DOYLE SOIL CONSULTING

LANDSLIDE ASSESSMENT REPORT

Lot 2, Rada Rd, Kettering

September 2024

Doyle Soil Consulting: 6/76 Auburn Rd Kingston Beach 7050 – 0488 080 455 – robyn@doylesoilconsulting.com.au

Founding Statement

Dr Richard Doyle is a highly qualified geologist, geomorphologist and soil scientist with over 40 years work experience in earth sciences. He has a B.Sc. (Hons) in geology with a double major in physical geography (Victoria University of Wellington, NZ), an M.Sc. in geology awarded with distinction specialising in geomorphology, erosion and soil development (Victoria University of Wellington, NZ) and a PhD in soil science (UTAS). Dr Doyle is a Certified Professional Soil Scientist (CPSS) of the Australian Society of Soil Science of which he is the former state and national president. Richard is a Program Leader with the Soil CRC an Australian Government supported national cooperative soil research centre. He has worked and taught around the world on a wide range of earth science projects (Greece, Namibia, USA, NZ and PNG). Dr Doyle has researched and taught soil and earth science at Tertiary level for over 30 years and co-supervised >30 honours/master students, and 23 research higher degree completions (PhDs and Masters). He has authored many landslides risk, coastal erosion, inundation and other earth-based risk assessments for Tasmanian councils and has over 100 refereed scientific publications in journals, books and conference proceedings with over 60,000 publication reads and 2000 citations leading to a H-Citation Index of 22.

Site Information

Client: Lachlan Reynolds and Jennifer Blair

Address: Lot 2 Rada Road, Kettering 7155 (CT 129908/2)

Date of inspection: 15/05/2024

Building type: New house

Planning Overlays: Landslide hazard (low)

Mapped Geology - Mineral Resources Tasmania 1:50 000 Southeast sheet: **Jd** = Jurassic dolerite with nearby **Cs** = Cretaceous syenite and **Qts =** Quaternary talus, predominantly syenite.

Soil Depth: 0.2 – 0.7 m

Subsoil Drainage: Imperfectly drained

Vegetation: bush

Rainfall in previous 7 days: Approximately 10 mm

Slope: Approximately 15° NE

Introduction

The proposed development (dwelling and driveway cutting) at Lot 2 Rada Road, Kettering, are in a Low Landslide Hazard Band overlay (Figure 1). According to Mineral Resources Tasmania (MRT), the modelled areas have no known active landslides but are identified as *susceptible* to land sliding. These areas are so classified due to slope angle – in this case *"Remaining areas slopes 11-20 degrees".*

This report addresses the surrounding landform, soil materials and local geomorphology to assess the potential for landslip to occur. The associated likelihood and risks with the potential landslide hazard are examined and best practice mitigation measures are recommended to ensure a tolerable risk can be achieved and maintained.

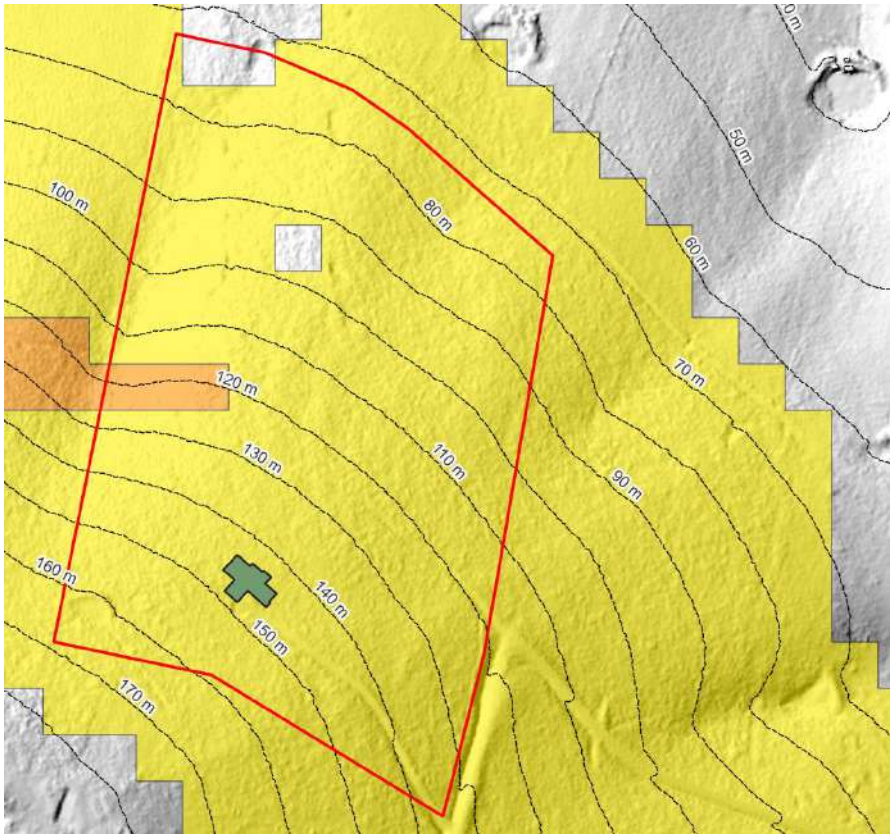


Figure 1: Proposed development envelope at Lot 2 Rada Road, Kettering with MRT Landslide Hazard overlay (yellow), proposed house (green) and 10 m contours shown.

Geomorphology, Soils and Geology

The proposed development (house, driveway and associated cut and fill operations) is located on NE facing slope of a dolerite and syenite hill. Slope angles at the site are approximately 10-15°. The slope is uniform without any major open depressions. Therefore, concentrated run-off flows are not expected in or around the building area. Relatively uniform sheet flow will occur (Appendix 5).

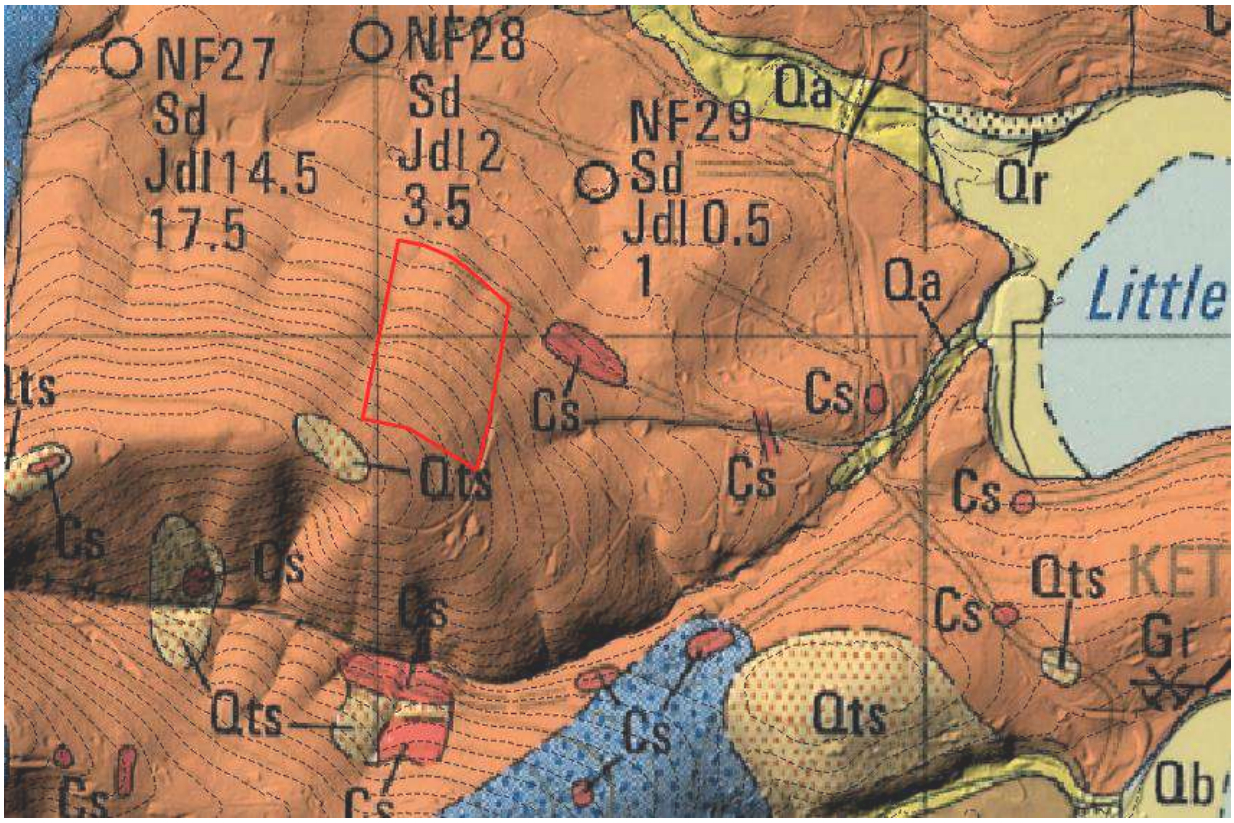


Figure 2: Mapped geology in the environs around Lot 2 Rada Road, Kettering from Mineral Resources Tasmania Geology 1:50,000 Kingborough sheet. Orange areas are mapped as Jurassic dolerite, red = Cretaceous syenite, and yellow with stippled red = Quaternary talus of syenite.

The soil profiles are formed from gravelly, clayey colluvium derived from the underlying Cretaceous syenite rock. A stone line of weathered syenite gravel and boulders is present between approximately 0.2 -0.4 m depth. The profiles are shallow, with test hole and DCP refusal at approximately 0.2 – 0.85 m on slightly weathered syenite bedrock.

Geotechnical Assessment of Landslip Hazard

The proposed development at Lot 2 Rada Road, Kettering has a Landslide Hazard Area (Low) overlay. The overlay is produced by:

- Recording observations of land instability in and surrounding the study area (the landslide database).
- Analysis of the processes that control each landslide type.
- Computer-assisted modelling that simulates each of the landslide processes to predict areas that could be affected by future landslides.

The proposed development area falls under the Tasmanian Interim Planning Scheme - Kingborough - State Planning Provisions Code E3.0 Landslide Code.

According to section E3.2.1, This Code applies to:

a) Development for buildings and works or subdivisions on land within a Landslide Hazard Area.
b) Use of land for vulnerable use or hazardous use within a Landslide Hazard Area.

The site is assessed according to E3.7.3 (Major Works) of the Scheme. This geotechnical advice on the site considers several important and specific parameters pertinent to the area.

Potential for Mass Movement of Soil and Geological Materials

The proposed development area is on moderately steep slopes of up to 10 – 15° (Appendix 4), with established stands of White Peppermint and associated woodland species. Two auger holes and two DCP tests, revealed soil regolith up to 0.85 m deep, with thin layers of highly reactive clay subsoil.

Elevated water content is a common trigger mechanism for landsliding in unconsolidated soil regolith on steep slopes. The water-shedding landform (convex cross and downslope profile) suggests very minimal concentrated flows of run-on water toward the building and driveway areas.

Preliminary designs (Appendix 1 – house elevations) indicate maximum cut depths of approximately 1.6 m at the rear of the building. Given the shallow depth of unconsolidated soil

regolith and the proposed cutting depths, the adoption of suitable cut batter angles will mitigate any slope failure concerns.

Cretaceous syenite is, typically, a moderately to highly competent lithology, and founding onto the hard bedrock will mitigate any land-sliding concerns at the proposed building.

The soils are moderately to strongly structured and, thus, moderately freely draining. They are highly reactive but are only thin and have a high content of non-reactive gravels. As such, slow downslope soil creep may occur over time.

In its current state, the site appears stable regarding land sliding, with no evidence of deep-seated landslide hazards, i.e., 3 – 10 m of soft regolith, at the site or in the near vicinity.

Measures to Mitigate Against Instability

All fill material, if required, should be granular and placed in lifts of a maximum of 0.2 m in height and adequately compacted per AS3798-2007.

For all cuts (< 2.0 m) in unconsolidated rock or soil regolith should be appropriately drained and use a gentle 1V: 2H (vertical: horizontal). Cuts or cut sections into the hard, consolidated, syenite bedrock may utilise steeper batter angles (e.g. 3V: 1H).

Include a cut-off v-drain above the cutting and a graded toe drain immediately below the cutting face. Where fill is required for driveway construction, it should be granular and placed in lifts of a maximum of 0.2m in height and adequately compacted (per AS3798-2007).

Vegetation should be retained and maintained where possible as vegetation helps stabilise soils and associated slopes and utilises soil moisture (wet soils being significantly more prone to land sliding). Establishing (secured) topsoil and vegetation on unretained cut batters is recommended.

Modification of drainage on site may affect regolith stability. Drainage design should avoid water accumulation in the construction areas.

Appropriate sediment and erosion control measures to in place during all phases of construction. Minimising soil disturbance throughout the construction phase and adopt appropriate and safe management of run-off and run-on waters.

The risk of land instability within the proposed building envelope can be reduced via use of current best practice for construction on sloping sites (refer to extract: *Good hillside construction practice from the Australian Geomechanics Society (Appendix 3) and CSIRO BTF-18.*

E3.7.3 Major Works

Objective:

To ensure that landslide risk associated with major works in Landslide Hazard Areas, is:

a) acceptable risk; or
b) tolerable risk, having regard to the feasibility and effectiveness of measures required to manage the landslide hazard.

Acceptable Solution A1	**Comments**
No acceptable solution.	

Performance Solution P1	**Comments**
Buildings and works must satisfy all the following: a) no part of the buildings and works is in a High Landslide Hazard Area b) the landslide risk associated with the buildings and works is either: i. acceptable risk; or ii. capable of feasible and effective treatment through hazard management measures, so as to be tolerable risk.	 Complies It is recommended that: - the proposed dwelling is to be founded on the syenite bedrock at or maximum observed depth of 0.85 m. - suitable batter angles and landscaping techniques applied on all deeper cuts, including on the driveway and for the dwelling (as outlined in the mitigation strategies of this report).

	- appropriate site drainage be installed during the construction phase and maintained during occupation. Do not locate drainage outfall areas behind or around buildings nor onto excessively steep areas. Drain all run-on waters created by the driveway cutting and discharge safely to downslope soakage areas or wide swale drains across the contour.

Landslide Risk Analysis

Risk assessment of land sliding relates to a measure of the probability and severity of an adverse effect to health, property, or the environment:

The likelihood of occurrence of any form of mass movement, e.g., soil creep, debris flow, slumping, landslide, rock fall, etc, including its likely scale (size, area, volume), would be affected by the proposed location and scale of construction (buildings and driveway).

In this case, the likelihood of land sliding is LOW based on the data and information collected and assessed for this site. This can be reduced to a VERY LOW risk by following the recommendations in this report.

Consequences to life, property and services of such is reduced to LOW if the site is appropriately developed as specifically outlined in this report. Thus, the overall RISK of landsides will be reduced to LOW and remain so if these guidelines and recommendations are followed in full.

Rowan Mason
B.Agr.Sc.(Hons).
Soil Scientist

Dr Richard Doyle
B.Sc.(Hons),
M.Sc.(Geol), Ph.D. (Soil Sci.), CPSS (Certified Prof Soil Scientist)
Geologist and Soil Scientist

Appendix 1A – Side Elevations & Cut Depths

North West Elevation

Appendix 2 – Risk tables

Extracted from *Australian Geomechanics Journal Volume 42 No.1 March 2007 - Australian GeoGuide LR7 (Landslide Risk)*.

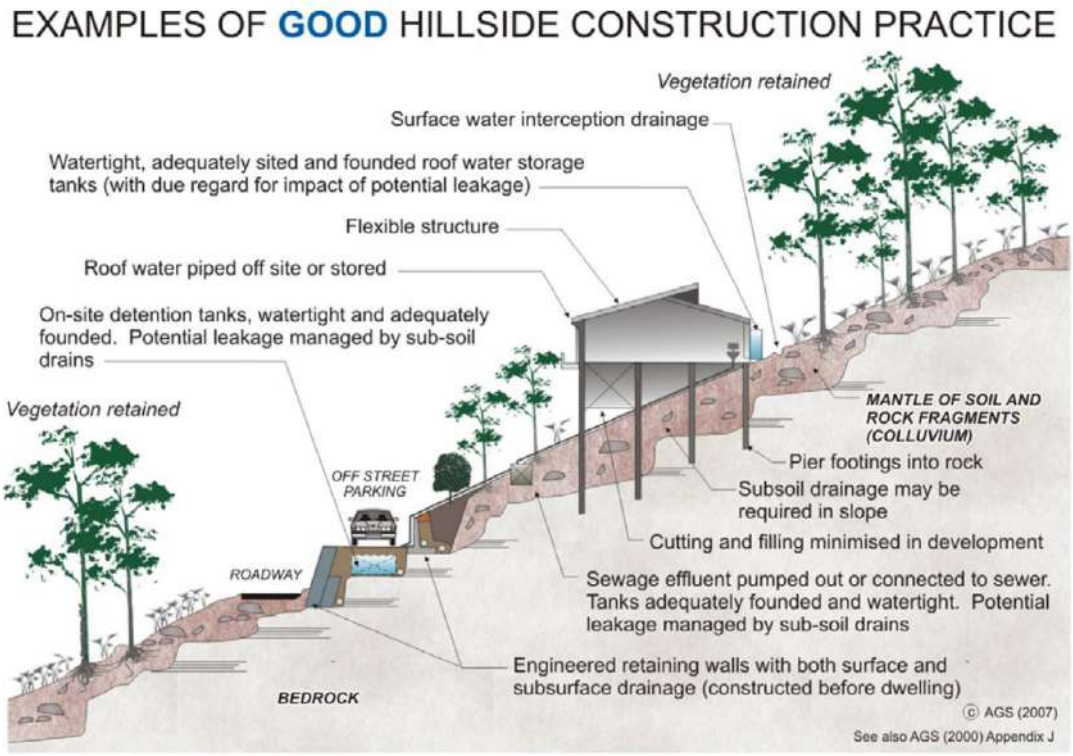
TABLE 1: RISK TO PROPERTY		
Qualitative Risk		**Significance - Geotechnical engineering requirements**
Very high	VH	**Unacceptable** without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low. May be too expensive and not practical. Work likely to cost more than the value of the property.
High	H	**Unacceptable** without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to acceptable level. Work would cost a substantial sum in relation to the value of the property.
Moderate	M	**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 possible.
Low	L	**Usually acceptable** to regulators. Where treatment has been needed to reduce the risk to this level, ongoing maintenance is required.
Very Low	VL	**Acceptable**. Manage by normal slope maintenance procedures.

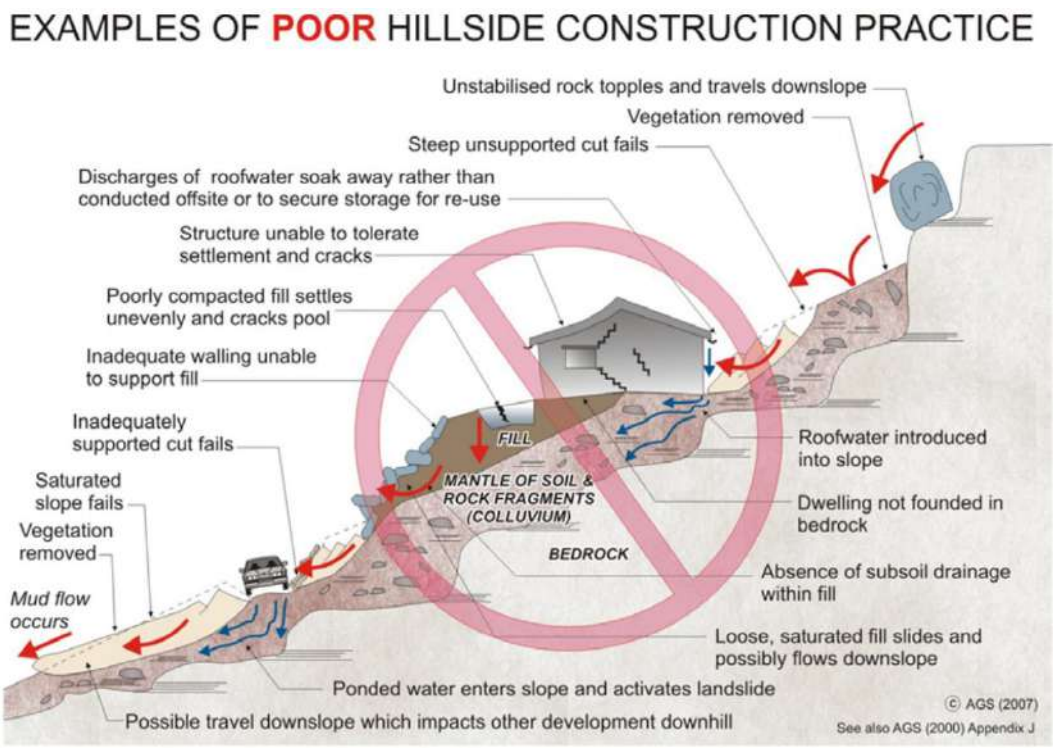
TABLE 2: LIKELIHOOD	
Likelihood	Annual Probability
Almost Certain	1:10
Likely	1:100
Possible	1:1,000
Unlikely	1:10,000
Rare	1:100,000
Barely Credible	1:1,000,000

TABLE 3: RISK TO LIFE	
Risk (deaths per participant per year)	**Activity/Event Leading to Death** (NSW data unless noted)
1:1,000	Deep sea fishing (UK)
1:1,000 to 1:10,000	Motor cycling, horse riding, ultra-light flying (Canada)
1:23,000	Motor vehicle use
1:30,000	Fall
1:70,000	Drowning
1:180,000	Fire/burn
1:660,000	Choking on food
1:1,000,000	Scheduled airlines (Canada)
1:2,300,000	Train travel
1:32,000,000	Lightning strike

Appendix 3 – Guidelines for hillside construction

Extracted from *Australian Geomechanics Journal Volume 42 No.1 March 2007 - Australian GeoGuide LR8 (Construction Practice)*.

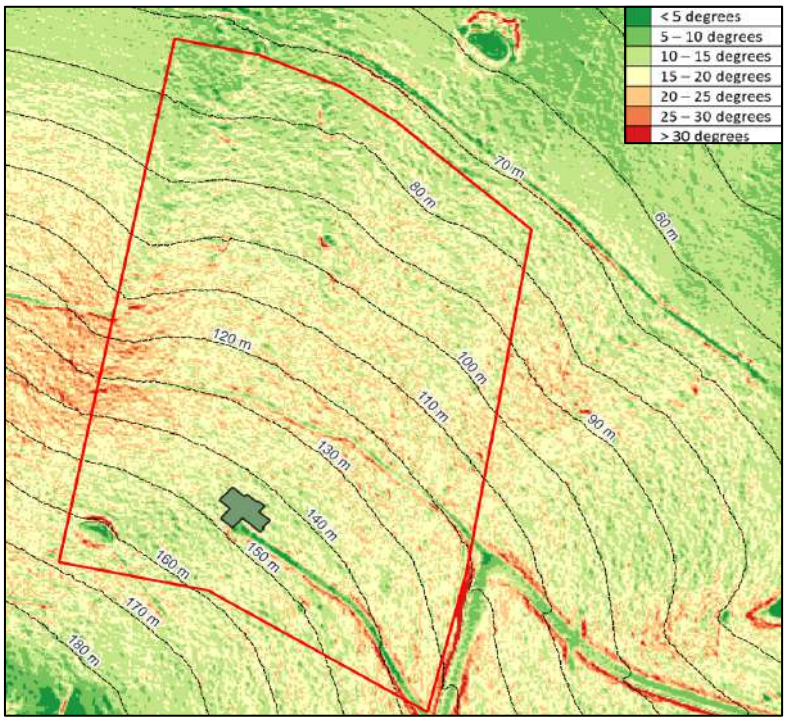




Appendix 4 – Map: Localised slope angle

Generated using QGIS with open source 1m Digital Elevation Model (DEM) data (source: elevation.fsdf.org.au) and cadastre shape data (source: maps.thelist.tas.gov.au/listmap).

The development is on slope angles of approximately 10-15°.



Appendix 5 – Map: Flow Accumulation Model

Surface water flow accumulation model (qualitative) projected over aerial photo of Lot 2, Rada Rd, Kettering. Generated using QGIS with open source 1m Digital Elevation Model (DEM) data (source: elevation.fsdf.org.au) and cadastre shape data (source: maps.thelist.tas.gov.au/listmap).

Note: The uniform slope form means very minor flows of surface water run-on are directed toward to area of development.

Appendix 6 – Site Assessment and Sample Testing

A geotechnical site investigation in accordance with AS1726-2017.

- Two test hole (TH) cores:
  - TH1 with refusal at 0.85 m
  - TH2 with refusal at 0.7 m
- Two DCP tests:
  - DCP2 with refusal at 0.6 m
  - DCP2 with refusal at 0.2 m
- Emerson Dispersion test on subsoils and linear shrinkage tests on all likely founding layers

- Test holes dug using a Christie Post Driver Soil Sampling Kit, comprising CHPD78 Christie Post Driver with Soil Sampling Tube (50 mm OD x 1600/2100 mm)

Appendix 7 – Linear Shrinkage and Soil Reactivity

Samples of the clayey subsoils were tested for reactivity using the linear shrinkage test. Linear shrinkage provides an approximate guide to aid soil classification of reactivity of clays for foundations. The tests indicate the clays Class H-1, indicating the subsoil clay layers are highly reactive – noting that the clayey subsoil are relatively this (up to 0.4 m)

Appendix 8 – Emerson Aggregate Dispersion

Samples of the clayey subsoils were tested for dispersion susceptibility using the Emerson Aggregate test. Aggregate dispersion provides an approximate guide to estimate possible erosion, and in particular tunnels leading to eventual gully erosion. A field survey of the (undisturbed) property and the surrounding area found no erosion due to soil dispersion. Testing resulted in Emerson class 2(2), i.e., slight dispersive characteristics.

Appendix 9 – SOIL PROFILES

Test Hole 1

Depth (m)	Horizon	Description and field texture grade	USCS Class
0 – 0.2	A1	Greyish brown (10YR 5/2), **Gritty Sandy Clay Loam,** dry loose consistency, strong fine angular blocky structure, few roots.	**SC**
0.2 – 0.3	A2	Light brownish grey (10YR 6/2), **Clayey Gravel,** abundant 5-20mm angular gravels in clayey matrix, single grain, dry hard consistency, slightly dilatant.	**GC**
0.3 – 0.7	B2	Grey (10YR 6/1), **Gritty Sandy Light Clay,** very strong medium angular blocky structure, abundant red angular gravels, dry very hard and stiff consistency.	**CH**
0.7 – 0.85	Cw	Light olive grey (2.5Y 6/2), **Gravel with minor fines.** Refusal on Syenite bedrock	**GC**

Test Hole 2

Depth (m)	Horizon	Description and field texture grade	USCS Class
0 – 0.1	A1	Greyish brown (10YR 5/2), **Gritty Sandy Clay Loam,** dry loose consistency, strong fine angular blocky structure, few roots.	**SC**
0.1 – 0.4	A2	Light brownish grey (2.5Y 6/2), **Sandy Clay Loam,** single grain, dry loose consistency, common fine gravels and a few larger gravels, slightly dilatant.	**SC**
0.4 – 0.6	B2	Grey (10YR 6/1), **Gritty Sandy Light Clay,** very strong medium angular blocky structure, abundant red angular gravels, dry very hard and stiff consistency.	**CH**
0.6 – 0.7	R	Refusal on hard Syenite bedrock.	

Appendix 10 – DCP Testing

The data from DCP 1 and 2 indicate that the bearing capacity of gravelly, rock-talus derived soil is at a suitable strength below 0.3 m. However, the highly competent syenite bedrock at approximately 0.3 – 0.85 m would be the *recommended* foundation material.

DCP 1				
Depth (mm)	**DCP n-number (Blows/100 mm)**	**DCP Penetration Index (mm/Blow)**	**Estimated Bearing Capacity (kPa = n x 30)**	**Likely Variance (+/-)**
0 - 100	6	16.7	180	60
100 - 200	19	5.3	570	190
200 - 300	7	14.3	210	70
300 - 400	12	8.3	360	120
400 - 500	14	7.1	420	140
500 - 600	20	5.0	600	200

DCP 3				
Depth (mm)	**DCP n-number (Blows/100 mm)**	**DCP Penetration Index (mm/Blow)**	**Estimated Bearing Capacity (kPa = n x 30)**	**Likely Variance (+/-)**
0 - 100	15	6.7	450	150
100 - 200	23	4.3	690	230

CERTIFICATE OF QUALIFIED PERSON – ASSESSABLE ITEM

Section 321

Form **55**

To: Another Perspective *Owner name*

Level 1, 67 Letitia St *Address*

North Hobart 7000 *Suburb/postcode*

Qualified person details:

Qualified person: Richard Doyle

Address: 6/76 Auburn Rd

Kingston Beach 7050

Phone No: 0488 080 455

Fax No:

Licence No: N/A

Email address: robyn@doylesoilconsulting.com.au

Qualifications and Insurance details: Geologist and Soil Scientist PhD
Certified Professional Soil Scientist (CPSS)
Professional Indemnity cover –

About Underwriting -Lloyd's of London
ENG 21 000305

(description from Column 3 of the Director's Determination - Certificates by Qualified Persons for Assessable Items

Speciality area of expertise: Geotechnical Assessment

(description from Column 4 of the Director's Determination - Certificates by Qualified Persons for Assessable Items)

Details of work:

Address: Lot 2 Rada Rd

Kettering 7155

Lot No: 2

Certificate of title No: 129908/2

The assessable item related to this certificate: Classification of foundation conditions according to AS2870-2011

(description of the assessable item being certified)
Assessable item includes –
- *a material;*
- *a design*
- *a form of construction*
- *a document*
- *testing of a component, building system or plumbing system*
- *an inspection, or assessment, performed*

Certificate details:

Certificate type: Geotechnical Assessment

(description from Column 1 of Schedule 1 of the Director's Determination - Certificates by Qualified Persons for Assessable Items n)

This certificate is in relation to the above assessable item, at any stage, as part of - *(tick one)*

building work, plumbing work or plumbing installation or demolition work: X

or

a building, temporary structure or plumbing installation:

In issuing this certificate the following matters are relevant –

Documents:	The attached Geotechnical Assessment Report for the address detailed above in, 'Details of Work'.
Relevant calculations:	Refer to above report.
References:	AS1726-2017 Geotechnical site investigations CSIRO Building Technology File -18

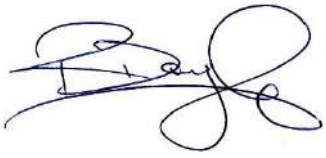
Substance of Certificate: *(what it is that is being certified)*

Geotechnical Assessment -Slope stability

Scope and/or Limitations

The classification applies to the site as inspected and does not account for future alteration to foundation conditions as a result of earthworks, drainage condition changes or variations in site maintenance.

I certify the matters described in this certificate.

	Signed:	*Certificate No:*	*Date:*
Qualified person:		1619	20/09/2024