Civil & Structural Engineering Design Services Pty. Ltd.

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26th March 2019

Mr & Mrs Morfitt
1633 Pittwater Road
MONA VALE NSW 2103

D-11-267023

Dear Sir,

Re: Geotechnical Report – Proposed Alteration & Addition at 1633 Pittwater Road, Mona Vale

INTRODUCTION

I, Edward A. Bennett, practicing Civil, Structural, Geotechnical and Environmental Engineer, hereby confirm that one of my officers have inspected the above site for the purpose of preparing a geotechnical report.

This geotechnical report has been prepared as part of documentation required by Northern Beaches Council for unauthorized works and future development application prior to the issue of a Building Certificate & Construction Certificate. The report assesses the underlying geology, the resulting site stability, identifies any potential of geotechnical hazards that may be inherent with this site, the works to be performed and how best to mitigate these hazards in order that the works may be performed safely and without risk to the existing natural environment.

PROPOSED DEVELOPMENT

The development is for the proposed alteration and addition at the rear(western) and side(southern) of the property. The new development requires structural engineering input from an appropriately qualified and experienced consultant.

DESCRIPTION OF SITE & SURROUNDING AREA

The proposed development lies on the Western side of Pittwater Street, Mona Vale. The site is moderately sloping, approximately (1:14) or 7 degrees downward, to the East.
No evidence of global or overall landslip risk was observed during the site inspection. Additionally, no movement of existing retaining walls or cracking in any nearby structures was found.

SITE GEOLOGY

Geomorphologic mapping of the area shows that the underlying bedrock is made up of Narrabeen group shales/lithic sandstones or Wianamatta Group medium to coarse-grained quartz sandstones. From evidence gained from previous projects in the nearby area, it is highly likely that suitable strength sandstone will be encountered for foundations.

From the observations from the site inspection, it was deemed unnecessary to perform any extra/special investigation of the underlying site geology.

Courtesy of Six Map

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OBSERVATIONS

No evidence of global or overall landslip risk was observed during the site inspection.
Refer to appendix 'A' for photographs and comments from the site inspection
appendix 'B' for proposed site plan.

REPORT – GENERAL

RISK MANAGEMENT AND MITIGATION

The main hazards identified for this site are:

Hazard A: Slope instability/potential land slip by excavating for retaining wall structures using mechanical equipment for rock removal.

Hazard B: Slope instability/potential land slip due to the uncovering of large sandstone boulders that unless broken up on-site before removal could potentially roll down-slope causing damage to the properties below the northern boundary.

Refer to Table 1 for risk analyses for the listed hazards above.

Some issues which assist to mitigate risk are as follows and should be adhered to:

1. *CLEARING - GOOD hillside practice*
   - 1.1. Provide siltation fencing and proper barriers around the property at the rear boundary
   - 1.2. Provide a catch spoon drain across the site at the top of the slope to collect surface run-off and avoid localised slippage from scouring effects
   - 1.3. Cover any exposed rock faces to prevent loss of moisture and at risk to spall overnight
2. *EXCAVATION*
   - 2.1. The proposed Development does require detailed excavation as mechanical equipment will be employed. There is always the likelihood that temporary shoring or underpinning is necessary to prevent ground loss when excavating near or adjacent to cliff faces to ensure safety to the workers at all times.
   - 2.2. The excavation for the proposed structure(s) may create a build-up of disposable material which, if not being utilised as on-site suitable fill, shall be placed in special stock piles and be protected and maintained with suitable batters and cover so as not to be transported off-site by natural localised slippage or cause instability of existing batters through heavy rains before being used at a future date.
3. *FOUNDATION MATERIALS AND FOOTINGS*
   - 3.1. It is recommended that all footings for the retaining structures be supported on the underlying rock using reinforced concrete piers, were necessary. Allow for end bearing piers to penetrate the medium strength sandstone surface by at least 150mm. The allowable bearing capacity for the piers shall be not less than 500kPa. The retaining wall structures may be "shotcreted" as a method of construction and any exposed

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surface may require camouflaging using stable and similar coloured oxides within the concrete matrix, if considered necessary.

4. *SUBSURFACE DRAINAGE*

4.1. Any retaining walls are to have adequate subsurface drains such as "strip drains" or sock covered agricultural pipes placed at the rear of the walls to prevent undue hydrostatic pressure.

5. *INSPECTIONS*

5.1. It is recommended that the rock jointing be discovered and inspected by the engineer. The foundation material and pier placement is to be inspected and approved prior to casting any concrete.

5.2. It is an obligation for the certifier/builder/contractor to organise the inspections noted above within 24 hours notice notwithstanding that the principal certifying authority and the structural engineer needs to be notified in advance.

6. *ON-GOING MAINTENANCE*

6.1. The property is to be maintained in good order and in accordance with the guidelines set out in CSIRO - BTF 18 "Foundation Maintenance and Footing Performance: A Homeowner's Guide" and the Australian Geomechanics Article "Landslide Risk Management Concepts and Guidelines" May 2002.

6.2. All retaining walls are to be inspected at intervals not exceeding 20 years.

7. *OTHER CONCERNS*

7.1. Should the surface of the rock be soft when uncovered then the piers must be sunk into the rock to a further depth of 150mm that will be medium strength rock (not less than 500kPa rock).

7.2. Rock bolting may be required.

CONCLUSIONS/RECOMMENDATIONS

The underlying sandstone will offer suitable founding material. A new piered/suspended structure is to be adopted for any new & existing decking structure including RC blockwork, timber log retaining walls and suspended decks in order that only minor surcharge loads could be transferred or applied to surrounding weaker capacity soils or neighboring structures.

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The site is suitable for the development proposed and the development proposal can achieve the Acceptable Risk Management required by the Northern Beaches council geotechnical policy provided that the structure is built in accordance with an appropriate structural design yet to be provided by CSEDS and all recommendations for risk mitigation in the sections above are adhered to.

Table 1: Summary of risk analysis calculations

	HAZARD A	COMMENTS
Description	Slope instability/potential land slip of new works	
Likelihood of hazard occurring (P_H)	RARE <= 10^{-5}	The structure is to be piered to suitable bedrock – no additional surcharge is applied to the surrounding soil
Consequence to property	MEDIUM	~20% Indicative Approximate Cost of Damage
Risk to property	LOW RISK	Refer to AGS 2007 (App 'C') - Qualitative Risk Analysis Matrix
Probability of building impact ($P_{S:H}$)	0.8	Existing residence lies below new structure
Probability of building occupation ($P_{T:S}$)	0.8	Non-habitable carport/driveway, however building in slip path is a habitable residence.
Vulnerability of individual (likelihood of loss of life given hazard occurring) ($V_{D:T}$)	0.8	
Risk to life ($R_{LoL} = P_H * P_{S:H} * P_{T:S} * V_{D:T}$)	1.92×10^{-6}	10^{-5} / annum maximum tolerable loss of life risk for the person at most risk
Conclusion	**'Acceptable'** risk for both property and life given structure is built in accordance with an appropriate piered structural design provided by CSEDS and all recommendations for risk mitigation in the sections above are adhered to.	
	HAZARD B	COMMENTS
Description	Slope instability/potential land slip of rolling down-slope of boulders	
Likelihood of hazard occurring (P_H)	RARE <= 10^{-5}	New structure is to be piered to suitable bedrock. Existing structure to be underpinned and stabilised where deemed appropriate
Consequence to property	MEDIUM	~20% Indicative Approximate Cost of Damage
Risk to property	LOW RISK	Refer to AGS 2007 (App 'C') - Qualitative Risk Analysis Matrix
Probability of building impact ($P_{S:H}$)	0.1	No buildings in path of slip (selected as conservative value)

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Probability of building occupation ($P_{T:S}$)	0.5	No buildings in path of slip (selected as conservative value)
Vulnerability of individual (likelihood of loss of life given hazard occurring) ($V_{D:T}$)	0.5	
Risk to life ($R_{LoL} = P_H * P_{S:H} * P_{T:S} * V_{D:T}$)	2.5×10^{-7}	10^{-5} / annum maximum tolerable loss of life risk for the person at most risk
Conclusion	**'Acceptable'** risk for both property and life given structure is built in accordance with an appropriate piered structural design provided by CSEDS and all recommendations for risk mitigation in the sections above are adhered to.	

Yours faithfully,

E.A. Bennett M.I.E. Aust. Cp Eng. NPER 198230, Member AGS, BPB 0820

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APPENDIX A

Photos from site inspection

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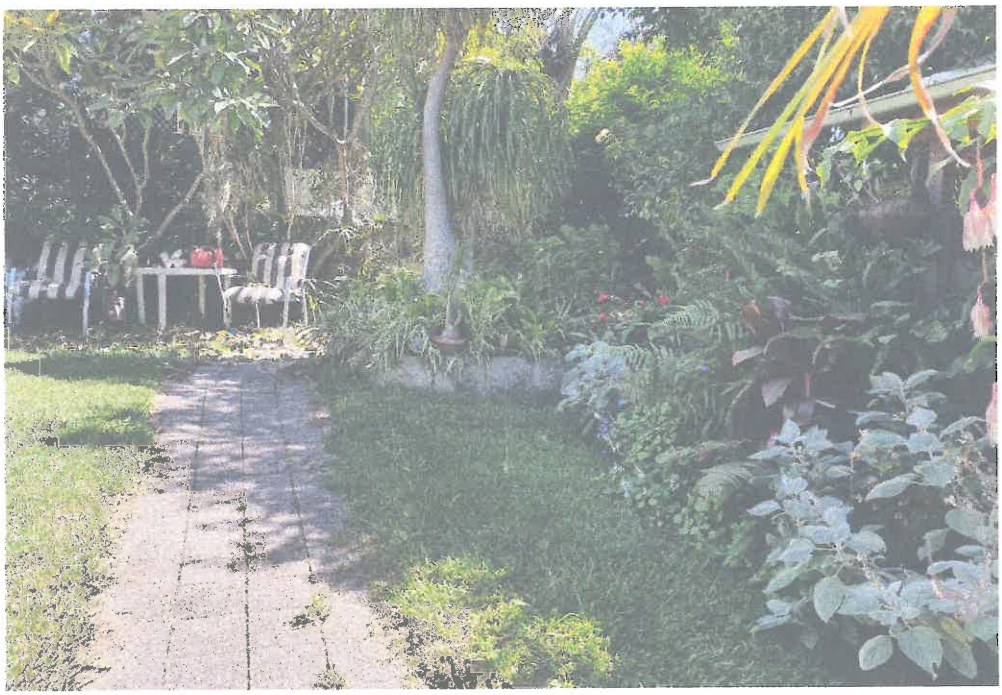

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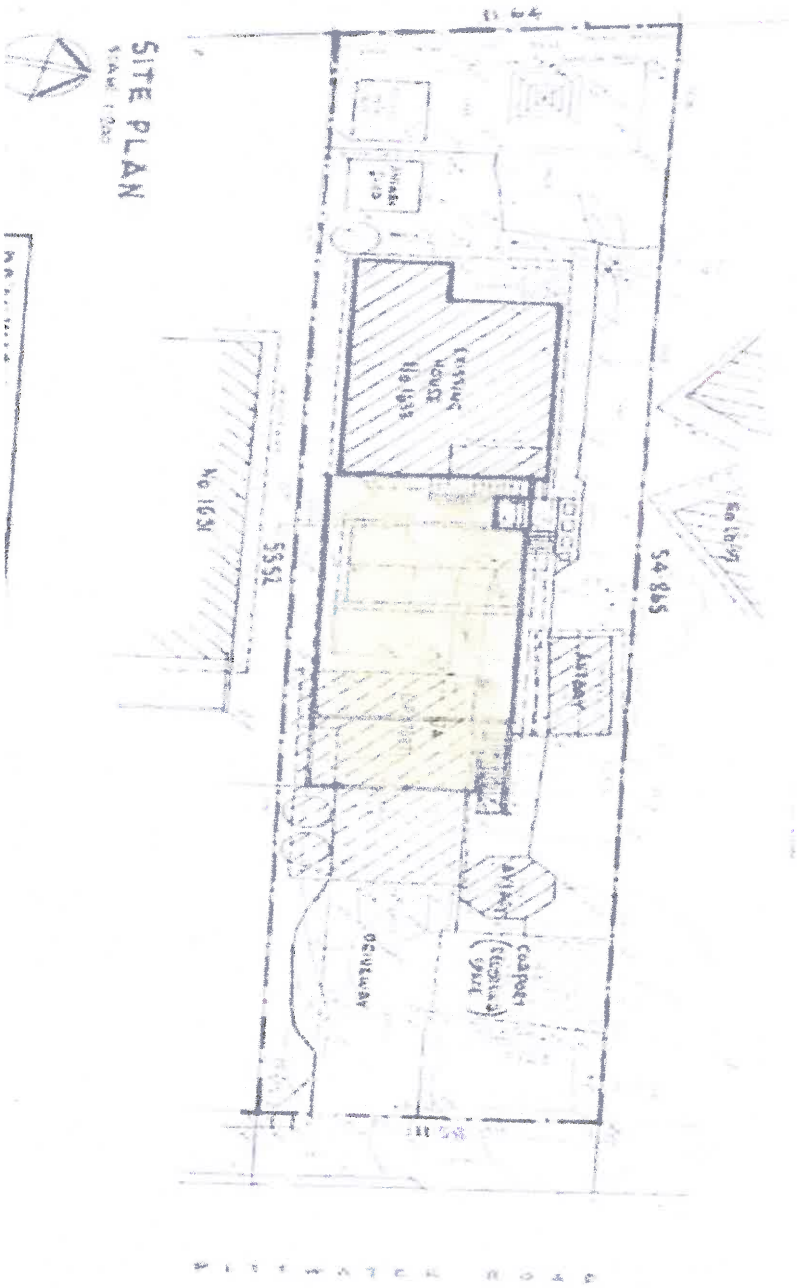
APPENDIX "B"



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APPENDIX "C" - NOTES

LANDSLIDE RISK MANAGEMENT **AGS SUB-COMMITTEE**

APPENDIX A

DEFINITION OF TERMS

INTERNATIONAL UNION OF GEOLOGICAL SCIENCES WORKING GROUP ON LANDSLIDES, COMMITTEE ON RISK ASSESSMENT

Risk – A measure of the probability and severity of an adverse effect to health, property or the environment. Risk is often estimated by the product of probability x consequences. However, a more general interpretation of risk involves a comparison of the probability and consequences in a non-product form.

Hazard – A condition with the potential for causing an undesirable consequence (*the landslide*). The description of landslide hazard should include the location, volume (or area), classification and velocity of the potential landslides and any resultant detached material, and the likelihood of their occurrence within a given period of time.

Elements at Risk – Meaning the population, buildings and engineering works, economic activities, public services utilities, infrastructure and environmental features in the area potentially affected by landslides.

Probability – The likelihood of a specific outcome, measured by the ratio of specific outcomes to the total number of possible outcomes. Probability is expressed as a number between 0 and 1, with 0 indicating an impossible outcome, and 1 indicating that an outcome is certain.

Frequency – A measure of likelihood expressed as the number of occurrences of an event in a given time. See also Likelihood and Probability.

Likelihood – used as a qualitative description of probability or frequency.

Temporal Probability – The probability that the element at risk is in the area affected by the landsliding, at the time of the landslide.

Vulnerability – The degree of loss to a given element or set of elements within the area affected by the landslide hazard. It is expressed on a scale of 0 (no loss) to 1 (total loss). For property, the loss will be the value of the damage relative to the value of the property; for persons, it will be the probability that a particular life (the element at risk) will be lost, given the person(s) is affected by the landslide.

Consequence – The outcomes or potential outcomes arising from the occurrence of a landslide expressed qualitatively or quantitatively, in terms of loss, disadvantage or gain, damage, injury or loss of life.

Risk Analysis – The use of available information to estimate the risk to individuals or populations, property, or the environment, from hazards. Risk analyses generally contain the following steps: scope definition, hazard identification, and risk estimation.

Risk Estimation – The process used to produce a measure of the level of health, property, or environmental risks being analysed. Risk estimation contains the following steps: frequency analysis, consequence analysis, and their integration.

Risk Evaluation – The stage at which values and judgements enter the decision process, explicitly or implicitly, by including consideration of the importance of the estimated risks and the associated social, environmental, and economic consequences, in order to identify a range of alternatives for managing the risks.

Risk Assessment – The process of risk analysis and risk evaluation.

Risk Control or Risk Treatment – The process of decision making for managing risk, and the implementation, or enforcement of risk mitigation measures and the re-evaluation of its effectiveness from time to time, using the results of risk assessment as one input.

Risk Management – The complete process of risk assessment and risk control (*or risk treatment*).

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LANDSLIDE RISK MANAGEMENT **AGS SUB-COMMITTEE**

Individual Risk – The risk of fatality or injury to any identifiable (named) individual who lives within the zone impacted by the landslide, or who follows a particular pattern of life that might subject him or her to the consequences of the landslide.

Societal Risk – The risk of multiple fatalities or injuries in society as a whole: one where society would have to carry the burden of a landslide causing a number of deaths, injuries, financial, environmental, and other losses.

Acceptable Risk – A risk for which, for the purposes of life or work, we are prepared to accept as it is with no regard to its management. Society does not generally consider expenditure in further reducing such risks justifiable.

Tolerable Risk – A risk that society is willing to live with so as to secure certain net benefits in the confidence that it is being properly controlled, kept under review and further reduced as and when possible.

In some situations risk may be tolerated because the individuals at risk cannot afford to reduce risk even though they recognise it is not properly controlled.

Landslide Intensity – A set of spatially distributed parameters related to the destructive power of a landslide. The parameters may be described quantitatively or qualitatively and may include maximum movement velocity, total displacement, differential displacement, depth of the moving mass, peak discharge per unit width, kinetic energy per unit area.

Note: Reference should also be made to Figure 1 which shows the inter-relationship of many of these terms and the relevant portion of Landslide Risk Management.

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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

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PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

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.

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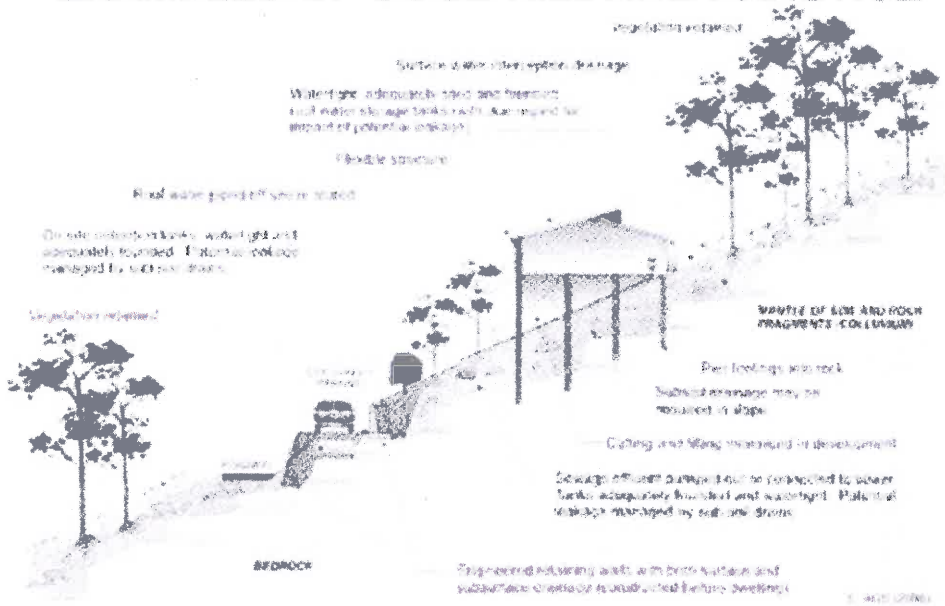
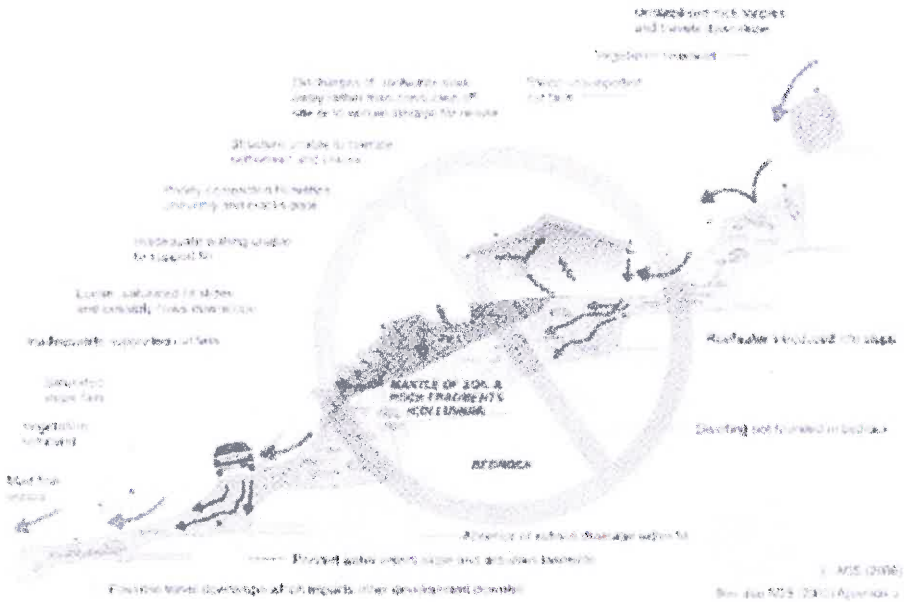
EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF POOR HILLSIDE PRACTICE



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