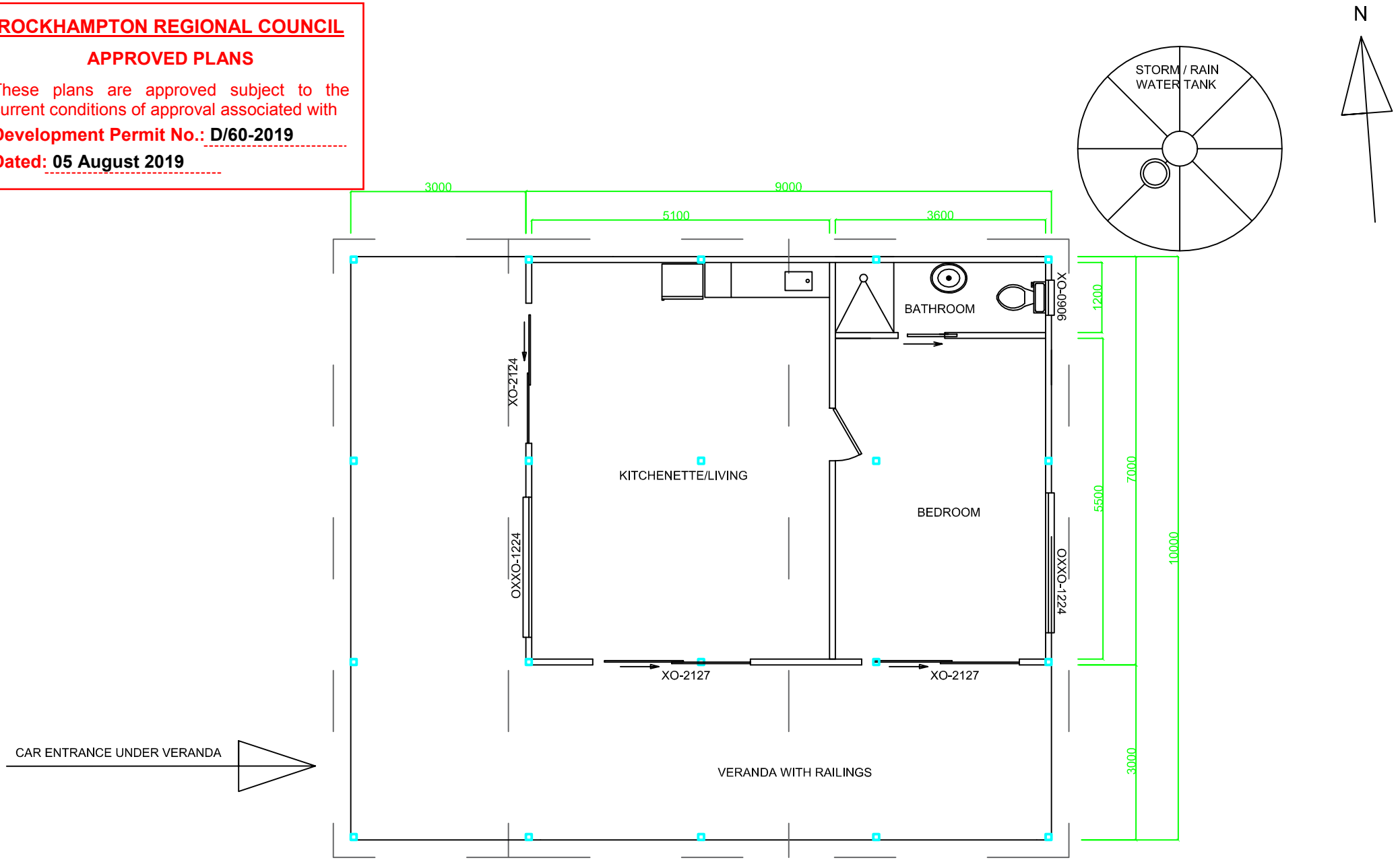
ROCKHAMPTON REGIONAL COUNCIL

APPROVED PLANS

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: D/60-2019

Dated: 05 August 2019

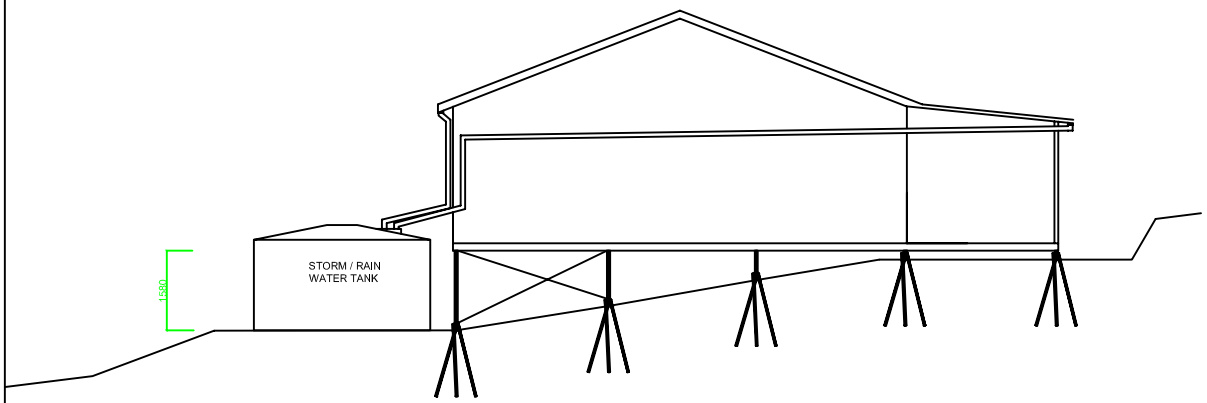


PROJECT:
PROPOSED DWELLING
LOT 164 TOONDA ROAD
MARMOR

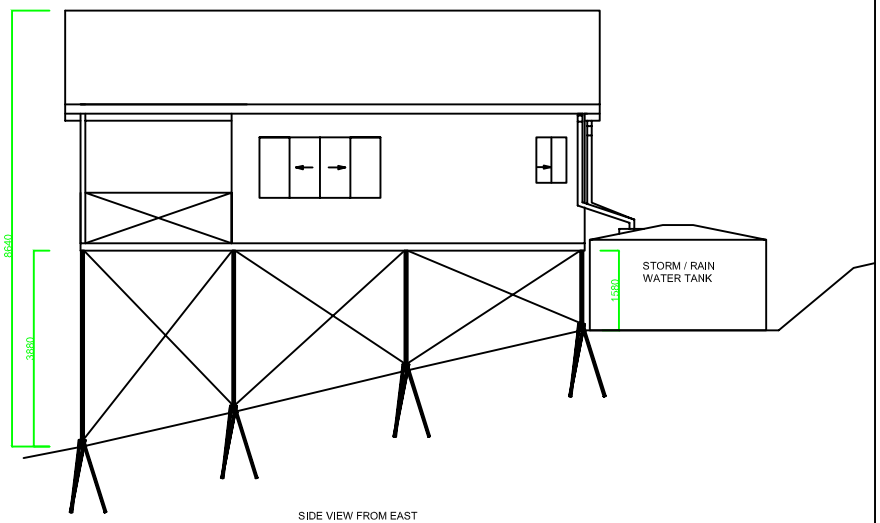
PRELIMINARY FLOOR PLAN
NO SCALE

DRAWN: P van Rensburg
DATE: July 2019

SHEET: 1 - 4



SIDE VIEW FROM NORTH



SIDE VIEW FROM EAST

ROCKHAMPTON REGIONAL COUNCIL

APPROVED PLANS

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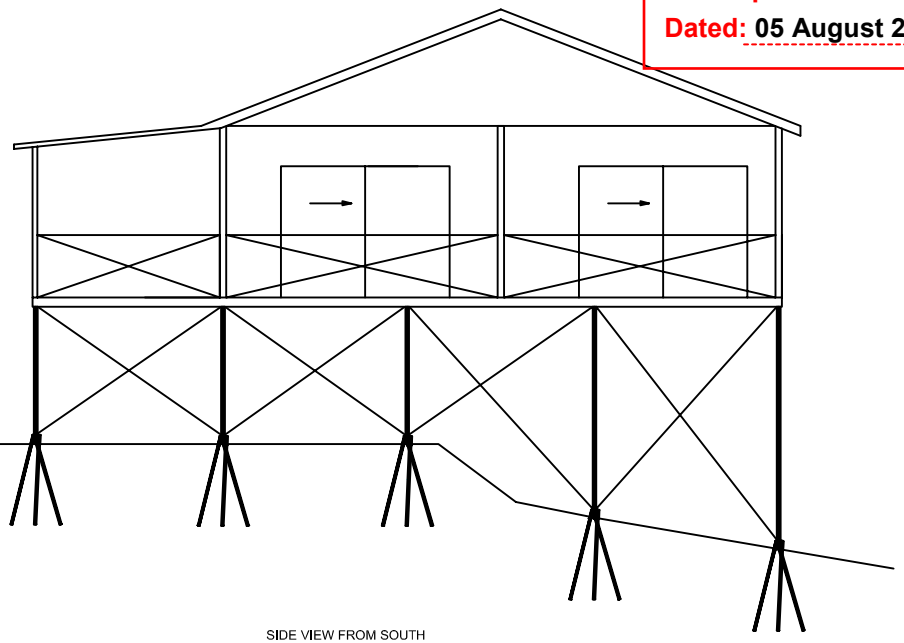
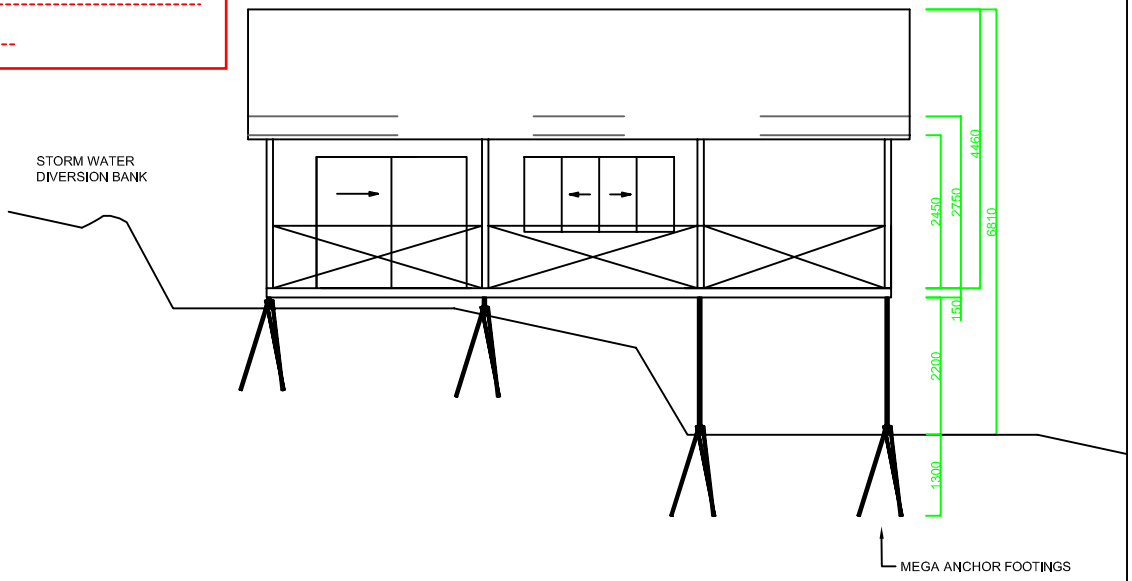
Development Permit No.: D/60-2019

Dated: 05 August 2019



SIDE VIEW FROM SOUTH

STORM WATER
DIVERSION BANK



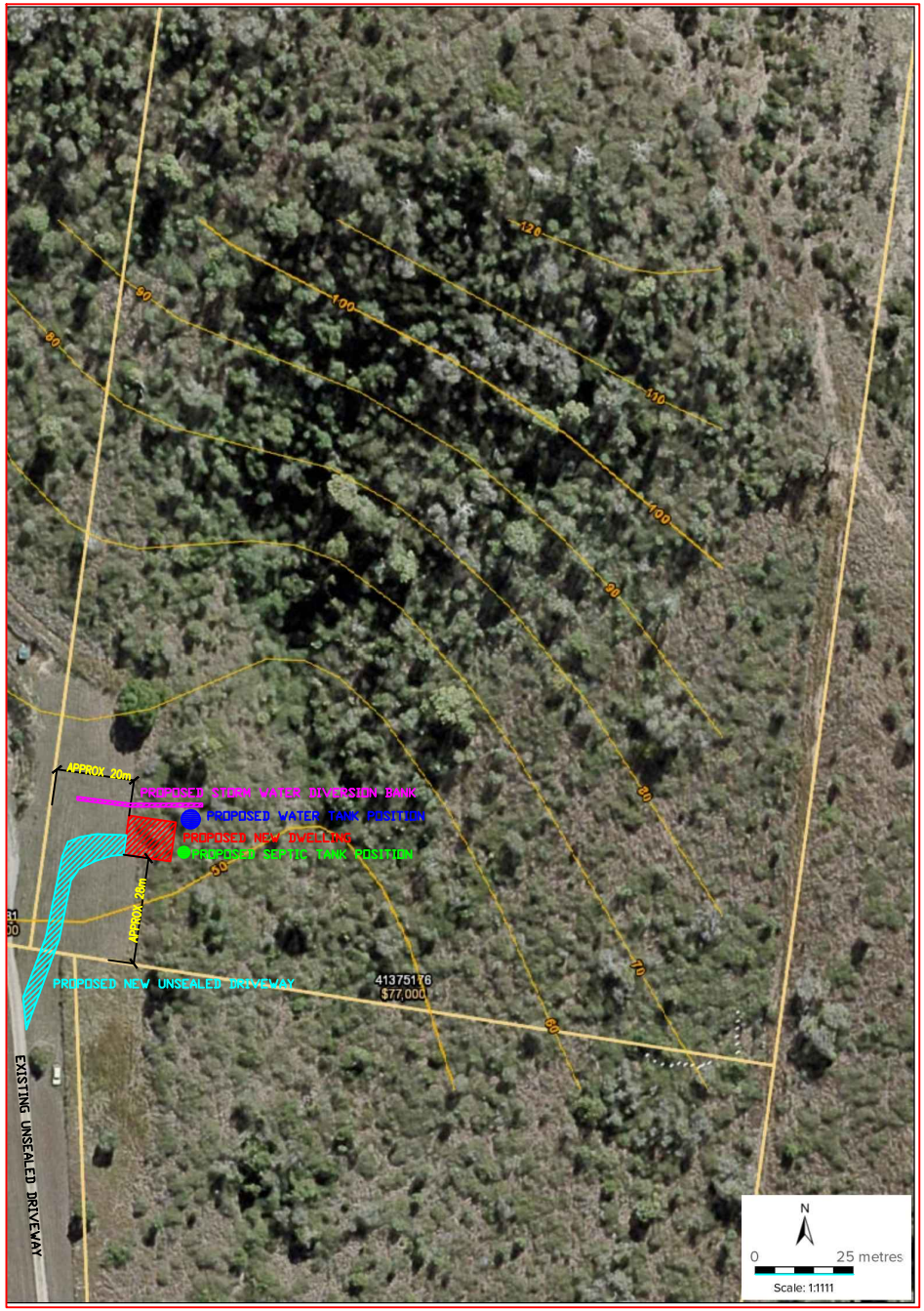
SIDE VIEW FROM WEST

PROJECT:
PROPOSED DWELLING
LOT 164 TOONDA ROAD
MARMOR

PRELIMARY ELEVATIONS
NO SCALE

DRAWN: P van Rensburg
DATE: July 2019

SHEET: 2 - 4



ROCKHAMPTON REGIONAL COUNCIL

APPROVED PLANS

These plans are approved subject to the current conditions of approval associated with

Development Permit No.: D/60-2019

Dated: 05 August 2019

PROJECT:
PROPOSED DWELLING
LOT 164 TOONDA ROAD
MARMOR

PROPOSED SITE PLAN
NO SCALE

DRAWN: P van Rensburg
DATE: July 2019

SHEET: 3 - 4

REPORT ON

SITE CLASSIFICATION

&

SITE SPECIFIC LANDSLIDE

SUSCEPTIBILITY RISK ASSESSMENT AND SLOPE STABILITY ANALYSIS

CLIENT: Piet van Rensburg

SITE ADDRESS: Lot 164 (DS251)
Toonda Road, Marmor QLD 4702

JOB NUMBER: CQ16057

ISSUE DATE: 9/07/2019

Client & Document Information

Client:	Piet van Rensburg
Project:	Lot 164 (DS251) Toonda Road, Marmor QLD 4702
Investigation Type:	**Site Classification, Landslide Susceptibility Risk Assessment and Slope Stability Report**
Job Number:	CQ16057
Date of Issue:	9/07/2019

Contact Information

CQ SOIL TESTING
ABN 47 715 943 484

PO Box 9654
PARK AVENUE QLD 4701

Telephone: (07) 4936 1163
Facsimile: (07) 4936 1162

Email: info@cqsoiltesting.com.au

Document Control

Version	Date	Author	Design Drawings	Reviewer	Reviewer Initials
A	9/07/2019	T Warne/S Jeyan	T Warne	Scott Walton	SWW

1.0 Introduction

The purpose of this report is to classify the subject allotment in accordance with Australian Standard 2870 Residential Slabs and Footings". From this classification a footing system can be recommended by an experienced/qualified engineer (designer) to suit the proposed structure. This design shall provide adequate performance of the footings under the soil conditions determined at the site.

This site investigation has been carried out by an experienced/qualified soils technician and in accordance with *AS 2870.* CQ Soil Testing is licensed with Building Services Australia to "Classify Sites".

This report relates exclusively to the proposed new dwelling at the address stated on page one of this report and has been prepared for the express purpose stated above. This document does not cover any other elements related to construction on the site.

2.0 Site Description

The subject site is a rural type allotment, which fronts an unsealed road.

The dwelling site is sparsely grassed and there no evidence of any large trees having been removed from within the proposed dwelling footprint (see photographs attached). The construction site falls towards the southeast and is considered to be well drained. Surface water will drain toward the southeast. Surface water from the adjoining allotments may traverse the site. A site sketch is attached to this report.

There is no evidence of fill having been placed on the allotment.

3.0 Soil Profile

Boreholes carried out at the site (refer attached site sketch for approximate localities) indicate a soil profile of gravelly silt which is underlain by clay soil then underlain by weathered rock (see attachment for detailed logs). Tungsten carbide drill bit refusal was encountered in weathered rock. Laboratory testing was carried out on typical soil sample/s to assess the potential of the underlying soils to exhibit shrink/swell characteristics and any underlying moisture conditions. Details of the laboratory test results are contained in Section 4.

- Groundwater was not encountered during the site investigation
- Weathered rock was encountered during the site investigation

It is possible that the soil profile may vary across the site from those shown in the bore logs which were used for this site classification. CQ Soil Testing are required to be notified if different conditions are encountered during construction. No allowance has been made for any substantial earthworks on the site, or importing building platform material. ***The classification provided is based on the borehole, which has the highest characteristic surface movement.***

4.0 Site Classification and Target Strata

Based on the findings of the site investigation and subsequent laboratory testing, the predicted surface movement for this site is between 21 - 30 mm:

CLASS "M"
(Moderately Reactive)

in accordance with Australian Standard 2870, Residential Slabs and Footings. The above classification has not allowed for the possibility of differential surface movement as a result of differing soil types throughout the site or as a result of construction activities. It is the responsibility of the engineer to allow for this possibility in the footing design.

An indicative bearing capacity of greater than 100 kPa was encountered throughout the strata at both borehole locations. Any fill placed over the existing ground shall be piered through into the existing suitable material. Further note that the placement of reactive material as fill, or cutting of the site may change the site's classification.

CQ Soil Testing recommends an engineer experienced with the design of foundations on/near to sloping allotments be commissioned to consider the slope stability of this allotment.

It is noteworthy that soil samples recovered from this site may be tested further to aid in the preparation of a database of Central Queensland soils currently being compiled by CQ Soil Testing. The aim of this database is to further understand the types of soils in the region and their mechanical properties.

If you should have any queries regarding this report, please do not hesitate to contact the undersigned at your convenience.

Yours faithfully

SCOTT WALTON
Laboratory Manager

Site Specific Landslide Susceptibility Risk Assessment and Slope Stability Analysis

1. Introduction

CQ Soil Testing (CQ) was commissioned to undertake site-specific landslide hazard assessment and slope stability analysis for the proposed residential development to be located at Lot 164 Toonda Road, Marmor QLD. The aim of the assessment was to:

- Identify the site in accordance with "Rockhampton Regional Council (RRC) Landslide Hazard and Steep Sloping Area;
- Carry out site-specific landslide hazard risk assessment based on "Geotechnical Stability Assessment Guidelines" published in March 2016 by Gold Coast City Council (GCCC);
- Carry out slope stability analyses for the proposed residential development and provide advice (where required); and
- Prepare a geotechnical site-specific landslide hazard risk and slope stability analysis report together with RPEQ certification in order to demonstrate general compliance with landslide hazard zone codes.

Survey plan was available from the client during the preparation of this reporting.

Note that the "Geotechnical Stability Assessment Guidelines" (by GCCC) incorporated Australian Geomechanics Society (AGS) guidelines for landslide hazard risk assessment. GCCC guidelines are generally accepted guidelines for similar conditions as an appropriate tool to prepare a geotechnical stability assessment and reporting in accordance with landslide hazard planning scheme policy.

2. Site Description and Geotechnical Investigation

On relevant 1:100,000 Geological map, site plots within Carboniferous-Permian Aged Rockhampton Group-Berserker Sedimentary Rock Formation.

Seven (7) Boreholes (1-7) were drilled using power auger drilling rig with adjacent Dynamic Cone penetrometer (DCP) tests. Ground conditions generally comprised natural very stiff clay or dense to very dense silt or gravel materials encountered up to 2.4 m depth followed by weathered rock. Tungsten carbide drill bit refusals were recorded between 0.6m and 2.5 m depths in stronger rock.

Based on the RRC interacting mapping database, the site lies within the landslide hazard and steep sloping area. A check was made using GCCC flowchart of geotechnical stability assessments. Based on this, site-specific landslide susceptibility risk assessment is only required for the proposed residential development and geotechnical report is not warranted. However, we have carried out slope stability analysis for the consideration of

the long term stability of the proposed residential development and good engineering practice. A copy of such flowchart is attached at the end of this report for further confirmation.

The following Table 1 summarises the outcome of the site-specific landslide hazard risk assessment.

Assessment Type	Output	Susceptibility
Existing Slope Including the Consideration of the Proposed Residential Development	0.20	Low

Borehole logs, site photographs and test location plan are attached at the end of this report.

3. Slope Stability Analysis

Typical section was used for slope stability analysis using commercially available *Slope/W* software. The assumed soil, rock and its parameters adopted in the stability analysis are presented in Table 2 below.

Material	Drained Cohesion, C' (kPa)	Drained Friction Angle, Φ' (°)	Unit Weight, γ (kN/m^3)
Natural Dense to Very Dense Silty Sandy Gravel	0	30	20
Low Strength or Stronger Weathered Rock	10	32	21

The slope profiles were modelled using the parameters given in Table 2 in line with the Morgenstern and Price method. Surcharge load of 20 kPa was adopted for residential load. Appropriate groundwater level has been incorporated into the modelling.

The analysis has considered a minimum long-term Factor of Safety (FOS) of 1.50 as required by "Geotechnical Stability Assessment Guidelines" by GCCC and current industry practice for permanent civil engineering slope works.

Slope Stability Model Set-Up

Model adopted in this stability analysis is presented below;

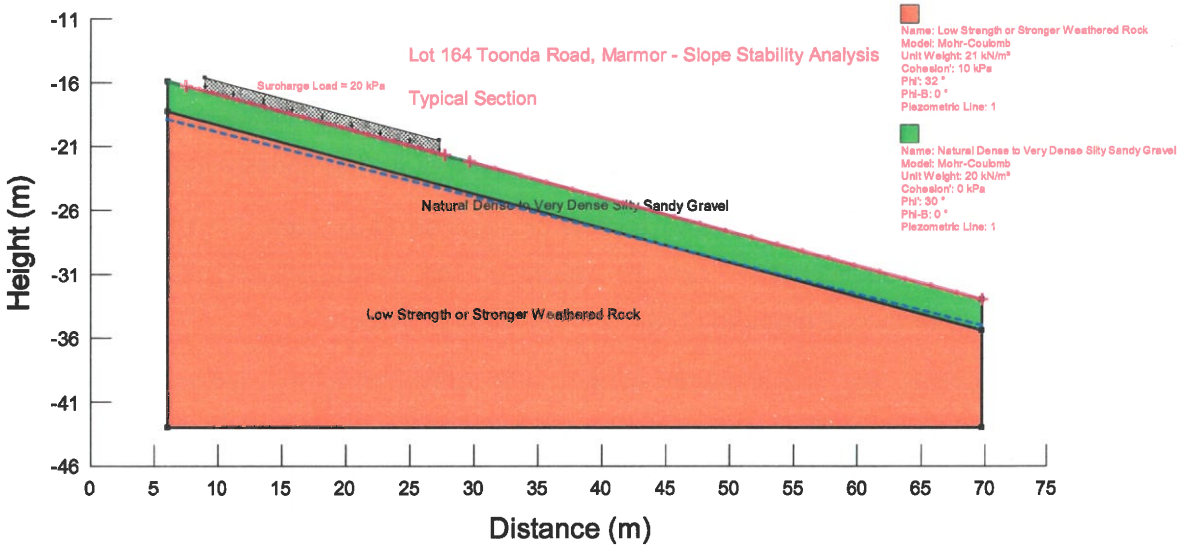


Figure 1: Typical Section Adopted in this Analysis

The results of the stability analysis with groundwater conditions are presented in Table 3 below.

Analysis Area	Analysis Condition	Long Term Factor of Safety (FOS) Achieved	Required Long Term FOS by "Geotechnical Stability Assessment Guidelines"
Typical Section	Existing/Proposed Slope Geometry with Surcharge Load and Appropriate Groundwater	2.02 (>1.50) (Drawing 1)	1.50

Stability analysis output is attached at the end of this report.

4. Safety in Design and Geotechnical Risk

The current industry practice incorporates and details risks which may be associated with the geotechnical design addressed in this report. This section outlines risks which may have an effect during construction and also outlines relevant risks which may exists in the operation, maintenance and demolition stages of the residential development or design.

We do believe that the following potential geotechnical risks may be associated with this design component and need to be managed by the builder/contractor:

- Ground strata encountered differing from design assumptions – can be managed by engaging a suitably qualified geotechnical engineer during the construction stage.

- Plants and equipment's movements with possible slips and falls – can be managed by safety checks and using an appropriate safe work method statements (SWMS).
- Temporary slope stability of the proposed excavation (if required) – can be managed by safety checks, using appropriate SWMS and by engaging a suitably qualified geotechnical engineer during construction.
- Unexpected groundwater flow or seepage encountered in the sub-surface (if observed) – can be managed by installing drainage pipes and discharge pipes to enhance the drainage system.

As far as practical, we have included appropriate control measures associated with the above-mentioned risks. It is contractor's responsibility to reduce such risks practically low as possible to abide by relevant regulations and standards including safe working practices and methods.

5. Foundation Options, Founding Conditions and Recommendations

Given the expected foundation conditions, bored pier foundations are expected/recommended to be suitable to support the proposed residential development. Any elements (including footings and slabs) that require support at ground level will need to be founded through natural very stiff or stronger clayey soils and/or weathered rock. Allowable pile end bearing pressures for bored pier foundation are given below;

- 450 kPa – Founded minimum three pile diameters and deeper into natural very stiff or stronger clayey soils.
- 900 kPa – Founded minimum 1.0 m and deeper into weathered rock.
- 1500 kPa – Founded minimum 1.0 m and deeper below the depth of tungsten carbide drill bit refusals and/or in stronger rock.

The following allowable shaft adhesion values are available below the base of the excavation;

Strata	Allowable Shaft Adhesion
Top 1.0 m	Ignore
Natural dense to very dense silty sandy gravel	10 kPa
Natural very stiff clayey soils	30 kPa
Weathered rock	60 kPa
Below the depth of tungsten carbide drill bit refusals and/or in stronger rock	100 kPa

Bored pier foundation settlements are not generally to be expected to exceed 1% to 2% of the pile diameter.

Reference can be made to AS2159-2009 for the detail pile design and construction procedures.

The selection of the foundation option is to be at the discussing by the structural engineer.

It is appropriate that footing excavations be inspected by a suitably qualified geotechnician or geotechnical engineer.

6. General Recommendations

There are no site-specific recommendations required for the proposed residential development. However, the following are generally recommended and to be followed where necessary in hillside constructions:

- Reference can be made to "Australian Geomechanics Society's Guidelines" for Good and Bad Hillside Construction Practices and Hillside Constructions. A copy of such extract is attached at the end of this report for further recommendations for hillside constructions.
- In general, ongoing long term stability will be subject to adequate crest and toe drainages and also slopes be vegetated (or any similar type of available erosion control methods) in order to prevent erosion and associated long term stability concerns.
- Instability is mainly caused by excavation and erosion. Unsupported/erosion prone excavation is not recommended.
- Stormwater, rainwater and overflow is to be properly diverted and piped to be away from the proposed residential development. All drainage is to be maintained in good working condition and regular inspections and maintenance are essential.
- Structural footings are to be designed and be certified by a suitably qualified structural engineer.
- Retaining walls and excavation generally over 1.0 m high should be engineered and be certified by a suitably qualified structural engineer.
- All site earthworks should be carried out in accordance with AS3798-2007 'Guidelines on Earthworks for Commercial and Residential Developments'.

7. Conclusions and Certification

Based on the above assessment and outcome, the site-specific landslide hazard risk assessment indicated that the existing site and the proposed residential development has a landslide hazard risk of 'low' based on site-specific geotechnical information and landslide susceptibility risk assessment outcome.

Slope stability analysis indicates that the existing and the proposed residential development slope geometry (as included in the attached Drawing 1) has FOS greater than "Geotechnical Stability Assessment Guidelines" by GCCC and current industry practice for permanent civil engineering slope works of 1.50.

Seismic hazard is considered to be very low and not been adopted in this assessment.

Based on the above information, we certify that the existing site and the proposed residential development lie with a landslide susceptibility risk of 'low' which is considered to be acceptable for RRC and current engineering practice for permanent civil engineering slope works.

8. Limitations

The statements presented in this document are intended to advise the reader of recommendations in line with stated assumptions.

This report has been prepared for the sole use of the client for the purpose described and no extended duty of care to any third party is implied or offered. Third parties using any information contained within this report do so at their own risk.

The comments given in this report and the opinions expressed herein are based on the information received from the client, the conditions encountered during the geotechnical investigation and associated landslide susceptibility & slope stability analysis. However, there may be conditions prevailing at the site which have not been disclosed by the client/geotechnical investigation/landslide susceptibility & slope stability analysis and which have not been taken into account in the report.

This report has been reasonably reviewed to eliminate human errors, inappropriateness, and omissions.

On Behalf of CQ Soil Testing

Sam Jeyan
Senior Geotechnical Engineer
RPEQ - 13339
RPEng – 0969
MIEAust - 3439772
Accredited Slope Risk Assessor – RMS Guide to Slope Risk Assessment Version 4

Approved By

Scott Walton
Proprietor/Manager

Attachments:

Extracts from RRC Landslide Hazard Overlay Map
GCCC Flowchart of Geotechnical Stability Assessments
Site-Specific Landslide Susceptibility Risk Assessment Report
Borehole Logs, Site Photographs, Survey Plan with Borehole Locations
Extract from Australian Geomechanics Society's Guidelines for Good and Bad Hillside Construction Practices and Hillside Constructions
Slope Stability Analysis Output
Completed Standard Pro-forma for Geotechnical Certification
Report Limitations

9. References

The following papers, reports or books have been consulted in preparing this report:

- "Geotechnical Stability Assessment Guidelines" by Gold Coast City Council (GCCC) – March 2016.
- SMEC (2011): Landslide Susceptibility Assessment Report for the City of the Gold Coast, August 2011.
- Australian Geomechnics Society (2007): Practice Note Guideline for Landslide Risk Management 2007, Journal of the Australian Geomechnics Society, Vol 42, No. 1, March 2007.
- Australian Standard AS 4678: Earth-Retaining Structures, February 2002.

Subject Site

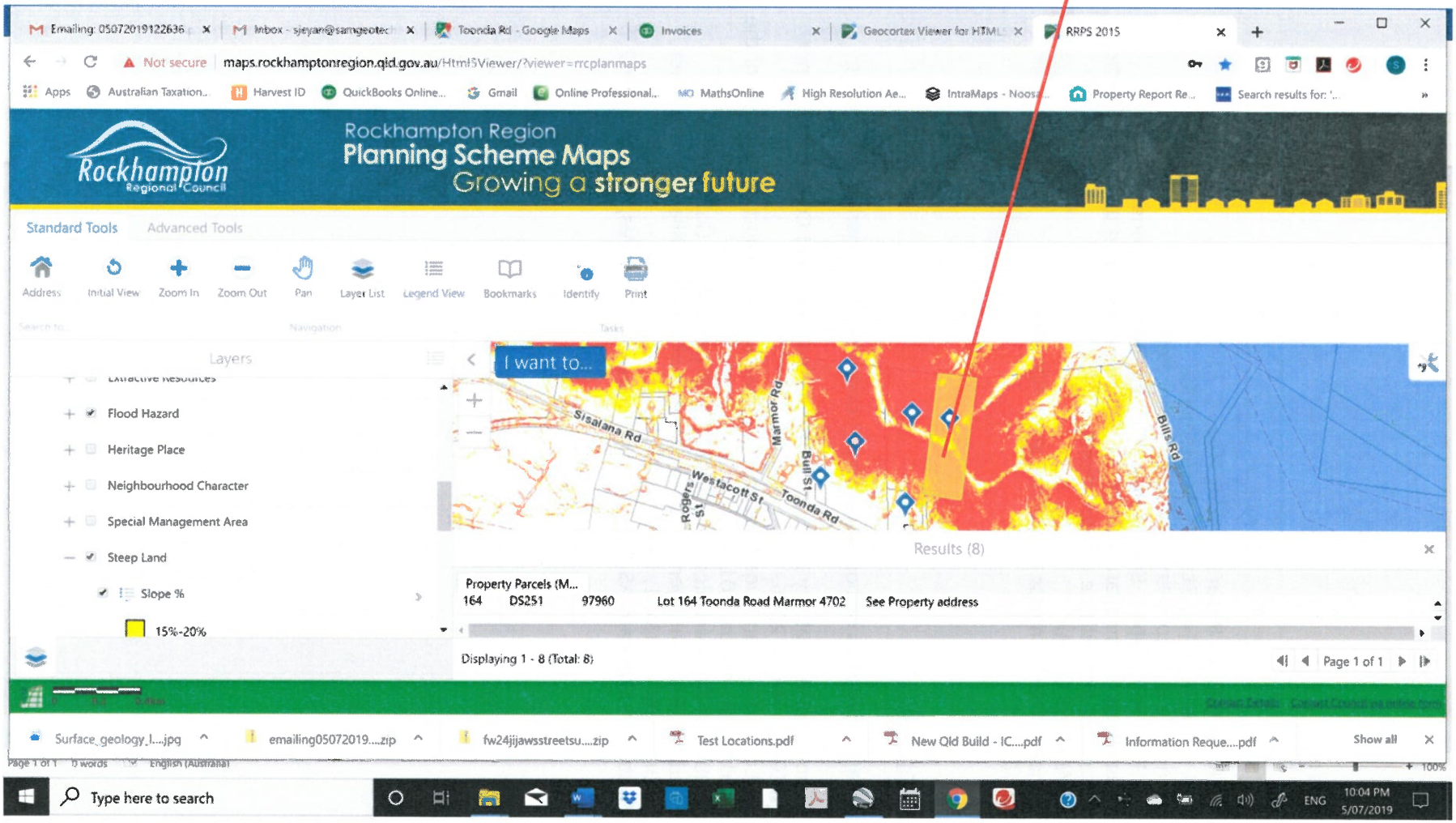
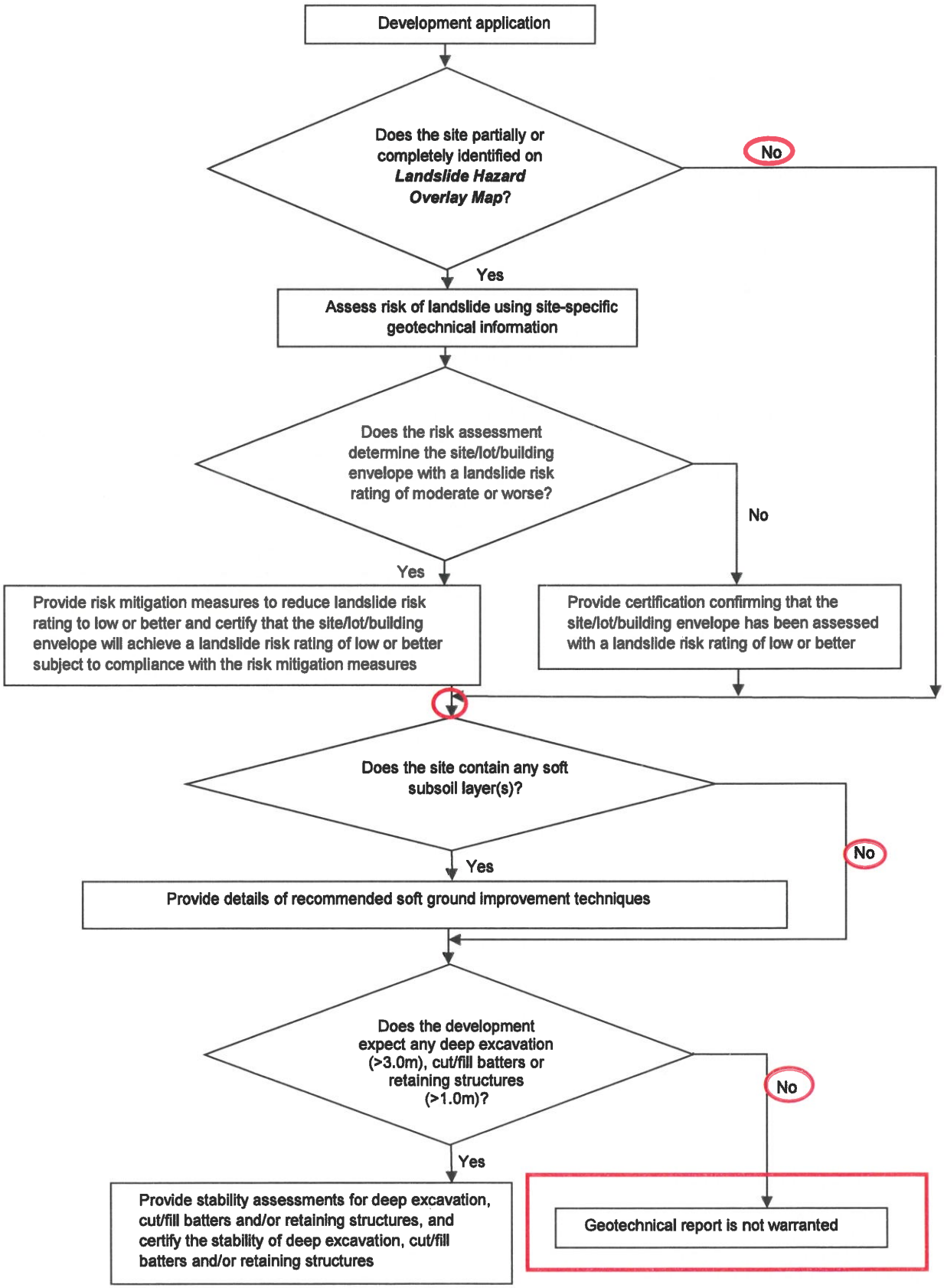


Figure 1 shows a flowchart for various geotechnical stability assessments that should be carried out and include in a *Geotechnical Report.*

Figure 1: Flowchart for geotechnical stability assessment



LANDSLIDE SUSCEPTIBILITY ANALYSIS

Site Address: Lot 164 Toonda Road, Marmor QLD 4702.
Geology: Carboniferous - Permian Aged Rockhampton Group - Berserker Sedimentary Rock Formation.
Landslide Hazard Overlay Map: Site lies within Rockhampton Regional Council (RRC) Landslide Hzard and Steep Sloping Area.

1 Natural Surface Slope

Site		Level	Factor
	Less than 5 degrees	L	0.1
	Between 5 and 15 degrees	M	0.5
	Between 15 and 30 degrees	M	0.8
	Between 30 and 45 degrees	H	1.2
	More than 45 degrees	M	0.8

2 Slope Shape

Site		Level	Factor
	Crest or ridge	L	0.7
	Planar / Convex	M	0.9
	Rough / Irregular	H	1.2
	Concave	H	1.5

3 Site geology

Site		Level	Factor
	Volcanic Extrusive rock	H	1.1
	Sedimentary rock	M	1
	Low grade metamorphic rock	M	1
	High grade metamorphic rock	L	0.9
	Volcanic Intrusive rock	M	1

4 Soils

Site		Level	Factor
	Rock at surface	VL	0.1
	Residual soil < 1m deep	L	0.5
	Residual soil 1-3m deep	M	0.9
	Residual soil > 3m deep	H	1.5
	Colluvial soil < 1m deep	H	1.5
	Colluvial soil 1-3m deep	VH	2
	Colluvial soil > 3m deep	VH	4

5 Fill height - Existing/Proposed

Site		Level	Factor
	None	L	0.9
	Less than 1m	M	1.1
	Between 1 and 3m	M	1.3
	Between 3 and 6m	H	1.7
	More than 6m	VH	2.5

6 Evidence of groundwater

Site		Level	Factor
	None apparent	L	0.7
	Minor moistness	M	0.9
	Generally wet	H	1.5
	Surface springs	VH	3

7 Cut height - N/A

Site		Level	Factor
	None	L	0.9
	Less than 1m	M	1.1
	Between 1 and 3m	M	1.3
	Between 3 and 6m	H	1.7
	More than 6m	VH	2.5

8 Slope of Cut Face - N/A

Site		Level	Factor
	Less than 30 degrees	L	0.5
	Between 30 and 45 degrees	M	1
	Between 45 and 60 degrees	H	1.5
	More than 60 degrees	VH	2

9 Material in cutting - N/A

Site		Level	Factor
	High strength rock	L	0.5
	Medium strength rock	L	1
	Low strength rock	M	1.2
	Very low strength rock and soil	H	1.5
	Soil	VH	2

10 Cut slope support - N/A

Site		Level	Factor
	Concrete/Block wall	L	0.5
	Crib wall	M	0.9
	Gabion wall	M	1
	Rock wall	H	1.5
	Unsupported	H	2

11 Concentration of surface water

Site		Level	Factor
	Ridge	L	0.7
	Crest	M	0.8
	Upper slope	M	0.9
	Mid slope	H	1.2
	Lower slope	H	1.5

12 Wastewater Disposal

Site		Level	Factor
	Fully Sewered	M	1
	Onsite disposal – Surface	M	1.2
	Onsite disposal – Soak Pit/Trenches	H	1.5

13 Stormwater Disposal

Site		Level	Factor
	All stormwater piped into road drainage	L	0.7
	Rain water tank with overflows	M	1
	Stormwater discharge on site	H	1.5

14 Evidence of instability

Site		Level	Factor
	No sign of instability	L	0.8
	Soil Creep	H	1.2
	Minor irregularity	VH	2
	Major irregularity	VH	5
	Active instability	VH	10

Summary

			Factor
1	Natural Surface Slope		0.5
2	Slope Shape		0.9
3	Site Geology		1.0
4	Soils		0.9
5	Fill Height		0.9
6	Evidence of Groundwater		0.7
7	Cut height		N/A
8	Slope of Cut Face		N/A
9	Material in Cutting		N/A
10	Cut Slope Support		N/A
11	Concentration of Surface Water		0.9
12	Wastewater Disposal		1.5
13	Stormwater Disposal		0.7
14	Evidence of Instability		0.8
Relative Susceptibility (1x2x3x4x5x6x7x8x9x10x11x12x13x14)			0.20

Low

Correlation between relative susceptibility and susceptibility rating

Relative Susceptibility	Susceptibility Rating
Less than 0.2	Very Low
0.2 – 0.6	Low
0.6 – 2.0	Moderate
2.0 – 6.0	High
Greater than 6.0	Very High

Soil Logs

BOREHOLE 1		
Depth (m)	**Visual Class'n Symbol**	**Visual Description of Material**
0.0 0.4	ML	Gravelly Sandy SILT, low plasticity, fine to medium grained, light brown to reddish brown w/depth, D, VST.
0.4 0.5	CI	Silty CLAY, medium plasticity, fine to coarse grained, brown, D, VST.
0.5 2.0	CI	Sandy CLAY, medium plasticity, fine to coarse grained, brown to greyish brown with depth, D, VST.
Borehole terminated at 2.0 m		

DCP TEST RESULTS		
Depth (mm)	**Blows per 100 mm**	**Indicative kPa**
100	3	100
200	15	300
300	9	250
400	12	300
500	11	250
600	12	300
700	>15	>300
800		
900		
1000		
1100		
1200		
1300		
1400		
1500		
1600		
1700		
1800		
1900		
2000		
2100		
2200		
2300		
2400		
2500		
2600		
2700		
2800		
2900		
3000		
3100		
3200		
3300		
3400		
3500		
3600		
3700		
3800		
3900		
4000		

MOISTURE CONDITION	CONSISTENCY	RELATIVE DENSITY
D – Dry	VS – Very Soft	VL – Very Loose
M – Moist	S – Soft	L – Loose
W – Wet	F – Firm	MD – Med Dense
	ST – Stiff	D – Dense
	V/ST – Very Stiff	VD – Very Dense
	H – Hard	

Allowable Bearing Pressure calculated using the guidelines in "Determination of Allowable Bearing Pressure under Small Structures" by MI Stockwell (NZ Engineering June 1997)

DCP test results are to be used as a guide only to relative density and consistency of soils. Changes in moisture contents or the presence of coarse grained material can greatly influence the outcome of this test.

Soil Logs

BOREHOLE 2		
Depth (m)	**Visual Class'n Symbol**	**Visual Description of Material**
0.0 0.5	CI	Sandy CLAY, medium plasticity, fine to coarse grained, light brown to reddish brown with depth, D, ST-VST w/depth.
0.5 0.6	GC/XW	Clayey Sandy GRAVEL, fine to coarse grained, low plasticity fines, greyish brown, D, VD. **Weathered rock**
Tungsten carbide bit refusal at 0.6 m		

MOISTURE CONDITION	CONSISTENCY	RELATIVE DENSITY
D – Dry	VS – Very Soft	VL – Very Loose
M – Moist	S – Soft	L – Loose
W – Wet	F – Firm	MD – Med Dense
	ST – Stiff	D – Dense
	V/ST – Very Stiff	VD – Very Dense
	H – Hard	

Allowable Bearing Pressure calculated using the guidelines in "Determination of Allowable Bearing Pressure under Small Structures" by MI Stockwell (NZ Engineering June 1997)

DCP test results are to be used as a guide only to relative density and consistency of soils. Changes in moisture contents or the presence of coarse grained material can greatly influence the outcome of this test.

DCP TEST RESULTS		
Depth (mm)	**Blows per 100 mm**	**Indicative kPa**
100	3	100
200	5	160
300	8	200
400	10	250
500	>15	>300
600		
700		
800		
900		
1000		
1100		
1200		
1300		
1400		
1500		
1600		
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2900		
3000		
3100		
3200		
3300		
3400		
3500		
3600		
3700		
3800		
3900		
4000		

Soil Logs

BOREHOLE 3		
Depth (m)	**Visual Class'n Symbol**	**Visual Description of Material**
0.0 0.5	ML	Gravelly Sandy SILT, low plasticity, fine to medium grained, light brown to reddish brown w/depth, D, ST-VST w/depth.
0.5 0.6	CI	Silty CLAY, medium plasticity, fine to coarse grained, brown, D, VST.
0.6 1.5	CI	Sandy CLAY, medium plasticity, fine to coarse grained, brown to greyish brown with depth, D, VST.
1.5 1.6	GC/XW	Clayey Sandy GRAVEL, fine to coarse grained, low plasticity fines, greyish brown, D, VD. **Weathered rock**
Tungsten carbide bit refusal at 1.6 m		

MOISTURE CONDITION	CONSISTENCY	RELATIVE DENSITY
D – Dry	VS – Very Soft	VL – Very Loose
M – Moist	S – Soft	L – Loose
W – Wet	F – Firm	MD – Med Dense
	ST – Stiff	D – Dense
	V/ST – Very Stiff	VD – Very Dense
	H – Hard	

Allowable Bearing Pressure calculated using the guidelines in "Determination of Allowable Bearing Pressure under Small Structures" by MI Stockwell (NZ Engineering June 1997)

DCP test results are to be used as a guide only to relative density and consistency of soils. Changes in moisture contents or the presence of coarse grained material can greatly influence the outcome of this test.

DCP TEST RESULTS		
Depth (mm)	**Blows per 100 mm**	**Indicative kPa**
100	5	160
200	3	100
300	3	100
400	6	180
500	10	250
600	12	300
700	15	300
800	Drill	
900	Drill	
1000	5	160
1100	6	180
1200	8	200
1300	8	200
1400	9	250
1500	8	200
1600	12	300
1700	15	300
1800		
1900		
2000		
2100		
2200		
2300		
2400		
2500		
2600		
2700		
2800		
2900		
3000		
3100		
3200		
3300		
3400		
3500		
3600		
3700		
3800		
3900		
4000		

Soil Logs

BOREHOLE 4		
Depth (m)	**Visual Class'n Symbol**	**Visual Description of Material**
0.0 2.2	CL	Gravelly Sandy Silty CLAY, low plasticity, fine to coarse grained, light brown to light grey with depth, D, VST.
2.2 2.3	GC/XW	Clayey Sandy GRAVEL, fine to coarse grained, low plasticity fines, light grey, D, VD. **Weathered rock**
Tungsten carbide bit refusal at 2.3 m		

MOISTURE CONDITION	CONSISTENCY	RELATIVE DENSITY
D – Dry	VS – Very Soft	VL – Very Loose
M – Moist	S – Soft	L – Loose
W – Wet	F – Firm	MD – Med Dense
	ST – Stiff	D – Dense
	V/ST – Very Stiff	VD – Very Dense
	H – Hard	

Allowable Bearing Pressure calculated using the guidelines in "Determination of Allowable Bearing Pressure under Small Structures" by MI Stockwell (NZ Engineering June 1997)

DCP test results are to be used as a guide only to relative density and consistency of soils. Changes in moisture contents or the presence of coarse grained material can greatly influence the outcome of this test.

DCP TEST RESULTS		
Depth (mm)	**Blows per 100 mm**	**Indicative kPa**
100	Drill	
200	Drill	
300	Drill	
400	7	200
500	9	250
600	7	200
700	7	200
800	8	200
900	9	250
1000	11	250
1100	7	200
1200	9	250
1300	14	300
1400		
1500		
1600		
1700		
1800		
1900		
2000		
2100		
2200		
2300		
2400		
2500		
2600		
2700		
2800		
2900		
3000		
3100		
3200		
3300		
3400		
3500		
3600		
3700		
3800		
3900		
4000		

Soil Logs

BOREHOLE 5		
Depth (m)	**Visual Class'n Symbol**	**Visual Description of Material**
0.0 1.8	GM	Silty Sandy GRAVEL, fine to coarse grained, low plasticity fines, light brown to light grey w/depth, D, D-VD w/depth.
1.8 1.9	GC/XW	Clayey Sandy GRAVEL, fine to coarse grained, low plasticity fines, light grey, D, VD. **Weathered rock**
Tungsten carbide bit refusal at 1.9 m		

MOISTURE CONDITION	CONSISTENCY	RELATIVE DENSITY
D – Dry	VS – Very Soft	VL – Very Loose
M – Moist	S – Soft	L – Loose
W – Wet	F – Firm	MD – Med Dense
	ST – Stiff	D – Dense
	V/ST – Very Stiff	VD – Very Dense
	H – Hard	

Allowable Bearing Pressure calculated using the guidelines in "Determination of Allowable Bearing Pressure under Small Structures" by MI Stockwell (NZ Engineering June 1997)

DCP test results are to be used as a guide only to relative density and consistency of soils. Changes in moisture contents or the presence of coarse grained material can greatly influence the outcome of this test.

DCP TEST RESULTS		
Depth (mm)	**Blows per 100 mm**	**Indicative kPa**
100	6	180
200	7	200
300	7	200
400	9	250
500	9	250
600	9	250
700	15	300
800	Drill	
900	Drill	
1000	7	200
1100	8	200
1200	10	250
1300	9	250
1400	9	250
1500	8	200
1600	12	300
1700	15	>300
1800		
1900		
2000		
2100		
2200		
2300		
2400		
2500		
2600		
2700		
2800		
2900		
3000		
3100		
3200		
3300		
3400		
3500		
3600		
3700		
3800		
3900		
4000		

Soil Logs

BOREHOLE 6		
Depth (m)	**Visual Class'n Symbol**	**Visual Description of Material**
0.0 2.4	GM	Silty Sandy GRAVEL, fine to coarse grained, low plasticity fines, light brown to light grey w/depth, D, D-VD w/depth.
2.4 2.5	GC/XW	Clayey Sandy GRAVEL, fine to coarse grained, low plasticity fines, light grey, D, VD. **Weathered rock**
Tungsten carbide bit refusal at 2.5 m		

DCP TEST RESULTS		
Depth (mm)	**Blows per 100 mm**	**Indicative kPa**
100	7	200
200	7	200
300	8	200
400	9	250
500	12	250
600	>14	>300
700		
800		
900		
1000		
1100		
1200		
1300		
1400		
1500		
1600		
1700		
1800		
1900		
2000		
2100		
2200		
2300		
2400		
2500		
2600		
2700		
2800		
2900		
3000		
3100		
3200		
3300		
3400		
3500		
3600		
3700		
3800		
3900		
4000		

MOISTURE CONDITION	CONSISTENCY	RELATIVE DENSITY
D – Dry	VS – Very Soft	VL – Very Loose
M – Moist	S – Soft	L – Loose
W – Wet	F – Firm	MD – Med Dense
	ST – Stiff	D – Dense
	V/ST – Very Stiff	VD – Very Dense
	H – Hard	

Allowable Bearing Pressure calculated using the guidelines in "Determination of Allowable Bearing Pressure under Small Structures" by MI Stockwell (NZ Engineering June 1997)

DCP test results are to be used as a guide only to relative density and consistency of soils. Changes in moisture contents or the presence of coarse grained material can greatly influence the outcome of this test.

Soil Logs

BOREHOLE 7		
Depth (m)	**Visual Class'n Symbol**	**Visual Description of Material**
0.0 0.9	GM	Silty Sandy GRAVEL, fine to coarse grained, low plasticity fines, light brown to light grey w/depth, D, D-VD w/depth.
0.9 1.0	GC/XW	Clayey Sandy GRAVEL, fine to coarse grained, low plasticity fines, light grey, D, VD. **Weathered rock**
Tungsten carbide bit refusal at 1.0 m		

MOISTURE CONDITION	CONSISTENCY	RELATIVE DENSITY
D – Dry	VS – Very Soft	VL – Very Loose
M – Moist	S – Soft	L – Loose
W – Wet	F – Firm	MD – Med Dense
	ST – Stiff	D – Dense
	V/ST – Very Stiff	VD – Very Dense
	H – Hard	

Allowable Bearing Pressure calculated using the guidelines in "Determination of Allowable Bearing Pressure under Small Structures" by MI Stockwell (NZ Engineering June 1997)

DCP test results are to be used as a guide only to relative density and consistency of soils. Changes in moisture contents or the presence of coarse grained material can greatly influence the outcome of this test.

DCP TEST RESULTS		
Depth (mm)	**Blows per 100 mm**	**Indicative kPa**
100	7	200
200	8	200
300	7	200
400	9	250
500	13	300
600	Drill	
700	Drill	
800	>15	>300
900		
1000		
1100		
1200		
1300		
1400		
1500		
1600		
1700		
1800		
1900		
2000		
2100		
2200		
2300		
2400		
2500		
2600		
2700		
2800		
2900		
3000		
3100		
3200		
3300		
3400		
3500		
3600		
3700		
3800		
3900		
4000		

Photographs

Figure 1 Proposed construction site

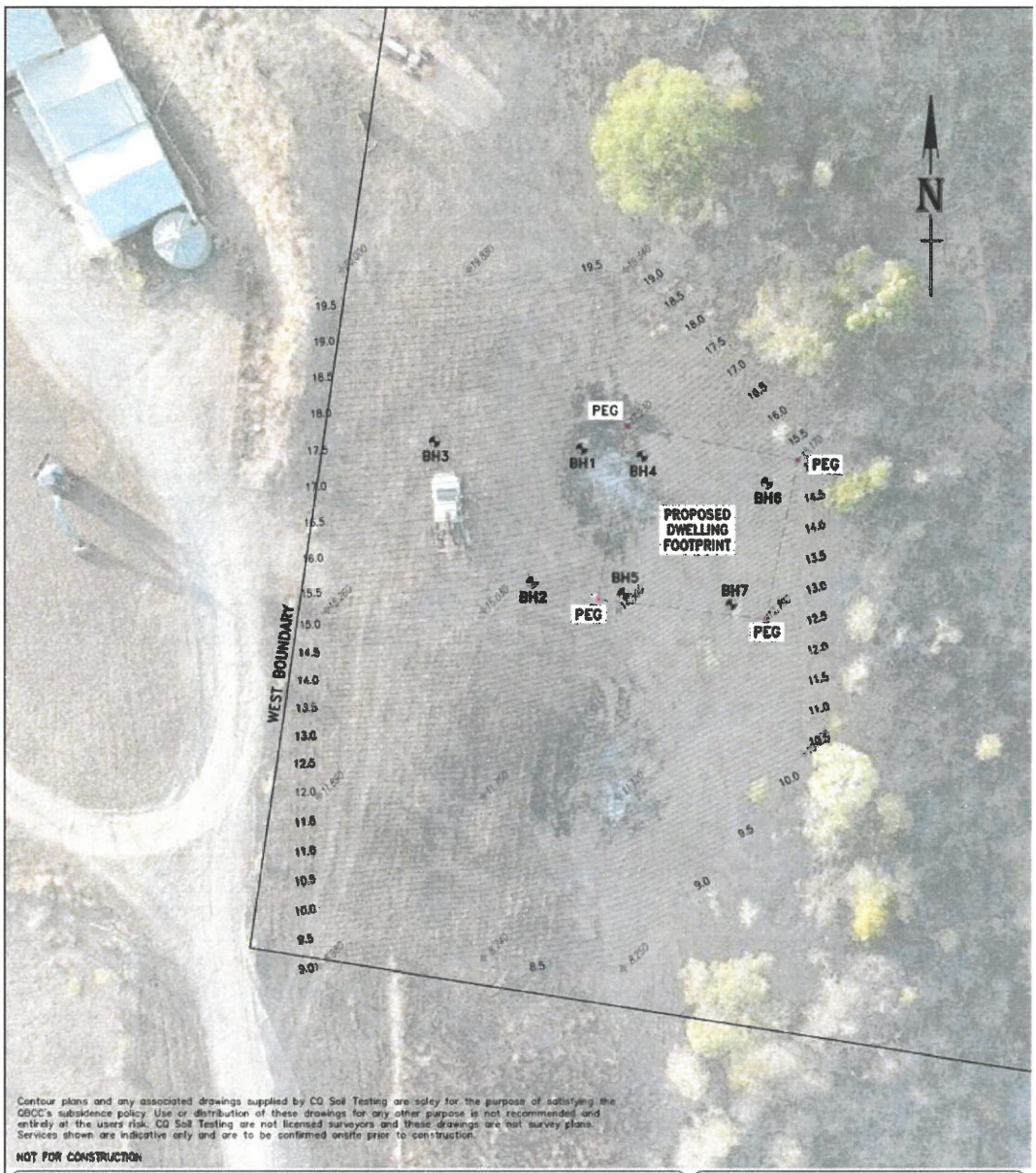
Figure 2 Proposed construction site

Photographs

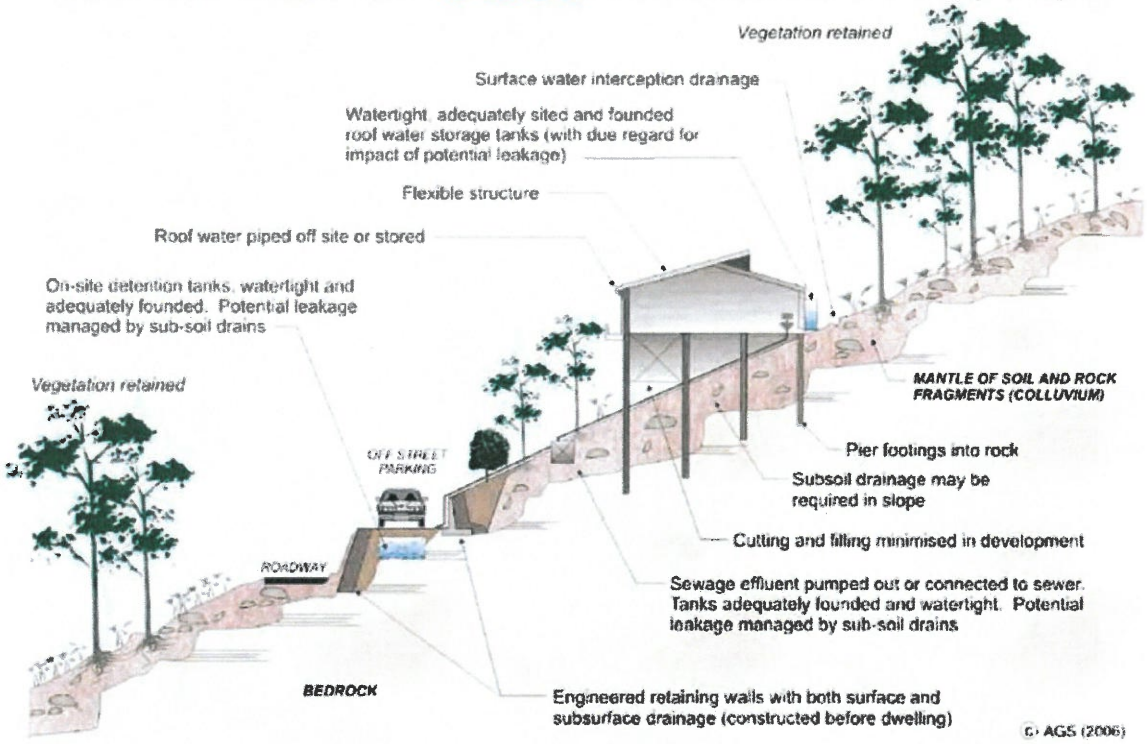
Figure 3 Proposed construction site

Figure 4 Proposed construction site

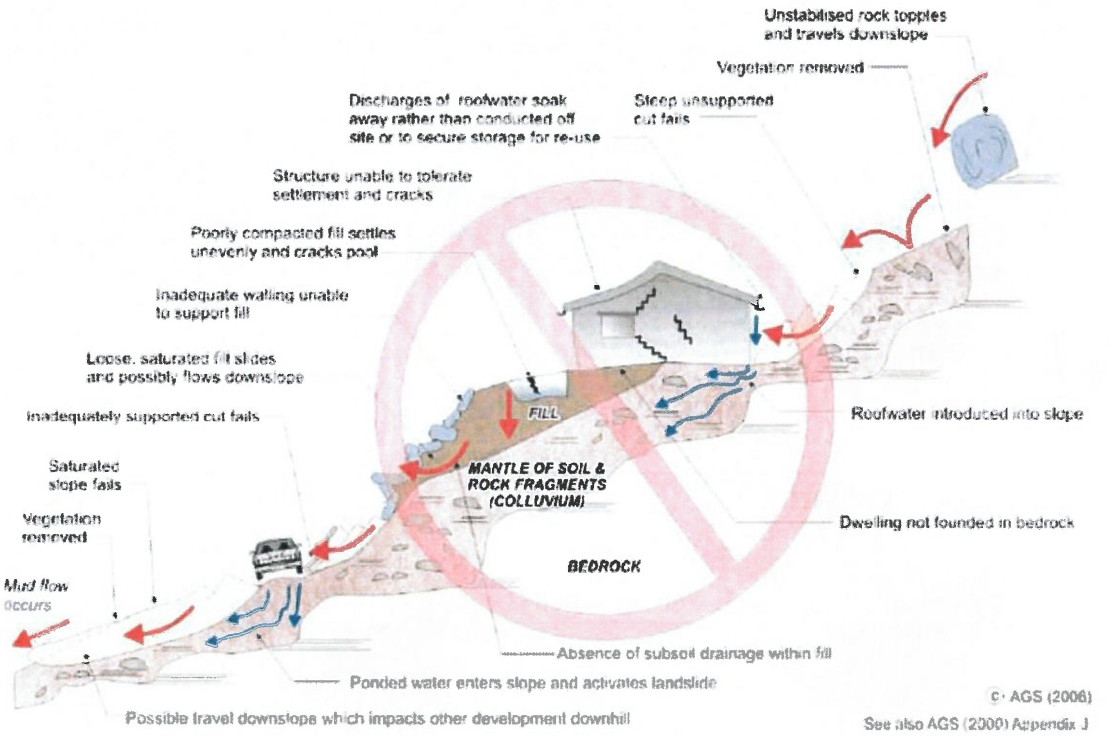
Survey Plan with Borehole Locations



EXAMPLES OF GOOD HILLSIDE PRACTICE

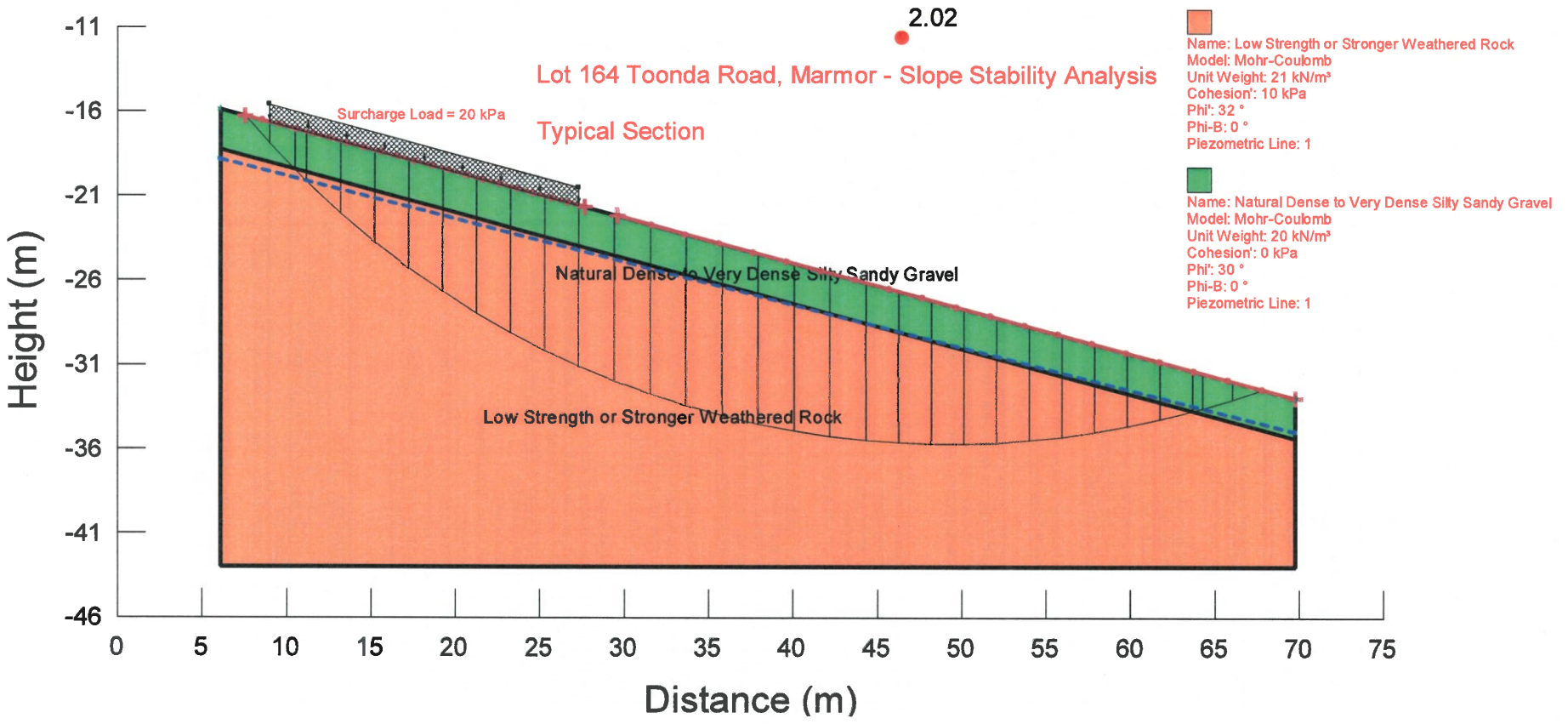


EXAMPLES OF POOR HILLSIDE PRACTICE



APPENDIX G - SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

	GOOD ENGINEERING PRACTICE	*POOR ENGINEERING PRACTICE*
ADVICE		
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical practitioner at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arising from the identified hazards and consequences in mind.	Plan development without regard for the Risk.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminatory bulk earthworks.
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use clean fill materials and compact to engineering standards. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill, which if it fails, may flow a considerable distance including onto property below. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may have unacceptable risk. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOOTINGS	Found within rock where practicable. Use rows of piers or strip footings oriented up and down slope. Design for lateral creep pressures if necessary. Backfill footing excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE		
SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide general falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	Discharge roof runoff into absorption trenches.
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some areas if risk is acceptable. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes. Use absorption trenches without consideration of landslide risk.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant	
SITE VISITS	Site Visits by consultant may be appropriate during construction/	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident see advice. If seepage observed, determine causes or seek advice on consequences.	



CQ SOIL TESTING Servicing all of Central Queensland	**Client:**	Piet van Rensburg	**Global Stability Analysis – Existing/Proposed Slope Geometry with Surcharge Load and Appropriate Groundwater**	
	Consultant:	CQ Soil Testing	**Slope Stability Analysis – Typical Section**	**Drawing No:** 1
	Date:	July 2019	**Lot 164 Toonda Road, Marmor QLD 4702**	**Revision:** 0

Appendix D – Standard pro-forma for geotechnical certification

Property details	
Lot Number If Applicable	Lot 164
Registered Plan Number	DS251
Site Address	Toonda Road, Marmor QLD 4702

Proposed works	
Description	Proposed Residential Development

Proposed development	
Description	Proposed Residential Development

Declaration

I,	Sam Jeyan	Registered Professional Engineer of Queensland (RPEQ) number	13339
of	CQ Soil Testing		(Consulting engineer's firm)

being duly authorised on this behalf, do certify that:

the existing site and the proposed residential development lie with a slope instability hazard risk of 'low' based on site-specific geotechnical information and landslip hazard risk assessment outcome.

I am aware that Rockhampton Regional Council (RRC) will rely upon this certificate and any associated maps, structural & drainage plans, drawings, tables and attachments etc. produced as a consequence of commissioning this development proposal.

Accredited Slope Risk Assessor - RMS Guide to Slope Risk Assessment - Version 4

Signature		**Designation**	Senior Geotechnical Engineer		
Certified this	9	**Day of**	July	**Year**	2019

Report Limitations

1. Recommendations given in this report are based on the information supplied by the client regarding the proposed building construction in conjunction with the findings of the investigation. Any change in construction type, building location or omission in the client supplied information, may require additional testing and/or make the recommendations invalid.

2. The recommendations herein may identify a target soil stratum into which the footings should be founded. The target stratum has been located by the depth in mm of the target stratum's upper horizon boundary below the existing ground surface level at the time of the site investigation. Any cutting or filling works and any surface erosion or deposits subsequent to the site investigation, will alter the measured location of the stratum relative to the surface. Where required, the author should be notified in such cases to confirm the location of the target stratum.

3. The description of the soil given in Section 3.0 of this report is intended as a brief overview of the soil's primary constituents. For a detailed classification of the soil, the reader should refer to the Soil Profile Reports and/or Borehole Reports.

4. Every reasonable effort has been made to locate the test sites so that the borehole profiles are representative of the soil conditions within the area investigated. The client should be made aware however, that exploration is limited by time available and economic restraints. In some cases soil conditions can change dramatically over short distances, therefore, even careful exploration programs may not locate all the variations.

5. If soil conditions different from those shown in this report are encountered or are inferred from other sources, then the author must be notified immediately.

6. This report may not be reproduced except in full. The information and site sketch shall only be used and will only be applicable for the development shown on the client-supplied information provided for this site.

7. Any dimensions, contours, slope directions and magnitudes shown on the site sketch plan shall not be used for any building construction or costing calculations. The purpose of the plan is to show approximate location of field tests only.

8. Any changes made to these recommendations by persons unauthorized by the author will legally be interpreted at that person assuming the responsibility for the long-term performance of the footing system.

9. The recommendations contained in this report have not taken into consideration the long term effects of any previous, current or potential subsurface work by mining companies or potential slope instability problems. At the time of writing this report neither our client (nor his agent) nor the local authority had made the author aware that these problems may be affecting this allotment. If a mining subsidence or slope stability assessment is required for this allotment, the recommendations of a suitably qualified geotechnical engineer should be sought.

10. Removal of trees from a site before an investigation can cause significant swelling of the soil over large areas. The removal of large trees from a construction site during development is rarely picked up during the investigation phase and is generally outside the scope of AS2870. Sites affected by large trees are often classified "P". If, during the footing excavation, it is noticed that there are soils with varying moisture contents or evidence of large trees having been removed CQ Soil Testing should be notified immediately.

11. The following documents are available from the CSIRO and BSA and shall be read and adhered to in relation to this site:

    - Builder's Guide to Preventing Damage to Dwellings- Part 1 Site Investigation and Preparation http://www.publish.csiro.au/nid/22/pid/3621.htm
    - Builder's Guide to Preventing Damage to Dwellings- Part 2 Sound Construction Methods http://www.publish.csiro.au/nid/22/pid/3661.htm
    - Foundation Maintenance and Footing Performance- A Homeowner's Guide http://www.publish.csiro.au/nid/22/pid/3612.htm
    - BSA Subsidence Fact Sheet

http://www.bsa.qld.gov.au/NR/rdonlyres/4CA6BA57-3CB5-4B75-B75E-3CA0469D7463/0/SubsidenceFacts.pdf