between the Liquid Limit (W_L) and the Plastic Limit (W_P). The Liquid Linear Shrinkage (L_S) is defined as the decrease in length, expressed as a percentage of the original length.

The plastic limit test is used throughout engineering specifications and the construction industry as a defining test of materials plasticity.

The test is performed on the material component that passes the 425 micron test sieve. The materials are then moistened and cured and the respective plastic and liquid state determined.

Rock samples obtained from the resource were crushed and the produced fines were collected and tested to determine their plasticity. Atterberg Limit test results are presented below in Table 21.

Table 21 – Atterberg Limits Results (AS1289.3.1.1, 3.2.1, 3.3.1, 3.4.1)

Sample ID	Rock Type	Liquid Limit (%)	Plastic limit (%)	Plasticity Index	Linear shrinkage (%)
DDH7 - composite (10.0m to 67.0m)	Rhyolite	Not Obtainable	Not Obtainable	Non-Plastic	0.0
DDH18 - composite (13.4m to 36.5m)	Rhyolite	18	14	4	1.5
DDH19 - composite (13.4m to 49.5m)	Rhyolite	Not Obtainable	Not Obtainable	Non-Plastic	0.0

The crushed rock fines produced from the composite sample from DDH7 & DDH19 sources did not display any reaction to the Atterberg Limits test. They were Non-Plastic, meaning that the liquid limit and or plastic limit could not be obtained due to the non-reactive nature of the fines produced.

The production of Non-plastic fines from these source rocks is ideal for the production of good quality aggregate for use as concrete and road sealing purposes, but is not ideal for the production of top quality road base and select materials which generally require some plasticity in order to produce a cohesive uniform compactable blend.

Further testing of overburden materials should be performed in order to establish likely blending ratios required for the introduction of plastic fines during the production process, in order to produce suitable road base materials.

3.15 Point Load Test (RMS T223)

The point load strength index test is a method developed for determining the strength of rock specimens in the field with portable equipment.

Specimens in the form of either rock core (the diametric and axial test) or irregular lumps (the irregular lump test) are broken by application of a concentrated load using a pair of conical platens. A point load strength index ($Is_{(50)}$) is obtained and may be used to classify rocks by strength. It can also be used to estimate uniaxial compressive strength where index-to-strength conversion factors are used.

The point load test is an accepted rock mechanics testing procedure used for the calculation of a rock strength index. This index can be used to estimate other rock strength parameters. The rock strength determined by the point load test (like the load frame strengths that they estimate), is an indication of the intact rock strength, and not necessarily the strength of the rock mass.

Specimens should be tested as close to their in-situ moisture content as possible, as strengths may vary due to sample geometry and rock properties. Rock that is bedded, schistose or otherwise shows observable anisotropy, should be tested in both weakest and strongest

directions. The uncorrected point load strength is corrected using equivalent core diameter calculation and expressed in MPa as Point Load Index ($I_{s(50)}$).

Table 22 – Typical Point Load Strength Results (RMS T223)

Sample ID	Rock Type	Strength Diametral $I_{s(50)}$ (MPa)	Strength Axial $I_{s(50)}$ (MPa)	Anisotropy Index
DDH7 (10.0m to 67.5m)	Rhyolite	8.01	7.07	1.13

The point load test results performed on rocks from DDH7 indicate that the material has $I_{s(50)}$ strength values between 8.01 MPa for diametral and 7.07 MPa for Axial strength, placing it in the “High Strength” to “Very High Strength” classification category. Rock of this strength rating is generally suitable for most construction purposes.

3.16 Uniaxial Compressive Strength (AS 4133.4.2.1)

Compressive strength is probably the most widely used and quoted rock engineering parameter. Under uniaxial load conditions, the maximum stress that a rock sample can sustain is referred to as Uniaxial Compressive Strength (UCS). It is one of the most important mechanical properties of rock material, used in design, analysis and modelling of quarry benches and infrastructure design.

The method is based on a rock sample of 54mm in diameter and with a height from 2.5 to 3 times greater than its diameter. The specimen is placed in the compression test machine and compressive force is applied to the sample. The force should have a constant increase over time until the sample breaks and is disintegrated, while simultaneously axial and lateral deformations are measured. The result is Uniaxial Compressive Strength. If axial deformations are measured, Youngs Modulus of elasticity can be obtained. Where lateral deformations are measured, the sample's Poissons coefficient is also obtained.

Table 23 – Uniaxial Compressive Strength Results (AS4133.4.2.1)

Sample ID	Rock Type	UCS (MPa)
DDH7 (10.0m to 67.5m)	Rhyolite	80.7

The uniaxial compressive strengths obtained indicate the intact rock strength of the sample to be “Strong” to “Very Strong”.

Point load testing indicated that the material is between 1.5 MPa to 12 MPa (Very Strong), while Uniaxial Compressive Strength testing performed on a typical sample of Rhyolite from DDH7 as outlined in Table 23 returned value of 80.7 MPa. This result indicates a good correlation with the numerous point load strength tests performed on DDH7. These uniaxial compressive strengths mirror the Point Load testing performed and indicate the rock from DDH7 is in the “Very Strong” range over the majority of the cored profile. Similar results would be expected from other borehole samples within this Rhyolite deposit.

3.17 Petrographic Examination (ASTM C295)

Petrographic examination of rock and source material is normally conducted in accordance with ASTM C295 by preparation of a petrological thin section of the source rock in question (microns thick), mounted on a glass slide suitable for use in a stereoscopic polarising microscope of high resolution at 500 x magnification.

A point count of approximately 100 individual points on the slide is made by viewing the slide and identifying and classifying each point. Due to the nature of this test, the results can vary significantly from one petrographic to another for the same sample. For this reason, petrographic examination reports are often used as a screening tool only for specifics, to identify potentially deleterious minerals and any classification is normally confirmed or denied based upon subsequent physical, mechanical or chemical tests undertaken on samples taken from the source in question.

A selected sample of the rock core type encountered was dispatched for analysis. Geochempet Services performed Petrographic analysis and provided geological descriptions regarding the potential uses of the material, based on the mineralogical assessment. The results of the petrographic analysis are summarised below and potential uses listed in below Table 24 below.

Table 24 – Petrographic Analysis Results (ASTM C295)

Sample Number	DDH7
Identification	Rhyolite
Durable	Yes
Suitable for Concrete Aggregate	Yes (i) (ii)
Suitable for Concrete Sand	Yes (i)
Suitable for Road base	Yes
Suitable for Asphaltic/Sealing Aggregate	Yes
Suitable for Rail Ballast	Yes
Suitable for Rip Rap	Yes
Free Silica Content (%)	34

- (i) Provided that the appropriate precautions are taken in mix and engineering design to take into account the potential for mild or slow deleterious alkali-silica reactivity.
- (ii) Quality may be diminished by the presence of about 18% secondary minerals content, which could increase water demand in concrete products.

4.0 Summary

Based on the laboratory testing and drilling investigation program undertaken the resource primarily consists of Rhyolite, interpreted to be volcanic rhyodacite. The rock has crystallized within a lava flow. Alteration in this rock is moderate and likely due to sub-greenschist facies and regional metamorphism. Rhyolitic rock types of similar quality, varying quantities and depths were noted within the four boreholes performed across the site. This rock type from an engineering, quarrying and construction perspective are very similar in nature to rhyodacite whilst being technically different from a geological viewpoint. The laboratory testing undertaken has been performed on composite samples obtained from the boreholes classified as a Rhyolite rock type. The summary of the combined properties of the tested materials from an engineering and construction perspective is set out below in Table 25.

The Rhyolite rock types encountered within the boreholes are classified as hard, strong and predicted to be durable. The Rhyolitic (Acid volcanic rock) sample tested had 34% quartz, of which there is about 5% of micro-crystalline quartz in spherulites (slowly reactive silica), and is considered to have potential deleterious alkali-silica reactivity in concrete.

However, if appropriate precautions are taken, this reactivity can generally be controlled adequately with the use of Supplementary Cementitious Materials (SCMs) such as flyash and shrinkage limited cements, during the concrete design and production stages.

RMS T363 accelerated Mortar Bar testing performed by Boral Construction Material Technical Services on crushed aggregate from DDH7, DDH18 and DDH19 (in combination with Berrima SL cement) are classified as Slowly Reactive.

Due to the non-porous and un-weathered nature of the Rhyolite it is also likely to be suitable for use as Dimension Stone and Armour Rock, subject to consideration of the impact of jointing or veining from visual inspection of the quarry face.

The rock is considered to have adequate strength and durability for use in Asphaltic / Sealing Aggregate, and is also suitable for use as a source of Road base, Rail Ballast, and Rip Rap.

The RMS 3151 and 3152 specification standards for use as sealing aggregates and asphalt aggregate vary slightly with regards to their PAFV requirements. Aggregates with PAFV values of greater than 44 are required for sealing aggregates and greater than 48 for asphalt. The general accepted rule is that the higher the PAFV value, the better the performance of the aggregate in terms of skid resistance. This should also be judged in conjunction with suitable aggregate strength, abrasion and durability results.

The samples that were crushed and tested in accordance AS1141.41 and AS1141.42 returned PAFV values ranging from 57 to 65. These are in excess of the specification requirements of either 44 or 48. It is therefore assessed that the resource material tested may be suitable for use as both sealing and asphalt aggregate.

These uniaxial compressive strengths mirror the Point Load testing performed and indicate the rock from DDH7 is in the "Very Strong" range over the majority of the cored profile, with Uniaxial compressive strength testing performed on core sample indicate the material has a compressive strength of 80.7 MPa.

The produced fines were low to non-plastic and water absorption test results indicate that the weighted average performed on coarse and fine material obtained was 2.2%. This is within the specified requirements for concrete and asphalt, but is also expected to improve once suitable crushing and processing techniques are implemented.

Chemical testing performed demonstrate the low soluble salts, and relatively low Methylene Blue Adsorption rates are consistent with material suitable for use as Concrete Sand and Asphalt filler.

The free silica content of the Rhyolite is 34%, all locked within crystalline rock. The rock contains 34% Quartz, of which there is about 5% of microcrystalline quartz in spherulites (a slowly reactive form of silica). Therefore, the rock is considered to have potential for mild or slow alkali-silica reactivity in concrete (if not treated correctly). The free silica content also indicates that material from this source will be highly abrasive on plant and equipment.

The Rhyolite may be won and crushed to produce aggregate or rock material separately, or blended with crusher fines to meet individual road base specification requirements. Table 25 below outlines the potential suitability for each material source.

The recommendations provided within this report are based on sampling and testing of composite samples from discrete borehole test locations. Whilst it is anticipated that the testing performed may be considered representative of the rock resource, suitability for specific applications should be confirmed by ongoing production QA/QC testing.

Table 25 – Material Suitability Summary

Sample Number	Identification	Durable	Potential Product Suitability						
			Concrete Aggregate	Concrete Sand	Road Base	Asphaltic/ Sealing Aggregate	Rail Ballast	Rip Rap	Select Fill
DDH7	Rhyolite	Yes	Yes (i)	Yes (i)	Yes	Yes	Yes	Yes	Yes
DDH17	Rhyolite	Yes	Yes (i)	Yes (i)	Yes	Yes	Yes	Yes	Yes
DDH18	Rhyolite	Yes	Yes (i)	Yes (i)	Yes	Yes	Yes	Yes	Yes
DDH19	Rhyolite	Yes	Yes (i)	Yes (i)	Yes	Yes	Yes	Yes	Yes

- (i) Provided that the appropriate precautions are taken in mix and engineering design to take into account the potential for mild or slow deleterious alkali-silica reactivity.
- (ii) The Rhyolite is likely to be suitable for dimension stone and marine armour rock, if defect spacing is minimal and suitable boulders are procured.

5.0 Limitations

The findings presented in the report and used as the basis for recommendations presented herein were obtained using normal, industry accepted geotechnical design practices and standards. To our knowledge, they represent a reasonable interpretation of the general conditions of the site.

The extent of testing associated with this assessment is limited to discrete borehole locations. It should be noted that subsurface conditions between and away from the borehole locations may be different to those observed during the field work and laboratory testing, and used as the basis of the recommendations contained in this report.

If subsurface conditions encountered during construction differ from those given in this report, further advice should be sought without delay.

Data and opinions contained within the report may not be used in other contexts or for any other purposes without prior review and agreement by Qualtest. If this report is reproduced, it must be in full.

If you have any further questions regarding this report, please do not hesitate to contact Alan Cullen or the undersigned.

For and on behalf of Qualtest Laboratory (NSW) Pty Ltd



Jason Lee
Principal Geotechnical Engineer



Alan Cullen
Principal Geotechnician

APPENDIX A:

Figures



 www.kleinfelder.com	PROJECT REFERENCE: 20151815	Diamond Drill Hole Locations DDH17, 18 and 19	FIGURE: 1
	DRAWN BY: J.Berry		
	DATE DRAWN: Thursday, 8 August 2019 / Version1	Deep Creek Quarry Project Ironstone Developments Pty Ltd Deep Creek Road, Limeburners Creek, NSW	
	DATA SOURCE: LPI Data		

APPENDIX B:

Results of Laboratory Testing – Qualtest (2014 & 2019)

LABORATORY (NSW) PTY LTD			DDH7 10 to 67m (S1)	DDH18 16.57 - 36.52m (S01)	DDH19 13.39 - 49.46m (S02)	Specification Limits			
			NEW14W- 0986-S04	NEW18W-3808- S01	NEW18W-3808- S02				
Test Methods	Reported Results		Rhyolite	Rhyolite	Rhyolite	AS2758 - Concrete Aggregate	RMS 3151 -Sealing Aggregate	RMS 3152 - Asphalt Aggregate	AS2758-5 - Armour Rock
AS1141.4 (Bulk Density)	Uncompacted (t/m³)		1.33	-	-	> 1.2 t/m³			
	Compacted (t/m³)		1.50	-	-				
AS1141.5 (Fine Particle Density)	Dry Basis (t/m³)		2.42	2.52	2.50	> 2.1 t/m³		Report	
	Saturated Surface Dry Basis (t/m³)		2.51	2.57	2.55	> 2.1 t/m³		Report	
	Apparent Particle Density (t/m3)		2.67	2.65	2.65	> 2.1 t/m³		Report	
	Water Absorption		3.8	2.0	2.3			≤ 3.0 %	
AS1141.6 (Coarse Particle Density)	Dry Basis (t/m3)		2.48	2.54	2.51	> 2.1 t/m³		Report	> 2.6
	Saturated Surface Dry Basis (t/m³)		2.54	2.58	2.56	> 2.1 t/m³		Report	
	Apparent Particle Density (t/m³)		2.64	2.65	2.64	> 2.1 t/m³		Report	
	Water Absorption		2.4	1.7	2.1				< 1.5 % (- 26.5 to + 9.5mm fraction)
AS1141.6.1 (Particle Density - Weighted)	Dry Basis (t/m3)		2.47	2.53	2.50	> 2.1 t/m³		Report	
	Saturated Surface Dry Basis (t/m3)		2.54	2.58	2.56	> 2.1 t/m³		Report	
	Apparent Particle Density (t/m3)		2.65	2.65	2.65	> 2.1 t/m³		Report	
	Water Absorption		2.7	1.7	2.1			≤ 2.5 % (Rhyolite - Report Only)	
AS1141.11 (Particle Size Distribution)	Percent (%) Passing								
	37.5mm		100	100	100	Dependent upon the nominal size of the aggregate	Dependent upon the nominal size of the aggregate	Asphalt manufacturers nominate grading envelope	Dependent upon the nominal size of the aggregate
	26.5mm		100	99	97				
	19.0mm		100	84	82				
	13.2mm		65	54	51				
	9.5mm		40	33	34				
	6.7mm		29	22	25				
	4.75mm		21	16	18				
	2.36mm		14	10	11				
	1.18mm		9	6	8				
	600um		6	4	5				
	425um		5	3	4				
	300um		4	2	3				
	150um		2	1	2				
	75um		1	1	1				
AS1141.12 (Material Finer than 75 Micron)	Finer Than 75um (%)		2.4	-	-	0 - 2	0 - 1	Report	
AS1141.14 (Particle Shape)	Total Misshapen (%)		24	32	37	< 35 - 2:1 < 10 - 3:1	< 35 - 2:1 < 10 - 3:1	< 35 - 2:1 < 10 - 3:1	
AS1141.22 (Wet/Dry Strength Variation)	Dry Strength (kN)		365	309	260				
	Wet Strength (kN)		277	231	310	(C Class) > 100kN	> 150kN	> 150kN	> 150kN
	Wet/Dry Strength Variation (%)		24	25	16	(C Class) - 25 %	< 35 %	< 35 %	< 25 %
AS1141.23 (Los Angeles Value)	Los Angeles Value		15	-	-	(C Class) - 30			< 25 %
AS1141.24 (Sodium Sulphate Soundness)	Total Weighted Loss of Sample (%)		0.8	-	0.0	(C Class) - 6 %		≤ 12 % Weighted Loss	< 6 %
AS1141.32 (Weak Particles)	Percentage Loss (%)		0.7	-	-	0.005 %			
AS1141.35 (Sugar in Aggregates)	Content		Not Detected	-	-	Negative			
AS1012-20 (Chlorides and Sulfates)	Chlorides (Cl %)		0.003	0.002	0.001	0.0001 %			
	Sulfates (SO4 %)		0.080	0.017	0.047				
RMS T219 (Acid Soluble Sulphates)	Sulfates (SO3 %)		0.041	-	-				
RMS T363 (Alkali Reactivity - Motar Bar)	Expansion (%)	Days							
		3	0.004	0.020	0.029				
		7	0.023	0.035	0.047				
		10	0.043	0.064	0.073				
		14	0.067	0.106	0.106				
		17	0.084	0.131	0.123				
		21	0.104	0.167	0.145	< 0.10% - Non Reactive			
AS1141.41/42 (Polished Aggregate Friction Value)	Polished Aggregate Friction Value		57	65	62		> 44	Wearing Course ≥ 48 All other courses ≥ 44	
RMS T659 (Methylene Blue Value)	Methylene Blue Value		5	-	-				
AS4133.4.1 (Point Load)	Strength Classification (Diametral) / Map Achieved		Very High / 8.01	-	-				
	Strength Classification - (Axial) / Map Achieved		Very High / 7.07	-	-				
	Anisotropy Index		1.13	-	-				
Petrographic Analysis			Rhyolite	Rhyolite	Rhyolite				
AS1289.3.1.1, 3.2.1, 3.3.1, 3.4.1 (Atterberg Limits)	Plasticity Index (%)		Non-Plastic	4	Non-Plastic				
	Liquid Limit (%)		-	18	-				
	Plastic Limit (%)		-	14	-				
AS4133.4.2.1 (Uniaxial Compressive Strength of Rock)	UCS (Map)		80.7	-	-				

Material Test Report

Report No: MAT:NEW14W-0986--S04
1
Issue No: 4

This report replaces all previous issues of report no 'MAT:NEW14W-0986--S04'.

Client: Ironstone Developments Pty Ltd
PO Box 2185
Greenhills NSW 2323

Principal:

Project No.: NEW14P-0043A

Project Name: Deep Creek Quarry Assessment



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Approved Signatory: Dane Cullen
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686

Date of Issue: 10/09/2019

Sample Details

Sample ID: NEW14W-0986--S04
Client Sample ID: DDH7 - 10 to 67m
Sampling Method: Sampled by Client
Date Sampled: 14/05/2014
Source: Deep Creek Quarry
Material: Rhyolite (20mm Minus Crush)
Specification: No Specification
Project Location: Deep Creek Road, Limeburners Creek

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Air-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	0.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	N/A	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	NP	
Plasticity Index (%)	AS 1289.3.3.1	NP	
Uncompacted Bulk Density (t/m ³)	AS 1141.4	1.33	
Compacted Bulk Density (t/m ³)		1.50	
Aggregate Moisture Condition		As Received	
Nominal Size of Sample (mm)		20	
Finer 75µm (%)	AS 1141.12	2	
Drying Method		Oven	
Los Angeles Value (%)	AS 1141.23	15	
Test Grading		B	
Apparent Particle Density - Coarse (t/m ³)	AS 1141.6.1	2.64	
Particle Density Dry (t/m ³)		2.48	
Particle Density SSD (t/m ³)		2.54	
Water Absorption (%)		2.4	
Apparent Particle Density (t/m ³)	AS 1141.5	2.67	
Particle Density Dry (t/m ³)		2.42	
Particle Density SSD (t/m ³)		2.51	
Water Absorption (%)		3.8	

Particle Size Distribution

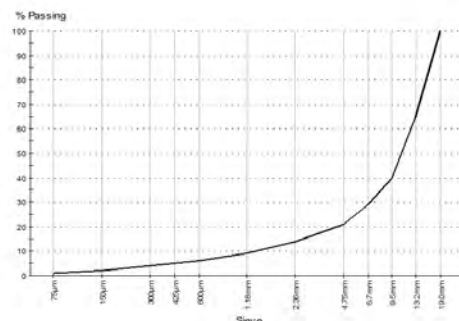
Method: AS 1141.11.1

Drying by: Oven

Note: Sample Not Washed

Sieve Size	% Passing	Limits
19.0mm	100	
13.2mm	65	
9.5mm	40	
6.7mm	29	
4.75mm	21	
2.36mm	14	
1.18mm	9	
600µm	6	
425µm	5	
300µm	4	
150µm	2	
75µm	1	

Chart



Comments

NP = Non Plastic

Material Test Report

Report No: MAT:NEW14W-0986--S04

1

Issue No: 4

This report replaces all previous issues of report no 'MAT:NEW14W-0986--S04'.

Client: Ironstone Developments Pty Ltd
PO Box 2185
Greenhills NSW 2323

Principal:

Project No.: NEW14P-0043A

Project Name: Deep Creek Quarry Assessment



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Approved Signatory: Dane Cullen
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686

Date of Issue: 10/09/2019

Sample Details

Sample ID: NEW14W-0986--S04
Client Sample ID: DDH7 - 10 to 67m
Sampling Method: Sampled by Client
Date Sampled: 14/05/2014
Source: Deep Creek Quarry
Material: Rhyolite (20mm Minus Crush)
Specification: No Specification
Project Location: Deep Creek Road, Limeburners Creek

Other Test Results

Description	Method	Result	Limits
Apparent Particle Density - Weighted (t/m ³)	AS 1141.6.1	2.65	
Particle Density Dry (t/m ³)		2.47	
Particle Density SSD (t/m ³)		2.54	
Water Absorption (%)		2.7	
Misshapen Particles (%)	AS 1141.14	24	
Flat Particles (%)		19.0	
Elongated Particles (%)		4.6	
Flat & Elongated Particles (%)		0.0	
Calliper Ratio		2:1	
Rounded PSD values used for fraction selection			
Loss 19.0 to 13.2 mm (%)	AS 1141.24	0.3	
Loss 13.2 to 9.5 mm (%)		0.6	
Loss 9.5 to 4.75 mm (%)		1.3	
Loss 4.75 to 2.36 mm (%)		3.2	
Total Weighted Loss (%)		0.8	
Weak Particles (%)	AS 1141.32	0.7	
Passing 2.36 mm Sieve (%)		0.0	
Nominal Sample Size (mm)	AS 1141.22	20	
Nature of Sample		Drill Core	
Agg Size and Crush Details		Constant Rate	
Fraction Size		-19.0 + 9.5 mm	
Wet Strength (kN)		277	
Dry Strength (kN)		365	
Wet/Dry Strength Variation (%)		24	
Breakdown Occurred		No	
Cylinder Size (diameter in mm)		150	

Particle Size Distribution

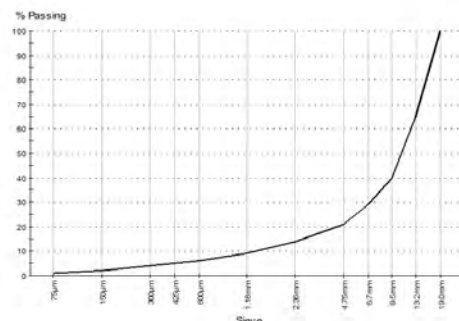
Method: AS 1141.11.1

Drying by: Oven

Note: Sample Not Washed

Sieve Size	% Passing	Limits
19.0mm	100	
13.2mm	65	
9.5mm	40	
6.7mm	29	
4.75mm	21	
2.36mm	14	
1.18mm	9	
600µm	6	
425µm	5	
300µm	4	
150µm	2	
75µm	1	

Chart



Comments

NP = Non Plastic

Material Test Report

Report No: MAT:NEW18W-3808--S01
Issue No: 1

Client: Ironstone Developments Pty Ltd
PO Box 2185
Greenhills NSW 2323

Principal:

Project No.: NEW14P-0043A

Project Name: Deep Creek Quarry Assessment



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B. Cullen

Approved Signatory: Brent Cullen
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686

Date of Issue: 5/12/2018

Sample Details

Sample ID: NEW18W-3808--S01
Sampling Method: Sample submitted by client
Date Sampled: 22/11/2018
Source: Deep Creek Quarry
Material: Crushed Core
Specification: No Specification
Project Location: Deep Creek Road, Limeburners Creek, NSW
Sample Location: DDH18 - (16.57 - 36.52m)

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Air-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	1.5	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		Yes	
Liquid Limit (%)	AS 1289.3.1.1	18	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	14	
Plasticity Index (%)	AS 1289.3.3.1	4	
Apparent Particle Density - Coarse (t/m ³)	AS 1141.6.1	2.65	
Particle Density Dry (t/m ³)		2.54	
Particle Density SSD (t/m ³)		2.58	
Water Absorption (%)		1.7	
Apparent Particle Density (t/m ³)	AS 1141.5	2.65	
Particle Density Dry (t/m ³)		2.52	
Particle Density SSD (t/m ³)		2.57	
Water Absorption (%)		2.0	
Apparent Particle Density - Weighted (t/m ³)	AS 1141.6.1	2.65	
Particle Density Dry (t/m ³)		2.53	
Particle Density SSD (t/m ³)		2.58	
Water Absorption (%)		1.7	
Misshapen Particles (%)	AS 1141.14	32	
Flat Particles (%)		22.8	
Elongated Particles (%)		7.4	
Flat & Elongated Particles (%)		1.7	
Calliper Ratio		2:1	

Rounded PSD values used for fraction selection

Particle Size Distribution

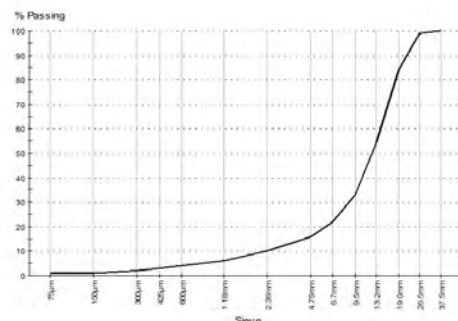
Method: AS 1141.11.1

Drying by: Oven

Note: Sample Not Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	99	
19.0mm	84	
13.2mm	54	
9.5mm	33	
6.7mm	22	
4.75mm	16	
2.36mm	10	
1.18mm	6	
600µm	4	
425µm	3	
300µm	2	
150µm	1	
75µm	1	

Chart



Comments

N/A

Material Test Report

Report No: MAT:NEW18W-3808--S01
Issue No: 1

Client: Ironstone Developments Pty Ltd
PO Box 2185
Greenhills NSW 2323

Principal:

Project No.: NEW14P-0043A

Project Name: Deep Creek Quarry Assessment



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B. Cullen

Approved Signatory: Brent Cullen
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686

Date of Issue: 5/12/2018

Sample Details

Sample ID: NEW18W-3808--S01
Sampling Method: Sample submitted by client
Date Sampled: 22/11/2018
Source: Deep Creek Quarry
Material: Crushed Core
Specification: No Specification
Project Location: Deep Creek Road, Limeburners Creek, NSW
Sample Location: DDH18 - (16.57 - 36.52m)

Other Test Results

Description	Method	Result	Limits
Nominal Sample Size (mm)	AS 1141.22	20	
Nature of Sample		Crushed Rock	
Agg Size and Crush Details		Constant Rate	
Fraction Size		-19.0 + 9.5 mm	
Wet Strength (kN)		231	
Dry Strength (kN)		309	
Wet/Dry Strength Variation (%)		25	
Breakdown Occurred		No	
Cylinder Size (diameter in mm)		150	

Particle Size Distribution

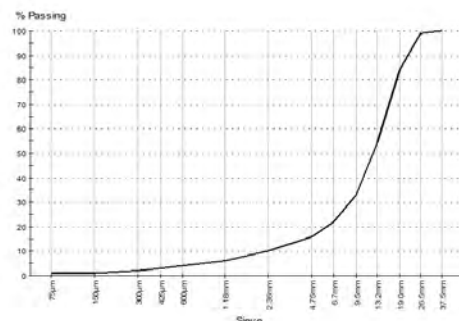
Method: AS 1141.11.1

Drying by: Oven

Note: Sample Not Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	99	
19.0mm	84	
13.2mm	54	
9.5mm	33	
6.7mm	22	
4.75mm	16	
2.36mm	10	
1.18mm	6	
600µm	4	
425µm	3	
300µm	2	
150µm	1	
75µm	1	

Chart



Comments

N/A

Material Test Report

Report No: MAT:NEW18W-3808--S02
Issue No: 1

Client: Ironstone Developments Pty Ltd
PO Box 2185
Greenhills NSW 2323

Principal:

Project No.: NEW14P-0043A

Project Name: Deep Creek Quarry Assessment



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B. Cullen

Approved Signatory: Brent Cullen
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686

Date of Issue: 12/12/2018

Sample Details

Sample ID: NEW18W-3808--S02
Sampling Method: Sample submitted by client
Date Sampled: 22/11/2018
Source: Deep Creek Quarry
Material: Crushed Core
Specification: No Specification
Project Location: Deep Creek Road, Limeburners Creek, NSW
Sample Location: DDH19 - (13.39 - 49.46m)

Other Test Results

Description	Method	Result	Limits
Sample History	AS 1289.1.1	Air-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	0.0	
Mould Length (mm)		250	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	N/A	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	NP	
Plasticity Index (%)	AS 1289.3.3.1	NP	
Apparent Particle Density - Coarse (t/m ³)	AS 1141.6.1	2.64	
Particle Density Dry (t/m ³)		2.51	
Particle Density SSD (t/m ³)		2.56	
Water Absorption (%)		2.1	
Apparent Particle Density (t/m ³)	AS 1141.5	2.65	
Particle Density Dry (t/m ³)		2.50	
Particle Density SSD (t/m ³)		2.55	
Water Absorption (%)		2.3	
Apparent Particle Density - Weighted (t/m ³)	AS 1141.6.1	2.65	
Particle Density Dry (t/m ³)		2.50	
Particle Density SSD (t/m ³)		2.56	
Water Absorption (%)		2.1	
Misshapen Particles (%)	AS 1141.14	37	
Flat Particles (%)		33.9	
Elongated Particles (%)		2.4	
Flat & Elongated Particles (%)		1.1	
Calliper Ratio		2:1	

Rounded PSD values used for fraction selection

Particle Size Distribution

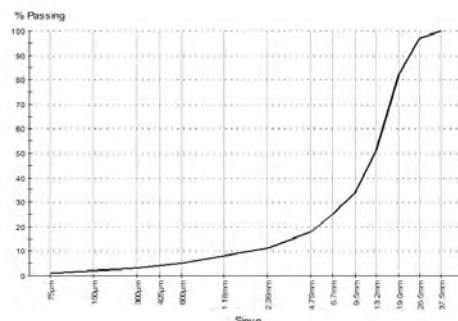
Method: AS 1141.11.1

Drying by: Oven

Note: Sample Not Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	97	
19.0mm	82	
13.2mm	51	
9.5mm	34	
6.7mm	25	
4.75mm	18	
2.36mm	11	
1.18mm	8	
600µm	5	
425µm	4	
300µm	3	
150µm	2	
75µm	1	

Chart



Comments

NP = Non Plastic

Material Test Report

Report No: MAT:NEW18W-3808--S02
Issue No: 1

Client: Ironstone Developments Pty Ltd
PO Box 2185
Greenhills NSW 2323

Principal:

Project No.: NEW14P-0043A

Project Name: Deep Creek Quarry Assessment



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B. Cullen

Approved Signatory: Brent Cullen
(Senior Geotechnician)

NATA Accredited Laboratory Number: 18686

Date of Issue: 12/12/2018

Sample Details

Sample ID: NEW18W-3808--S02
Sampling Method: Sample submitted by client
Date Sampled: 22/11/2018
Source: Deep Creek Quarry
Material: Crushed Core
Specification: No Specification
Project Location: Deep Creek Road, Limeburners Creek, NSW
Sample Location: DDH19 - (13.39 - 49.46m)

Other Test Results

Description	Method	Result	Limits
Loss 26.5 to 19.0 mm (%)	AS 1141.24	0.0	
Loss 19.0 to 13.2 mm (%)		0.0	
Loss 13.2 to 9.5 mm (%)		0.0	
Loss 9.5 to 4.75 mm (%)		0.1	
Loss 4.75 to 2.36 mm (%)		0.0	
Total Weighted Loss (%)		0.0	
Nominal Sample Size (mm)	AS 1141.22	20	
Nature of Sample		Crushed Rock	
Agg Size and Crush Details		Constant Rate	
Fraction Size		-19.0 + 9.5 mm	
Wet Strength (kN)		260	
Dry Strength (kN)		310	
Wet/Dry Strength Variation (%)		16	
Breakdown Occurred		No	
Cylinder Size (diameter in mm)		150	

Particle Size Distribution

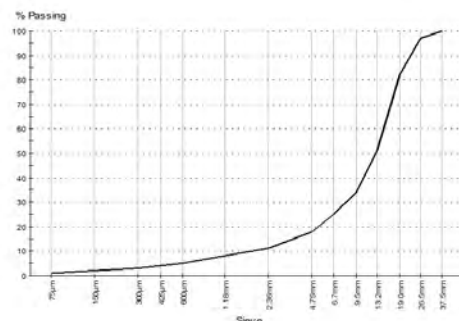
Method: AS 1141.11.1

Drying by: Oven

Note: Sample Not Washed

Sieve Size	% Passing	Limits
37.5mm	100	
26.5mm	97	
19.0mm	82	
13.2mm	51	
9.5mm	34	
6.7mm	25	
4.75mm	18	
2.36mm	11	
1.18mm	8	
600µm	5	
425µm	4	
300µm	3	
150µm	2	
75µm	1	

Chart



Comments

NP = Non Plastic

APPENDIX C:

Results of Laboratory Testing – External (2019)



**Boral Construction Materials
Materials Technical Services**

Unit 4, 3-5 Gibbon Road
Baulkham Hills NSW 2153 Australia
PO Box 400, Winston Hills NSW 2153

T: +61 (02) 9624 9900
F: +61 (02) 9624 9999

www.boral.com.au

Test Report

Client: QUALTEST LABORATORY (NSW) PTY LTD
Address: 8 Ironbark Close Warabrook, NSW 2304
Date Received: February 2019
Project: Testing of Crushed Core Samples for AAR, Location: Deep Creek Road, Limeburners Creek, NSW
Test Method: Accelerated Mortar Bar Test for AAR Assessment - RMS T363

File No: 812/19
Req. No: 82875
Date Sampled: 22/11/2018

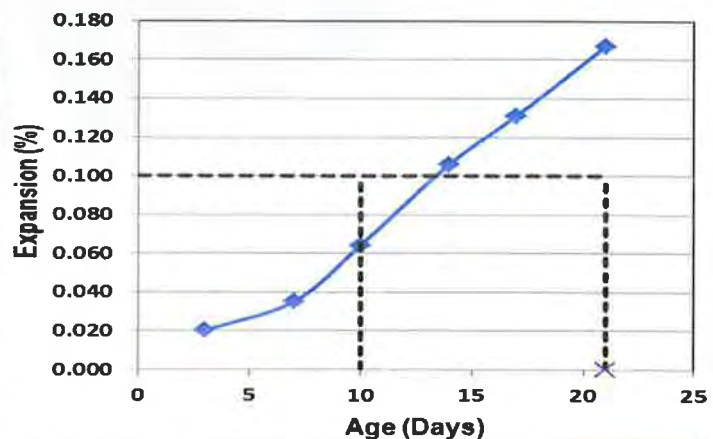
Lab Sample No	Sample Description	Location
217024	Crushed Core - DDH18-(16.57-36.52m), Sample N° NEW 19W-0387-S01, Project N° NEW14P-0043	Deep Creek Quarry
N/A	Boral GP / SL Cement	Berrima

Results:

Flow (%): 8

W/C Ratio: 0.43

Age (Days)	Expansion (%) Avg. of 3 specimens
3	0.020
7	0.035
10	0.064
14	0.106
17	0.131
21	0.167



Mortar Bar Expansion (E) % Duration of Specimens in 1mol/L NaOH at 80°C		RMS T363 Aggregate Reactivity Classification
10 Days	21 Days	
< 0.1*	< 0.1*	Non-Reactive
< 0.1*	≥ 0.1*	Slowly Reactive
≥ 0.1*	>> 0.1*	Reactive

* 0.15% for naturally occurring fine aggregates

Notes: N/A

Alan Cullen, Dane Cullen, Adam Dwyer, Brent Cullen, Q. C File, Mat. File, File



Approved Signatory Safwan Fawal

Date 8/04/2019 Serial No. 17 908 1

NATA Accredited Laboratory

Accredited for compliance with ISO/IEC 17025

Number: 547



**Boral Construction Materials
Materials Technical Services**

Unit 4, 3-5 Gibbon Road
Baulkham Hills NSW 2153 Australia
PO Box 400, Winston Hills NSW 2153

T: +61 (02) 9624 9900
F: +61 (02) 9624 9999

www.boral.com.au

Test Report

Client: QUALTEST LABORATORY (NSW) PTY LTD
Address: 8 Ironbark Close Warabrook, NSW 2304
Date Received: February 2019
Project: Testing of Crushed Core Samples for AAR, Location: Deep Creek Road, Limeburners Creek, NSW
Test Method: Accelerated Mortar Bar Test for AAR Assessment - RMS T363

File No: 812/19
Req. No: 82875
Date Sampled: 22/11/2018

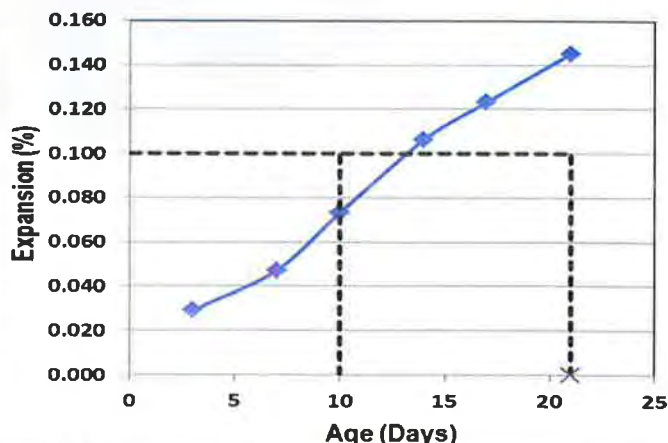
Lab Sample No	Sample Description	Location
217025	Crushed Core - DDH19-(13.39-49.46m), Sample N° NEW 19W-0387-S02, Project N° NEW14P-0043	Deep Creek Quarry
N/A	Boral GP / SL Cement	Berrima

Results:

Flow (%): 8

W/C Ratio: 0.42

Age (Days)	Expansion (%) Avg. of 3 specimens
3	0.029
7	0.047
10	0.073
14	0.106
17	0.123
21	0.145



Mortar Bar Expansion (E) % Duration of Specimens in 1mol/L NaOH at 80°C		RMS T363 Aggregate Reactivity Classification
10 Days	21 Days	
< 0.1*	< 0.1*	Non-Reactive
< 0.1*	≥ 0.1*	Slowly Reactive
≥ 0.1*	>> 0.1*	Reactive

* 0.15% for naturally occurring fine aggregates

Notes: N/A

Alan Cullen, Dane Cullen, Adam Dwyer, Brent Cullen, Q. C File, Mat. File, File



Approved Signatory: Safwan Fawal

Date: 8/04/2019 Serial No: 17 9082

Accredited for compliance with ISO/IEC 17025

NATA Accredited Laboratory

Number: 547

SYDNEY ANALYTICAL LABORATORIES

Page 1 of 3

Office:
PO BOX 48
ERMINGTON NSW 2115

Laboratory:
1/4 ABBOTT ROAD
SEVEN HILLS NSW 2147
Telephone: (02) 9838 8903
Fax: (02) 9838 8919
A.C.N. 003 614 695
A.B.N. 81 829 182 852
NATA No: 1884

ANALYTICAL REPORT for:

QUALTEST LABORATORY PTY LTD

8 IRONBARK CLOSE
WARABROOK, NSW 2304

ATTN: DANE CULLEN

JOB NO: SAL27035C
CLIENT ORDER: 18W-3808
DATE RECEIVED: 06/12/18
DATE COMPLETED: 14/12/18
TYPE OF SAMPLES: AGGREGATES
NO OF SAMPLES: 2



.....
Issued on 14/12/18
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

**JOB NO: SAL27035C
CLIENT ORDER: 18W-3808**

SAMPLES	Cl %	SO4 % as SO3
1 NEW18W-3808-S01	0.002	0.017
2 NEW18W-3808-S02	0.001	0.047
MDL	0.001	0.001
Method Code	C32	C33
Preparation	P5	P5

RESULTS ON DRY BASIS, DATE OF COLLECTION: 22/11/18
SAMPLE DESCRIPTION: S01-DDH18, S02-DDH19
RESULT IS COMPLIANT WITH RMS3051/TABLE 3051.3 SPECIFICATION 0.30%

ANALYTICAL REPORT

JOB NO: SAL27035C

CLIENT ORDER: 18W-3808

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory.

P5	Sample dried, split and crushed to -150um
C32	Acid Soluble Chloride - AS1012.20
C33	Acid Soluble Sulphate - AS1012.20

Report for Potential Alkali-Silica Reactivity of Aggregates Accelerated Mortar Bar Method

Wollongong Laboratory
1/140 Industrial Rd Oak flats

Phone: +61 2 42574458
Email/Fax: +61 2 42574458

Client:	Qualtest	Report No:	T4261S18163-070119
Address:	8 Ironbark Close, Warabrook NSW	Project No:	10848/P/36
Project:	Material Testing	Request No:	10848/T/4261

Sample No: 10848/S/18163

Client's ID: NEW18W-3808-S01DDH19

Material Description: Rock Core

Material Source: Deep Creek Quarry

Cement Type: Gladstone GP

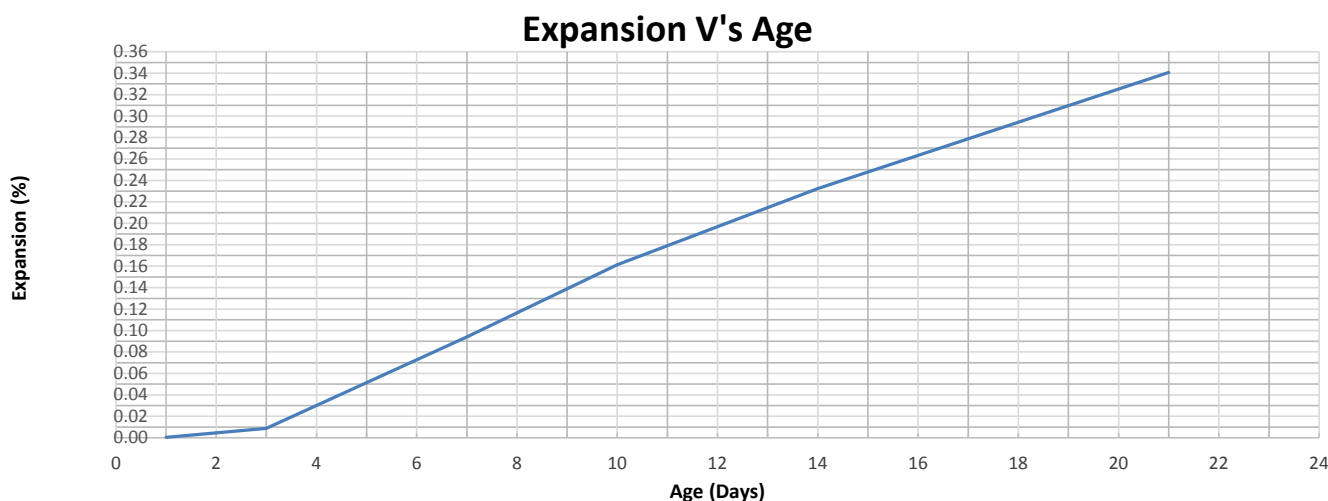
Cement Source: Cement Australia

Material Sampling Method: Client Sampled

Date / Time Sampled: 22/11/2018

Test Method: RMS T363

Test Date	Age (Days)	Expansion (%)			Average
		Bar 1	Bar 2	Bar 3	
12/01/19	1	-0.000	0.000	0.000	0.000
14/01/19	3	0.010	0.010	0.010	0.009
18/01/19	7	0.095	0.095	0.090	0.094
21/01/19	10	0.165	0.165	0.155	0.161
25/01/19	14	0.240	0.235	0.220	0.232
01/02/19	21	0.350	0.345	0.325	0.341



Water/Cement Ratio: 0.43
Flow (%) 10.00

Remarks: Results apply to the sample as received.



Accreditation Number: 1318
Corporate Site Number: 10848
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025 - Testing



Name: Tim Mathie
Function: Authorised Signatory
Date: 06-Feb-19

Wollongong Laboratory
Unit 1, 140 Industrial Road, Oak Flats, NSW, 2529
Phone: 02 4257 4458
Email/Fax: wollongong@constructionsciences.net

**Report for
Polished Aggregate Friction Value - Horizontal Bed Machine**

Client: Qualtest	Report No: T4261124207S181632
Address: 8 Ironbark Close Warabrook NSW 2304	Project No: 10848/P/36
Project: Material Testing	Request No: 10848/T/4261
Client Request Ref: QTPO18-0327	

Component:	Area Description:
Tested By: Tim Mathie	Date Tested: 17/12/18

Test Method/s: AS 1141.41 & AS 1141.42

Sample Data:						
Sample No:	10848/S/18162	10848/S/18163				
Client Sample ID	NEW18W-3808-S01	NEW18W-3808-S02				
	DDH18	DDH19				
Client Reference:						
Sample Source:	Deep Creek Quarry	Deep Creek Quarry				
Sample Description:	Rock Core	Rock Core				
Sampling Method:	Tested As Received	Tested As Received				
Sampled By:	Client Sampled	Client Sampled				
Date Sampled:	22/11/18	22/11/18				
Test Data:						
Fraction Size Tested: (Passing mm to Retained mm)	13.20 to 9.50	13.20 to 9.50				
Unpolished Friction Value, Temperature Corrected:	78.4	80.3				
Ambient Temperature at Test: (°C)	22.0	22.0				
Polished Aggregate Friction Value: (PAFV)	65	62				
Ambient Temperature at Test: (°C)	21.0	21.0				

Reference Specimen:	Temperature Corrected Unpolished Friction Value:	Temperature Corrected Polished Friction Value:
	72.7	48.4

Remarks: Results apply to the samples as received.
--

Corporate Site Number: 10848 Accreditation Number: 1318  The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards. Accredited for compliance with ISO/IEC 17025 - Testing	Signature  Name: Tim Mathie Function: Authorised Signatory Date: 18-Dec-18
---	---

Report for Potential Alkali-Silica Reactivity of Aggregates Accelerated Mortar Bar Method

Wollongong Laboratory
1/140 Industrial Rd Oak flats

Phone: +61 2 42574458
Email/Fax: +61 2 42574458

Client:	Qualtest	Report No:	T4261S18162-070119
Address:	8 Ironbark Close, Warabrook NSW	Project No:	10848/P/36
Project:	Material Testing	Request No:	10848/T/4261

Sample No: 10848/S/18162

Client's ID: NEW18W-3808-S01DDH18

Material Description: Rock Core

Material Source: Deep Creek Quarry

Cement Type: Gladstone GP

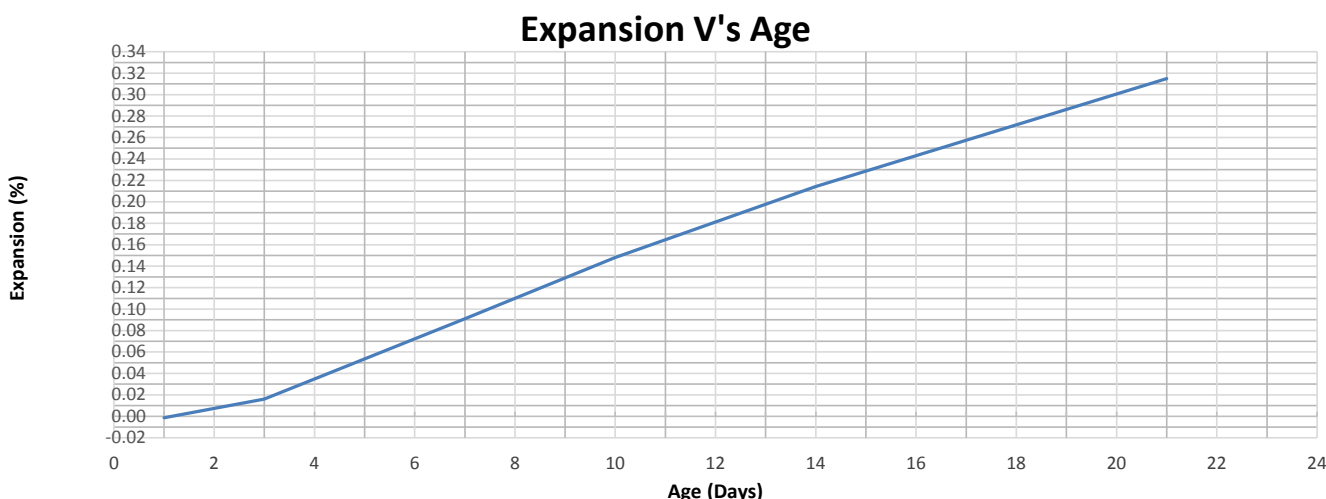
Cement Source: Cement Australia

Material Sampling Method: Client Sampled

Date / Time Sampled: 22/11/2018

Test Method: RMS T363

Test Date	Age (Days)	Expansion (%)			Average
		Bar 1	Bar 2	Bar 3	
12/01/19	1	0.000	-0.000	-0.005	-0.001
14/01/19	3	0.020	0.015	0.015	0.016
18/01/19	7	0.090	0.095	0.085	0.091
21/01/19	10	0.145	0.155	0.140	0.148
25/01/19	14	0.215	0.225	0.200	0.214
01/02/19	21	0.320	0.335	0.290	0.315



Water/Cement Ratio: 0.42
Flow (%) 7.00

Remarks: Results apply to the sample as received.



Accreditation Number: 1318
Corporate Site Number: 10848
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.
Accredited for compliance with ISO/IEC 17025 - Testing


Name: Tim Mathie
Function: Authorised Signatory
Date: 06-Feb-19

APPENDIX D:

Results of Laboratory Testing – External (2014)



**Boral Construction Materials
Materials Technical Services**
Unit 4, 3-5 Gibbon Road
Baulkham Hills NSW 2153 Australia
PO Box 400, Winston Hills NSW 2153
T: +61 2 9624 9900
F: +61 2 9624 9999
www.boral.com.au

TEST REPORT

CLIENT: QUALTEST LABORATORY (NSW) PTY LTD
8 Ironbark Close Warabrook, NSW 2304

FILE No.: 812 / 14

PROJECT: Testing of Crushed Rock Core Sample – Project: NSW14P-0043

REQUEST No.: 57634

TEST PROCEDURE:

RMS T659 – Methylene Blue Adsorption Value of Road Construction Material

Laboratory Sample No.:

154296

Date Sampled:

14.05.14

Date Received:

29.05.14

Sample Description:

Crushed Rock Core - Rhyolite
Sample No. NEW 14W-0986-S01
Depth: 33 to 54m

Field No.:

1

TEST RESULTS

Methylene Blue Adsorption value (mg/g) 5

Methylene Blue Adsorption value for a Duplicate (mg/g) 5

Average Methylene Blue Adsorption value (mg/g) 5

Samples submitted by the Client

Alan Cullen, Dane Cullen, Adam Dwyer, Brent Cullen, Mat. File, Q.C. File, File.

SAM DEBRINCAT

Approved Signatory

Date 3.06.14 Serial No. 127272



ACCREDITED FOR
TECHNICAL
COMPETENCE

This document is issued in accordance with the NATA's accreditation requirements.
Accredited for compliance with ISO/IEC 17025

NATA Accredited Laboratory
Number: 547


**Boral Construction Materials
Materials Technical Services**

Unit 4, 3-5 Gibbon Road
Baulkham Hills NSW 2153 Australia
PO Box 400, Winston Hills NSW 2153

T: +61 (02) 9624 9900
F: +61 (02) 9624 9999

www.boral.com.au

TEST REPORT

CLIENT: QUALTEST LABORATORY (NSW) PTY LTD.

FILE NO: 812/14

Address: 8 IRONBARK CLOSE WARABROOK, NSW 2304

Date Received: May 2014

REQ NO: 57634

Date Sampled: 14/05/2014

PROJECT: Testing of Aggregate Samples, Project: NEW 14P-0043

TEST METHOD: Accelerated Mortar Bar Test for AAR Assessment -RMS T363.

LAB SAMPLE NO	MATERIAL	DESCRIPTION
154299	Crushed Rock Core-Rhyolite -NEW 14 W -0986-S04,Description 10.0 to 67.0 m	Qualtest
1402270	Boral GP Cement	SL-Berrima

Results:

Flow: 10%

W/C Ratio: 0.45

Age (days)	Expansion % (Ave. of 3 specimens)
3	0.004
7	0.023
10	0.043
14	0.067
17	0.084
21	0.104

Aggregate reactivity classification:

Mortar Bar Expansion (%) in 1M NaOH (80° C)		Classification
10 days	21 days	
<0.10*	<0.10*	Non Reactive
<0.10*	≥0.10*	Slowly reactive
≥0.10*	>> 0.10*	Reactive

*0.15% for naturally occurring Fine Aggregates

Alan Cullen, Dane Cullen, Adam Dwyer, Brent Cullen, Q.C. File, Mat. File, File



Approved Signatory

Date 15-07-14 Serial No. 127271

Accredited for compliance with ISO/IEC 17025

Muans Abdulnebe

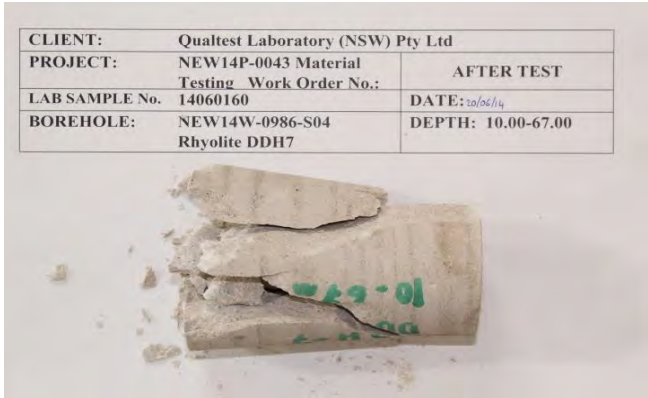
NATA Accredited Laboratory

Number: 547

UNIAXIAL COMPRESSIVE STRENGTH TEST REPORT

Test Method: AS 4133.4.2.1

Client	Qualtest Laboratory (NSW) Pty Ltd	Report No.	14060160-UCS
Project	NEW14P-0043 Material Testing Work Order No.: NEW14W-0986	Test Date	20/06/2014
		Report Date	24/06/2014

Sample No.	14060160
Client ID	NEW14W-0986-S04 Rhyolite DDH7
Depth (m)	10.00-67.00
Description	-
Wet Density (t/m ³)	2.53
Moisture Content (%)	0.9
Specimen Length (mm)	120.8 *
Specimen Diameter (mm)	59.9
Mode of Failure	Conical
Test Duration (Min:Sec)	9:13
	
UCS (MPa)	80.7

NOTES/REMARKS:

 Stored and tested as received
 Sample/s supplied by the client

 * Length to diameter ratio less than 2.5:1
 Test Apparatus - Kelba 1000 kN Load Cell

 Photo not to scale
 Page: 1 of 1 REP02701

 Accredited for compliance with ISO/IES 17025.
 The results of the tests, calibrations, and/or measurements included in
 this document are traceable to Australian/National Standards.

Tested at Trilab Brisbane Laboratory.

Authorised Signatory


 C. Channon


Laboratory No. 9926

The results of calibrations and tests performed apply only to the specific instrument or sample at the time of test unless otherwise clearly stated.

Reference should be made to Trilab's "Standard Terms and Conditions of Business" for further details.

Trilab Pty Ltd ABN 25 065 630 506

ACCURATE QUALITY RESULTS FOR TOMORROW'S ENGINEERING

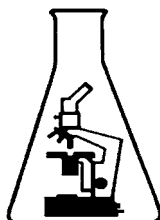
GEOCHEMPET SERVICES BRISBANE

Geochempet Services

ABN 980 6945 3445

PETROLOGICAL and GEOCHEMICAL CONSULTANTS

Principals: K.E. Spring B.Sc.(Hons), MAppSc and H.M. Spring B.Sc.



5/14 Redcliffe Gardens Drive
Clontarf, QLD 4019

Telephone: (07) 3284 0020

Fax: (07) 3284 0018

Email: info@geochempet.com
www.geochempet.com

PETROGRAPHIC REPORT ON A DRILL CORE SAMPLE (NEW14W-0850-S04)

prepared for

**QUALTEST LABORATORIES (NSW) PTY LTD
WARABROOK**

Purchase Order: QTP014-1405

Invoice Number: 00005856

Client Ref: Adam Dwyer

Issued by

K. E. Spring B.Sc.(Hons), MAppSc
26 June 2014

MAY, 2014

Q1140504

Page 1 of 4

The material contained within this report may not be quoted other than in full. Extracts may be used only with expressed prior written approval of Geochempet Services.

GEOCHEMPET SERVICES BRISBANE

Sample No.: NEW14W-0850-S04 **Date Sampled:** 24/04/14

Sample Type: Drill Core **Date Sampled:** 01/05/14

Borehole No.: DDH7 **Depth (m):** 36.40 – 36.50

Sample Source: Not Provided **Date Received:** 24/04/14

Work Requested Petrographic analysis in relation to suitability for use as a source of concrete sand, concrete aggregate, asphaltic/sealing aggregate, road base, rail ballast and rip rap; petrographic assessment of potential for alkali-silica reactivity

Methods Account taken of ASTM C 295 Standard Guide for *Petrographic Assessment of Aggregates for Concrete*, the AS2758.1 – 1998 *Aggregates and rock for engineering purposes part 1; Concrete aggregates (Appendix B)*, the AS1141 Standard Guide for the *Method for sampling and testing aggregates*, of the content of the 1996 joint publication of the Cement and Concrete Association of Australia and Standards Australia, entitled *Alkali Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structures in Australia*

Identification Rhyolite

Description

The sample consists of a drill core of robust, very hard, essentially unweathered, greyish orange-pink, finely crystalline acid igneous rock. The rock can only be very lightly scratched by a steel tool.

A thin section was prepared from the drill core to permit detailed microscopic examination in transmitted polarised light. An approximate average composition of the rock, expressed in volume percent and based on a brief count of 100 widely spaced points with the thin section, is:

Primary Minerals

38% plagioclase feldspar and K-feldspar
15% spherulites (finely microcrystalline quartz and feldspar)
29% quartz
<1% opaque oxide (magnetite)
<1% sphene/leucoxene

Secondary Minerals

12% sericite/illite
6% calcite
<1% chlorite

GEOCHEMPET SERVICES BRISBANE

trace biotite

In thin section, the rock is seen to represent a quite strongly quartz and plagioclase-phyric rhyolitic lava with a spherulitic groundmass. Plagioclase phenocrysts (about 10%) are up to 3 mm across and most are slightly rounded and resorbed, with slight sericite and pale carbonate alteration. They often occur in multi-crystal clots, several of which also contain small former biotite plates that are altered to olive chlorite. Quartz phenocrysts (around 5 - 8%) are slightly resorbed but generally well formed, 0.5 – 2 mm crystals, often with crystallized melt inclusions, and they show marginal overgrowths due to interaction with the cooling groundmass.

The groundmass is a texturally well preserved spherulitic intergrowth in which anhedral quartz and alkali feldspar spots occur between the individual spherulites with patchy sericite/illite and calcite alteration. A number of possible pneumatolytic cavities or irregular vesicles are lined by subhedral, inward-growing quartz, and filled by pale green chlorite and/or coarse-grained carbonate.

Comments and Interpretations

The supplied drill core sample (labelled NEW14W-0850-S04) at 36.40 – 36.50 m from DDH7 is interpreted to be volcanic rhyodacite. The rock crystallized within a lava flow. Alteration in this rock is moderate, and likely due to sub-greenschist facies regional metamorphism.

For engineering purposes, the rock represented in the supplied drill core sample may be summarised as:

- **rhyolite** (acid volcanic rock)
- finely crystalline
- slightly unweathered
- non-porous
- moderately altered
- carrying about 18% of secondary mineral content (12% sericite/illite, 6% calcite <1% chlorite and a trace of biotite)
- **hard**
- **strong**

The rock is predicted to be **durable**.

The rock contains 34% quartz, of which there is about 5% of microcrystalline quartz in spherulites (a slowly reactive form of silica). Therefore, the rock is considered to have **potential for mild or slow alkali-silica reactivity in concrete**.

Thus, rock of the type represented in the supplied sample is predicted to be **suitable for use as a source for concrete aggregate** provided that appropriate precautions are taken in mix and engineering design to take account of its perceived potential for mild or slow deleterious alkali-silica reactivity.

GEOCHEMPET SERVICES BRISBANE

Guidance on appropriate precautions can be obtained from the 1996 joint publication of the Cement and Concrete Association of Australia and Standards Australia, entitled *Alkali Aggregate Reaction - Guidelines on Minimising the Risk of Damage to Concrete Structures in Australia*.

Rock of the type represented by the supplied sample is predicted to be **suitable for use as a source for road base and asphaltic/sealing aggregate**.

The supplied rock sample is considered to be **suitable for use as a source of rail ballast**.

Free Silica Content

The free silica content is about 34%, all locked within crystalline rock.

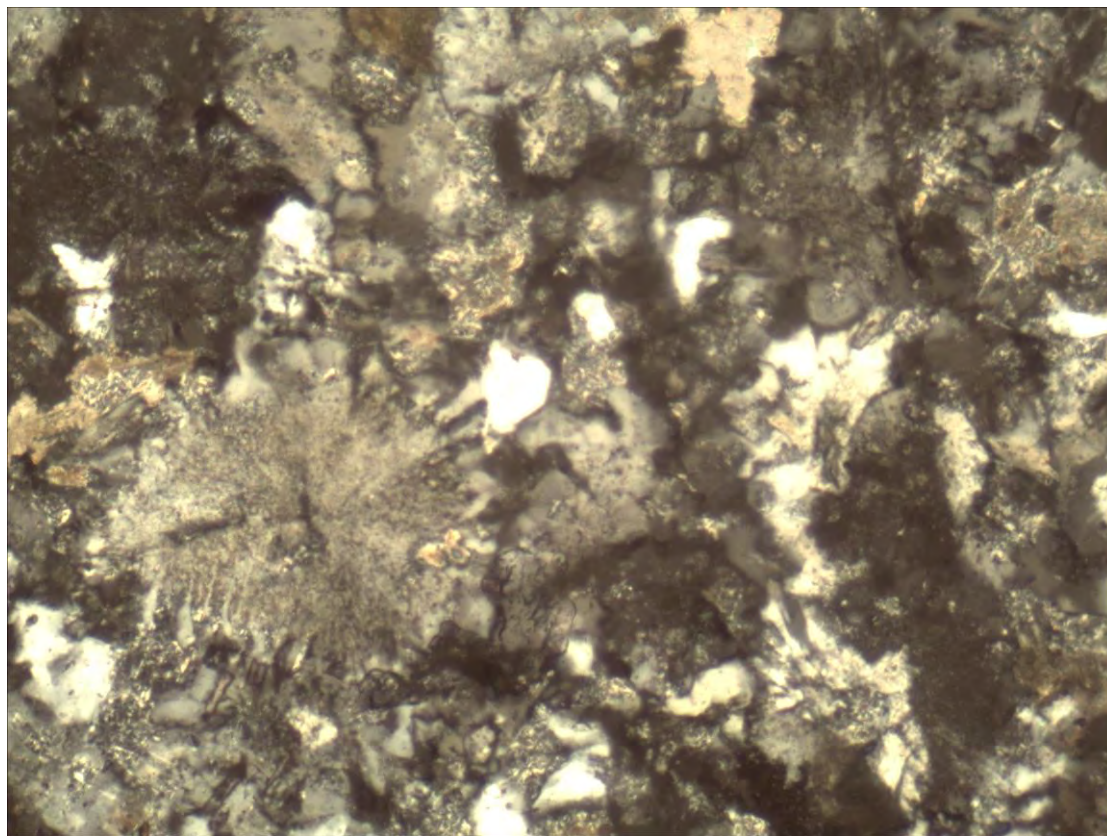


Plate 1. Medium magnification, crossed polars, transmitted light image of part of rhyolite showing ragged spherulites (with radial extinction patterns) in the quartzofeldspathic groundmass (lower left corner of image). Image width is 0.59 mm.

ROADS AND MARITIME SERVICES

File: S003989 Part: 4

PAFV Record No: 393



Transport
Roads & Maritime
Services

Materials Technology

Unit H, 75 St. Hilliers Rd

Auburn, NSW 2144

T: (02) 8745 6040

F: (02) 8745 6093

PO Box 329 Auburn NSW 2144

LABORATORY TEST REPORT

Reference: Work order no. NEW14W-0986

Project No: **S003989**

Project: Crushed Core PAFV Material Testing

Date Testing Started: **19/06/2014**

Client: Qualtest Laboratory PTY LTD - Adam Dwyer

Date Testing Completed: **19/06/2014**

Address: 8 Ironbark Close, Warabrook NSW 2304

Sampling Method: **Not known sampled by client**

Date Sampled: **14/5/2014**

Supplied By: **Client**

SAMPLE DETAILS

Client Sample Identification: **NEW14W-0986-S04**

Laboratory Sample Number: **3989/04**

Location of Quarry: **Not specified**

Geological Classification: **Rhyolite**

Size of Aggregate (mm): **14mm**

Fraction Tested: **-13.2 + 9.5**

(*1) Reference Aggregate: **Panmure Basalt**

AS1141.41 - Horizontal Bed Machine and AS1141.42 - Pendulum Friction Test (*4)	Polishing Time (Hours)	(*2) Mean Friction Value, 23°C		Air Temperature (°C)
		Sample (SMVc)	(*1)Ref. Aggregate (Vc)	
Reading before polishing	0	78	75	21
Reading after 2 hours of polishing	2	62	56	22
Reading after 4 hours of polishing	4	57	51	23
Polished Aggregate Friction Value	P.A.F.V.	57	51	

*1 Note: The reference aggregate is Panmure Basalt. (The Australian Standards Reference Aggregate)

*2 Note: Mean Friction Values and P.A.F.V. corrected to 23°C (From measured air temperature at time of testing)

*3 Note: Samples Tested as Supplied

*4 Note: Size of Slider used 24mm deep, 6mm thick.



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Accreditation Number: **259**

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except in full.

Alecsey Liu

Scientific Officer

Report Date: 20/06/2014

SYDNEY ANALYTICAL LABORATORIES

Page 1 of 3

Office:
PO BOX 48
ERMINGTON NSW 2115

Laboratory:
1/4 ABBOTT ROAD
SEVEN HILLS NSW 2147
Telephone: (02) 9838 8903
Fax: (02) 9838 8919
A.C.N. 003 614 695
A.B.N. 81 829 182 852
NATA No: 1884

ANALYTICAL REPORT for:

QUALTEST LABORATORY PTY LTD

8 IRONBARK CLOSE
WARABROOK, NSW 2304

ATTN: ADAM DWYER

JOB NO: SAL25108
CLIENT ORDER: 14W-0986
DATE RECEIVED: 28/05/14
DATE COMPLETED: 03/06/14
TYPE OF SAMPLES: AGGREGATES
NO OF SAMPLES: 5



.....
Issued on 03/06/14
Lance Smith
(Chief Chemist)

ANALYTICAL REPORT

JOB NO: SAL25108
CLIENT ORDER: 14W-0986

SAMPLES	SUGAR	Cl %	SO4 %
1 RHYOLITE 33-54m	N.D.	0.002	0.090
2 ARENITE 11.5-30m	N.D.	0.002	0.12
3 RHYOLITE 3.2-20m	N.D.	0.002	0.19
4 RHYOLITE 10-67m	N.D.	0.003	0.080
5 ARENITE 47-57m	N.D.	0.003	0.10
MDL		0.001	0.001
Method Code	C5	C32	C33
Preparation	P1	P5	P5

RESULTS ON DRY BASIS
ND = NOT DETECTED

ANALYTICAL REPORT

JOB NO: SAL25108

CLIENT ORDER: 14W-0986

METHODS OF PREPARATION AND ANALYSIS

The tests contained in this report have been carried out on the samples as received by the laboratory.

- P1 Analysis performed on sample as received
- P5 Sample dried, split and crushed to -150um
- C5 Sugar - AS1141.35 1974
- C32 Acid Soluble Chloride - AS1012.20
- C33 Acid Soluble Sulphate - AS1012.20



Beyond compliance

VGT Environmental Compliance Solutions Pty Ltd
ABN 26 621 943 888

Unit 4, 30 Glenwood Drive Thornton NSW 2322
PO Box 2335, Greenhills NSW 2323

Ph: (02) 4028 6412
E: mail@vgt.com.au

www.vgt.com.au