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Introduction

Client: Jenny Wang
Date of inspection: 21/3/2019
Location: 72 Sproules Road, Snug
Land description: Approx. 2ha rural residential lot
Building type: Proposed new dwelling
Investigated by: A. Plummer

Background information

Map: Mineral Resources Tasmania 1:50 000 Kingborough Sheet
Rock type: Jurassic dolerite
Soil depth: 0.2 – 1.20m
Planning overlay: Biodiversity Protection Area
Scenic Landscape Area
Landslide Hazard Area – Low
Bushfire Prone Area
Local meteorology: Annual rainfall approx 600 mm
Local services: Tank water and onsite wastewater disposal required.

Site conditions

Slope and aspect: Approx. 8-14° slope to the South
Site drainage: Moderately well to Imperfectly drained
Vegetation: Mixed native vegetation and grasses
Weather conditions: Overcast, approx. 10mm rainfall received in preceding 7 days.
Ground surface: Disturbed soil surface

Investigation

A number of excavations were completed to identify the distribution of, and variation in soil materials on the site. One representative excavation was chosen for classification of soil and geological materials on the site.
Profile summaries

<table>
<thead>
<tr>
<th>Hole 1 Depth (m)</th>
<th>Hole 2 Depth (m)</th>
<th>Hole 3 Depth (m)</th>
<th>Horizon</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0.0 – 0.20</td>
<td>A1</td>
<td>Dark Brown CLAYEY SAND (SC), weak polyhedral structure, moist medium dense consistency, gradual boundary to</td>
</tr>
<tr>
<td>0 – 0.20</td>
<td>0.20 – 0.60</td>
<td>B2</td>
<td></td>
<td>Dark Brown and Yellowish Brown GRAVELLY CLAY (CH), moderate angular structure, slightly moist very stiff consistency, high plasticity, gradual boundary to</td>
</tr>
<tr>
<td>0 – 0.20</td>
<td>0.20 – 0.40</td>
<td>0.60 – 1.20</td>
<td>BC</td>
<td>Yellowish Brown CLAYEY GRAVEL (GC), weak structure, slightly moist dense consistency, refusal on rock</td>
</tr>
</tbody>
</table>

Soil profile notes

Profile 1 shows a typical residual soil developing on Jurassic Dolerite with moderate clay content, medium plasticity, and an estimated design movement ($Y_s$) of up to 40 mm (AS2870-2011 Class M). A shallow profile and a low content of large boulders in the profile indicate that these soils are the accumulated products of localised weathering rather than slope deposits. The site is predominantly covered with residual soils, and appears stable in its present form, with no evidence of potential instability due to unconsolidated sediments/boulders.

AS2870 Site Classification

According to AS2870-2011 for construction the natural soils are classified as Class M, that is slightly reactive clays with an estimated design movement ($Y_s$) of approximately 40 mm.

Geotechnical Assessment of site stability

Site and published geological information was integrated to complete a detailed geotechnical assessment of the site according to the principles outlined in AS1726-1993 Geotechnical Site Investigations and the Australian Geomechanics Society (2007).
Site location and context
The proposed development site is located on Jurassic aged dolerite, in an upper slope position. The site has a moderately steep slope of up to 12° below the house site, but the construction area is flatter (approx. 10°) and the slope morphology shows no visible signs of past land instability. The site is not in a declared landslip zone, but is close to an area mapped by Mineral Resources Tasmania (Mazengarb 2004) as having possible geological hazards. However, in accordance with local government requirements a thorough investigation of each of the possible land instability hazards has been undertaken in the following sections.

Figure 1 – Site location

Geological setting
The site is underlain by Jurassic aged dolerite with vertical jointed structure and common weathering zones along vertical joints. The rock at depth has a relatively high load point index, but the blocky structure and weathering zones should allow for excavation for construction. The excavated profiles examined in the current development area appear to be stable in its present state. Therefore, the local geology confirms the general stable nature that Jurassic dolerite is renowned for. Sites developing on Jurassic dolerite on East facing slopes
generally feature shallow residual soils less than 1m in depth with medium reactivity, therefore the parent material generally imparts a low geological hazard to a site. However, where deeper weathered soils or colluvial deposits overly the bedrock, then localised slope stability may be an issue as some of the dolerite soils can be prone to soil creep. The soils examined in site appear to be largely residual in their nature and the profiles are generally less than 1.0m in depth, therefore the risk posed by the underlying geology of the site is rated as low.

![Figure 2 – Extract from Mineral Resources Tasmania 1:25000 Geological Sheet](image)

**Potential for landslide**

The site has a moderately steep south facing slope of approximately 6-12°, with vegetative cover of mixed scrub and forest species. The excavations on site revealed Jurassic dolerite overlain by well consolidated natural soils. The slope angle in the construction area is generally less than 12°, and the slope is far less than the modelled instability threshold for dolerite bedrock in the MRT hazard analysis of over 50° (Mazengarb 2004).

There was no evidence of landslip or soil creep, notably those trees still present on the site on the slope were growing straight and vertical. Further, the ground surface showed no hummocks, terracing or patterns from past slips or soil creep. The site therefore appears stable in its present state, and there is no evidence of movement of soil materials on site. The
assessment of possible land instability has three possible risk classes; debris slide, deep seated movement, and rock fall hazard.

**Deep seated instability**

The local area is not listed as a possible deep seated instability hazard due to the geology and slope angles utilised in the modelling of Mazengarb (2004). Based upon field inspection of the Jurassic dolerite in the local area (exposed in the existing site cuttings) the sediments have undergone shallow weathering, and the exposed rock has a strong structure. Hence the risk of possible instability in the local area from exceptional conditions such as extreme rainfall/groundwater flows has been identified as low. The development area is located in a low identified hazard area, with slope angles just above the modelled threshold of 11 degrees. The development area including cleared bushfire management area and wastewater disposal area may reach the low hazard overlay mapped however the slopes are well below the published deep seated instability thresholds for dolerite.

![Figure 3– Extract from landslide hazard overlay (approximate building area in red), low hazard area yellow shading and medium hazard area in light brown shading](image-url)
Debris Flow hazard
The possibility of a debris flow in the highly weathered upper layer of the Jurassic dolerite in the local area has been modelled due to the moderate slope. In particular where excavation and filling has occurred there is a small possibility of shallow seated instability if the ground cover conditions altered. Field inspection on the subject site revealed predominantly shallow residual soils overlying weathered Jurassic dolerite with an inherent low potential for slope movement. Therefore, any shallow surface instability would only have some chance of occurring where deep and poorly placed fill is present. Therefore, the proposed construction of a residential dwelling/access is likely to result in minimal disturbance to the site in its present state, and no increase in the apparent risk of slope instability.

Rock fall hazard
The site has been mapped as free from potential rock fall hazard area. The lack of exposed steep scarps and exposed bedrock imparts a low risk classification.

Potential for foundation movement
The moderate slope and presence of clay subsoils must be considered in the design of the footings, but both factors do not preclude the design of serviceable footings. In particular, the depth (approx. maximum of 1.0m) and low plasticity of the underlying weathered gravels impart a low risk of significant ground surface movement from moisture variation on the site. Given the slope morphology of the site careful attention should be paid to surface drainage, with upslope drainage of any construction area recommended. Therefore, provided that footings are designed in accordance with recommendations for clay sites in AS2870-2011 the geotechnical risk relating to potential foundation movement is low and acceptable. I do however stress that attention should be paid to suitable backfill surrounding footings, articulation in the buildings, and drainage to avoid water accumulation in the foundation area (in line with recommendations in AS2870-2011 and CSIRO BTF-18).

Potential for vegetation removal to cause instability & erosion
There is open dry forest present on site, the removal of which is likely to have a small effect upon surface soil stability. Therefore, the risk of site instability and erosion from vegetation removal is low and acceptable. The risk of soil erosion should not be ignored either, such that I recommend standard Soil and Water Management Planning (SWMP) is undertaken prior to any earthworks.
**Potential for runoff/flooding to cause instability**

Given the sloping nature of the site there is a small potential for excess water flow onto the site to cause shallow seated instability if the construction does not make allowance for appropriate drainage. At present there are no formal drainage structures in place to divert surface water flows from the access or the driveway should the need arise in extreme weather events. Therefore, consideration should be given to drainage controls during the detailed design phase of the project prior to building/plumbing approvals.

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**Geotechnical Risk Assessment**

The following quantitative risk assessment is based upon the Australian Geomechanics Society Sub-committee report (March 2007) Landslide Risk Management Concepts and Guidelines. The risk assessment has been undertaken for the most limiting hazard identified for the site – potential for shallow seated instability – debris flow.
Landslide Risk Management Model

Adapted from AGS Sub-committee (March 2007) Landslide Risk Management Concepts and Guidelines.

Date 06/11/2019
Site 72 Sproules Road
Project Proposed residential dwelling
Scoping Residential dwelling on Jurassic dolerite with slope angle 10°

Hypothetical Shallow (<2m deep) slide develops in soil/fill on site below dwelling Hazard and risk to be quantified.

1. Hazard Identification
   a. Type of potential instability Debris slide
   b. Location down-slope of proposed dwelling
   c. Estimated area affected (m²) 50 (10m across and 5 m downslope)
   d. Estimated volume (m³) 50 (soil/sediments 1 m deep)
   e. Initiating event(s) Extreme heavy/prolonged rainfall
   f. Estimated velocity of movement Slow (5 x 10⁻³ mm/sec)
   g. Estimated travel distance 5m

2. Frequency Analysis
   a. Estimated frequency of event (P_H) 0.002 (1 in 500 yr event)
   b. Justification of frequency Stability of sediments on site & existing cuttings

3. Consequence Analysis
   a. Element at risk Property, services & occupants
   b. Value at risk (E) $300 000 (dwelling)
   c. Temporal probability (P_T:S) 0.5 (probability of occupation)
   d. Property vulnerability (V_P:S) 0.10 (proportion of property value lost)
   e. Probability of effect (P_S:H) 0.10 (probability of debris affecting building)
   f. Human vulnerability (V_H:T) 0.001 (probability of loss of life)

4. Quantitative Risk Calculation
   a. Property [R_prop = (P_H) x (P_S:H) x (V_P:S) x (E)] = $15 (annual loss of dollar value)
   b. Loss of life [R_DI = (P_H) x (P_S:H) x (P_T:S) x (V_H:T)] = 2.5 x 10⁻⁷

5. Semi-quantitative risk estimation for property
   a. Likelihood of event Level E- Rare (exceptional conditions req)
   b. Consequence to property Level 4 – Minor (limited damage)
   c. Combined level of risk Very Low – risk acceptable

6. Sensitivity Analysis
   Most uncertainty surrounds frequency of event (item 2a)

7. Risk Evaluation (should the risk be accepted, reduced, avoided or rejected?)
   From the assessment in 4a&4b the risk to life and property is acceptable

8. Risk Treatment
   a. Options
      Accept risk Recommended
      Avoid risk
      Reduce likelihood Yes – utilise drainage controls on site
      Reduce consequences yes – footing design based upon best practice
      Transfer
   b. Treatment Plan
      Appropriately designed footings in line with best practice recommendations
      Installation of appropriate drainage surrounding dwelling
      Stormwater and wastewater correctly connected to council services
      Any site cuts to be adequately retained and fill minimised
   c. Implement Plan
      Yes
   d. Monitoring
      Project monitoring required – professional supervision of sensitive earthworks recommended
## Conclusions

The geotechnical risk associated with residential development on the site is classified as **Very low** according to *Australian Geomechanics Society Guidelines* and **minor** according to *AS1726-2011 Geotechnical Site Investigations*.

- The development is not expected to have any significant effect upon land stability on the subject or neighbouring properties.
- The risk of foundation instability is moderately low, but footing designs should ensure placement of foundations into competent underlying rock wherever possible.
- Deep excavation and placement of fill should be avoided in accordance with *Australian Geomechanics Society Guidelines for Hillside Construction* (please refer to appendix 2).
- Careful attention should be paid to foundation design and drainage design to further eliminate the potential for foundation movement.
- All earthworks on site must comply with AS3798-2007 and sediment and erosion control plan should be implemented on site during and after construction.
- All stormwater should be immediately directed to appropriately designed absorption areas upon the construction of hard surfaces to minimise any possible water accumulation and excess flows onto the steep slopes below.

It is my opinion that the risk of land instability will not increase substantially as a result of the proposed development provided that current best practice for construction on sloping sites and soil and water management practices are followed.

I do however recommend that during construction that I and/or the design engineer be notified of any major variation to the foundation conditions as predicted in this report.

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Dr John Paul Cumming  B.Agr.Sc (hons) PhD CPSS GAICD  
*Environmental and Engineering Soil Scientist*
Appendix 1 – Geotechnical risk assessment terminology

Geotechnical Risk Assessment – Example of Qualitative Terminology
Adapted from AGS Sub-committee (March 2007) Landslide Risk Management Concepts and Guidelines.

Qualitative Measures of Likelihood

<table>
<thead>
<tr>
<th>Level</th>
<th>Descriptor</th>
<th>Description</th>
<th>Indicative Annual Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Almost Certain</td>
<td>The event is expected to occur</td>
<td>&gt; $10^{-1}$</td>
</tr>
<tr>
<td>B</td>
<td>Likely</td>
<td>The event will probably occur under adverse conditions</td>
<td>$10^{-2}$</td>
</tr>
<tr>
<td>C</td>
<td>Possible</td>
<td>The event could occur under adverse conditions</td>
<td>$10^{-3}$</td>
</tr>
<tr>
<td>D</td>
<td>Unlikely</td>
<td>The event might occur under very adverse circumstances</td>
<td>$10^{-4}$</td>
</tr>
<tr>
<td>E</td>
<td>Rare</td>
<td>The event is conceivable only under exceptional circumstances</td>
<td>$10^{-5}$</td>
</tr>
<tr>
<td>F</td>
<td>Barely Credible</td>
<td>The event is inconceivable or fanciful</td>
<td>$10^{-6}$</td>
</tr>
</tbody>
</table>

Note: “~” means approximate

Qualitative Measures of Consequences to Property/Element at risk

<table>
<thead>
<tr>
<th>Level</th>
<th>Descriptor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Catastrophic</td>
<td>Structure completely destroyed or large scale damage requiring major engineering works for stabilization.</td>
</tr>
<tr>
<td>2</td>
<td>Major</td>
<td>Extensive damage to most of structure, or extending beyond site boundaries requiring significant stabilization works.</td>
</tr>
<tr>
<td>3</td>
<td>Medium</td>
<td>Moderate damage to some of structure, or significant part of site requiring large remedial works.</td>
</tr>
<tr>
<td>4</td>
<td>Minor</td>
<td>Limited damage to part of structure or part of site requiring some reinstatement or remedial works.</td>
</tr>
<tr>
<td>5</td>
<td>Insignificant</td>
<td>Little damage or effect.</td>
</tr>
</tbody>
</table>

Note: The “Description” may be edited to suit a particular case.

Qualitative Risk Analysis Matrix – Level of Risk to Property/Element at Risk

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Consequences to Property</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1: Catastrophic</td>
</tr>
<tr>
<td>A – Almost Certain</td>
<td>VH</td>
</tr>
<tr>
<td>B – Likely</td>
<td>VH</td>
</tr>
<tr>
<td>C – Possible</td>
<td>VH</td>
</tr>
<tr>
<td>D – Unlikely</td>
<td>H</td>
</tr>
<tr>
<td>E – Rare</td>
<td>M</td>
</tr>
<tr>
<td>F – Not Credible</td>
<td>L</td>
</tr>
</tbody>
</table>

Risk Level Implications

<table>
<thead>
<tr>
<th>Risk Level</th>
<th>Example Implications</th>
</tr>
</thead>
<tbody>
<tr>
<td>VH</td>
<td>Very High Risk</td>
</tr>
<tr>
<td></td>
<td>Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to acceptable levels; may be too expensive and not practical</td>
</tr>
<tr>
<td>H</td>
<td>High Risk</td>
</tr>
<tr>
<td></td>
<td>Detailed investigation, planning and implementation of treatment option required to reduce risk to acceptable levels</td>
</tr>
<tr>
<td>M</td>
<td>Moderate Risk</td>
</tr>
<tr>
<td></td>
<td>Tolerable provided treatment plan is implemented to maintain or reduce risks. May be acceptable. May require investigation and planning of treatment options.</td>
</tr>
<tr>
<td>L</td>
<td>Low Risk</td>
</tr>
<tr>
<td></td>
<td>Usually acceptable. Treatment requirements and responsibility to be defined to maintain or reduce risks.</td>
</tr>
<tr>
<td>VL</td>
<td>Very Low Risk</td>
</tr>
<tr>
<td></td>
<td>Acceptable. Manage by normal site maintenance procedures.</td>
</tr>
</tbody>
</table>

Notes: (1) The implications for a particular situation are to be determined by all parties to the risk assessment; these are only given as a general guide. (2) Judicious use of dual descriptors for likelihood, Consequence and Risk to reflect the uncertainty of the estimate may be appropriate in some cases.
### Appendix G – Some Guidelines for Hillside Construction

**Practice Note Guidelines for Landslide Risk Management 2007**

#### Appendix 2 – Guidelines for Hillside Construction

<table>
<thead>
<tr>
<th>Topic</th>
<th>Good Engineering Practice</th>
<th>Poor Engineering Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geotechnical Assessment</strong></td>
<td>Obtain advice from a qualified, experienced geotechnical practitioner at early stage of planning and before site works.</td>
<td>Prepare detailed plan and start site works before geotechnical advice.</td>
</tr>
<tr>
<td><strong>Planning</strong></td>
<td>Having obtained geotechnical advice, plan the development with the risks arising from the identified hazards and consequences in mind.</td>
<td>Plan development without regard for the risks.</td>
</tr>
<tr>
<td><strong>Design and Construction</strong></td>
<td>Use flexible structures which incorporate properly designed backwall, timber or steel frames, timber or panel cladding.</td>
<td>Overlook the importance of drainage.</td>
</tr>
<tr>
<td><strong>House Design</strong></td>
<td>Select natural vegetation whenever practicable.</td>
<td>Use unduly narrow or steeply pitched roofs.</td>
</tr>
<tr>
<td><strong>Access &amp; Driveways</strong></td>
<td>Satisfy requirements below for cuts, fills, retaining walls and drainage.</td>
<td>Ignore the need for drainage.</td>
</tr>
<tr>
<td><strong>Earthworks</strong></td>
<td>Retain natural contours wherever possible.</td>
<td>Use cut and fill without regard for geotechnical advice.</td>
</tr>
<tr>
<td><strong>Cuts</strong></td>
<td>Minimize depth.</td>
<td>Large cut and fill blocks.</td>
</tr>
<tr>
<td><strong>Fills</strong></td>
<td>Minimize height.</td>
<td>Unsupported cuts.</td>
</tr>
<tr>
<td><strong>Rocks, Soils &amp; Spiderholes</strong></td>
<td>Remove or stabilize boulders which may have unacceptable risk.</td>
<td>Dismantle or leave undetected blocks or boulders.</td>
</tr>
<tr>
<td><strong>Retaining Walls</strong></td>
<td>Allow access design to resist applied soil and water forces.</td>
<td>Construct a structurally inadequate wall such as sandstone piling, brick or unreinforced concrete.</td>
</tr>
<tr>
<td><strong>Footings</strong></td>
<td>Found within rock where practicable.</td>
<td>Found on top of loose, detatched blocks or undercut cliffs.</td>
</tr>
<tr>
<td><strong>Swimming Pools</strong></td>
<td>Design for high soil pressure which may develop on uphill side whilst these may be little or no lateral support on downhill side.</td>
<td></td>
</tr>
<tr>
<td><strong>Drainage</strong></td>
<td>Provide at top of cut and fill slopes.</td>
<td>Discharge at top of fill and move.</td>
</tr>
<tr>
<td><strong>Surface &amp; Subsurface</strong></td>
<td>Provide guttering and downpipes to protect foundation.</td>
<td>Ignore the need for drainage.</td>
</tr>
<tr>
<td><strong>Seepage &amp; Sullage</strong></td>
<td>Usually requires pump-out or mains sewer system.</td>
<td>Discharge sullage directly onto and into slopes.</td>
</tr>
<tr>
<td><strong>Erosion Control &amp; Landscaping</strong></td>
<td>Control erosion in such a way as to minimize:</td>
<td>Failure to observe aesthetic and damage recommendations when landscaping.</td>
</tr>
</tbody>
</table>

#### Drawings and Site Visits During Construction

<table>
<thead>
<tr>
<th>Drawings</th>
<th>Site Visits by Consultant should be recorded by geotechnical consultant.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inspections</td>
<td>Site Visits by Consultant may be appropriate during construction.</td>
</tr>
</tbody>
</table>

| Owner’s Responsibility | Clean drainage systems; repair broken joints in drains and leaks in supply pipes. |
|------------------------| Where structural defects are evident use advice. |
| | If unstable observed, determine cause or seek advice on consequence. |
PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

EXAMPLES OF GOOD HILLSIDE PRACTICE

1. Vegetation retained
2. Surface water interception drainage
3. Water tight, adequately sized and founded roof water storage tanks
4. Flexible structure
5. On site detention tanks, water tight and adequately founded. Potential leakage managed by sub-surface drains

EXAMPLES OF POOR HILLSIDE PRACTICE

1. Discharges of roofwater soaking away rather than collected on site or into secure storage for re-use
2. Structure unable to withstand settlement and cracking
3. Poorly compacted fill sites settle and cracks occur
4. Inadequate filling unable to support fill
5. Loose, saturated fill slips and possibly flows downslope
6. Saturated slope fails
7. Vegetation removed
8. Mud flow occurs
9. Possible travel downslope which impacts other development downslope

See also AGS (2006) Appendix J