Douglas Partners
Geotechnics / Environment / Groundwater

Integrated Practical Solutions

Report on
Geotechnical Assessment

Fahey's Pit
9632 Armidale Road, Tyringham

Prepared for
Sheridans Hard Rock Quarry

Project 211755.00
November 2022

Douglas Partners
Geotechnics / Environment / Groundwater

Document History

Document details

Project No.	211755.00	Document No.	R.001.Rev1
Document title	Report on Geotechnical Assessment Fahey's Pit		
Site address	9632 Armidale Road, Tyringham		
Report prepared for	Sheridans Hard Rock Quarry		
File name	211755.00.R.001.Rev1.Faheys		

Document status and review

Status	Prepared by	Reviewed by	Date issued
Revision 0	John Niland	Michael Gawn	16 November 2022
Revision 1	John Niland	Michael Gawn	24 November 2022

Distribution of copies

Status	Electronic	Paper	Issued to
Revision 0	1	0	Abbey Richards, Sheridans Hard Rock Quarry
Revision 1	1	0	Abbey Richards, Sheridans Hard Rock Quarry

The undersigned, on behalf of Douglas Partners Pty Ltd, confirm that this document and all attached drawings, logs and test results have been checked and reviewed for errors, omissions and inaccuracies.

	Signature	Date
Author	John Niland	24 November 2022
Reviewer		24 November 2022

bsi ISO 9001 Quality Management Systems CERTIFIED
FS 604853

Douglas Partners Pty Ltd
ABN 75 053 980 117
www.douglaspartners.com.au
18 Lawson Crescent
Coffs Harbour NSW 2450
Phone (02) 6650 3200

Douglas Partners
Geotechnics | Environment | Groundwater

Table of Contents

Report on Geotechnical Assessment
Fahey's Pit
9632 Armidale Road, Tyringham

1. Introduction

This report presents the results of a geotechnical assessment undertaken for Fahey's Pit at 9632 Armidale Road, Tyringham. The assessment was commissioned in an email dated 29 September 2022 by Abbey Richards of Sheridans Hard Rock Quarry and was undertaken with reference to Douglas Partners Pty Ltd proposal 211755.00.P.003.Rev0 dated 26 September 2022.

It is understood that it is proposed to extract clay and weathered rock material from Fahey's Pit. Concept plans for Fahey's Pit indicate 5 m and 10 m bench heights with cut batters sloped at 70°, 5 m wide benches and a 10 m wide trafficable / haul ramp.

The top of the pit highwall is approximately 1080 AHD and the concept floor level of the pit is proposed to be about 1055 AHD. A sediment basin is proposed in the north-western part of the pit with a basin floor RL of about 1050 AHD.

A preliminary geotechnical assessment was required to provide information on level of risk with reference to slope stability for the proposed quarry geometry and any recommendations for additional investigation.

The assessment included a review of concept pit designs, a site walkover performed by a senior geotechnical engineer on 12 October 2022 to note geotechnical features with reference to slope stability and the preparation of this report. The details of the field work are presented in this report, together with information on the items noted above.

The approximate location of Fahey's Pit is shown in Figure 1 and the plan view of the concept design is shown in Figure 2. Cross sections of the concept design are included in Appendix B.

Figure 1: Google Earth aerial imagery of approximate site location.

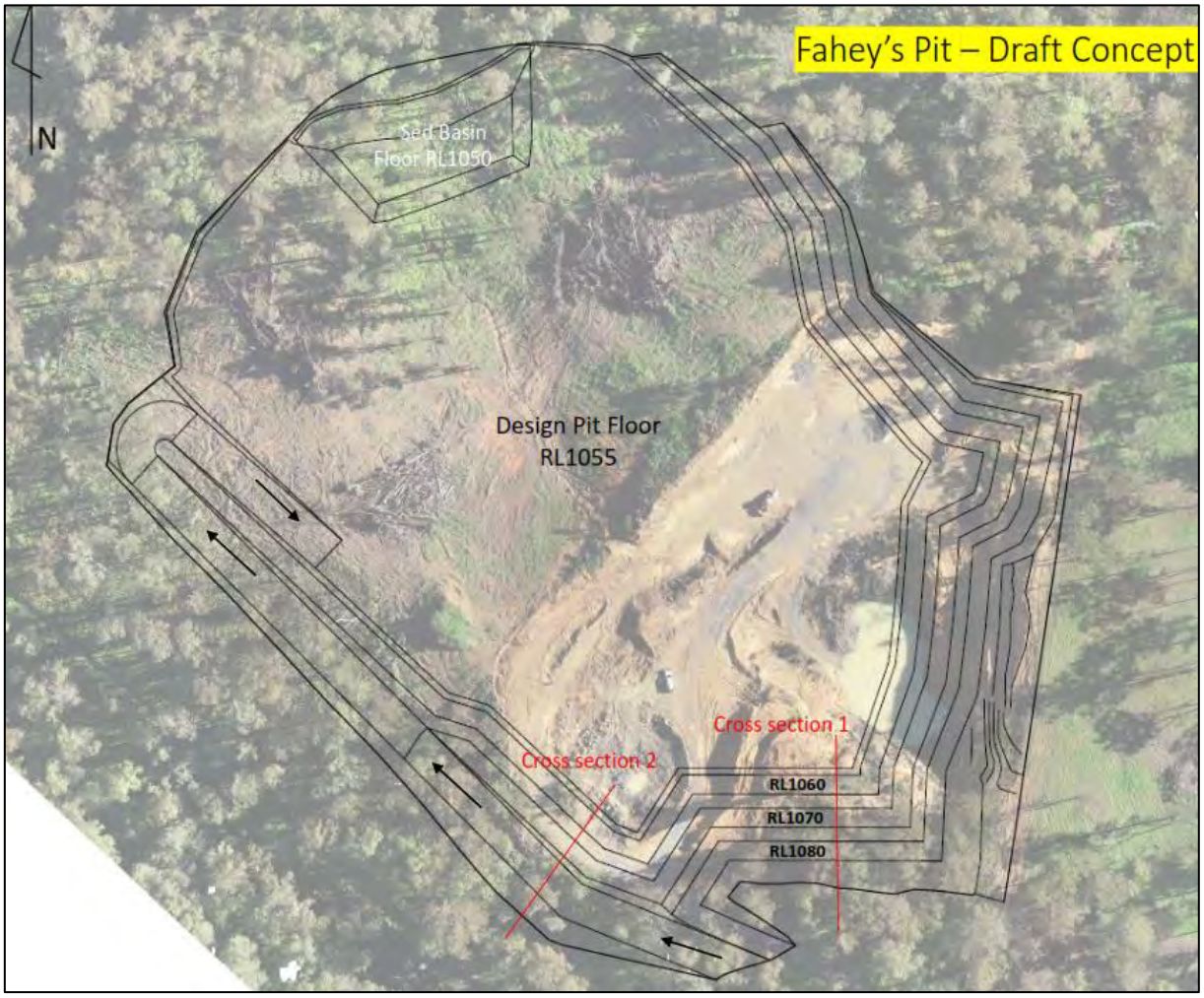


Figure 2: Draft concept design for Fahey's Pit (image provided by client).

2. Regional Geology

Reference to the NSW Seamless Geology mapping (refer Figure 3) indicates that Fahey's Pit is underlain by residual soil and rocks of the Moombil Siltstone of the Coffs Harbour Block which typically comprises black massive siltstone, rare lithofeldspathic wacke and granule conglomerate with a deep marine depositional environment.

The mapping also indicates Fahey's Pit is situated about 150 m to the west of an area mapped as underlain by basalt of the Ebor Volcanics.

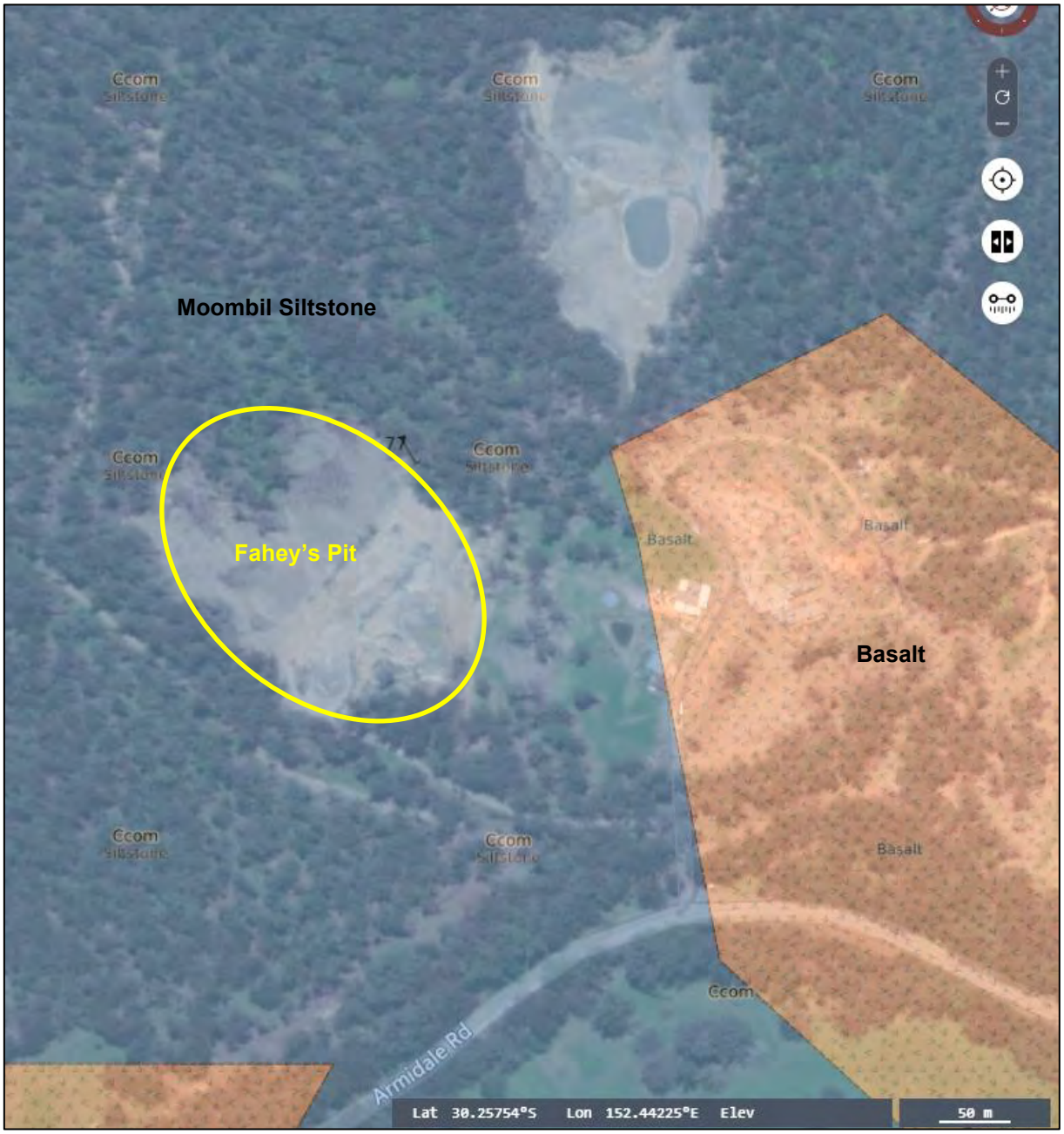


Figure 3: Geology mapping

3. Site Observations

An aerial image of Fahey's Pit with some marked up site features, based on a site inspection, is shown in Figure 4.

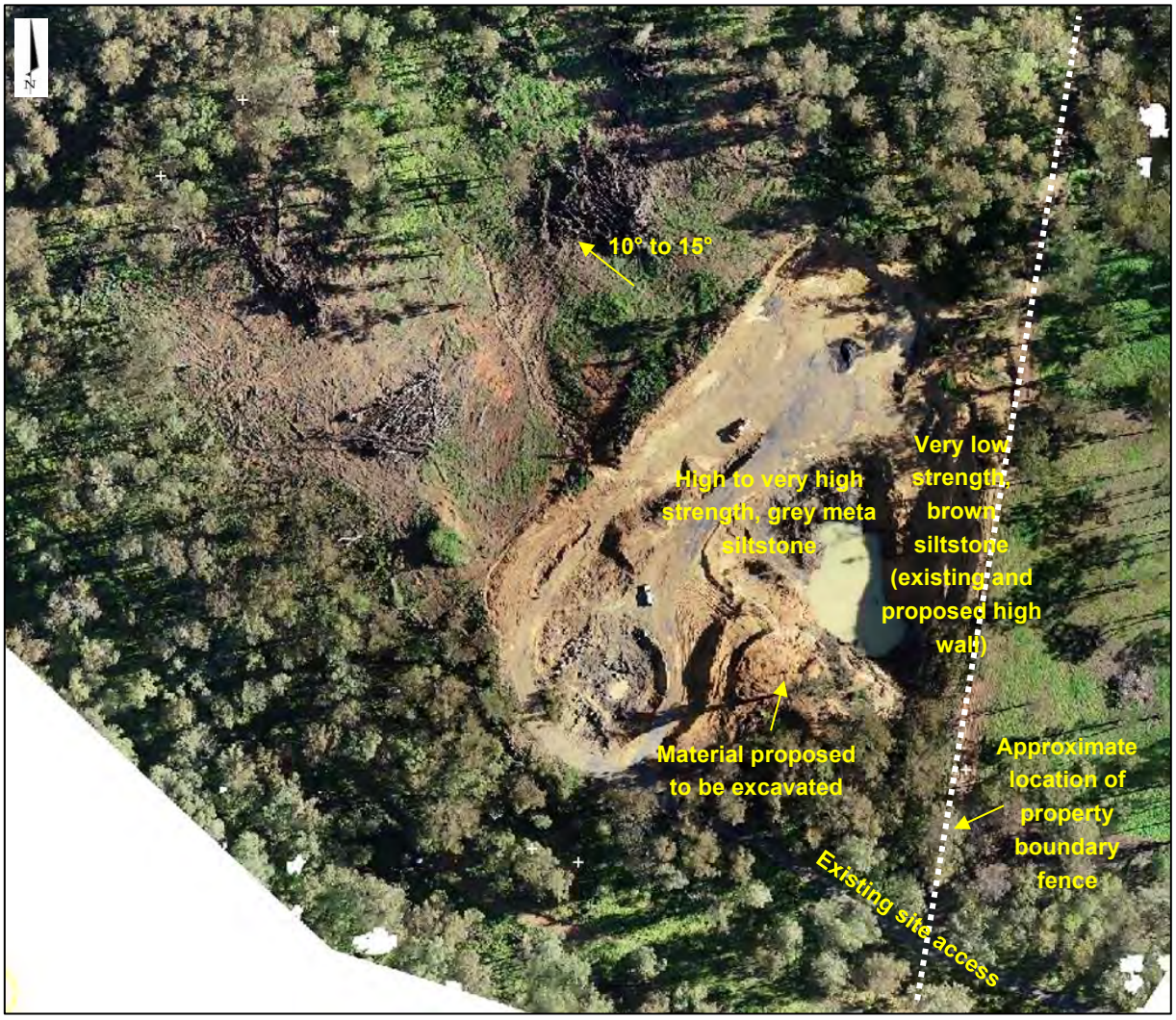


Figure 4: Aerial image of Fahey's Pit (image supplied by client).

Site features noted at the time of inspection include:

- Very low strength brown siltstone in the eastern part of the quarry. Two existing cut batters typically sloped down to the west at about 45° to 55° and were about 4 m to 6 m high with benches about 2 m to 6 m wide. Some variable medium to high strength siltstone was observed in the cut batters in parts. There were also some parts of the cut batters in very low strength siltstone that had some shallow rill erosion. The crest of the top cut batter is generally located approximately at least 5 m to the west of the property boundary fence;
- High to very high strength grey meta-siltstone was exposed in the deepest part of the existing quarry and over parts of the existing quarry floor;
- The northern part of the proposed quarry had been cleared of vegetation and topsoil was exposed at the ground surface; and
- Overall slope was generally about 10° to 15° down towards the north-west.

Refer to Figure 5 to Figure 12 for site photos.

Figure 5: Looking south along the eastern boundary fence (quarry on the right)

Figure 6: Looking east towards the existing eastern cut slope.

Figure 7: From the south-eastern part of the quarry looking north.

Figure 8: Looking north along the existing cut batter and bench in the eastern part of the quarry (typically very low strength siltstone exposed).

Figure 9: From the northern part of the quarry looking south-east

Figure 10: Central part of the existing quarry, high to very high strength meta siltstone.

Figure 11: From the southern part of the quarry looking east to the existing access road.

Figure 12: From the north-western part of the proposed quarry looking north-east.

4. Landslide Risk Assessment

The site contains existing cut batter slopes of up to 12 m in total height and have been formed at slopes generally ranging from about 45° to 55°. The cut batters typically exposed very low strength siltstone in the eastern part of the quarry.

Concept drawings indicate up to 10 m bench heights sloped at 70°, 5 m wide benches and a 10 m wide trafficable / haul ramp.

The highest part of the quarry will be about 1080 AHD and the concept floor level of the pit is proposed to be about 1055 AHD.

Based on site geomorphology and geology, a qualitative assessment with reference to landslide risk assessment can be made as outlined in AGS (2007) which is included in Appendix A.

For the purposes of the assessment it is anticipated that further quarry excavation will encounter very low strength siltstone for the upper say 5 m to 10 m underlain by high to very high strength meta-siltstone. It is recommended that as excavation of the quarry progresses, additional investigation and assessment is undertaken to inform any alterations to the proposed layout design.

Based on site observations and topographical / geological information for the site the following hazards are identified:

1. A rapid, large scale landslide (volume of approximately 150 m^3 or greater) occurring through one of the proposed 10 m high cut batter slopes and impacting the bench and / or quarry floor below. The likelihood of property damage (i.e. machinery and equipment) caused as a result of the formation of a large scale landslide is considered to be "rare" for the design life of the development provided due consideration is given to slope stability constraints (rock jointing, rock strength) during excavation of the quarry, including appropriate design of earthworks, control of site drainage and regular inspections of cut slopes by authorised quarry personnel / delegate along with further investigation and assessment of the walls of the quarry during continued excavation of the quarry. The consequence of this hazard has therefore been assessed to be "medium" based on the need to re-instate the batter and possibly the access ramp.
2. Shallow landslip / erosion in proposed cut batters. Failure might occur under adverse conditions with an assessed likelihood of "likely". For assessment purposes it is assumed that control of site drainage would be undertaken such that surface water is not directed over the batters, and regular inspections by authorised quarry personnel / delegate is undertaken to assess for signs of erosion and allow for remedial measures. The consequence of this hazard has therefore been assessed to be "insignificant", based on it being limited to erosion which would require minor alterations to surface drainage paths and localised repair to batter slopes.

The consequences of the events are summarised in Table 1, below, together with the qualitative risk assessment as per Appendix C of AGS (2007).

Table 1: Slope Stability Risk Assessment

Hazard Description	Likelihood	Consequence of Hazard		Risk Evaluation for Property
		Elements at Risk	Consequence for Property	
1. Large scale landslip impacting benches and property damage on the quarry floor (approximately 150 m^3 with a velocity of about 1.8 m/hour to 3 m/min)	Rare	Quarry floor, benches and ramp, quarry machinery and equipment	Medium	Low
2. Shallow landslip / erosion proposed cut batters	Likely	Cut slopes, benches	Insignificant	Low

Low risks would normally be considered acceptable by owners and authorities but would require management by normal slope maintenance procedures to maintain or reduce risks.

It is noted that standard quarry practices would include machinery, equipment and personnel staying clear of designated exclusion zones placed at the toe of cut slopes/batters.

Design and construction of the quarry should consider surface drainage, particularly at the crest of proposed batter slopes, along benches and at the floor of the quarry.

The current assessment comprised a walkover and visual assessment of site features and assumptions have been made based on the exposed rock at the time of the inspection. It is recommended that geotechnical inspection is performed periodically during quarry excavation (say each 5 m of excavation height) to assess geotechnical properties of the material exposed in the cut slopes and continued suitability for the proposed cut geometry.

5. Comments

Based on the results of the preliminary assessment and assumed material parameters the proposed cut slope geometry, comprising 5 m to 10 m bench heights with cut batters sloped at 70° and incorporating 5 m wide benches and a 10 m wide trafficable / haul ramp is considered suitable with reference to long term stability subject to additional investigation and assessment during bulk excavation for the quarry.

However, it is noted that the stability of individual benches / batters is somewhat reliant on the presence, persistence and orientation of jointing within the rock mass and the effects of stress relief of the rock mass. Preliminary assessment of the stability of the proposed batters and benches, assuming very low strength or stronger siltstone indicates a suitable factor of safety (greater than 1.2) against global instability. It must be recognised, however, that in the event that persistent, adverse jointing is exposed during excavation, the development of a large joint block may occur, which would increase the risk of instability of the proposed benches within the cut batters.

It is therefore recommended that periodical geotechnical inspection be performed during quarry excavation (e.g. say initially every 5 m of vertical excavation of the final cut slope batters) to assess rock strength, geotechnical parameters, rock jointing and confirm design assumptions and applicability to long term cut slope stability. If adverse conditions are encountered, additional stabilisation measures may be required.

The cut slopes and particularly the proposed access ramp should be regularly inspected by authorised quarry personnel for signs of movement during operation and in the event of adverse weather (say daily rainfall totals exceeding 40 mm).

6. References

AGS. (2007). *Practice Note Guidelines for Landslide Risk Management.* Australian Geomechnics, Volume 42, No 1: Australian Geomechanics Society, Landslide Taskforce, Landslide Practice Note Working Group.

7. Limitations

Douglas Partners Pty Ltd (DP) has prepared this report for this project at Fahey's Pit at 9632 Armidale Road, Tyringham with reference to DP's proposal 211755.00.P.003.Rev0 dated 26 September 2022 and acceptance received from Abbey Richards of Sheridans Hard Rock Quarry dated 29 September 2022. The work was carried out under DP's Conditions of Engagement. This report is provided for the exclusive use of Sheridans Hard Rock Quarry for this project only and for the purposes as described in the report. It should not be used by or relied upon for other projects or purposes on the same or other site or by a third party. Any party so relying upon this report beyond its exclusive use and purpose as stated above, and without the express written consent of DP, does so entirely at its own risk and without recourse to DP for any loss or damage. In preparing this report DP has necessarily relied upon information provided by the client and/or their agents.

The results provided in the report are indicative of the conditions exposed at the site during the inspection. Sub-surface conditions can change abruptly due to variable geological processes and also as a result of human influences. Such changes may occur after DP's inspection has been completed.

DP's advice is based upon the conditions observed during this inspection. The accuracy of the advice provided by DP in this report may be affected by undetected variations in ground conditions across the site between and beyond inspection locations. The advice may also be limited by budget constraints imposed by others or by site accessibility.

The assessment of typical safety hazards arising from this advice is restricted to the geotechnical components set out in this report and based on known project conditions and stated design advice and assumptions. While some recommendations for safe controls may be provided, detailed 'safety in design' assessment is outside the current scope of this report and requires additional project data and assessment.

This report must be read in conjunction with all of the attached and should be kept in its entirety without separation of individual pages or sections. DP cannot be held responsible for interpretations or conclusions made by others unless they are supported by an expressed statement, interpretation, outcome or conclusion stated in this report.

This report, or sections from this report, should not be used as part of a specification for a project, without review and agreement by DP. This is because this report has been written as advice and opinion rather than instructions for construction.

Douglas Partners Pty Ltd

Appendix A

About This Report
AGS (2007) - Landslide Risk Assessment, Appendix C

About this Report

Douglas Partners

Introduction

These notes have been provided to amplify DP's report in regard to classification methods, field procedures and the comments section. Not all are necessarily relevant to all reports.

DP's reports are based on information gained from limited subsurface excavations and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Copyright

Borehole and Test Pit Logs

The borehole and test pit logs presented in this report are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling or excavation. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable or possible to justify on economic grounds. In any case the boreholes and test pits represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes or pits, the frequency of sampling, and the possibility of other than 'straight line' variations between the test locations.

Groundwater

Where groundwater levels are measured in boreholes there are several potential problems, namely:

- In low permeability soils groundwater may enter the hole very slowly or perhaps not at all during the time the hole is left open;
- A localised, perched water table may lead to an erroneous indication of the true water table;
- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report; and
- The use of water or mud as a drilling fluid will mask any groundwater inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water measurements are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Reports

The report has been prepared by qualified personnel, is based on the information obtained from field and laboratory testing, and has been undertaken to current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal, the information and interpretation may not be relevant if the design proposal is changed. If this happens, DP will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface conditions, discussion of geotechnical and environmental aspects, and recommendations or suggestions for design and construction. However, DP cannot always anticipate or assume responsibility for:

- Unexpected variations in ground conditions. The potential for this will depend partly on borehole or pit spacing and sampling frequency;
- Changes in policy or interpretations of policy by statutory authorities; or
- The actions of contractors responding to commercial pressures.

If these occur, DP will be pleased to assist with investigations or advice to resolve the matter.

About this Report

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, DP requests that it be immediately notified. Most problems are much more readily resolved when conditions are exposed rather than at some later stage, well after the event.

Information for Contractual Purposes

Where information obtained from this report is provided for tendering purposes, it is recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. DP would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The company will always be pleased to provide engineering inspection services for geotechnical and environmental aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

Approximate Annual Probability		Implied Indicative Landslide Recurrence Interval		Description	Descriptor	Level
Indicative Value	Notional Boundary					
10^{-1}	$5x10^{-2}$	10 years	20 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10^{-2}	$5x10^{-3}$	100 years	200 years	The event will probably occur under adverse conditions over the design life.	LIKELY	B
10^{-3}	$5x10^{-4}$	1000 years	2000 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10^{-4}	$5x10^{-5}$	10,000 years	20,000 years	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10^{-5}	$5x10^{-6}$	100,000 years	200,000 years	The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
10^{-6}		1,000,000 years		The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

Note: (1) The table should be used from left to right; use Approximate Annual Probability or Description to assign Descriptor, not *vice versa*.

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approximate Cost of Damage		Description	Descriptor	Level
Indicative Value	Notional Boundary			
200%	100%	Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.	CATASTROPHIC	1
60%	40%	Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.	MAJOR	2
20%	10%	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.	MEDIUM	3
5%	1%	Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works.	MINOR	4
0.5%		Little damage. (Note for high probability event (Almost Certain), this category may be subdivided at a notional boundary of 0.1%. See Risk Matrix.)	INSIGNIFICANT	5

Notes: (2) The Approximate Cost of Damage is expressed as a percentage of market value, being the cost of the improved value of the unaffected property which includes the land plus the unaffected structures.

(3) The Approximate Cost is to be an estimate of the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the landslide which has occurred and professional design fees, and consequential costs such as legal fees, temporary accommodation. It does not include additional stabilisation works to address other landslides which may affect the property.

(4) The table should be used from left to right; use Approximate Cost of Damage or Description to assign Descriptor, not vice versa

APPENDIX C: – QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY (CONTINUED)

QUALITATIVE RISK ANALYSIS MATRIX – LEVEL OF RISK TO PROPERTY

LIKELIHOOD		CONSEQUENCES TO PROPERTY (With Indicative Approximate Cost of Damage)				
	Indicative Value of Approximate Annual Probability	**1: CATASTROPHIC 200%**	**2: MAJOR 60%**	**3: MEDIUM 20%**	**4: MINOR 5%**	**5: INSIGNIFICANT 0.5%**
A – ALMOST CERTAIN	10^{-1}	VH	VH	VH	H	M or **L** (5)
B - LIKELY	10^{-2}	VH	VH	H	M	**L**
C - POSSIBLE	10^{-3}	VH	H	M	M	**VL**
D - UNLIKELY	10^{-4}	H	M	**L**	**L**	**VL**
E - RARE	10^{-5}	M	**L**	**L**	**VL**	**VL**
F - BARELY CREDIBLE	10^{-6}	**L**	**VL**	**VL**	**VL**	**VL**

Notes: (5) For Cell A5, may be subdivided such that a consequence of less than 0.1% is Low Risk.
(6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

RISK LEVEL IMPLICATIONS

Risk Level		**Example Implications** (7)
VH	VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
H	HIGH RISK	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
M	MODERATE RISK	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable.
L	LOW RISK	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

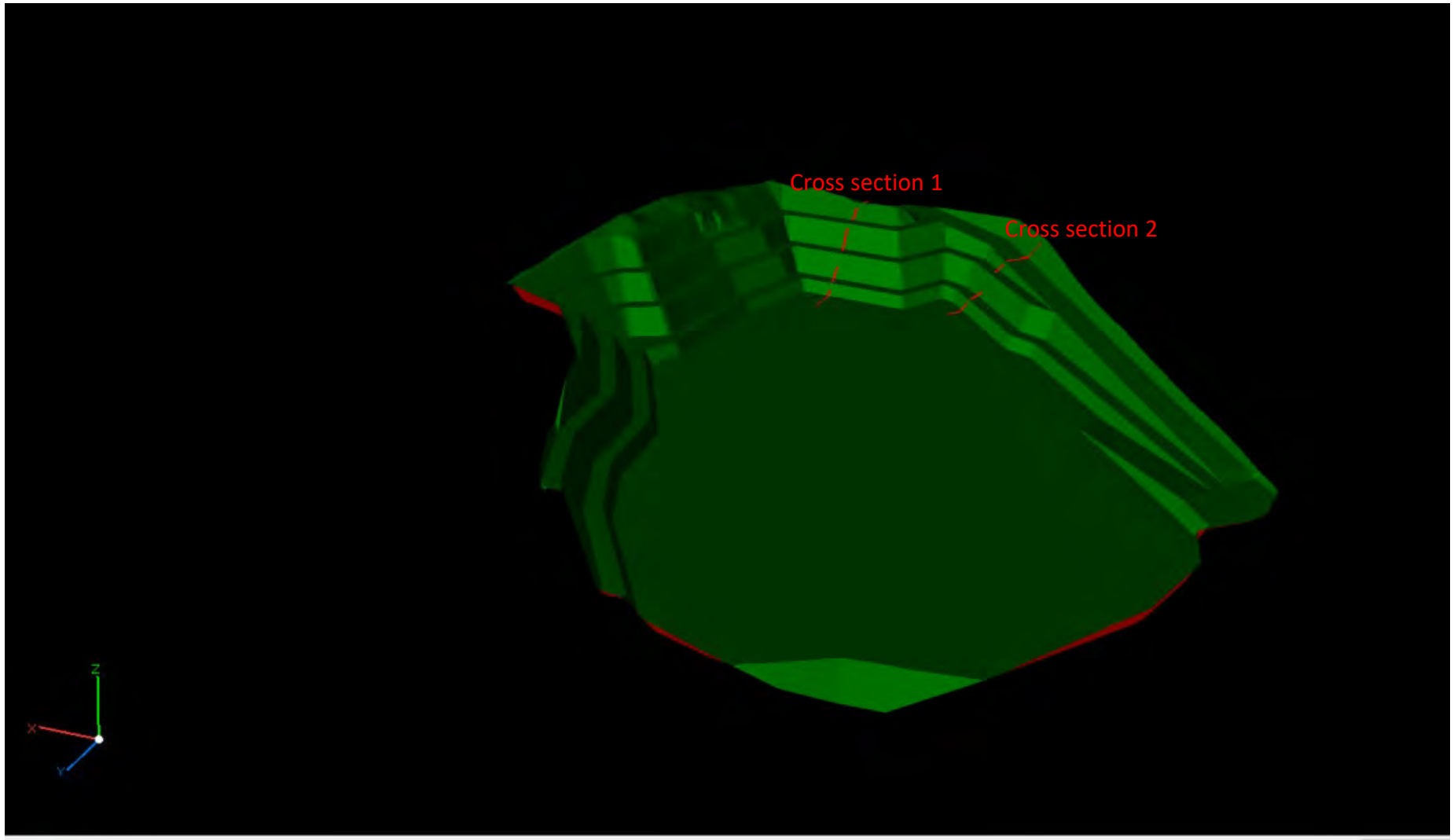
Note: (7) The implications for a particular situation are to be determined by all parties to the risk assessment and may depend on the nature of the property at risk; these are only given as a general guide.

Appendix B

Draft Concept Design

Fahey's Pit – Draft Concept Design

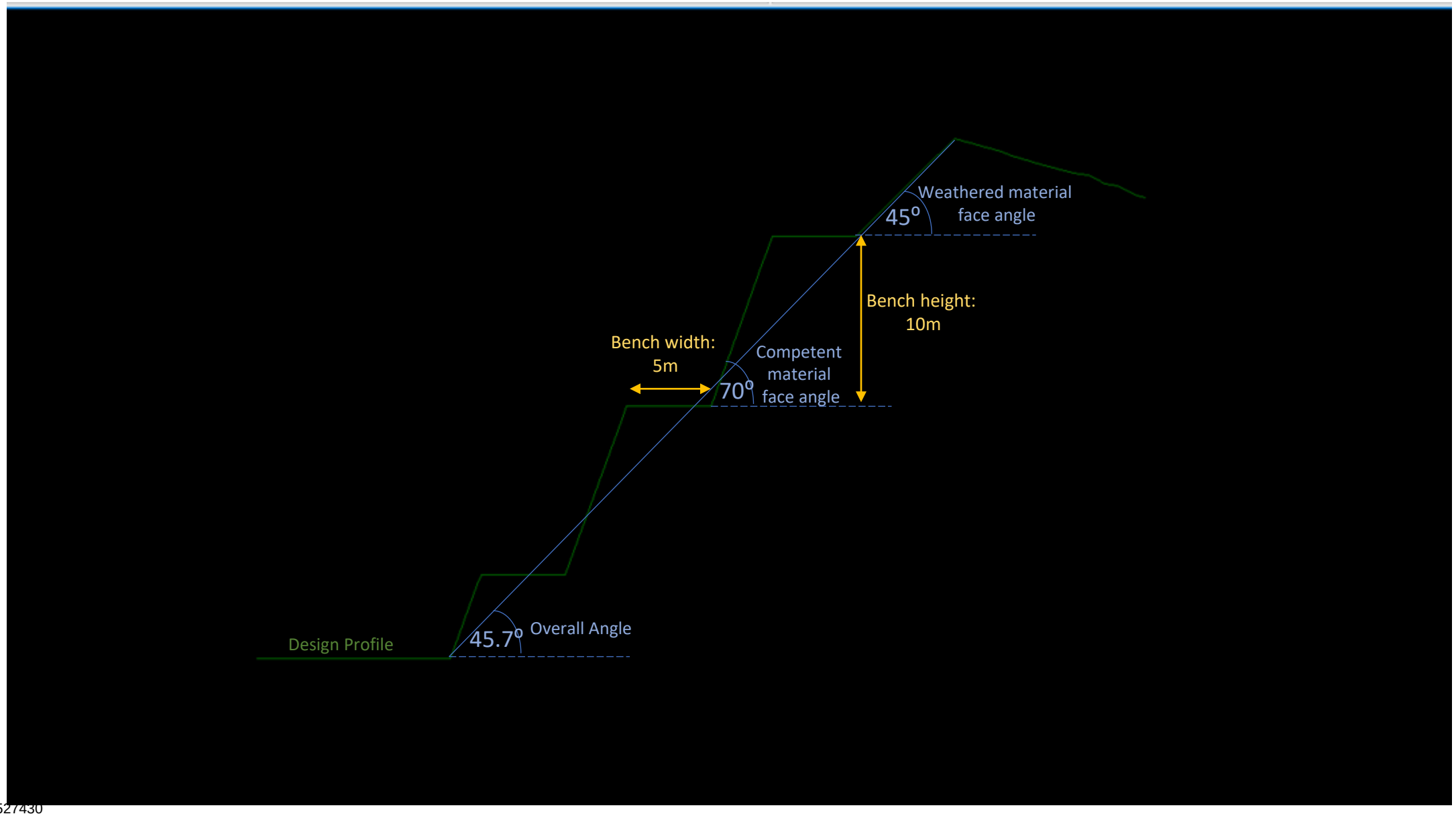
3D View



Document Set ID: 2527430
Version: 1, Version Date: 19/10/2023

Cross Section 1

Fahey's Pit – Draft Concept Design



Cross Section 2