Geotechnical Review

GEOFIRST PTY LTD
ABN 94 637 631 826 ACN637 631 826
PO Box 137 Figtree 2525
2/7 Luso Drive, Unanderra NSW 2526

Our Ref: GF1692-C Slope Assessment

Contact: Long Tsang

Email: long.tsang@geofirst.com.au

Date: 30 August 2023

Client: CP Caringbah Pty Ltd c/- Connoisseur Properties

Address: PO Box 389 Chatswood NSW 2057

Email: Justinng@connoisseurproperties.com.au

Dear Justin,

Re: Geotechnical Risk Management for Proposed Residential Redevelopment
No. 13 Lodge Lane, Freshwater, NSW, 2096

1 Introduction

This report is to provide a landslide risk management assessment in accordance with "Australian Geomechanics Society (AGS) Guidelines" published in 2000 and 2007.

Our Principal Geotechnical Engineer visited the site on 11 October 2022 and 3 August 2023 to conduct a walkover assessment.

During our site visit, the following observations were made:

- No sign of slope instability was observed.
- Based on our cursory inspection, no obvious cracks were observed on the neighbour building external walls.
- Medium to high-strength Sandstone outcrops were exposed in the backyard and the frontyard of the site.

2 Slope Stability Assessment

2.1 Slope Stability Assessment

The risk to the existing dwelling area due to landslide has been assessed in accordance with the risk assessment method described in the Australian Geomechanics Society (AGS) Landslide Risk Management Concepts and Guidelines (LRMCG), 2007 – Appendix C, which is attached.

2.2 Signs of Slope Instability

Signs of slope instability can include, but are not limited to:

- Creep-observed by tilting of trees, structures including retaining walls, and fences or by soil/rock encroaching onto roads or over drains, gutters etc.
- Hummocky disturbed ground in or at the base of the slopes.
- Tension cracks in or at the top of slopes.

During our site visit, no indicators of the above signs of slope instability were observed.

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2.3 Potential Slope Failure Types

The assessed potential slope failure types considered for this site are:

- Large-scale slope instability;
- Localised slope instability within or downslope of the site; and
- Localised soil creep due to steep slopes, groundwater conditions and other factors.

2.4 Quantitative Risk Estimation for Loss of Life

The risk to 'Loss of Life' was considered for the potential landslide events detailed in the section 2.2 above. The annual probability of loss of Life, R(LOL), following the proposed development, is assessed as follows:

$$R(LOL) = P(H) \times P(S:H) \times P(T:S) \times V(D:T)$$

Where P(H) is the annual probability of landslide
P(H) is the probability of annual landslide.
P(S:H) is the probability of spatial impact, which considers the potential travel distance, size of the slide and the geometry of the site.
P(T:S) is the temporal spatial probability which considers the time a person may be on site and the time they may occupy the part of the site impacted by the landslide.
V(D:T) is the vulnerability of the individual on the site.

Table 2: Summary of Risk Estimation of Annual Probability of Loss of Life

Case	Hazard	P(H)	P(S:H)	P(T:S)	V(D:T)	R(LoL)
1	Large-scale slope instability	1×10^{-6}	0.8	0.5	0.8	3.2^{-07}
2	Failure of slope within and down slope of the site	1×10^{-5}	0.2	0.1	0.5	1.0^{-07}
3	Localised soil creep	1×10^{-5}	0.2	0.1	0.05	1.0^{-08}

On the basis of these scenarios, the site is assessed in accordance with the classification system described above, to be an 'Acceptable' risk.

2.5 Risk Assessment for Loss of Property

The potential hazards, the assessed likelihood, the expected consequences, and the assessed level of risk for the proposed development are shown in Table 2 below. (Refer to Appendix C attached, for an explanation of terms)

Table 2: Summary of Assessed Likelihood, Consequence of Instability and Associated

Location/Hazard	Likelihood	Consequence	Risk
Large-scale slope instability	Barely Credible	Major	Very Low
Failure of slope within and downslope of the site	Rare	Major	Low
Localised soil creep	Rare	Minor	Very Low

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3 Conclusion

On the basis of these scenarios, the site is assessed, in accordance with the classification system described above, to have '**Low'** risk of slope instability.

The risks to the property are assessed to be generally low while the risks against loss of life are considered to be acceptable in accordance with AGS 2007.

The site was assessed in consideration of the conditions after the proposed development. Acceptable Risk for Loss of Property is taken as 'Low' as defined in the Practice Note issued by AGS in 2007.

Generally, the risk for loss of human life induced by the various hazards was assessed to be acceptable, following the implementation of the advice given in this report. AGS suggested the individual life loss risk criteria for the person most at risk of 10^{-6} per annum for acceptable risk and 10^{-5} per annum for tolerable risk.

Please do not hesitate to contact the undersigned should you have any queries.

For and on behalf of

GEOFIRST PTY LTD

Prepared by:

Long Tsang

Principal Geotechnical Engineer

BEng(civil), MEngSci (geo), CPEng, NER, APEC Engineer, IntPE (Aus), RPEQ, DER, PER,PDPR

Encl: Information About The Report

Appendixes C and G of the Australian Geomechanics Journal, Vol.42, No.1, dated March 2007

AGS GeoGuide LR08 Good Hillside Practice

Information About The Report

General information

This report has been prepared for the project described. The sole purpose of this report is to assess the condition of the site in accordance with the scope of works set out between GEOFIRST PTD LTD and the Client.

In preparing this report, GEOFIRST PTD LTD has not attempted to verify the accuracy or completeness of any information provided by the Client and/or from other sources. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Site Condition

This report is considered accurate at the date of issue with regards to the current conditions of the site. The engineering logs presented herein are based on geological interpretation of the subsurface condition subjects to method of drilling or excavation. The results provided in the report are indicative of the subsurface conditions on the site only at the specific sampling locations, and then only to the depths investigated and at the time of work was carried out. Subsurface conditions between the test locations may vary significantly from conditions encountered at the test locations.

Groundwater

Water table levels recorded / shown on the engineering logs may vary from time to time with seasons or recent weather changes. No matter what, allowance should be made for dewatering during the construction stages as the groundwater level may not be the same at the time of construction.

Soil Description

The methods of description and classification of subsurface profile used in this report are in according with Australian Standard AS1726:2017.

Reports

The reports are prepared by a qualified engineer and are based on the information found and on current engineering standards of interpretation and analysis. Duty of Care has been taken with the report in relation to interpretation of subsurface, recommendation and comments for design and construction, but not limit to the following:

- Subsurface condition change between the test points;
- Changes in policy or interpretation of policy by statutory authorities;
- The actions of persons or contractors responding to commercial pressures.

The company obtain a right to assist with further investigation or advice to resolve the matter.

Site Inspection

The Company recommends to provide engineering inspection services for geotechnical aspects of work to which this report is related. This could range from a site visit to confirm that ground conditions are similar description to the report.

Responsibility

Reporting relies on interpretation of factual information based on opinion and judgement and has a level of uncertainty attached to it, which is far less exact than the design disciplines. This has often resulted in claims being lodged against consultants. The client /designer should consult with the GEOFIRST PTY LTD to interpret the geotechnical information prior to commencement of their projects in order to obtain an adequate geotechnical information for the construction. This will reduce the potential risk to misinterpretations of the reports by the client / designer at the initial stage, resulted in logging a claim against consultants. Haven GEOFIRST explain the report implications to design professionals affected by them and then review plans and specifications produced to see how they incorporate the report findings.

Copyright

Limitation

GEOFIRST accepts no responsibility whatsoever for the performance of the structure where recommendations are not implemented in full or properly tested, inspected and documented.

GEOFIRST has prepared this report in accordance with the usual care and diligence of consulting engineers. However, no other warranty or guarantee, whether expressed or implied, is made or intended.

If there is any change in the proposed development described in this report, then all recommendations should be reviewed.

This report should be read in full, and no excerpts are to be taken as representative of the findings. No responsibility is accepted by GEOFIRST for use of any part of this report in any other context. This report has been prepared on behalf of, and for the exclusive use of the Client of GEOFIRST. GEOFIRST accepts no liability or responsibility for any use of this report by any third party.

This report valid for one year from date of issue. The report will be automatically withdrawn after two weeks from date of issue if no payment received. Hence, Geofirst accepts no liability or responsibility for any use of this report.

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

QUALITATIVE RISK ANALYSIS MATRIX – LEVEL OF RISK TO PROPERTY

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

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

RISK LEVEL IMPLICATIONS

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

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

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

APPENDIX C: LANDSLIDE RISK ASSESSMENT

QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

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

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

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

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

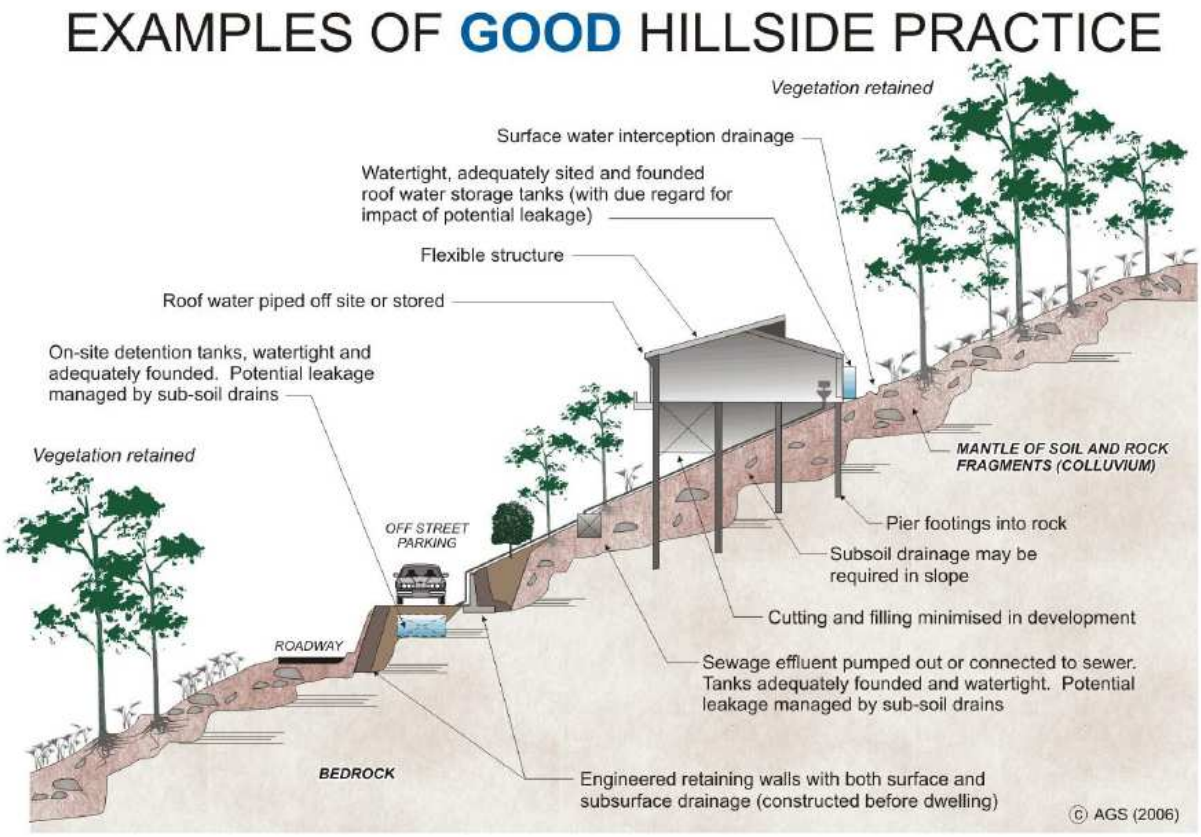
Notes: (2) The Approximate Cost of Damage is expressed as a percentage of market value, being the cost of the improved value of the unaffected property which includes the land plus the unaffected structures.

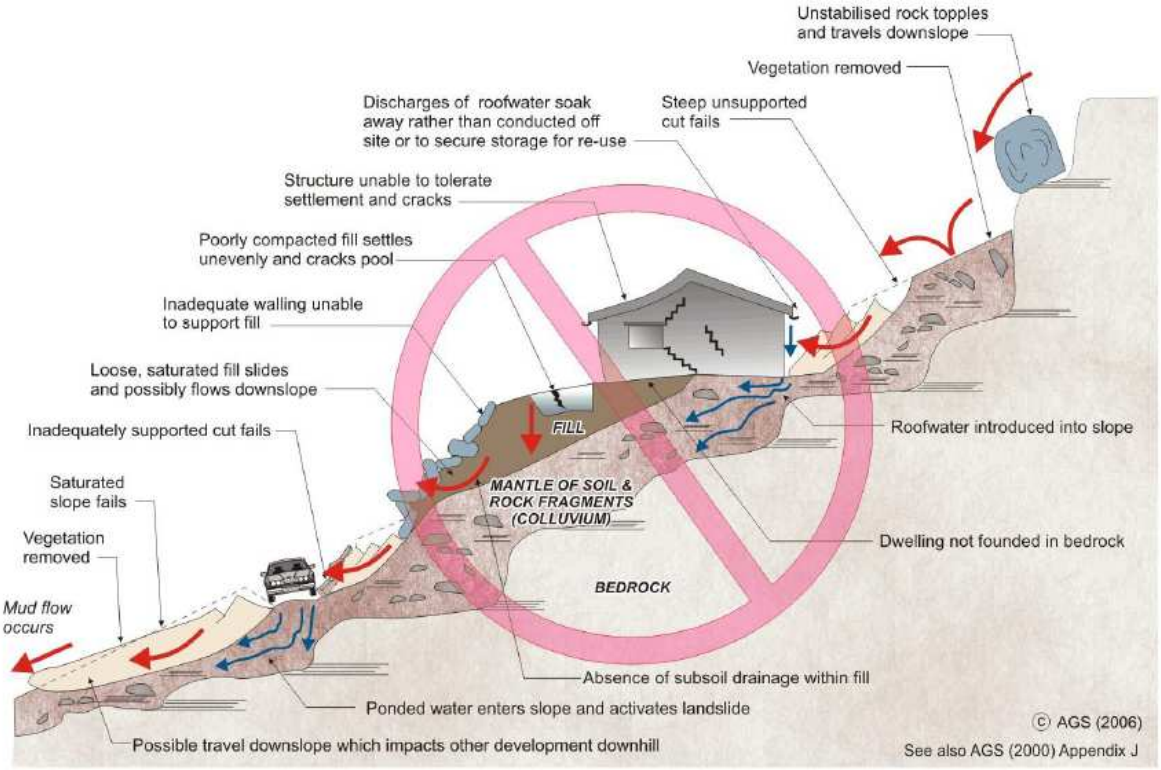
(3) The Approximate Cost is to be an estimate of the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the landslide which has occurred and professional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

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

APPENDIX 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.	


EXAMPLES OF GOOD HILLSIDE PRACTICE
Vegetation retained
Surface water interception drainage
Watertight, adequately sited and founded roof water storage tanks (with due regard for impact of potential leakage)
Flexible structure
Roof water piped off site or stored
On-site detention tanks, watertight and adequately founded. Potential leakage managed by sub-soil drains
Vegetation retained
MANTLE OF SOIL AND ROCK FRAGMENTS (COLLUVIUM)
OFF STREET PARKING
Pier footings into rock
Subsoil drainage may be required in slope
Cutting and filling minimised in development
ROADWAY
Sewage effluent pumped out or connected to sewer. Tanks adequately founded and watertight. Potential leakage managed by sub-soil drains
BEDROCK
Engineered retaining walls with both surface and subsurface drainage (constructed before dwelling)
© AGS (2006)


EXAMPLES OF POOR HILLSIDE PRACTICE
Unstabilised rock topples and travels downslope
Vegetation removed
Discharges of roofwater soak away rather than conducted off site or to secure storage for re-use
Steep unsupported cut fails
Structure unable to tolerate settlement and cracks
Poorly compacted fill settles unevenly and cracks pool
Inadequate walling unable to support fill
Loose, saturated fill slides and possibly flows downslope
Inadequately supported cut fails
FILL
Roofwater introduced into slope
Saturated slope fails
MANTLE OF SOIL & ROCK FRAGMENTS (COLLUVIUM)
Vegetation removed
Dwelling not founded in bedrock
BEDROCK
Mud flow occurs
Absence of subsoil drainage within fill
Ponded water enters slope and activates landslide
Possible travel downslope which impacts other development downhill
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See also AGS (2000) Appendix J