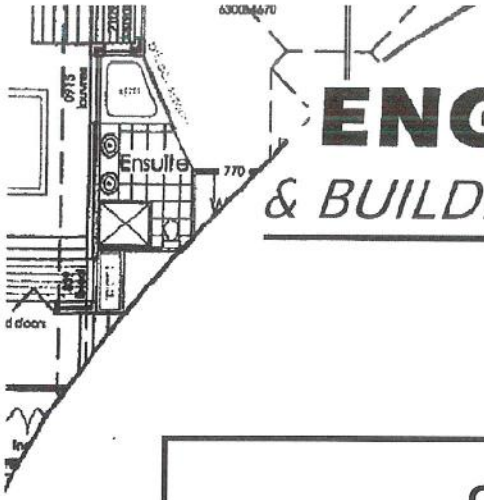


ENGINEERING
& BUILDING INVESTIGATION SERVICES

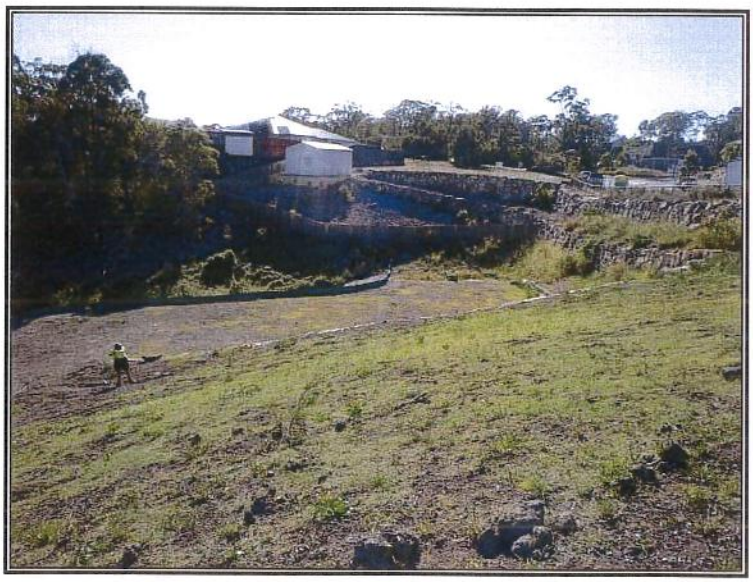
EBIS

ACN: 104 324 969
ABN: 93 104 324 969

CODE FOR DEVELOPMENT ON STEEP OR UNSTABLE LAND – GEOTECHNICAL REPORT

LOT 2 MON TERRE DRIVE, MON TERRE RIDGE ESTATE LITTLE MOUNTAIN

CLIENT:	Glynnis Schwarzel 5 Tallowwood Close LITTLE MOUNTAIN Q 4551
EBIS REFERENCE:	160580- SU-Geo-Pre
PROJECT DESCRIPTION:	Preliminary Report
DATE:	30 January 2017



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- Photos of Site
- Borehole Explanatory Notes

Appendix C

- Landslide and Steep Land Overlay Map (1) (Landslide) – Sunshine Coast Planning Scheme 2014
- Landslide and Steep Land Overlay Map (2) (Steep Land) – Sunshine Coast Planning Scheme 2014
- Landslide Risk Management (Examples of Good Hillside Practice)
- Landslide Risk Management Appendix J (Some guidelines for hillside construction)

SITE INVESTIGATION – GEOTECHNICAL REPORT

1.0 INTRODUCTION

EBIS, practising as a geotechnical engineer, has carried out a site investigation at Lot 2 on Mon Terre Drive, Mon Terre Ridge Estate, Little Mountain. The investigation was conducted in order to assess the conditions on the site for the proposed development of a dwelling.

1.1 Details of Development

Plans and details were not developed at the time of this report, however the owner indicates that the dwelling will be an elevated home on timber poles or steel posts set in concrete piers.

1.2 Site Location & Description

The site is described as Lot 2 on Mon Terre Drive, Mon Terre Ridge Estate, Little Mountain on SP246943 and is 1250m^2 in area. The site is shown in the aerial photograph below (pre-development).

Photograph 1 – Aerial Image of the Site

1.3 Method & Scope of Investigations

A walkover and subsurface investigation was undertaken on 18 January, 2017. A total of two (2) boreholes were excavated using hand augers. Disturbed samples of the subgrade material were taken and tested for shrinkage characteristics.

EBIS were commissioned to carry out a preliminary geotechnical investigation to identify issues that may affect the proposed development and give recommendations in this regard.

1.4 Qualifications of Responsible Individual(s) &/or Company

Don Stanfield, Owner/Director of EBIS has worked as a geotechnical engineer in this region for over 25 years and has a Bachelor of Engineering BE (Civil). Don is registered as a professional engineer in the states of Queensland (RPEQ No.4177). Victoria (E.C.19910) and is on the National Profession Engineers Register (NPER3).

Mr Stanfield has lived and worked on the Sunshine Coast for over 30 years and has undertaken work throughout the South East Queensland region.

Lindsay Wheeler, our site and soil assessor is experienced in local conditions and has worked for EBIS for over 15 years. Relevant experience includes the investigation of sites and design and supervision of stabilisation for various sites having landslip risk.

2.0 DESCRIPTION OF EXISTING CONDITIONS

2.1 Geology (local & regional)

The geology of the site is shown on Queensland Geological Survey maps as being Rjl - Landsborough sandstone.

Boreholes excavated on site generally confirmed the above. Details of subsurface investigations are included in the following section.

2.2 Soil Profiles

The natural soil was found to be shallow high plasticity silty clay overlying hard extremely weathered sandstone rock. Approximately 200mm of high plasticity silty clay fill was observed in Borehole no 1. In Borehole no 2 approximately 500 mm of medium to high plasticity silty clay fill with gravels and cobbles was observed with auger refusal on cobbles in the fill at 500m depth. DCP testing at Borehole no 2 (on the east side) indicated that the extremely weathered rock to be at approximately 1600mm depth. Rocks and boulders were observed on the site. Seepage was not observed however is likely to occur above the bedrock layer during and after extended wet weather.

2.3 Site Classification

In accordance with the "Residential Slabs and Footings" code we have classified the above site as a 'P' Class site.

This site has been classified as a 'P' site due to the presence of the following on or near the site:

- Fill
- Steep slope of site

A 'P' classified site requires engineering design input beyond a "Deemed to Comply" detail to AS2870 'Residential Slab and Footings Code'.

The site has also been classified as "M" in terms of soil as it is moderately reactive to changes in soil moisture.

The footing design for this site must consider the following factors:

1. The site slopes steeply.
2. Fill exists on the site.
3. Shallow weathered sandstone rock at Borehole no.1.
4. Trees previously removed from the site.
5. Clays present in the soil profile are moderately reactive.
6. Rocks/rock floaters are likely to be encountered during footing excavations.
7. There needs to be drainage control of surface and subsurface water.

2.4 Topography

The allotment is on the north side of a hill system (Little Mountain) and has a slope of approximately 30% to the northeast. There are boulder rock retaining walls along the front south side and east side.

2.5 Groundwater

Ground water was not encountered during excavations. Significant ground water is not likely however seepage will occur in the fill and natural soils above the weathered sandstone bedrock interface during and after extended wet weather.

2.6 Surface Drainage

Surface drainage is typically good however due to the steep site surface water runoff is rapid.

Surface water traversing the site from higher areas is minimal with the street drain directing surface water to the estate stormwater system.

2.7 Vegetation

The site is sparsely grassed with some coarse weeds and regrowth.

2.8 Buildings, other structures

The allotment at the time of testing and assessment was vacant. Structures consist of boulder retaining walls on the front south side and east side.

3.0 ASSESSMENT OF LAND STABILITY

3.1 Stability Zoning

Sunshine Coast Regional Council town plan mapping shows that this area contains regions of moderate and high slip hazard.

The Landslide Hazard map (1) (Landslide) from the Sunshine Coast Planning Scheme for Landslip Hazard Special Management Areas shows this area to be high risk.

The Steep Land Map (2) (Steep Land) shows this allotment to have slopes of 20-25% and over (see Maps in Enclosures).

NOTE: The council overlays are a "typical" guide to the site conditions in the location shown in terms of steep land and landslip risk.

Risk Level Implications

Risk Level		Example Implications (1)
VH	VERY HIGH RISK	Extensive detailed investigation and research, planning and implementation of site treatment options essential to reduce risk to acceptable levels; may be too expensive and not practical
H	HIGH RISK	Detailed investigation, planning and implementation of site treatment options required to reduce risk to acceptable levels.
M	MODERATE RISK	Tolerable provided site treatment plan is implemented to maintain or reduce risks. May be accepted. May require investigation and planning of various options.
L	LOW RISK	Usually acceptable. The site treatment requirements and responsibility to be defined to maintain or reduce risk.
VL	VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (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.

It is considered that the blanket overlay high risk rating is reduced by the following site conditions:

- Relatively shallow soils overlying stable sandstone bedrock strata (typically less than 1,200mm);
- No previous known or mapped landslips on or close to site;
- Ground water not evident during site testing and not generally associated with the Landsborough Sandstone geology of the site;
- Very little overland surface water is directed towards the site from higher areas being cut off by the street drainage immediately above the site.

It is considered by EBIS that the site in present condition has a risk of landslip due to:

- Very steep site

Suitable building methods must be adopted with treatment required as outlined following in this report to provide for acceptable risk levels (low – very low risk).

3.2 Existing Conditions

No evidence of recent slope instability was observed across the site during the investigation. Weathered rock was intersected at relatively shallow depth across the site.

3.3 Geotechnical Constraints to Development

Conditions encountered on site generally support the landslip classifications given in the reviewed mapping from the Sunshine Coast Council. That is, that the site is of moderate to high risk due to the steep slopes on the site. It is considered that these risks can be effectively managed using a number of techniques.

Recommended methods for managing landslip risk on site can be summarised as follows:

- Minimise disturbance to existing ground surfaces and extents of cut and fill;
- Manage construction of services and structures to reduce likelihood of instability;
- Key structures into underlying massive rock formation.

In addition to addressing landslip potential, a number of other site characteristics will impact on development, these are summarised below.

The surface gradient is steep, which, in conjunction with the recommendation to minimise extents of cuts and fills, will necessitate suspended floor type structures, or possibly split level construction.

4.0 DESCRIPTION OF PROPOSED DEVELOPMENT

4.1 Site Layout

At the time of this report a site plan or layout was yet to be developed.

4.2 Proposed Development Components

Development components will consist of construction of a new dwelling, access driveway, supporting stormwater drainage and connection to water supply and sewerage infrastructure.

4.3 Potential Geotechnical Effects

Potential geotechnical effects from site development are varied, and can be managed by giving due consideration to site constraints during design and throughout construction. In particular, the management of earthworks, stormwater drainage and sewer excavations on the site will be important. Recommendations for limiting the impact of various elements of the land development process are included in the following section, with additional information included in Appendix C, "Guidelines for Hillside Construction".

5.0 ASSESSMENT OF DEVELOPMENT IMPACTS

5.1 Roadworks, Driveways & Other Pavements

Access to the site will need to conform with Councils' guidelines as shown on Plan Drawing-Driveways-Residential Driveway – Drawing No. R-050.

Pavements should be sealed, either asphalt or concrete with adequate surface and subsurface drainage provided.

5.2 Earthworks

Earthworks should be limited to access construction, foundation/footing excavations, service trenching and site drainage.

Cuts are not recommended due to risk of undercutting foundations on a higher level.

Fills are not recommended but where required should be retained by engineer designed retaining wall structures to suit the site conditions.

5.3 Foundations

The footings/foundation design is to be undertaken by an engineer to suit the site conditions.

The foundations/footings for the dwelling are to be founded (keyed) minimum of 600mm into sound underlying massive rock formation (weathered sandstone).

5.4 Surface Drainage

It is recommended surface water diversion swales be provided along the top side of the site in the early stages of construction. Surface water should be directed to existing drainage routes in undisturbed ground.

Swales should also be provided to redirect water immediately above any embankments, retaining structures or earthworks areas. In addition, permanent drainage should be provided behind any retaining structures.

Erosion and sediment control measures will be necessary during any earthworks.

Drainage lines should be installed to direct roof water to the appropriately provided discharge points.

5.5 Sewerage

The site is connected to the Council's sewerage network.

5.6 Overall Effect of Development on Stability

By implementing the recommendations in this report the proposed development is considered to have little effect on overall site stability. The methods proposed to minimise any potential effects of the development are designed to limit levels of landslip or instability to an acceptable level.

6.0 SUMMARY & CONCLUSIONS

EBIS has undertaken the design for development to provide a very low risk of instability and to have a safety factor of greater than 1.5.

Having given due consideration to all relevant issues including access, topography, geological conditions and drainage, the proposed location of a dwelling on the site is considered to be appropriate.

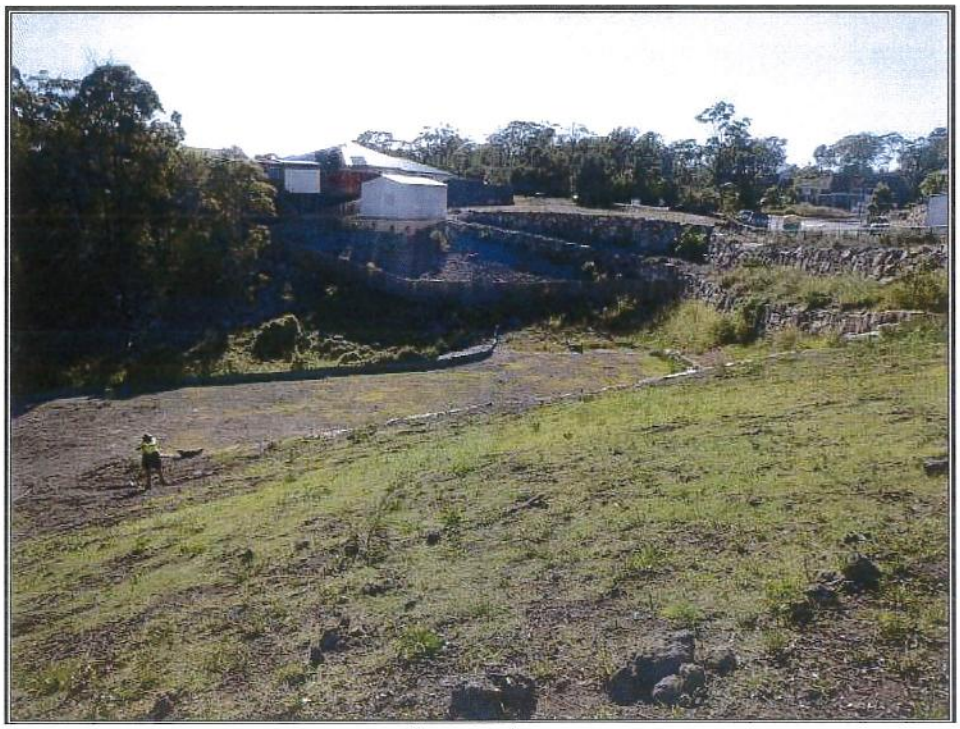
In accordance with the General Land Use and Development on steep land, due regard has been given to the proposed building, and foundations. We have also assessed the surface drainage and stormwater system and sewage disposal (sewered allotment) and consider these will not adversely affect the site stability of this site and adjoining allotments.

It is advisable that a final assessment evaluation of plans and structural design recommendations including footing/foundation design and including cuts/fills retaining walls and surface and subsurface drainage systems be undertaken by a competent person. This is to ensure general compliance to the above recommendations and sound building practices on steep and sloping sites.

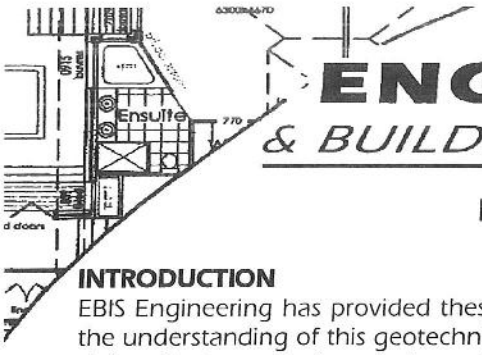
D. R. Stanfield
B.E. (civil), C.P. Eng., M.I.E. Aust., R.P.E.Q. No. 4177, Vic EB 19910.

LOT 2 MON TERR DRIVE, MON TERR RIDGE ESTATE LITTLE MOUNTAIN

PHOTOGRAPHS OF SITE



Site testing



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BOREHOLE LOG EXPLANATORY NOTES

INTRODUCTION

EBIS Engineering has provided these notes to aid in the understanding of this geotechnical report and to define the terms and symbols used in our borehole logs.
Some of these notes may not be relevant to all reports.

SOILS

Soils exhibit a variety of characteristics which can change across a site and alter over time. Geotechnical engineering involves collecting constrained facts about these soil characteristics in order to recognize and predict the behaviour of the soil on a particular site under certain conditions.

Description and classification methods for soils and rocks used in this report are based on the Australian Standard AS1726-1993 and include properties such as major soil or rock type, minor soil or rock type, inclusions, colour, structure, strength, density and plasticity.

SAMPLES TAKEN

Two types of samples can be taken.

1. D – Disturbed Sample. These samples are taken during drilling and provide information on grain size, plasticity, colour, moisture content, minor constituents and sometimes strength and structure.

2. U50 – Undisturbed Sample. These samples are usually only taken from cohesive soils and are performed by pressing a tube with a thin wall and 50mm diameter into the soil and pulling it out with a section of the soil in a fairly intact state. Strength, structure, volume change potential and compressibility are some of the tests which can be performed using this sample.

BOREHOLES

There are several methods for digging through the soil to find the constituents that make up the soil type in that location. Generally most soil testing by EBIS is done by hand auger as this process has the least impact on the location of the testing. Occasionally when necessary, other methods such as drilling with a powered auger, truck mounted drill rig or excavation using a backhoe or excavator may be used.

It must be recognised that boreholes represent the soil conditions in a very small sample of the overall subsurface situation and as such the soil profile may vary across the site. If the soil conditions do appear different from those indicated in this report, EBIS should be contacted to confirm the requirements.

Boreholes are terminated for two reasons.

1. UTP – Unable to Penetrate. When there is refusal for the hand auger and it cannot penetrate any further due to rock, rock fragments, gravel or hard clay.

2. The soil type is consistent and able to support building foundations. Industry standards generally recognise two (2) metres as 'typical' depth to termination of boreholes without a limiting layer (eg rock) for 'typical' dwellings.

FIELD TESTING

There are two main tests which we perform on the site.

1. DCP – Dynamic Cone Penetrometer. A rod is driven into the ground using a falling weight hammer and the number of drops that it takes the hammer to drive the rod in 100mm increments into the ground is recorded. Higher numbers indicate more stable soils.

2. PP – Pocket Penetrometer. This is a hand-held instrument which is used to measure shear strength and indicates unconfined compressive strength. A number over 100 is acceptable but higher numbers indicate more stable soils.

CLASSIFICATION

Soils are generally divided into two main categories according to their cohesiveness. After cohesiveness, they are separated by the dominant size of the particles in the soil. This is shown on the table on the following page.

FILL

Fill relates to any soil or other material which has been placed on top of the natural soil. It is sometimes recognised by the inclusion of foreign materials, such as organic matter, metal or bricks, or through unusual colour, texture or compaction which varies considerably from the natural soil profile.

The variation in material type, degree of compaction and strength of fill materials can differ from the natural soil and, in some instances where it is uncontrolled, this leads to a greater possibility of unfavourable engineering properties and deficiencies in performance and possible complications for building on the site. The performance of the fill as a foundation material is dependent upon the depth of the fill and the degree of compaction.

Fill can be:
UC – Uncompacted
VC –Variably Compacted
WC – Well Compacted

PLASTICITY

Plasticity is defined by the Liquid Limit of the sample. As such, this term relates only to cohesive soils. Liquid Limit (LL) is the water content where a soil changes from plastic to liquid in behaviour.

Code	Term	Liquid Limit Range (%)
CL	Low Plasticity	<35
CI	Medium Plasticity	≥35 ≤50
CH	High Plasticity	>50

Liquid Limit is measured as a percentage.

MOISTURE

This refers to the moisture content of the soil at the time of testing.

Code	Term	Cohesive Soils	Non-Cohesive Soils
DR	Dry	Hard, Powdery, Friable	Free-flowing, Very Loose
MO	Moist	Smooth	
DA	Damp	Can be moulded,	Cool, dark, Tends to cohere
VDA	Very Damp	Sticky	
WE	Wet	Weakened. Free water forms on hands when holding	Cool, dark, Tends to cohere

CONSISTENCY / DENSITY

Cohesive soils have consistency.
Non-Cohesive Soils have relative density.

Consistency – Cohesive Soils		
Code	Term	Description
H	Hard	Thumb nail indents with difficulty
VSt	Very Stiff	Thumb nail can indent
St	Stiff	Indented by thumb. Cannot be moulded by hand
F	Firm	Moulded by strong finger pressure
S	Soft	Moulded by light finger pressure
VS	Very Soft	Easily squeezed, sloppy

Density – Non-Cohesive Soils		
Code	Term	Index
VD	Very Dense	>85
D	Dense	≥65 ≤85
MD	Moderately Dense	≥35 ≤65
L	Loose	≥15 ≤35
LL	Very Loose	<15

ROCK MATERIAL

Rock Material has **Strength** and can be **Weathered**.

STRENGTH

Code	Term	Description
EX	Extremely High	May break after many blows when hit with pick. Ringing sound.
VH	Very High	Breaks after more than one blow when hit with pick. Ringing sound.
H	High	Breaks after one blow when hit with pick. Ringing sound.
M	Medium	Readily scored with a knife. Broken in hand with difficulty.
L	Low	Easily scored with a knife. Indentations up to 3mm appear with firm pick blows. Dull sound
VL	Very Low	Pealed with a knife. Crumbles with firm blows. Broken by finger pressure.
EL	Extremely Low	Shows soil properties. Easily remoulded by hand

WEATHERING

Code	Term	Description
FR	Fresh Rock	No staining or decomposition
SW	Slightly Weathered Rock	Slightly discoloured but little/no change in strength
DW	Distinctly Weathered Rock	Highly discoloured usually by iron. Change in strength
XW	Extremely Weathered Rock	'Soil' properties ie disintegrates or can be remoulded in water
RS	Residual Soil	Soil developed from rock – structure and substance of rock is no longer evident

APPENDIX J

SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

	GOOD ENGINEERING PRACTICE	*POOR ENGINEERING PRACTICE*
ADVICE		
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical consultant 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.	Indiscriminant 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.	

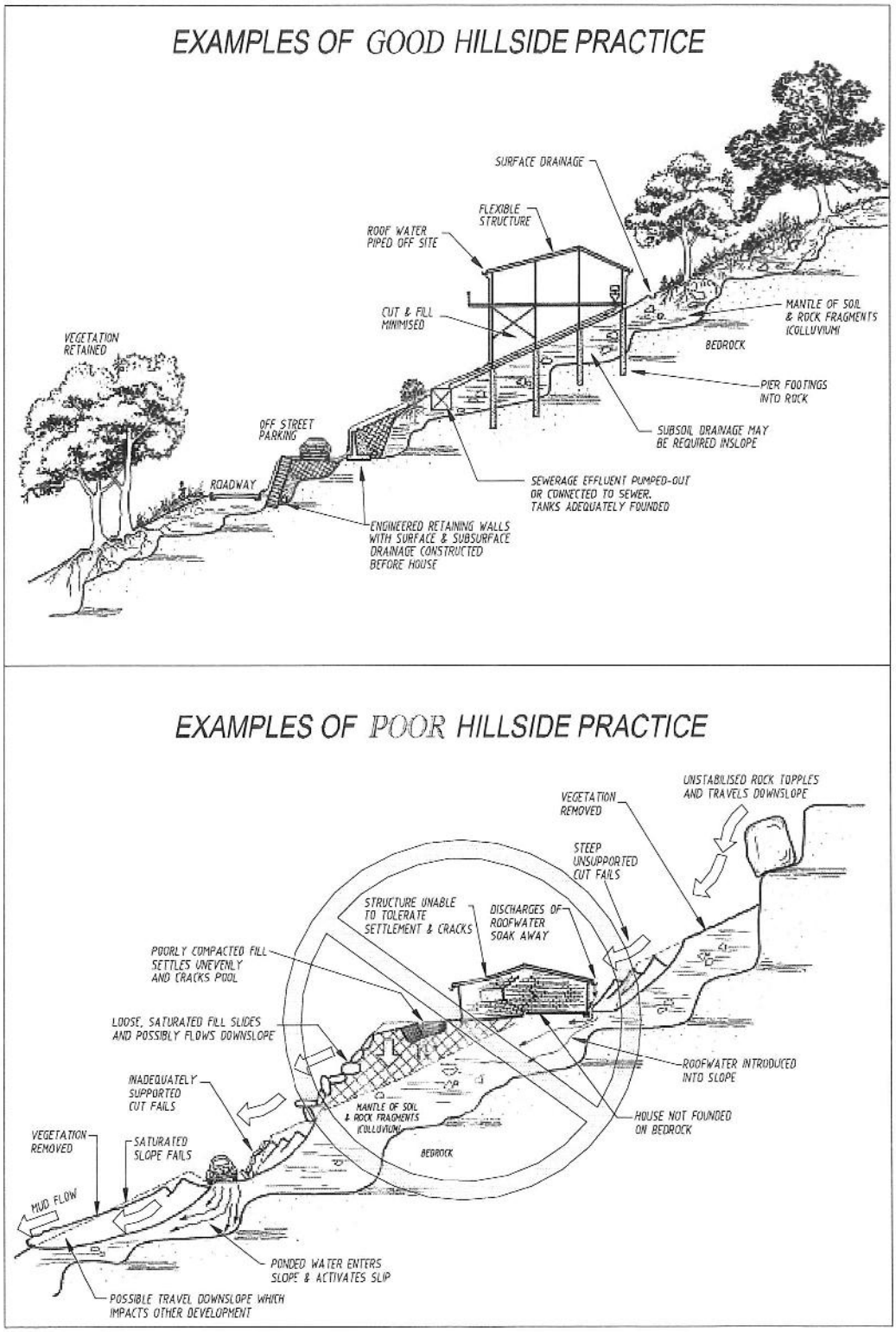

Figure J1 Illustrations of Good and Poor Hillside Practice