LANDSLIDE ASSESSMENT REPORT

203 Woodbridge Hill Road

Woodbridge

January 2024

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

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Founding Statement

Dr Richard Doyle is a highly qualified geologist, geomorphologist and soil scientist with over 38 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 29 years and co-supervised >30 honours/master students, and 22 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: Laura Miñami and Zlatko Paksec

Address: 203 Woodbridge Hill Road, Woodbridge (CT 149070/1)

Site Area: Approximately 1.52 ha

Date of inspection: 11/01/2024

Building type: New house

Planning Overlays: Scenic landscape area; Landslide Hazard area (low); Biodiversity protection area; Bushfire prone area

Mapped Geology - Mineral Resources Tasmania 1:50 000 Kingborough sheet:
Jd = Jurassic dolerite

Soil Depth: 0.75 – 1.0 m

Subsoil Drainage: moderately well drained

Drainage lines/water courses:

Vegetation: pasture

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Rainfall in previous 7 days: Approximately 12 mm

Slope: Variable approx. 8 - 21°around ridge/spur

Introduction

The proposed dwelling and driveway cutting at 203 Woodbridge Hill Rd, Woodbridge, are located 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. This area is 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.

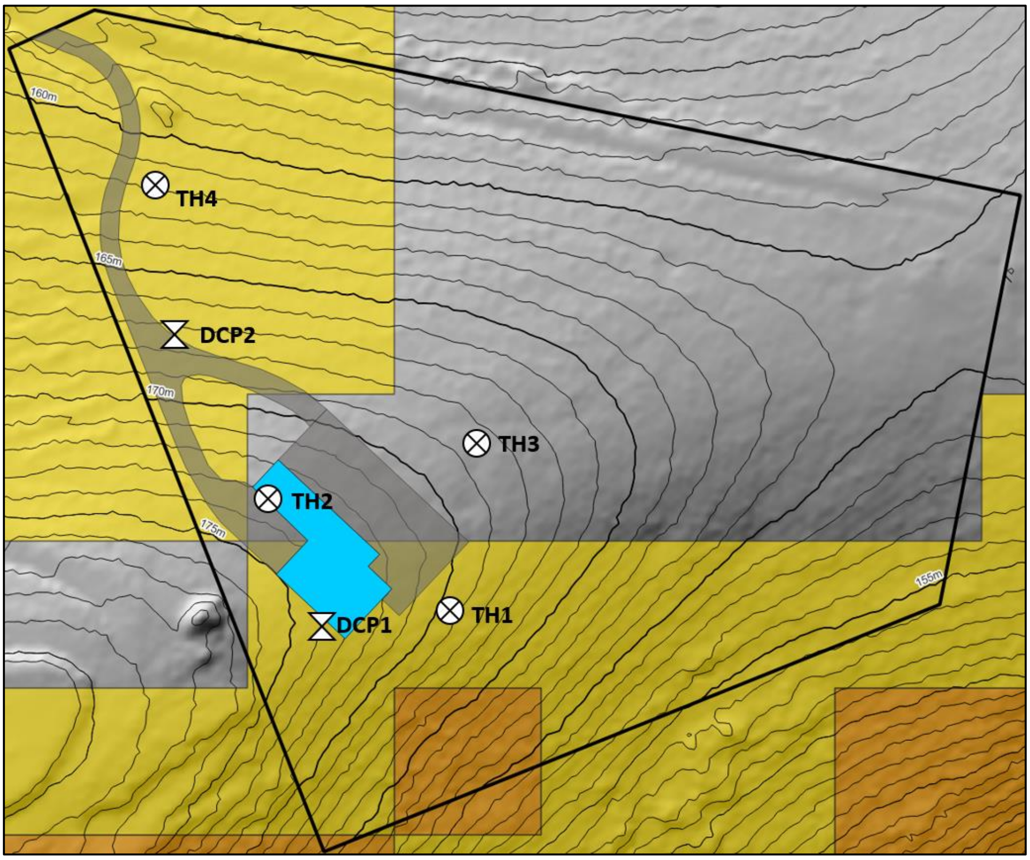

Figure 1: 203 Woodbridge Hill Rd, Woodbridge with MRT Landslide Hazard overlay (yellow= Low hazard band; orange = Medium hazard band. House site (blue) and driveway/raised levelled arena (grey) shown, along with test hole and DCP locations.

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Geomorphology, Soils and Geology

The proposed development (dwelling, driveway cutting and onsite wastewater management system) are located on a ridge (W-E) with local anlges upto 30° on the southern face of the ridge. Slope angles within the development area range from approximately 15-20° (Appendix 4). The landform at the site will naturally shed surface water flows (Appendix 5).

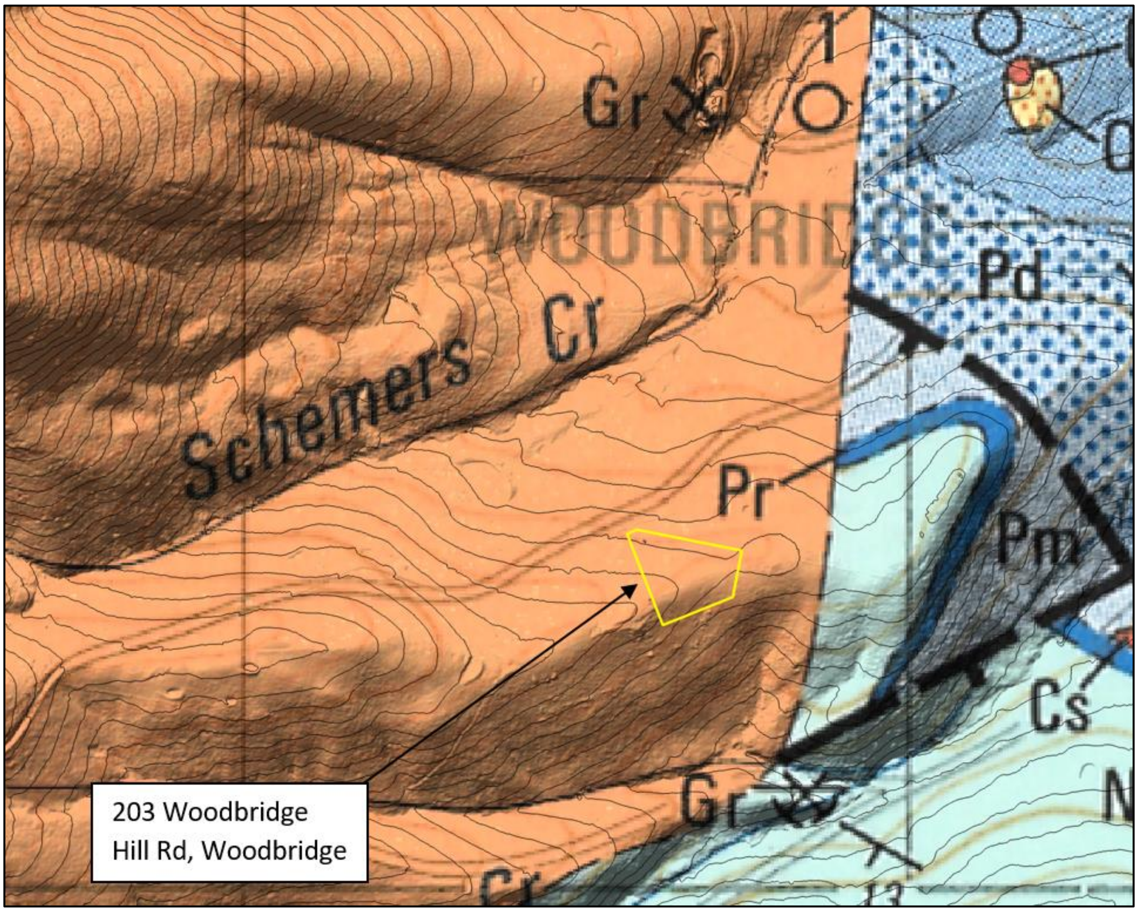

Figure 2: Mapped geology in the environs around 203 Woodbridge Hill Rd, Woodbridge from Mineral Resources Tasmania Geology 1:50,000 Kingborough sheet. Orange = areas mapped as Jurassic Dolerite and all blue shades = areas mapped as Permian sediments.

The soil profiles are formed from clayey colluvium derived from Jurassic dolerite with common dolerite floaters in the upper horizons. The profiles are moderately shallow with test hole and DCP refusal on weathered dolerite bedrock occurring between 0.75 and 1.0 m (see Figure 3 below)

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Figure 3: Shallow cutting into the hard weathered dolerite bedrock. Cutting forms the roadside stormwater drain at the north of the site.

Common surface cracks, up to 100 mm wide, and localised "hummocks" and "hollows" in the land indicate the clays at the site are highly reactive and may slowly creep downslope. Results from the linear shrinkage test support this, with the topsoil and subsoils being moderately to highly reactive.

Geotechnical Assessment of Landslip Hazard

The proposed development at 203 Woodbridge Hill Rd, Woodbridge 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 Planning Scheme – Huon Valley - State Planning Provisions Code E3.0 Landslide Code.

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

a) Development for buildings and works or subdivision 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 approximately 15 – 20° (Appendix 4) with majority pasture cover. Four auger holes and two DCP tests, revealed 0.75 – 1.0 m of clay colluvium over hard Jurassic dolerite bedrock.

The naturally water shedding landform (convex cross and downslop profile) suggests minimal flows or concentrated run-on water (a common triggure mechanism for landsliding).

Jurassic dolerite bedrock is, typically, a very competent lithology and founding onto the hard dolerite bedrock will mitigate any land-sliding concerns at the proposed dwelling. However, if pockets of more deeply weathered bedrock are encountered (a common property of jointed weathering in dolerite), deeper, less consolidated, materials may have higher potential for localised mass movement if undermined or subjected to concentrated flows of water (surface or subsurface).

Preliminary design plans (Appendix 1) indicate cutting to approx. 1.75 m depth, topped with fill materials approximately 1.75 m, resulting in an approx. 3.5m face of cut/filled materials. Appropriate

In its current state, the site appears stable regarding land sliding, with minor evidence of downslope soil creep due to reactivity. There is no evidence of more 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 cuts > 2.0 m will require a suitably engineered design solutions e.g., for retaining walls or structures if required including appropriate drainage both above and below the cutting – i.e.,

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at the deep (~3.5 m) cut/fill face at the rear of the ground floor. All fill material should be granular and placed in lifts of maximum 0.2 m in height and adequately compacted per AS3798-2007.

For cuts < 2.0 m, e.g., cut slopes for the construction of the driveway if unconsolidated rock or soil regolith occurs this should be appropriately drained and use a gentle 1:2 (vertical:horizontal) batter angles at the upper part of such cuts in otherwise competent dolerite. Cuts into the hard consolidated dolerite bed rock may utilise a steeper e.g. 3V:1H batter angle, unless deep jointing in the rock is revealed when cut. In this case, a moderate (1V : 1H) should be used.

Driveway cuttings should include a cut-off v-drain above the cutting and a graded toe drain immediately below the cutting face. Where fill is required driveway construction it should also be granular and placed in lifts of maximum 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 are significantly more prone to land sliding.

The (OWMS) should designed to spread the effluent application as wide as possible on the site. It is recommended that the shallow terraced absorption trenches be sited so they are out of the landslip overlay areas.

We suggest that appropriate sediment and erosion control measures are in place during all phases of construction and thought be given to minimising soil disturbance throughout the construction phase along with appropriate and safe management of run-off and run-on waters.

Modification of drainage on site (particularly the driveway cutting) may affect regolith stability if , as excess water destabilises loose or soft surface (<0.5 m) sediments – therefore drainage design should avoid water accumulation in the construction area

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.*

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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	Complies
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.	It is recommended that: - the proposed dwelling is to be founded on the dolerite bedrock at or below approx. 0.75 – 1.0 m in most areas. - minimal land and native vegetation disturbance occurs during construction phase. Further - tree, shrub and deep-rooted grassy vegetation be re-established on the steepest slopes to stabilise against water erosion. - suitable retention, batter angles and landscaping techniques applied on all deeper cuts, including on the driveway and for the dwelling (as outline in the text of this report). - appropriate drainage be installed during the construction phase and maintained during occupation

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:

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 (house 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.

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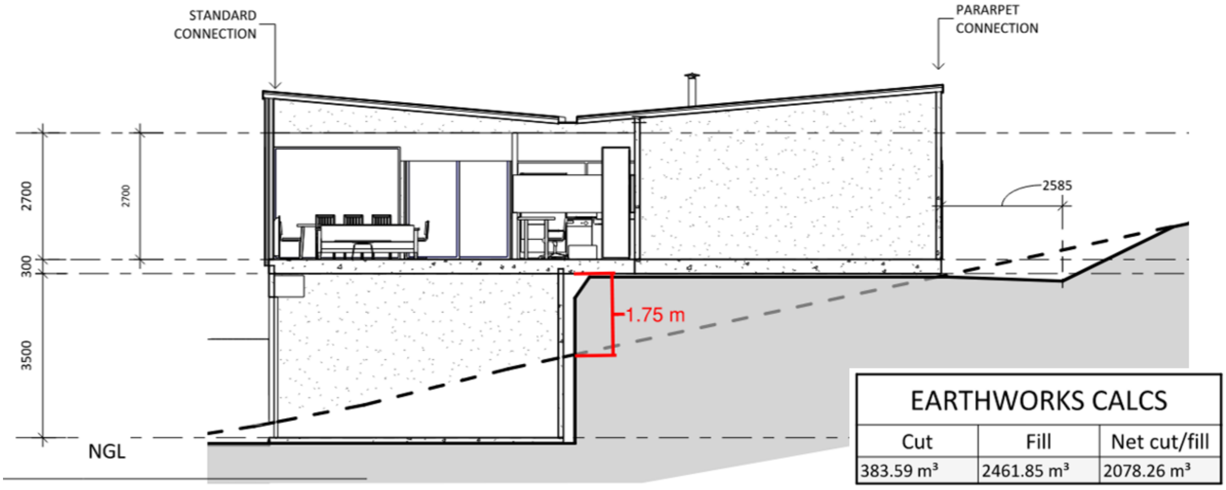
Appendix 1 – Side Elevation



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)

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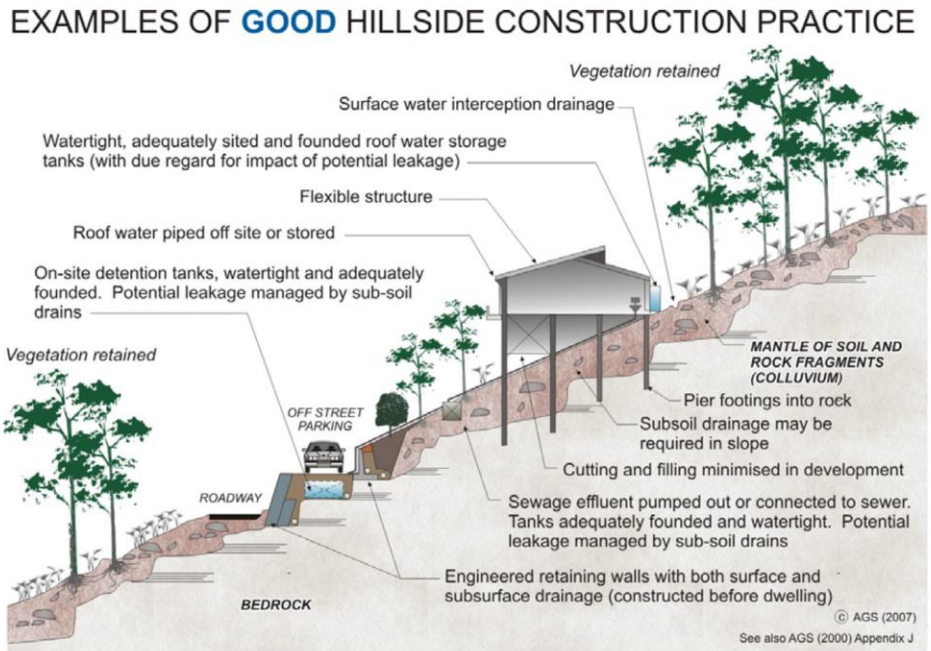
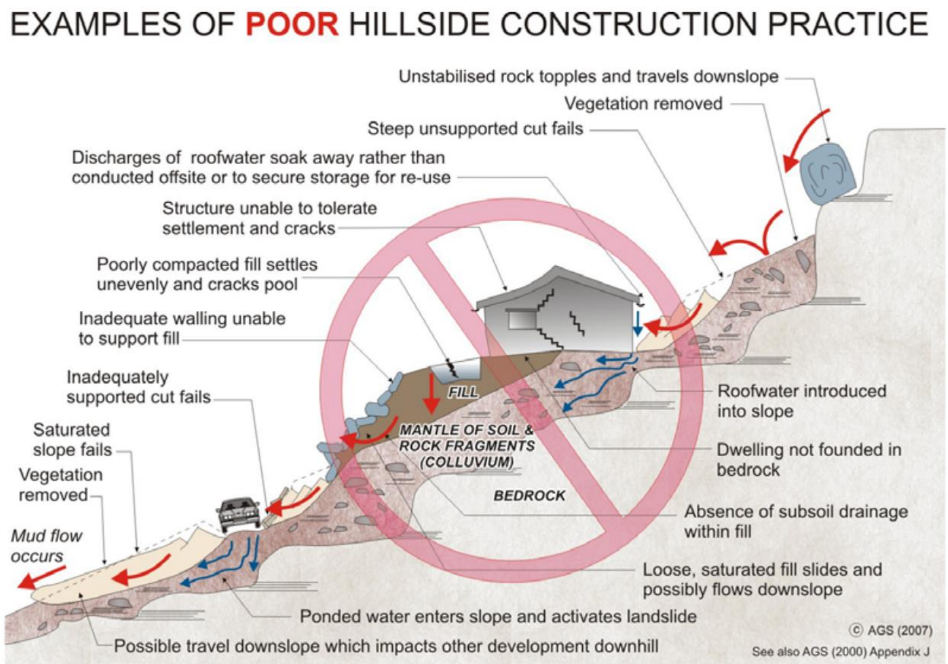
1:23,000	Motor vehicle use
1:30,000	Fall
1:70,000	Drowning
1:180,000	Fire/burn
1:660,000	Choking on food
1:1,000,000	Scheduled airlines (Canada)
1:2,300,000	Train travel
1:32,000,000	Lightning strike

Appendix 3 – Guidelines for hillside construction

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

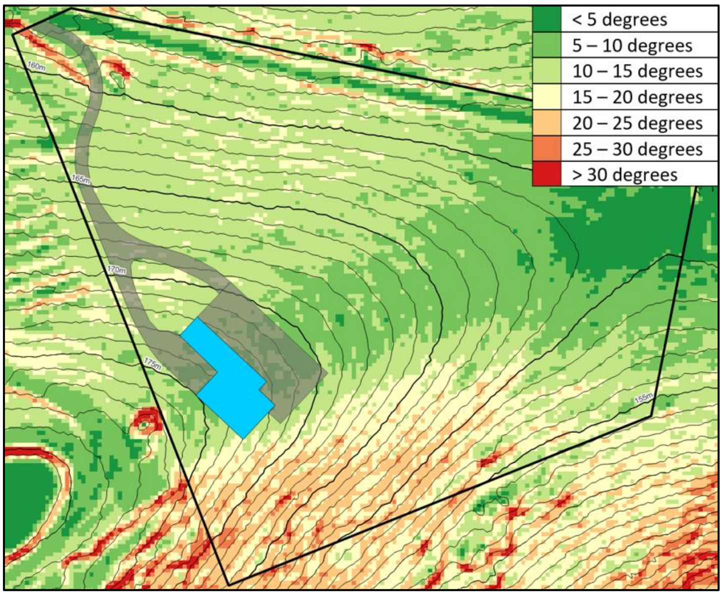




Appendix 4 – Map: Localised slope angle

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).

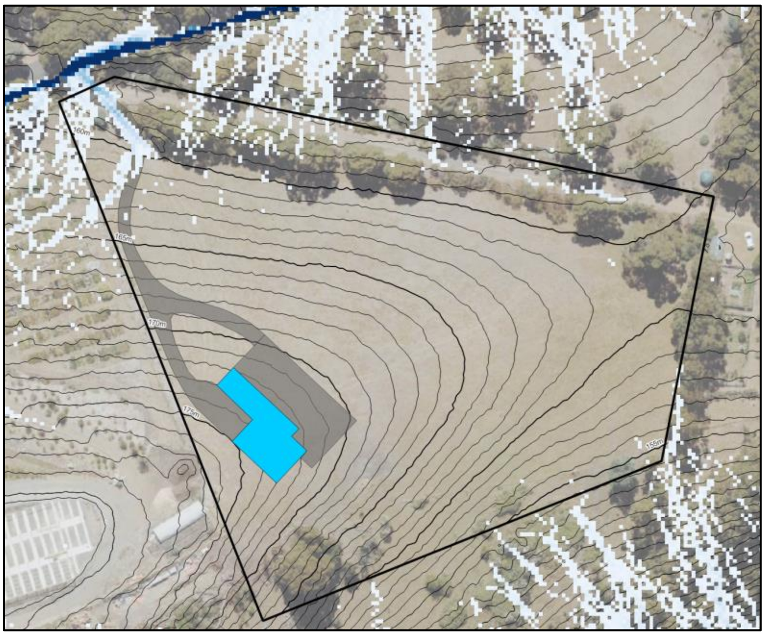
The areas of proposed develoment are on 10-15° slopes.



Appendix 5 – Map: Flow Accumulation Model

Surface water flow accumulation model (qualitative) projected over hill shade base map of 234 Knights Rd, Huonville. 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: Concentrated flows of surface water run-on are minimal in the across the property, especially in the areas of proposed development.



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Appendix 6 – Site Assessment and Sample Testing

A geotechnical site investigation in accordance with AS1726-2017.

- Three test hole (TH) cores:
    - TH1 with refusal at 1.0 m
    - TH2 with refusal at 0.8 m
    - TH3 with refusal at 0.75 m
    - TH4 with refusal at 0.9 m
- Three DCP tests:
    - DCP2 with refusal at 0.8 m
    - DCP2 with refusal at 0.8 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. However th

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 property and the surrounding area found no erosion due to soil dispersion. Testing resulted in Emerson class 2(1), i.e., slight dispersive characteristics.

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Appendix 9 – SOIL PROFILES – Test Holes 1 - 4

Test Hole 1

Depth (m)	Horizon	Description and field texture grade	USCS Class
0 – 0.05	A1	Brown (10YR 4/3) **Sandy Light Clay**, strong fine angular blocky structure, single grain, dry medium dense consistency, abundant roots.	**CL/CH**
0.05 – 0.3	$B2_1$	Brown (10YR 5/3) with organic coatings of peds/down cracks, **Gritty Light Clay**, strong medium angular blocky structure, slightly moist stiff consistency, few roots, few gravels.	**CL/CH**
0.3 – 0.6	$B2_2$	Light olive brown (2.5Y 5/3) **Gritty Light Clay**, massive breaking to weak coarse blocky structure.	**CL/CH**
0.6 – 0.8	BC	Light yellowish brown (2.5Y 6/4) **Gritty Clay Loam**, strong fine angular blocky structure, single grain, dry dense consistency.	**SC**
0.8 – 1.0	C_w	Mixed grey (2.5Y 5/1) and light olive brown (2.5Y 5/3), **Clayey gravel**, single grain, common dolerite gravels, dry dense consistency. <u>Refusal.</u>	**GC**

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Depth TH2 (m)	Depth TH3 (m)	Horizon	Description and field texture grade	USCS Class
0 – 0.1	0 – 0.1	A1	Brown (10YR 4/3) **Sandy Light Clay**, strong fine angular blocky structure, single grain, dry medium dense consistency, abundant roots.	**CL/CH**
0.1 – 0.5	0.1 – 0.3	$B2_1$	Olive brown (2.5Y 4/3) **Sandy Light Clay**, massive breaking to weak medium blocky structure, few green mottles, slightly moist stiff consistency, trace of charcoal.	**CL/CH**
0.5 – 0.65	0.3 – 0.5	$B2_2$	Light yellowish brown (2.5Y 6/4), **Gritty Light Clay**, massive breaking to weak medium blocky structure, slightly moist firm consistency.	**CL/CH**
0.65 – 0.8	0.5 – 0.75	Cw	Mixed grey (2.5Y 5/1) and light olive brown (2.5Y 5/3), **Clayey gravel**, single grain, common dolerite gravels, dry dense consistency. <u>Refusal.</u>	**GC**

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Test Hole 4

Depth (m)	Horizon	Description and field texture grade	USCS Class
0 – 0.1	A1	Brown (10YR 4/3) **Sandy Light Clay**, strong fine angular blocky structure, single grain, dry medium dense consistency, abundant roots.	**CL/CH**
0.1 – 0.5	$B2_1$	Olive brown (2.5Y 4/3) with organic coatings down cracks, **Sandy Light Clay**, strong medium angular blocky structure, few green mottles, slightly moist stiff consistency, trace of charcoal at 0.20 m.	**CL/CH**
0.5 – 0.6	$B2_2$	Light yellowish brown (2.5Y 6/4), **Gritty Light Clay**, massive breaking to weak medium blocky structure, slightly moist firm consistency.	**CL/CH**
0.6 – 0.7	BC_1	Light yellowish brown (2.5Y 6/4) **Gritty Clay Loam**, strong fine angular blocky structure, single grain, dry dense consistency.	**SC**
0.7 – 0.9	CW	Mixed grey (2.5Y 5/1) and light olive brown (2.5Y 5/3), **Clayey gravel**, single grain, common dolerite gravels, dry dense consistency. Refusal.	**GC**

Appendix 10 – DCP Testing

The subsoils were slightly moist to moist when tested and so the field DCP values are likely to be higher than in very moist to saturated soil conditions (i.e., winter/spring).

The data from DCP 1 and 2 indicate that the bearing capacity of the soil is at a suitable strength below 0.6 – 0.8 m, i.e., on the weathered dolerite bedrock. This is the recommended foundation material.

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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	5	20.0	150	50
100 - 200	8	12.5	240	80
200 - 300	4	25.0	120	40
300 - 400	3	33.3	90	30
400 - 500	2	50.0	60	20
500 - 600	3	33.3	90	30
600 - 700	9	11.1	270	90
700 - 800	40	2.5	1200	400

DCP 2				
Depth (mm)	**DCP n-number (Blows/100 mm)**	**DCP Penetration Index (mm/Blow)**	**Estimated Bearing Capacity (kPa = n x 30)**	**Likely Variance (+/-)**
0 - 100	3	33.3	90	30
100 - 200	4	25.0	120	40
200 - 300	4	25.0	120	40
300 - 400	3	33.3	90	30
400 - 500	3	33.3	90	30
500 - 600	8	12.5	240	80
600 - 700	18	5.6	540	180
700 - 800	40	2.5	1200	400

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